TP 14869E

Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2007-08 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.

December 2008
Final Version 1.0

TP 14869E

Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2007-08 Winter

by

Stephanie Bendickson

APS Aviation Inc.

December 2008
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
Program Manager

Approved by: **

Jack Rigley — Date
Vice President, Communications Engineering
ADGA Group

Un sommaire français se trouve avant la table des matières.

This report was first provided to Transport Canada as Final Draft 1.0 in December 2008.
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 December 2008. A Transport Canada technical and editorial review was subsequently completed and the report was finalized in October 2019; Jack Rigley 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, 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;
- To examine the effect of heated fluids on Type II, III and IV fluid endurance times;
- To evaluate weather data from previous winters that can have an impact on the holdover time table format;
- To assist in the testing of flow of contaminated fluid from aircraft wings during takeoff;
- To validate the laboratory snow test protocol with Type II, III and IV fluids;
- To develop performance specifications for an integrated weather system that measures holdover time;
- To conduct general and exploratory de/anti-icing research;
- To conduct endurance time tests on non-aluminum plates;
- To conduct endurance time tests in frost on various test surfaces;
- To compile historical data for calculation of holdover times based on a small number of inputs; and
- To assist DND Canada in evaluating the standards used at various DND sites.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2007-08 are documented in six reports. The titles of the reports are as follows:

- TP 14869E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2007-08 Winter;
- TP 14870E Winter Weather Impact on Holdover Time Table Format (1995-2008);
- TP 14871E Aircraft Trials to Examine Anti-Icing Fluid Flow-Off Characteristics: Ice Pellet Allowance Time Expansion Research;
- TP 14872E Aircraft Ground Icing General Research Activities During the 2007-08 Winter;
- TP 14873E Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables; and
- TP 14874E Effect of Heat on Endurance Times of Anti-Icing Fluids.

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

- *Endurance Time Testing in Snow: Comparison of Indoor and Outdoor Data for 2007-08 and Other Artificial Snow Projects;*
- *Fluid Endurance Times Using Composite Surfaces; and*

- *Substantiation of Aircraft Ground Deicing Holdover Times in Frost Conditions.*

In addition, the following report was written for DND as part of this contract; this report does not have a TP number:

- Development of the Canadian Forces Approved Ground Icing Program (AGIP), Evaluation Methods for Current Performance and Recommendations for Improvement Project: Report on Site Visit to 14 Wing Greenwood.

This report, TP 14869E, has the following objective:

- To develop holdover time data for all newly qualified de/anti-icing fluids.

This objective was met by conducting endurance time tests with different fluids in simulated freezing precipitation at the National Research Council Canada Climatic Engineering Facility in Ottawa, and by carrying out tests in natural snow conditions at a test facility operated by APS Aviation Inc. at Montreal-Trudeau Airport in Montreal.

PROGRAM ACKNOWLEDGEMENTS

This multi-year research program has been funded by the Civil Aviation Group, 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: George Balaban, Katrina Bell, Stephanie Bendickson, Michael Chaput, John D'Avirro, Peter Dawson, Benjamin Guthrie, Michael Hawdur, Eric Perocchio, Dany Posteraro, Marco Ruggi, Filippo Suriano, Joey Tiano, David Youssef and Victoria Zoitakis.

Special thanks are extended to Barry Myers, Frank Eyre and Yagusha Bodnar, who on behalf of the Transportation Development Centre, 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.

Transport Canada / Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No. TP 14869E	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 2007-08 Winter		5. Publication Date December 2008 6. Performing Organization Document No. CM2103.001
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 800 René-Lévesque Blvd. West, Suite 600 Montreal, Quebec, H3B 1X9		13. Type of Publication and Period Covered Final 14. Project Officer Antoine Lacroix for Barry Myers

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 2007-08 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 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. APS conducted a total of 520 endurance time tests with four fluids, including two Type II fluids, one Type III fluid and one Type IV fluid.

Changes to the holdover time guidelines for the winter of 2008-09 include: the introduction of a fluid-specific tables for Kilfrost ABC-K Plus (Type II) and Dow Chemical UCAR™ FlightGuard AD-480 (Type IV); increases to the upper values in the Type IV generic guidelines for rain on cold soaked wing; and the addition of a note to the Type II and Type IV fluid-specific and generic HOT tables which advises users that radiational cooling during active frost conditions may reduce holdover time when operating close to the lower end of the temperature range. No changes were made to the Type I, II or III generic holdover time guideline values.

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.

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) Unclassified	20. Security Classification (of this page) Unclassified	21. Declassification (date) —	22. No. of Pages xviii, 78 apps	23. Price —

CDT/TDC 79-005
Rev. 96

Canada

Transports Canada Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. Nº de la publication de Transports Canada TP 14869E	2. Nº de l'étude B14W	3. Nº de catalogue du destinataire
4. Titre et sous-titre Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2007-08 Winter		5. Date de la publication Décembre 2008 6. Nº de document de l'organisme exécutant CM2103.001
7. Auteur(s) Stephanie Bendickson		8. Nº 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. Nº de dossier - TPSGC TOR-4-37170 11. Nº 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 800, Boul. René-Lévesque Ouest, Bureau 600 Montréal (Québec) H3B 1X9		13. Genre de publication et période visée Final 14. Agent de projet Antoine Lacroix pour Barry Myers

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 2007-2008 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 520 essais d'endurance ont ainsi été réalisés par APS avec quatre liquides, soit deux liquides de type II, un liquide de type III et un liquide de type IV.

Parmi les changements apportés aux lignes directrices relatives aux durées d'efficacité pour l'hiver 2008-2009, notons la création de tableaux spécifiques aux liquides Kilfrost ABC-K Plus (type II) et Dow Chemical UCARMC FlightGuard AD-480 (type IV), l'augmentation des valeurs supérieures des lignes directrices génériques relatives à l'utilisation de liquides de type IV dans des conditions de pluie sur une aile imprégnée de froid et l'ajout, dans les tableaux génériques et spécifiques des durées d'efficacité des liquides de type II et de type IV, d'une note avisant les utilisateurs que le refroidissement par rayonnement dans des conditions de givre actif peut réduire la durée d'efficacité des liquides utilisés dans des températures se rapprochant de la température extérieure la plus basse. Aucun changement n'a été apporté aux valeurs des lignes directrices génériques relatives aux durées d'efficacité des liquides de type I, de type II ou de type III.

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.

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)	20. Classification de sécurité (de cette page)	21. Déclassification (date)	22. Nombre de pages	23. Prix
Non classifiée	Non classifiée	—	xviii, 78 ann.	—

CDT/TDC 79-005
Rev. 96

Canada

EXECUTIVE SUMMARY

Under contract to the Transportation Development Centre (TDC) 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) tables for new de/anti-icing fluids, is addressed in this report. The objective was met by conducting HOT tests with four new fluids.

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 Subcommittee for Type II/III/IV and Type I fluids, respectively. The tests consisted of pouring freezing point depressant fluids onto clean, inclined (10°), standard flat aluminum plates. The plates were mounted on test stands and systematically exposed to a variety of natural or simulated icing conditions. For each plate, the elapsed time required to reach a predefined end condition was recorded.

The variables 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 2007-08 test season, data was collected from tests conducted during natural snow events at the APS test site at Montreal-Trudeau Airport in Montreal, and from tests conducted 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 520 tests in the winter of 2007-08. Four fluids were tested, including two Type II fluids, one Type III fluid and one Type IV fluid. The distribution of tests is listed in Table ES-1 by precipitation condition and fluid type.

TABLE ES-1: Summary of Tests Conducted in 2007-08

Fluid Type	Precipitation Condition					
	Freezing Fog	Natural Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold-Soaked Wing	Total
Type I	0	0	0	0	0	**0**
Type II Neat	24	52	16	16	8	**116**
Type II 75/25	16	33	16	16	8	**89**
Type II 50/50	8	37	8	8	0	**61**
Type III Neat	12	54	8	10	5	**89**
Type III 75/25	8	50	8	9	4	**79**
Type III 50/50	4	24	4	6	0	**38**
Type IV Neat	0	19	0	0	0	**19**
Type IV 75/25	0	21	0	0	0	**21**
Type IV 50/50	0	8	0	0	0	**8**
Total	**72**	**298**	**60**	**65**	**25**	**520**

Changes to the Holdover Time Guidelines

The changes below were made to the HOT guidelines for the winter of 2008-09.

1. A fluid-specific table was produced for one new Type II fluid, Kilfrost ABC-K Plus.
2. At the request of the fluid manufacturer, a fluid-specific table was produced for Dow Chemical UCAR™ FlightGuard AD-480. The table is identical to the ABAX AD-480 table.
3. The removal of obsolete data resulted in increases to cold-soaked wing holdover times in the generic Type IV HOT guidelines.
4. A note has been added to all Type II and Type IV tables to advise users that radiational cooling during active frost conditions may reduce holdover time when operating close to the lower end of the temperature range.
5. The FAA removed the Aviation Xi'an KHF-II Type II fluid-specific table due to results of additional testing; at the time of writing, the table remained in the Transport Canada guidelines.

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 in the HOT tables.

SOMMAIRE

En vertu d'un contrat avec le Centre de développement des transports (CDT) 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 quatre liquides.

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 sous-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. Les essais consistaient à verser des liquides abaisseurs du point de congélation sur des plaques d'aluminium standards, 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 2007-2008 concernaient des tests sous neige naturelle menés à l'installation d'essai d'APS, à l'aéroport Montréal-Trudeau, à Montréal, de même que des essais effectués dans des conditions de précipitations simulées 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 2007-2008, un total de 520 essais ont été menés par APS. Quatre liquides ont fait l'objet de tests, soit deux liquides de type II, un liquide de type III et un liquide de type IV. Le tableau ES-1 présente la répartition des essais réalisés, selon la précipitation et le type de liquide.

TABLEAU ES-1 : Sommaire des essais effectués en 2007-08

Type de liquide	Condition de précipitation					
	Brouillard verglaçant	Neige naturelle	Bruine verglaçante	Pluie verglaçante faible	Pluie sur aile imprégnée de froid	Total
Type I	0	0	0	0	0	**0**
Type II pur	24	52	16	16	8	**116**
Type II 75/25	16	33	16	16	8	**89**
Type II 50/50	8	37	8	8	0	**61**
Type III pur	12	54	8	10	5	**89**
Type III 75/25	8	50	8	9	4	**79**
Type III 50/50	4	24	4	6	0	**38**
Type IV pur	0	19	0	0	0	**19**
Type IV 75/25	0	21	0	0	0	**21**
Type IV 50/50	0	8	0	0	0	**8**
Total	**72**	**298**	**60**	**65**	**25**	**520**

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 2008-2009.

1. Un tableau spécifique a été créé pour un nouveau liquide de type II, Kilfrost ABC-K Plus.
2. À la demande du fabricant, un tableau spécifique a été créé pour le liquide Dow Chemical UCAR^{MC} FlightGuard AD-480. Ce tableau est identique à celui pour ABAX AD-480.
3. Le retrait de données obsolètes a entraîné l'augmentation des durées d'efficacité dans des conditions de pluie sur une aile imprégnée de froid indiquées dans les lignes directrices génériques relatives aux durées d'efficacité des liquides de type IV.
4. Une note avisant les utilisateurs que le refroidissement par rayonnement dans des conditions de givre actif peut réduire la durée d'efficacité des liquides utilisés dans des températures se rapprochant de la température extérieure la plus basse a été ajoutée à tous les tableaux des liquides de type II et de type IV.

5. La FAA a retiré le tableau spécifique au liquide de type II Aviation Xi'an KHF-II en raison des résultats obtenus dans le cadre d'essais supplémentaires ; au moment de la rédaction de ce rapport, ce tableau figurait toujours dans les lignes directrices de Transports Canada.

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.

This page intentionally left blank.

CONTENTS Page

LIST OF APPENDICES

This page intentionally left blank.

LIST OF TABLES Page

GLOSSARY

AMS	Aerospace Material Specification
APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
EG	Ethylene Glycol
FAA	Federal Aviation Administration
HOT	Holdover Time
MSC	Meteorological Service of Canada
NRC	National Research Council Canada
PG	Propylene Glycol
SAE	SAE International
TDC	Transportation Development Centre

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

Over the past 18 winters, APS has completed considerable testing related to de/anti-icing fluids on behalf of Transport Canada. 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 research activities related to fluid HOT testing completed by APS is provided in Table 1.1.

1.2 Objectives

The detailed objectives of the HOT test program for the 2007-08 winter season are provided in the work statement given in Appendix A. The primary objective of the test program was to conduct flat plate tests under conditions of natural and simulated precipitation to determine de/anti-icing fluid endurance times for new fluids, and to develop HOT guidelines based on samples of newly and previously qualified deicing and anti-icing fluids.

Table 1.1: Summary of APS Holdover Time Testing Activities

Year	Transport Canada Publication #	Conditions Tested	Fluids Tested	Location of Testing
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	Mostly Montreal St. John's
1992-93	TP 11836E	• Natural Precipitation (snow) • Simulated Freezing Drizzle (prelim) • Simulated Freezing Fog (outdoor)	• Type I (Standard)	Montreal Ottawa (NRC)
1993-94	Summary Report Available	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (outdoor)	• Type II (75/25, 50/50)	Montreal Ottawa (NRC)
1994-95	TP 12654E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface (prelim)	• Type I • Type IV (Preliminary)	Montreal Ottawa (NRC)
1995-96	TP 12896E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type IV	Montreal Ottawa (NRC)
1996-97	TP 13131E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• New Type IVs • Type III	Montreal Ottawa (NRC)
1997-98	TP 13318E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• New Type IVs	Montreal Ottawa (NRC)
1998-99	TP 13477E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow	• Type IV (Low Viscosity) • Type II • Type I	Montreal Ottawa (NRC)
1999-2000	TP 13659E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow • Preliminary Frost	• Type IV • Type II • Type I	Montreal Ottawa (NRC) Varennes (IREQ)
2000-01	TP 13826E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow • Preliminary Frost	• Type IV • Type II • Type I	Montreal Ottawa (NRC) Varennes (IREQ)

M:\Groups\CM2103 (07-08)\Reports\HOT\Working Documents\Table 1.1

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

Year	Transport Canada Publication #	Conditions Tested	Fluids Tested	Location of Testing
2001-02	TP 13991E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow	• Type IV • Type II • Type I	Montreal Ottawa (NRC) Val D'Or North Bay
2002-03	TP 14144E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow	• Type IV • Type II • Type I	Montreal Ottawa (NRC)
2003-04	TP 14374E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow	• Type III • Type II	Montreal Ottawa (NRC) Val d'Or Ste-Adele
2004-05	TP 14443E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type IV • Type III • Type II	Montreal Ottawa (NRC)
2005-06	TP 14712E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type IV • Type II • Type I	Montreal Ottawa (NRC)
2006-07	TP 14776E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type IV • Type II • Type I	Montreal Ottawa (NRC)
2007-08	TP 14869E	• Natural Precipitation • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type IV • Type III • Type II	Montreal Ottawa (NRC)

M:\Groups\CM2103 (07-08)\Reports\HOT\Working Documents\Table 1.1

1.3 Content of this Report

APS has written a report on the HOT test program for each year it has been carried out. In 2003-04, the report was condensed to increase readability and to present the reader with, for the most part, only new and current information 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 HOT report, TP 14144E (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.

The 2007-08 report is presented the same way.

1.4 Report Format

The following list provides short descriptions of subsequent sections of this report:

a) Section 2 summarizes 2007-08 testing;

b) Section 3 documents changes to the Type I HOT table;

c) Section 4 documents changes to the Type II HOT tables;

d) Section 5 documents changes to the Type III HOT table;

e) Section 6 documents changes to the Type IV HOT tables;

f) Section 7 presents conclusions derived from the test program; and

g) Section 8 lists recommendations for future testing.

1.5 Publication of Holdover Time Guidelines

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

- http://www.tc.gc.ca/CivilAviation/commerce/HoldoverTime/menu.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 2007-08

2.1 Procedures

Test procedures for HOT testing of Type II, III and IV fluids were developed in accordance with SAE International (SAE) Aerospace Recommended Practice (ARP) 5485, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type II, III, and IV* (3). Test procedures for HOT 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 APS' endurance time testing procedures, all of the procedures are included in the report, even if they are not 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 2007-08 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; and
4. Overall Program of Tests at NRC, March-April 2008.

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 procedure was developed to coordinate HOT testing and other aircraft ground icing research projects at the annual APS indoor simulated precipitation test session. HOT testing and other program element testing were conducted at the same session in order to maximize use of the facility and resources. The procedure provides detailed test plans, personnel assignments, fluid requirements and the precipitation schedule for this session.

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

During the 2007-08 test season, data was collected for tests conducted during natural snow events at the APS test site at Montreal-Trudeau Airport in Montreal. Data was also collected in simulated precipitation conditions including 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

Four fluids were tested during the winter of 2007-08: Kilfrost ABC-K Plus (Type II), Kilfrost P2143-2 (Type II), Clariant Safewing MP III (Type III), and ABAX F292 (Type IV). All four fluids were formulated with propylene glycol (PG); no ethylene glycol (EG) formulated fluids were tested. Additional relevant data for these fluids is given in Table 2.1. Fluid viscosity information is given in Table 2.2.

Table 2.1: List of Fluids Received

Fluid Manufacturer	Fluid Name	Fluid Type	Fluid Dilution	Date Received	Batch #	APS Measured Brix
Clariant	Safewing MP III	III	100%	8-Jan-08	TV 455	34.75
Clariant	Safewing MP III	III	75%	8-Jan-08	TV 455	27.00
Clariant	Safewing MP III	III	50%	8-Jan-08	TV 455	18.25
ABAX	F292	IV	100%	6-Feb-08	L7-311	not measured
ABAX	F292	IV	75%	6-Feb-08	L7-311	not measured
ABAX	F292	IV	50%	6-Feb-08	L7-311	not measured
Kilfrost	ABC-K Plus	II	75%	14-Feb-08	P2143-021408	26.50
Kilfrost	ABC-K Plus	II	50%	14-Feb-08	P2143-021408	20.25
Kilfrost	ABC-K Plus	II	100%	14-Feb-08	P2143-021408	35.75
Kilfrost	P2143-2	II	100%	14-Feb-08	P2143-021408	35.75
Kilfrost	P2143-2	II	75%	13-Mar-08	P2143-0313408	26.50
Kilfrost	P2143-2	II	50%	13-Mar-08	P2143-0313408	20.25

M:\Groups\PM2103 (TC-Deicing 07-08)\Reports\HOT\Working Docs\Fluids Received (07-08) At:

Table 2.2: Fluid Viscosity

Fluid	Fluid Dilution	Viscosity[1]		Manufacturer Viscosity Method					Viscosity[2]		AIR 9968 Viscosity Method				
		Stated (mPa.s)	Measured (mPa.s)	Spindle (Brookfield)	Volume (mL)	Temp (°C)	Speed (rpm)	Time (mins)	Stated (mPa.s)	Measured (mPa.s)	Spindle (Brookfield)	Volume (mL)	Temp (°C)	Speed (rpm)	Time (mins)
Clariant Safewing MP III	100%	135	139	LV0	16	20	0.3	11	not required		n/a	n/a	n/a	n/a	n/a
Clariant Safewing MP III	75%	304	387	LV0	16	20	0.3	11	not required		n/a	n/a	n/a	n/a	n/a
Clariant Safewing MP III	50%	142	197	LV0	16	20	0.3	11	not required		n/a	n/a	n/a	n/a	n/a
ABAX F292	100%	14,800	not measured	31	10	20	0.3	10	not provided	not measured	n/a	n/a	n/a	n/a	n/a
ABAX F292	75%	8,700	not measured	31	10	20	0.3	10	not provided	not measured	n/a	n/a	n/a	n/a	n/a
ABAX F292	50%	900	not measured	31	10	20	0.3	10	not provided	not measured	n/a	n/a	n/a	n/a	n/a
Kilfrost ABC-K Plus	75%	13,500	12,650	LV2-disc	150	20	0.3	10	13,500	12,650	LV1	500	20	0.3	10
Kilfrost ABC-K Plus	50%	4,000	4,200	LV2-disc	150	20	0.3	10	4,800	5,260	LV2-disc	150	20	0.3	10
Kilfrost ABC-K Plus	100%	3,500	2,850	LV2-disc	150	20	0.3	10	3,100	2,640	LV1	500	20	0.3	10
Kilfrost P2143-2	100%	5,000	5,500	LV2-disc	150	20	0.3	10	5,500	4,940	LV1	500	20	0.3	10
Kilfrost P2143-2	75%	8,300	8,300	LV2-disc	150	20	0.3	10	9,000	10,010	LV1	500	20	0.3	10
Kilfrost P2143-2	50%	3,500	8,150	LV2-disc	150	20	0.3	10	4,000	7,500	LV1	500	20	0.3	10

[1] Manufacturer Method
[2] AIR 9968 Method

M:\Groups\PM2103 (TC-Deicing 07-08)\Reports\HOT\Working Docs\Fluids Received (07-08) At: Viscosity

Testing with ABAX F292 was stopped at the request of the fluid manufacturer prior to the simulated freezing precipitation test session. Testing was completed with Kilfrost P2143-2, Clariant Safewing MP III and ABAX F292; however, none of these fluids will be commercialized.

Detailed reports on the performance of each fluid were provided to the fluid manufacturers. As per the protocol described in Subsection 1.3, a copy of the Kilfrost ABC-K Plus report has been included as an appendix to this report (see Appendix C).

2.4 Description of Tests

In total, 520 endurance time tests were conducted during the winter of 2007-08. A log of endurance time tests for each fluid tested was included in the detailed fluid performance reports provided to the fluid manufacturers.

A summary of the total number of tests conducted by precipitation condition, fluid type and fluid dilution in the winter of 2007-08 is shown in Table 2.3.

Table 2.3: Summary of Tests Conducted

Fluid Type	Precipitation Condition					
	Freezing Fog	Natural Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold-Soaked Wing	Total
Type I	0	0	0	0	0	**0**
Type II Neat	24	52	16	16	8	**116**
Type II 75/25	16	33	16	16	8	**89**
Type II 50/50	8	37	8	8	0	**61**
Type III Neat	12	54	8	10	5	**89**
Type III 75/25	8	50	8	9	4	**79**
Type III 50/50	4	24	4	6	0	**38**
Type IV Neat	0	19	0	0	0	**19**
Type IV 75/25	0	21	0	0	0	**21**
Type IV 50/50	0	8	0	0	0	**8**
Total	**72**	**298**	**60**	**65**	**25**	**520**

2.5 Artificial Snow Tests

A number of tests were also conducted in artificial snow. These tests were documented in a separate interim report which was provided to Transport Canada and the FAA. They will be documented in a published report in future.

2.6 Supplemental Tests with Octagon EcoFlo

Octagon EcoFlo, a non-glycol based fluid, was submitted for testing in June 2007. It was tested in simulated conditions, including artificial snow, in July 2007 and subsequently added to the list of qualified Type I fluids. Natural snow tests were conducted with this fluid during the winter 2007-08 to confirm the endurance times previously measured in artificial snow. The natural snow tests confirmed the fluid performance is equivalent or superior to Type I fluids tested in past years. The results were provided to the fluid manufacturer in a revised version of the individual fluid report.

2.7 Supplemental Tests with Aviation Xi'an KHF-II

Supplemental tests were conducted with Aviation Xi'an KHF-II in July 2008. The tests were conducted as a result of concerns with the viscosity of the production fluid that were brought forward at the SAE G-12 HOT Subcommittee meeting in May 2008 in Warsaw. The purpose of the tests was to verify holdover times with a new sample.

A supplemental test procedure, *Overall Program of Tests at NRC, July 2008*, was developed for the conduct of these tests. Additional unrelated research projects were conducted concurrently at the July NRC test session. The test procedure is included in Appendix D.

In addition to the NRC holdover time verification tests, Xi'an also indicated they would be carrying out additional tests according to SAE Aerospace Material Specification (AMS) 1428. The results of the AMS 1428 tests, in particular the aerodynamic test, have not yet been provided to Transport Canada and the FAA. As a result, the FAA decided to remove Aviation Xi'an KHF-II from its list of qualified fluids, and to remove the Aviation Xi'an KHF-II fluid-specific table from its 2008-09 HOT guidelines. At the time of writing, Transport Canada had not yet decided if Aviation Xi'an KHF-II would be removed from the Canadian guidelines.

The removal of the Aviation Xi'an KHF-II table from the guidelines did not impact the Type IV generic HOT table.

This page intentionally left blank.

3. TYPE I ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

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.

Although APS no longer measures endurance times of all Type I fluids, the Type I Endurance Time Results and HOT Guidelines chapter remains in this report to document the current values in the Type I HOT guidelines. In addition, endurance times of some Type I fluids are still tested, either a) at the request of the fluid manufacturer or b) because the fluid is not propylene glycol, ethylene glycol or diethylene glycol based. In years where Type I fluids are tested, the results are published in this chapter.

No Type I fluids were submitted for testing in 2007-08 and no changes were made to the values in the Type I HOT guidelines for 2008-09. The Transport Canada and FAA 2008-09 generic Type I HOT guidelines are included in Appendix E.

This page intentionally left blank.

4. TYPE II ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

Two Type II fluids were tested in 2007-08: Kilfrost ABC-K Plus and Kilfrost P2143-2. Kilfrost P2143-2 was not commercialized and therefore detailed test results have not been included in this report. The Transport Canada and FAA 2008-09 Type II HOT guidelines are included in Appendix E.

4.1 New Fluids

One new Type II fluid, Kilfrost ABC-K Plus, was tested in the winter of 2007-08 and will be introduced for the winter 2008-09 operating season. A fluid-specific HOT table was created for Kilfrost ABC-K Plus based on the results of the HOT testing and will be included in the 2008-09 HOT guidelines.

The detailed test results and analysis for Kilfrost ABC-K Plus are included in the fluid-specific report that was provided to the fluid manufacturer. A copy of this report is included in Appendix C.

The introduction of Kilfrost ABC-K Plus did not impact the generic Type II HOT guidelines.

4.2 Removed Fluids

Aviation Xi'an KHF-II was removed from the FAA guidelines in the winter of 2008-09 as a result of concerns with the viscosity of the production fluid (see Subsection 2.6). At the time of writing, the fluid had not been removed from the Transport Canada guidelines.

4.3 Changes to Holdover Time Guidelines Format

Testing during natural frost events has indicated that fluid endurance times in frost may be shorter than the published holdover times in some conditions. Further work is required to substantiate the current endurance time test protocol for natural frost conditions, before any changes are made to frost holdover times. Additional work will be completed during the winter of 2008-09.

In the interim, Transport Canada and the FAA have addressed this issue by adding a note to all Type II and Type IV HOT tables, including generic and fluid-specific tables, to advise users that radiational cooling during active frost conditions may reduce holdover time when operating close to the lower end of the outside air temperature range.

4.4 Evolution of 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 then, the data from all new fluids tested has been used to modify the generic HOT guidelines as required. There are several notable exceptions.

1. 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 values.

2. Although Aviation Xi'an KHF-II was removed from the FAA HOT guidelines for 2008-09 winter operations, it remains in the calculation of generic Type II values as it remains in the Transport Canada guidelines (see Subsection 2.6).

3. 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.

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 4.1 to 4.24. Each table represents one cell in the HOT guidelines and the title of the table links the table to the appropriate cell. The first row in each table contains the generic values from testing in 1998-99. 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 2008-09 winter operations. Underlined values indicate the fluid or fluids responsible for the generic holdover time. If no value is underlined, it implies that the generic value is based on the results of "grandfathered" fluids.

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

- Kilfrost ABC-II PLUS (ABC-II+);
- Clariant Safewing MP II 1951 (C-1951);
- ABAX Ecowing 26 (A-E26);
- Kilfrost ABC-2000 (K2000);

- Kilfrost ABC-K Plus (ABC-K+);
- 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); and
- Aviation Xi'an Hi-tech KHF-II (X-KHF-II).

4.5 Fluids Responsible for the Type II Generic Holdover Time Values

The fluids responsible for the values in each cell of the generic Type II HOT guidelines in 2008-09 are shown in Table 4.25. "Grandfather" is indicated where "grandfathered" fluids are responsible for the 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 4.1: Type II Neat Fluid, Snow, -3°C and Above

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

Table 4.2: Type II 75/25 Fluid, Snow, -3°C and Above

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

Table 4.3: Type II 50/50 Fluid, Snow, -3°C and Above

		GENERIC	ABC-II+	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	X-KHF-II	ABC-K+
HISTORICAL	1998-99 HOT Table Values	0:05-0:15										
HISTORICAL	1998-99 Endurance Time Test Results		0:15-0:35									
HISTORICAL	1999-00 HOT Table Values	0:05-0:15	0:15-0:35									
HISTORICAL	1999-00 Endurance Time Test Results			0:05-0:15								
HISTORICAL	2000-01 HOT Table Values	0:05-0:15	0:15-0:35	0:05-0:15								
HISTORICAL	2000-01 Endurance Time Test Results				0:10-0:20							
HISTORICAL	2001-02 HOT Table Values	0:05-0:15	0:15-0:35	0:05-0:15	0:10-0:20							
HISTORICAL	2001-02 Endurance Time Test Results					0:15-0:30	0:10-0:25					
HISTORICAL	2002-03 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25					
HISTORICAL	2002-03 Endurance Time Test Results							0:05-0:15				
HISTORICAL	2003-04 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15				
HISTORICAL	2003-04 Endurance Time Test Results											
HISTORICAL	2004-05 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15				
HISTORICAL	2004-05 Endurance Time Test Results											
HISTORICAL	2005-06 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15				
HISTORICAL	2005-06 Endurance Time Test Results								0:10-0:25			
HISTORICAL	2006-07 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25			
HISTORICAL	2006-07 Endurance Time Test Results									0:15-0:25	0:15-0:25	
HISTORICAL	2007-08 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25	0:15-0:25	0:15-0:25	
CURRENT	2007-08 Endurance Time Test Results											0:05-0:15
CURRENT	2008-09 HOT Table Values	0:05-0:15	0:15-0:35		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25	0:15-0:25	0:15-0:25	0:05-0:15

Table 4.4: Type II Neat Fluid, Snow, Below -3°C to -14°C

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

Table 4.5: Type II 75/25 Fluid, Snow, Below -3°C to -14°C

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

Table 4.6: Type II Neat Fluid, Snow, Below -14°C to -25°C

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

*Generic HOT values were used for this cell

Table 4.7: Type II Neat Fluid, Freezing Drizzle, -3°C and Above

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

Table 4.8: Type II 75/25 Fluid, Freezing Drizzle, -3°C and Above

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

Table 4.9: Type II 50/50 Fluid, Freezing Drizzle, -3°C and Above

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

Table 4.10: Type II Neat Fluid, Freezing Drizzle, -3°C to -10°C

		GENERIC	ABC-II+	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	X-KHF-II	ABC-K+
HISTORICAL	1998-99 HOT Table Values	0:30-1:00										
HISTORICAL	1998-99 Endurance Time Test Results		0:15-0:45									
HISTORICAL	1999-00 HOT Table Values	0:15-0:45	0:15-0:45									
HISTORICAL	1999-00 Endurance Time Test Results			0:25-0:50								
HISTORICAL	2000-01 HOT Table Values	0:15-0:45	0:15-0:45	025-0:50								
HISTORICAL	2000-01 Endurance Time Test Results				0:30-1:10							
HISTORICAL	2001-02 HOT Table Values	0:15-0:45	0:15-0:45	025-0:50	0:30-1:10							
HISTORICAL	2001-02 Endurance Time Test Results					0:25-0:50	0:35-1:00					
HISTORICAL	2002-03 HOT Table Values	0:15-0:45	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00					
HISTORICAL	2002-03 Endurance Time Test Results							0:35-1:05				
HISTORICAL	2003-04 HOT Table Values	0:15-0:45	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05				
HISTORICAL	2003-04 Endurance Time Test Results											
HISTORICAL	2004-05 HOT Table Values	0:15-0:45	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05				
HISTORICAL	2004-05 Endurance Time Test Results											
HISTORICAL	2005-06 HOT Table Values	0:15-0:45	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05				
HISTORICAL	2005-06 Endurance Time Test Results								0:35-1:30			
HISTORICAL	2006-07 HOT Table Values	0:15-0:45	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 Endurance Time Test Results									0:20-0:45	0:20-1:35	
HISTORICAL	2007-08 HOT Table Values	0:15-0:45	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	0:20-1:35	
CURRENT	2007-08 Endurance Time Test Results											0:25-1:00
CURRENT	2008-09 HOT Table Values	0:15-0:45	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	0:20-1:35	0:25-1:00

Table 4.11: Type II 75/25 Fluid, Freezing Drizzle, -3°C to -10°C

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

Table 4.12: Type II Neat Fluid, Light Freezing Rain, -3°C and Above

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

Table 4.13: Type II 75/25 Fluid, Light Freezing Rain, -3°C and Above

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

Table 4.14: Type II 50/50 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	ABC-II+	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	X-KHF-II	ABC-K+
HISTORICAL	1998-99 HOT Table Values	0:05-0:10										
HISTORICAL	1998-99 Endurance Time Test Results		0:05-0:15									
HISTORICAL	1999-00 HOT Table Values	0:05-0:10	0:05-0:15									
HISTORICAL	1999-00 Endurance Time Test Results			0:05-0:10								
HISTORICAL	2000-01 HOT Table Values	0:05-0:10	0:05-0:15	0:05-0:10								
HISTORICAL	2000-01 Endurance Time Test Results				0:05-0:10							
HISTORICAL	2001-02 HOT Table Values	0:05-0:10	0:05-0:15	0:05-0:10	0:05-0:10							
HISTORICAL	2001-02 Endurance Time Test Results					0:05-0:15	0:10-0:15					
HISTORICAL	2002-03 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15					
HISTORICAL	2002-03 Endurance Time Test Results							0:05-0:10				
HISTORICAL	2003-04 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10				
HISTORICAL	2003-04 Endurance Time Test Results											
HISTORICAL	2004-05 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10				
HISTORICAL	2004-05 Endurance Time Test Results											
HISTORICAL	2005-06 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10				
HISTORICAL	2005-06 Endurance Time Test Results								0:10-0:15			
HISTORICAL	2006-07 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15			
HISTORICAL	2006-07 Endurance Time Test Results									0:05-0:10	0:05-0:10	
HISTORICAL	2007-08 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15	0:05-0:10	0:05-0:10	
CURRENT	2007-08 Endurance Time Test Results											0:10-0:15
CURRENT	2008-09 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15	0:05-0:10	0:05-0:10	0:10-0:15

Table 4.15: Type II Neat Fluid, Light Freezing Rain, Below -3°C to -10°C

		GENERIC	ABC-II+	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	X-KHF-II	ABC-K+
HISTORICAL	1998-99 HOT Table Values	0:10-0:30										
	1998-99 Endurance Time Test Results		0:10-0:30									
	1999-00 HOT Table Values	0:10-0:30	0:10-0:30									
	1999-00 Endurance Time Test Results			0:15-0:30								
	2000-01 HOT Table Values	0:10-0:30	0:10-0:30	0:15-0:30								
	2000-01 Endurance Time Test Results				0:15-0:35							
	2001-02 HOT Table Values	0:10-0:25*	0:10-0:30	0:15-0:30	0:15-0:35							
	2001-02 Endurance Time Test Results					0:10-0:30	0:20-0:30					
	2002-03 HOT Table Values	0:10-0:25*	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30					
	2002-03 Endurance Time Test Results							0:20-0:35				
	2003-04 HOT Table Values	0:10-0:25*	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35				
	2003-04 Endurance Time Test Results											
	2004-05 HOT Table Values	0:10-0:25*	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35				
	2004-05 Endurance Time Test Results											
	2005-06 HOT Table Values	0:10-0:25*	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35				
	2005-06 Endurance Time Test Results								0:25-0:45			
	2006-07 HOT Table Values	0:10-0:25*	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45			
	2006-07 Endurance Time Test Results									0:15-0:20	0:25-0:40	
	2007-08 HOT Table Values	0:10-0:20	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20	0:25-0:40	
CURRENT	2007-08 Endurance Time Test Results											0:15-0:35
	2008-09 HOT Table Values	0:10-0:20	0:10-0:30		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20	0:25-0:40	0:15-0:35

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

Table 4.16: Type II 75/25 Fluid, Light Freezing Rain, Below -3°C to -10°C

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

Table 4.17: Type II Neat Fluid, Freezing Fog, -3°C and Above

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

Table 4.18: Type II 75/25 Fluid, Freezing Fog, -3°C and Above

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

Table 4.19: Type II 50/50 Fluid, Freezing Fog, -3°C and Above

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

Table 4.20: Type II Neat Fluid, Freezing Fog, Below -3°C to -14°C

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

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

Table 4.21: Type II 75/25 Fluid, Freezing Fog, Below -3°C to -14°C

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

Table 4.22: Type II Neat Fluid, Freezing Fog, Below -14°C to -25°C

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

Table 4.23: Type II Neat Fluid, Rain on Cold-Soaked Wing, -3°C and Above

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

Table 4.24: Type II 75/25 Fluid, Rain on Cold-Soaked Wing, -3°C and Above

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

Table 4.25: Fluids Responsible for Type II Generic Holdover Time Values

OAT °C	OAT °F	Type II Fluid Concentration Neat Fluid/Water (% by volume)	Approximate Holdover Times Anticipated Under Various Weather Conditions (hours:minutes) FROST	FREEZING FOG	SNOW	FREEZING DRIZZLE	LIGHT FRZ RAIN	RAIN ON COLD-SOAKED WING
-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)**	Grandfather **(U)** ABC II + **(L)** N-FCY-2 **(L)**
		75/25		Grandfather **(B)** X-KHF-II **(U)**	Grandfather **(B)** C-1951 **(L)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)** N-FCY-2 **(U)** X-KHF-II **(U)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)** N-FCY-2 **(U)** X-KHF-II **(U)**	Grandfather **(B)** N-FCY-2 **(B)** ABC II + **(L)** C-1951 **(L)** C-2025 **(L)** C-Flight **(L)**
		50/50		Grandfather **(L)** ABC II + **(L)** C-1951 **(U)** X-KHF-II **(U)**	Grandfather **(B)** C-1951 **(B)** C-2025 **(B)** ABC-K+ **(B)**	C-1951 **(B)** ABC II + **(L)** C-2025 **(U)** X-KHF-II **(U)**	Grandfather **(B)** C-1951 **(B)** C-2025 **(B)** S E26 **(B)** N-FCY-2 **(B)** X-KHF-II **(B)** ABC II + **(L)** K2000 **(L)**	
below -3 to -14	below 27 to 7	**100/0**		Type IV **(L)*** ABC II + **(U)** ABC-K+ **(U)**	Grandfather **(L)** ABC II + **(L)** N-FCY-2 **(U)**	ABC II + **(B)** N-FCY-2 **(U)**	Grandfather **(L)** ABC II + **(L)** K2000 **(L)** N-FCY-2 **(U)**	
		75/25		ABC II + **(B)**	N-FCY-2 **(B)**	ABC II + **(B)** N-FCY-2 **(B)**	N-FCY-2 **(B)** ABC-K+ **(L)**	
below -14 to -25	below 7 to -13	**100/0**		ABC II + **(B)**	Grandfather **(B)** ABC II + **(B)**			
below -25	below -13	**100/0**	SAE TYPE II fluid may be used below -25ºC (-13ºF), provided the freezing point of the fluid is at least 7ºC (13ºF) below the OAT and the aerodynamic acceptance criteria are met. Consider use of SAE Type I when SAE Type IV fluid cannot be used.				**LEGEND** **L = DRIVES LOWER LIMIT** **U = DRIVES UPPER LIMIT** **B = DRIVES BOTH**	

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

M:\Groups\PM2103\Reports\HOT\Working Documents\Fluids Responsible for Generic Table Values At: Type II

5. TYPE III ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

One Type III fluid, Clariant Safewing MP III, was tested in 2007-08. The fluid will not be commercialized and therefore detailed test results have not been included in this report. However, in addition to the standard HOT tests, additional heated fluid tests were conducted with this fluid. The results of the heated fluid research are documented in the Transport Canada report, TP 14874E, *Effect of Heat on Endurance Times of Anti-Icing Fluids* (Vol. 2) (5).

No changes were made to the Type III HOT guidelines for the winter of 2008-09. The Transport Canada and FAA 2008-09 Type III HOT guidelines are included in Appendix E.

5.1 Evolution of Type III Holdover Times

Following the winter of 1999-2000, the need for a de/anti-icing fluid for aircraft with slower rotation speeds was identified. The new fluid needed to have longer holdover times than Type I fluids but a lower viscosity than Type II or Type IV fluids.

During the next several winters, Transport Canada, the FAA, APS, American Eagle and Clariant worked together to determine the precise requirements of this new fluid. During this process, it was decided that any new fluid created to meet these requirements would be classified as a new Type III.

In 2004, Clariant Safewing MP III 2031 ECO was submitted for endurance time testing and subsequently became the first fluid qualified to AMS 1428 as a new Type III fluid. As a result, Transport Canada and the FAA produced new generic Type III HOT guidelines for use in the winter of 2004-05.

The new Type III guidelines were based on the endurance times of Clariant Safewing MP III 2031 ECO. The following protocol was used to obtain the values:

- Endurance time results of Clariant 2031 were reduced by 10 percent; and
- The reduced values were changed to reasonably round values.

When the Type III test results and guidelines were presented at the SAE G-12 Holdover Subcommittee meeting in May 2004, several companies showed an interest in using Type III fluids in dilute form. As a result, 75/25 and 50/50 samples of Clariant Safewing MP III 2031 ECO were tested the following winter and the same protocol used to generate the neat fluid values was employed to generate 75/25 and 50/50 values. These values were incorporated in the winter 2005-06 HOT guidelines.

No changes have been made to the complete generic Type III HOT guidelines since they were introduced for the winter of 2005-06.

This page intentionally left blank.

6. TYPE IV ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

One Type IV fluid, ABAX F292, was tested in 2007-08. However, the fluid will not be commercialized and therefore detailed test results have not been included in this report. The Transport Canada and FAA 2008-09 Type IV HOT guidelines are included in Appendix E.

6.1 New Fluids

No new fluids will be commercialized for the winter of 2008-09. However, at the request of the fluid manufacturer, a new fluid-specific table was added to the Transport Canada HOT guidelines for Dow Chemical UCAR™ FlightGuard AD-480. This product is identical to ABAX AD-480, and the table already exists in the FAA guidelines. The addition of the FlightGuard AD-480 table did not impact the generic Type IV HOT guidelines.

6.2 Removed Fluids/Data

No fluids were removed from the Type IV HOT guidelines for the winter of 2008-09. However, obsolete data was removed from the generic analysis.

The Type IV generic HOT table is meant to encompass the *worst-case* performance of all available Type IV fluids. When the first generic Type IV HOT table was created in 1998-99, fluid-specific data was not available for all fluids on the market. To ensure the true *worst-case* values were included in the generic table, the analysis to determine the generic table values included all available fluid-specific data *and* the 1997-98 SAE Type IV values. The 1997-98 SAE Type IV values reflect the worst holdover times measured with all Type IV fluids up to 1997-98. By including this data in the analysis, the first generic table reflected the *worst-case* performance of all fluids available at the time it was published.

An analysis conducted during the winter of 2007-08 revealed that fluid-specific holdover times now exist for all available Type IV fluids. This indicated that the 1997-98 SAE Type IV holdover times are no longer relevant to the Type IV generic analysis. The 1997-98 SAE Type IV holdover times were therefore removed from the analysis for the winter of 2008-09.

The removal of this data resulted in increases to the generic cold-soaked wing holdover times. The increases are detailed in Section 6.5.

6.3 Changes to Holdover Time Guidelines Format

Testing during natural frost events has indicated that fluid endurance times in frost may be shorter than published frost holdover times in some conditions. Further work is required to substantiate the current endurance time test protocol for natural frost conditions, before any changes are made to frost holdover times. Additional work will be completed during the winter of 2008-09.

In the interim, Transport Canada and the FAA have addressed this issue by adding a note to all Type II and Type IV HOT tables, including generic and fluid-specific tables, to advise users that radiational cooling during active frost conditions may reduce holdover time when operating close to the lower end of the outside air temperature range.

6.4 Evolution of Type IV Generic Holdover Time Values

The Type IV generic HOT guidelines are developed each year using data from Type IV fluids tested since 1996-97. At the SAE G-12 HOT Subcommittee meeting held in New Orleans in May 2001, it was decided that data from fluids that have not been commercially available for four years or more (and which have not been not re-qualified) would be eliminated from the analysis. Since then, Hoechst MP IV 1957, diluted forms of Dow UCAR Ultra+, SPCA AD-404, Clariant Safewing Four and Clariant Safewing MP IV 1957 have been eliminated from the analysis for this reason.

It should be noted that 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 EG-based fluid on the market, Dow UCAR Ultra+, which retains fluid-specific holdover times in very cold snow.

The history of testing with Type IV fluids and the evolution of the fluid-specific and generic Type II holdover time values are illustrated through a series of tables presented in Tables 6.1 to 6.24. 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 above) are not included.

The first row in each table contains the holdover time 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 2008-09 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:

- Octagon Max-Flight (O-Max);
- Kilfrost ABC-S (K-ABC-S);
- Dow UCAR Ultra+ (Ultra+);
- ABAX AD-480 (A-480);
- Clariant MP IV 2001 (C-2001);
- Octagon Max-Flight 04 (O-Max 04);
- Clariant Safewing MP IV Protect 2012 (C-2012);
- Octagon MaxFlo (O-MFlo);
- Clariant Safewing MP IV Launch (C-Launch);
- Dow UCAR Endurance EG106 (D-E106);
- Kilfrost ABC-S PLUS (K-ABCS+); and
- Lyondell ARCTIC Shield® (L-AS).

Table 6.1: Type IV Neat Fluid, Snow, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:35-1:00	0:50-1:35	1:00-1:40	0:35-1:15									
	1997-98 Endurance Time Test Results					~~1:05-2:00~~	1:00-1:55							
	1998-99 HOT Table Values	0:35-1:00	0:50-1:35	1:00-1:40	0:35-1:15	1:05-2:00	1:00-1:55							
	1998-99 Endurance TimeTest Results		~~0:50-1:20~~	1:00-1:40	0:35-1:15	~~1:05-1:50~~								
	1999-2000 HOT Table Values	0:30-0:55	0:50-1:20	1:00-1:40	0:35-1:15	1:05-1:50	1:00-1:55							
	1999-2000 Endurance Time Test Results					0:40-1:20								
	2000-01 HOT Table Values	0:30-0:55	0:50-1:20	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55							
	2000-01 Endurance Time Test Results		~~1:25-2:00~~					1:25-2:00	0:40-1:15					
	2001-02 HOT Table Values	0:30-0:55	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55		0:40-1:15					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:30-0:55	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55		0:40-1:15					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:30-0:55	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	0:40-1:15					
	2004-05 Endurance Time Test Results									0:40-1:30				
	2005-06 HOT Table Values	0:35-1:15	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	0:40-1:15	0:40-1:30				
	2005-06 Endurance Time Test Results										~~1:00-1:35~~	0:40-1:20	~~0:45-1:25~~	
	2006-07 HOT Table Values	0:35-1:15	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	0:40-1:15	0:40-1:30	1:00-1:35	0:40-1:20	0:45-1:25	
	2006-07 Endurance Time Test Results										1:05-1:45		1:15-2:00	0:50-1:25
	2007-08 HOT Table Values	0:35-1:15	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	0:40-1:15	0:40-1:30	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:35-1:15	0:50-1:35	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	0:40-1:15	0:40-1:30	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25

Table 6.2: Type IV 75/25 Fluid, Snow, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:35	0:45-1:45	~~0:35-1:05~~	~~0:20-0:35~~									
	1997-98 Endurance Time Test Results					~~0:45-1:25~~	0:35-1:00							
	1998-99 HOT Table Values	0:20-0:35	0:45-1:45	0:35-1:05		0:45-1:25	0:35-1:00							
	1998-99 Endurance TimeTest Results		~~0:30-1:00~~	0:30-0:55		~~0:45-1:25~~								
	1999-2000 HOT Table Values	0:20-0:35	0:30-1:00	0:30-0:55		0:45-1:25	0:35-1:00							
	1999-2000 Endurance Time Test Results					0:30-1:05								
	2000-01 HOT Table Values	0:20-0:35	0:30-1:00	0:30-0:55		0:30-1:05	0:35-1:00							
	2000-01 Endurance Time Test Results		~~1:05-2:00~~					1:05-2:00	0:25-0:55					
	2001-02 HOT Table Values	0:25-0:50	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00		0:25-0:55					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:25-0:50	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00		0:25-0:55					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:25-0:50	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	0:25-0:55					
	2004-05 Endurance Time Test Results									0:20-0:55				
	2005-06 HOT Table Values	0:20-0:55	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	0:25-0:55	0:20-0:55				
	2005-06 Endurance Time Test Results										~~0:40-1:20~~		~~0:25-0:55~~	
	2006-07 HOT Table Values	0:20-0:55	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	0:25-0:55	0:20-0:55	0:40-1:20		0:25-0:55	
	2006-07 Endurance Time Test Results										1:00-1:45		0:45-1:15	0:40-1:05
	2007-08 HOT Table Values	0:20-0:55	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	0:25-0:55	0:20-0:55	1:00-1:45		0:45-1:15	0:40-1:05
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:20-0:55	0:45-1:45	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	0:25-0:55	0:20-0:55	1:00-1:45		0:45-1:15	0:40-1:05

Table 6.3: Type IV 50/50 Fluid, Snow, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:05-0:15	~~0:40-1:20~~	0:05-0:15	~~0:05-0:15~~									
HISTORICAL	1997-98 Endurance Time Test Results		~~0:40-1:20~~	0:05-0:15		~~0:10-0:30~~	0:10-0:20							
HISTORICAL	1998-99 HOT Table Values	0:05-0:15	0:40-1:20	0:05-0:15		0:10-0:30	0:10-0:20							
HISTORICAL	1998-99 Endurance TimeTest Results	0:05-0:15	~~0:15-0:30~~	0:05-0:15										
HISTORICAL	1999-2000 HOT Table Values	0:05-0:15	0:15-0:30	0:05-0:15		0:10-0:30	0:10-0:20							
HISTORICAL	1999-2000 Endurance Time Test Results					0:10-0:20								
HISTORICAL	2000-01 HOT Table Values	0:05-0:15	0:15-0:30	0:05-0:15		0:10-0:20	0:10-0:20							
HISTORICAL	2000-01 Endurance Time Test Results		0:25-1:15					0:25-1:15	0:15-0:25					
HISTORICAL	2001-02 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20		0:15-0:25					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20		0:15-0:25					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:15-0:25					
HISTORICAL	2004-05 Endurance Time Test Results									0:05-0:15				
HISTORICAL	2005-06 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:15-0:25	0:05-0:15				
HISTORICAL	2005-06 Endurance Time Test Results										~~0:10-0:25~~		~~0:05-0:15~~	
HISTORICAL	2006-07 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:15-0:25	0:05-0:15	0:10-0:25		0:05-0:15	
HISTORICAL	2006-07 Endurance Time Test Results										0:25-0:45		0:15-0:30	0:20-0:35
HISTORICAL	2007-08 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:15-0:25	0:05-0:15	0:25-0:45		0:15-0:30	0:20-0:35
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	0:05-0:15	0:25-1:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:15-0:25	0:05-0:15	0:25-0:45		0:15-0:30	0:20-0:35

Table 6.4: Type IV Neat Fluid, Snow, Below -3°C to -14°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55									
	1997-98 Endurance Time Test Results					~~0:20-0:40~~	0:30-0:50							
	1998-99 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:20-0:40	0:30-0:50							
	1998-99 Endurance TimeTest Results		~~0:45-1:05~~	0:45-1:20	~~0:30-1:00~~	0:30-0:55								
	1999-2000 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50							
	1999-2000 Endurance Time Test Results					0:30-0:55								
	2000-01 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50							
	2000-01 Endurance Time Test Results		~~0:35-1:10~~					0:35-1:10	0:20-0:40					
	2001-02 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50		0:20-0:40					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50		0:20-0:40					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:20-0:40					
	2004-05 Endurance Time Test Results									0:25-1:00				
	2005-06 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:20-0:40	0:25-1:00				
	2005-06 Endurance Time Test Results										~~0:40-1:05~~	0:30-1:05	~~0:35-1:00~~	
	2006-07 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:20-0:40	0:25-1:00	0:40-1:05	0:30-1:05	0:35-1:00	
	2006-07 Endurance Time Test Results										0:50-1:20		1:00-1:45	0:45-1:15
	2007-08 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:20-0:40	0:25-1:00	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:20-0:40	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:20-0:40	0:25-1:00	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15

Table 6.5: Type IV 75/25 Fluid, Snow, Below -3°C to -14°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	0:20-0:50	~~0:35-1:05~~	~~0:15-0:30~~									
	1997-98 Endurance Time Test Results					~~0:15-0:25~~	0:20-0:35							
	1998-99 HOT Table Values	0:15-0:25	0:20-0:50	0:35-1:05		0:15-0:25	0:20-0:35							
	1998-99 Endurance TimeTest Results		~~0:20-0:40~~	0:25-0:50		~~0:25-0:45~~								
	1999-2000 HOT Table Values	0:15-0:25	0:20-0:40	0:25-0:50		0:25-0:45	0:20-0:35							
	1999-2000 Endurance Time Test Results					0:20-0:45								
	2000-01 HOT Table Values	0:15-0:25	0:20-0:40	0:25-0:50		0:20-0:45	0:20-0:35							
	2000-01 Endurance Time Test Results		~~0:40-1:20~~					0:40-1:20	0:20-0:40					
	2001-02 HOT Table Values	0:15-0:25	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35		0:20-0:40					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:20-0:35	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35		0:20-0:40					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-0:35	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:20-0:40					
	2004-05 Endurance Time Test Results									0:15-0:40				
	2005-06 HOT Table Values	0:15-0:35	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:20-0:40	0:15-0:40				
	2005-06 Endurance Time Test Results										~~0:20-0:40~~		~~0:25-0:50~~	
	2006-07 HOT Table Values	0:15-0:35	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:20-0:40	0:15-0:40	0:20-0:40		0:25-0:50	
	2006-07 Endurance Time Test Results										0:45-1:25		0:35-1:00	0:35-0:55
	2007-08 HOT Table Values	0:15-0:35	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:20-0:40	0:15-0:40	0:45-1:25		0:35-1:00	0:35-0:55
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:15-0:35	0:20-0:50	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:20-0:40	0:15-0:40	0:45-1:25		0:35-1:00	0:35-0:55

Table 6.6: Type IV Neat Fluid, Snow, Below -14ºC to -25ºC

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	0:20-0:40	0:40-1:10	0:20-0:45									
	1997-98 Endurance Time Test Results					~~0:15-0:30~~	0:20-0:35							
	1998-99 HOT Table Values	0:15-0:30	0:20-0:40	0:40-1:10	0:20-0:45	0:15-0:30	0:20-0:35							
	1998-99 Endurance TimeTest Results		~~0:40-1:00~~	0:40-1:10	~~0:30-0:55~~	0:25-0:40								
	1999-2000 HOT Table Values	0:15-0:30	0:20-0:40	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35							
	1999-2000 Endurance Time Test Results					~~0:25-0:50~~								
	2000-01 HOT Table Values	0:15-0:30	0:20-0:40	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35							
	2000-01 Endurance Time Test Results		~~0:25-0:50~~					0:25-0:50	0:15-0:30					
	2001-02 HOT Table Values	0:15-0:30	0:20-0:40	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35		0:15-0:30					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:15-0:30	0:20-0:40	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35		0:15-0:30					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:30	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*					
	2004-05 Endurance Time Test Results									0:20-0:50				
	2005-06 HOT Table Values	0:15-0:30	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*				
	2005-06 Endurance Time Test Results										~~0:35-0:55~~	0:25-0:55	~~0:30-0:50~~	
	2006-07 HOT Table Values	0:15-0:30	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*	
	2006-07 Endurance Time Test Results										0:45-1:10		0:55-1:35	0:40-1:10
	2007-08 HOT Table Values	0:15-0:30	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*
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:15-0:30	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*

*The generic HOT values were used for this cell

Table 6.7: Type IV Neat Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:40-1:00	0:55-2:00	1:20-1:50	~~1:00-2:00~~									
	1997-98 Endurance Time Test Results		~~1:10-2:00~~	~~1:55-2:00~~		~~1:05-2:00~~	0:55-1:55							
	1998-99 HOT Table Values	0:40-1:00	0:55-2:00	1:20-1:50	1:00-2:00	1:05-2:00	0:55-1:55							
	1998-99 Endurance TimeTest Results		~~1:00-1:55~~	~~2:00-2:00~~	0:45-1:35									
	1999-2000 HOT Table Values	0:40-1:00	0:55-1:55	1:20-1:50	0:45-1:35	1:05-2:00	0:55-1:55							
	1999-2000 Endurance Time Test Results					0:50-1:30								
	2000-01 HOT Table Values	0:40-1:00	0:55-1:55	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55							
	2000-01 Endurance Time Test Results		~~2:00-2:00~~					2:00-2:00	0:40-1:10					
	2001-02 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55		0:40-1:10					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55		0:40-1:10					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	0:40-1:10					
	2004-05 Endurance Time Test Results									1:20-2:05				
	2005-06 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	0:40-1:10	1:20-2:00				
	2005-06 Endurance Time Test Results										1:30-2:00	1:10-2:00	~~1:15-1:55~~	
	2006-07 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	0:40-1:10	1:20-2:00	1:30-2:00	1:10-2:00	1:15-1:55	
	2006-07 Endurance Time Test Results												1:50-2:00	0:55-1:40
	2007-08 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	0:40-1:10	1:20-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:40-1:10	0:55-2:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	0:40-1:10	1:20-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40

Table 6.8: Type IV 75/25 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-1:00	1:15-2:00	~~0:50-1:25~~	~~0:30-1:00~~									
	1997-98 Endurance Time Test Results		~~1:20-2:00~~	~~0:50~~-1:10		~~0:50-1:20~~	0:35-1:10							
	1998-99 HOT Table Values	0:30-1:00	1:15-2:00	0:50-1:10		0:50-1:20	0:35-1:10							
	1998-99 Endurance TimeTest Results		~~0:50-1:20~~	0:45-1:10										
	1999-2000 HOT Table Values	0:30-1:00	0:50-1:20	0:45-1:10		0:50-1:20	0:35-1:10							
	1999-2000 Endurance Time Test Results					0:50-1:15								
	2000-01 HOT Table Values	0:30-1:00	0:50-1:20	0:45-1:10		0:50-1:15	0:35-1:10							
	2000-01 Endurance Time Test Results		~~1:50-2:00~~					1:50-2:00	0:35-0:50					
	2001-02 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10		0:35-0:50					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10		0:35-0:50					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	0:35-0:50					
	2004-05 Endurance Time Test Results									0:40-1:05				
	2005-06 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	0:35-0:50	0:40-1:05				
	2005-06 Endurance Time Test Results										1:40-2:00		~~0:45-1:10~~	
	2006-07 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	0:35-0:50	0:40-1:05	1:40-2:00		0:45-1:10	
	2006-07 Endurance Time Test Results												1:00-1:20	0:55-1:25
	2007-08 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	0:35-0:50	0:40-1:05	1:40-2:00		1:00-1:20	0:55-1:25
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:35-0:50	1:15-2:00	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	0:35-0:50	0:40-1:05	1:40-2:00		1:00-1:20	0:55-1:25

Table 6.9: Type IV 50/50 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:10-0:20	~~0:55-1:40~~	0:15-~~0:25~~	~~0:10-0:20~~									
HISTORICAL	1997-98 Endurance Time Test Results		0:35-1:00	0:15-0:20		~~0:15-0:35~~	0:10-0:20							
HISTORICAL	1998-99 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:35	0:10-0:20							
HISTORICAL	1998-99 Endurance TimeTest Results		~~0:15-0:25~~	0:15-0:20										
HISTORICAL	1999-2000 HOT Table Values	0:10-0:20	0:15-0:25	0:15-0:20		0:15-0:35	0:10-0:20							
HISTORICAL	1999-2000 Endurance Time Test Results					0:15-0:25								
HISTORICAL	2000-01 HOT Table Values	0:10-0:20	0:15-0:25	0:15-0:20		0:15-0:25	0:10-0:20							
HISTORICAL	2000-01 Endurance Time Test Results		~~0:35-1:10~~					0:35-1:10	0:15-0:20					
HISTORICAL	2001-02 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20		0:15-0:20					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20		0:15-0:20					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:15-0:20					
HISTORICAL	2004-05 Endurance Time Test Results									0:10-0:20				
HISTORICAL	2005-06 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:15-0:20	0:10-0:20				
HISTORICAL	2005-06 Endurance Time Test Results										0:30-0:50		~~0:10-0:20~~	
HISTORICAL	2006-07 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:15-0:20	0:10-0:20	0:30-0:50		0:10-0:20	
HISTORICAL	2006-07 Endurance Time Test Results												0:15-0:40	0:20-0:30
HISTORICAL	2007-08 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:15-0:20	0:10-0:20	0:30-0:50		0:15-0:40	0:20-0:30
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	0:10-0:20	0:35-1:00	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:15-0:20	0:10-0:20	0:30-0:50		0:15-0:40	0:20-0:30

Table 6.10: Type IV Neat Fluid, Freezing Drizzle, -3°C to -10°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-1:00	~~0:30~~-1:10	~~0:35~~-1:00	~~0:50-1:35~~									
	1997-98 Endurance Time Test Results		~~0:30-1:25~~	~~0:40-1:20~~		0:25-1:20	0:55-1:35							
	1998-99 HOT Table Values	0:25-1:00	0:30-1:10	0:35-1:00	0:50-1:35	0:25-1:20	0:55-1:35							
	1998-99 Endurance TimeTest Results		~~0:25-1:15~~	0:20~~-1:30~~	0:45-1:25									
	1999-2000 HOT Table Values	0:20-0:55	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35							
	1999-2000 Endurance Time Test Results					0:25-1:20								
	2000-01 HOT Table Values	0:20-0:55	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35							
	2000-01 Endurance Time Test Results		0:25~~-1:30~~					0:25-1:30	0:25-0:45					
	2001-02 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35		0:25-0:45					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35		0:25-0:45					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:25-0:45					
	2004-05 Endurance Time Test Results									0:35-1:45				
	2005-06 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:25-0:45	0:35-1:45				
	2005-06 Endurance Time Test Results										0:35-1:40	0:55-1:50	~~0:30-1:35~~	
	2006-07 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:25-0:45	0:35-1:45	0:35-1:40	0:55-1:50	0:30-1:35	
	2006-07 Endurance Time Test Results												0:25-1:35	0:25-1:30
	2007-08 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:25-0:45	0:35-1:45	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:20-0:45	0:25-1:10	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:25-0:45	0:35-1:45	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30

Table 6.11: Type IV 75/25 Fluid, Freezing Drizzle, -3°C to -10°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-1:00	~~0:30-1:05~~	~~0:50-1:25~~										
	1997-98 Endurance Time Test Results		~~0:25-1:20~~	~~0:30~~-1:10		~~0:30-1:15~~	0:40-1:10							
	1998-99 HOT Table Values	0:30-1:00	0:25-1:05	0:30-1:10		0:30-1:15	0:40-1:10							
	1998-99 Endurance TimeTest Results		~~0:20-1:00~~	0:20-~~1:30~~										
	1999-2000 HOT Table Values	0:20-0:55	0:20-1:00	0:20-1:10		0:30-1:15	0:40-1:10							
	1999-2000 Endurance Time Test Results					0:25-1:05								
	2000-01 HOT Table Values	0:20-0:50	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10							
	2000-01 Endurance Time Test Results		0:20-1:00					0:20-1:00	0:15-0:30					
	2001-02 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10		0:15-0:30					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10		0:15-0:30					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:15-0:30					
	2004-05 Endurance Time Test Results									0:35-1:15				
	2005-06 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:15-0:30	0:35-1:15				
	2005-06 Endurance Time Test Results										0:25-1:10		~~0:25-1:15~~	
	2006-07 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:15-0:30	0:35-1:15	0:25-1:10		0:25-1:15	
	2006-07 Endurance Time Test Results												0:20-1:10	0:30-1:15
	2007-08 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:15-0:30	0:35-1:15	0:25-1:10		0:20-1:10	0:30-1:15
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:15-0:30	0:35-1:15	0:25-1:10		0:20-1:10	0:30-1:15

Table 6.12: Type IV Neat Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:35-0:55	~~0:40-1:15~~	1:00-1:25	~~0:35-1:00~~									
	1997-98 Endurance Time Test Results		0:35-1:00	~~1:20-2:00~~		~~0:50-1:10~~	0:40-1:00							
	1998-99 HOT Table Values	0:35-0:55	0:35-1:00	1:00-1:25	0:35-1:00	0:50-1:10	0:40-1:00							
	1998-99 Endurance TimeTest Results		~~0:30-0:50~~	~~1:20-2:00~~	0:25-0:40									
	1999-2000 HOT Table Values	0:25-0:40	0:30-0:50	1:00-1:25	0:25-0:40	0:50-1:10	0:40-1:00							
	1999-2000 Endurance Time Test Results					0:35-0:55								
	2000-01 HOT Table Values	0:25-0:40	0:30-0:50	1:00-1:25		0:35-0:55	0:40-1:00							
	2000-01 Endurance Time Test Results		~~1:10-1:30~~					1:10-1:30	0:25-0:45					
	2001-02 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00		0:25-0:45					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00		0:25-0:45					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	0:25-0:45					
	2004-05 Endurance Time Test Results									0:30-1:00				
	2005-06 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	0:25-0:45	0:30-1:00				
	2005-06 Endurance Time Test Results										1:00-1:40	0:50-1:15	~~0:50-1:10~~	
	2006-07 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	0:25-0:45	0:30-1:00	1:00-1:40	0:50-1:15	0:50-1:10	
	2006-07 Endurance Time Test Results												1:05-2:00	0:45-1:05
	2007-08 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	0:25-0:45	0:30-1:00	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:25-0:40	0:35-1:00	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	0:25-0:45	0:30-1:00	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05

Table 6.13: Type IV 75/25 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	~~0:50-1:15~~	0:35-0:50	~~0:15-0:30~~									
	1997-98 Endurance Time Test Results		0:35-1:10	~~0:40-0:55~~		~~0:35-0:50~~	0:25-0:35							
	1998-99 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:35-0:50	0:25-0:35							
	1998-99 Endurance TimeTest Results		~~0:20-0:40~~	0:35-0:50										
	1999-2000 HOT Table Values	0:15-0:30	0:20-0:40	0:35-0:50		0:35-0:50	0:25-0:35							
	1999-2000 Endurance Time Test Results					0:30-0:45								
	2000-01 HOT Table Values	0:15-0:30	0:20-0:40	0:35-0:50		0:30-0:45	0:25-0:35							
	2000-01 Endurance Time Test Results		~~1:00-1:20~~					1:00-1:20	0:15-0:30					
	2001-02 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35		0:15-0:30					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35		0:15-0:30					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:15-0:30					
	2004-05 Endurance Time Test Results									0:20-0:35				
	2005-06 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:15-0:30	0:20-0:35				
	2005-06 Endurance Time Test Results										0:45-1:15		~~0:30-0:45~~	
	2006-07 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:15-0:30	0:20-0:35	0:45-1:15		0:30-0:45	
	2006-07 Endurance Time Test Results												0:30-0:50	0:30-0:45
	2007-08 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:15-0:30	0:20-0:35	0:45-1:15		0:30-0:50	0:30-0:45
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:15-0:30	0:35-1:10	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:15-0:30	0:20-0:35	0:45-1:15		0:30-0:50	0:30-0:45

Table 6.14: Type IV 50/50 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:05-0:10	~~0:30-0:55~~	~~0:10-0:15~~	~~0:05-0:10~~									
	1997-98 Endurance Time Test Results	0:05-0:10	0:15-0:30	~~0:10-0:15~~		~~0:10-0:25~~	<u>0:05</u>-0:15							
	1998-99 HOT Table Values	0:05-0:10	0:15-0:30	0:10-0:15		0:10-0:25	0:10-0:15*							
	1998-99 Endurance TimeTest Results	0:05-0:10	~~0:05-0:15~~	<u>0:05</u>-<u>0:10</u>										
	1999-2000 HOT Table Values	0:05-0:10	0:05-0:15	0:05-0:10		0:10-0:25	0:05-0:15							
	1999-2000 Endurance Time Test Results					<u>0:05</u>-0:15								
	2000-01 HOT Table Values	0:05-0:10	0:05-0:15	0:05-0:10		0:05-0:15	0:05-0:15							
	2000-01 Endurance Time Test Results		~~0:25-0:35~~					0:25-0:35	<u>0:05</u>-<u>0:10</u>					
	2001-02 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15		0:05-0:10					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15		0:05-0:10					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:05-0:10					
	2004-05 Endurance Time Test Results									<u>0:05</u>-<u>0:10</u>				
	2005-06 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:05-0:10	0:05-0:10				
	2005-06 Endurance Time Test Results										0:20-0:25		~~0:05-0:10~~	
	2006-07 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:05-0:10	0:05-0:10	0:20-0:25		0:05-0:10	
	2006-07 Endurance Time Test Results												0:15-0:20	0:10-0:15
	2007-08 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:05-0:10	0:05-0:10	0:20-0:25		0:15-0:20	0:10-0:15
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:05-0:10	0:15-0:30	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:05-0:10	0:05-0:10	0:20-0:25		0:15-0:20	0:10-0:15

*Values were rounded to 0:10-0:15 in 1998-99 and 0:05-0:15 in subsequent years

Table 6.15: Type IV Neat Fluid, Light Freezing Rain, -3°C to -10°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-0:45	~~0:30-0:55~~	~~0:30-0:45~~	~~0:30-0:50~~									
	1997-98 Endurance Time Test Results		0:20-0:40	~~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	0:20-0:40	0:30-0:50	0:20-0:40	0:30-0:45							
	1998-99 Endurance TimeTest Results		~~0:15-0:40~~	0:10-0:30	0:30-0:45									
	1999-2000 HOT Table Values	0:10-0:30	0:15-0:40	0:10-0:30	0:30-0:45	0:20-0:40	0:30-0:45							
	1999-2000 Endurance Time Test Results					0:15-0:30								
	2000-01 HOT Table Values	0:10-0:30	0:15-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45							
	2000-01 Endurance Time Test Results		0:20-0:40					0:20-0:40	0:15-0:25					
	2001-02 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45		0:15-0:25					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45		0:15-0:25					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:15-0:25					
	2004-05 Endurance Time Test Results									0:30-0:50				
	2005-06 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:15-0:25	0:30-0:50				
	2005-06 Endurance Time Test Results										0:25-0:45	0:45-1:10	~~0:25-0:35~~	
	2006-07 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:15-0:25	0:30-0:50	0:25-0:45	0:45-1:10	0:25-0:35	
	2006-07 Endurance Time Test Results												0:20-0:30	0:25-0:30
	2007-08 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:15-0:25	0:30-0:50	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:10-0:25	0:20-0:40	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:15-0:25	0:30-0:50	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30

Table 6.16: Type IV 75/25 Fluid, Light Freezing Rain, -3°C to -10°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	~~0:25-0:35~~	~~0:35-0:50~~	~~0:15-0:30~~									
	1997-98 Endurance Time Test Results		~~0:20-0:30~~	~~0:25~~-0:35		~~0:20-0:35~~	0:20-0:30							
	1998-99 HOT Table Values	0:15-0:30	0:20-0:30	0:25-0:35		0:20-0:35	0:20-0:30							
	1998-99 Endurance TimeTest Results		~~0:15-0:30~~	0:10-0:35										
	1999-2000 HOT Table Values	0:10-0:30	0:15-0:30	0:10-0:35		0:20-0:35	0:20-0:30							
	1999-2000 Endurance Time Test Results					0:15-0:30								
	2000-01 HOT Table Values	0:10-0:25	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30							
	2000-01 Endurance Time Test Results		0:15-0:30					0:15-0:30	0:10-0:20					
	2001-02 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30		0:10-0:20					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30		0:10-0:20					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:10-0:20					
	2004-05 Endurance Time Test Results									0:15-0:30				
	2005-06 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:10-0:20	0:15-0:30				
	2005-06 Endurance Time Test Results										0:25-0:45		~~0:30-0:40~~	
	2006-07 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:10-0:20	0:15-0:30	0:25-0:45		0:30-0:40	
	2006-07 Endurance Time Test Results												0:15-0:25	0:25-0:30
	2007-08 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:10-0:20	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:10-0:20	0:15-0:30	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:10-0:20	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30

Table 6.17: Type IV Neat Fluid, Freezing Fog, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	2:20-3:00												
HISTORICAL	1997-98 Endurance Time Test Results													
HISTORICAL	1998-99 HOT Table Values	2:00-3:00												
HISTORICAL	1998-99 Endurance TimeTest Results		~~2:15-4:00~~	2:35-4:00	1:35-3:35									
HISTORICAL	1999-2000 HOT Table Values	1:05-2:15	2:15-4:00	2:35-4:00	1:35-3:35	1:05-2:15	1:05-2:15							
HISTORICAL	1999-2000 Endurance Time Test Results					2:00-3:30	1:20-3:20							
HISTORICAL	2000-01 HOT Table Values	1:05-2:15	2:15-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20							
HISTORICAL	2000-01 Endurance Time Test Results		2:40-4:00					2:40-4:00	1:15-2:30					
HISTORICAL	2001-02 HOT Table Values	1:05-2:15	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20		1:15-2:30					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	1:05-2:15	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20		1:15-2:30					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	1:05-2:15	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	1:15-2:30					
HISTORICAL	2004-05 Endurance Time Test Results									2:20-3:35				
HISTORICAL	2005-06 HOT Table Values	1:15-2:30	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	1:15-2:30	2:20-3:35				
HISTORICAL	2005-06 Endurance Time Test Results										4:00-4:00	2:05-3:10	~~1:50-3:40~~	
HISTORICAL	2006-07 HOT Table Values	1:15-2:30	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	1:15-2:30	2:20-3:35	4:00-4:00	2:05-3:10	1:50-3:40	
HISTORICAL	2006-07 Endurance Time Test Results												2:10-4:00	1:55-3:10
HISTORICAL	2007-08 HOT Table Values	1:15-2:30	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	1:15-2:30	2:20-3:35	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	1:15-2:30	2:40-4:00	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	1:15-2:30	2:20-3:35	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10

Table 6.18: Type IV 75/25 Fluid, Freezing Fog, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	1:05-2:00												
	1997-98 Endurance Time Test Results													
	1998-99 HOT Table Values	1:05-2:00												
	1998-99 Endurance TimeTest Results		~~1:30-2:50~~	1:05-1:45										
	1999-2000 HOT Table Values	1:05-1:45	1:30-2:50	1:05-1:45		1:05-1:45	1:05-1:45							
	1999-2000 Endurance Time Test Results					1:30-2:45	1:20-2:00							
	2000-01 HOT Table Values	1:05-1:45	1:30-2:50	1:05-1:45		1:30-2:45	1:20-2:00							
	2000-01 Endurance Time Test Results		2:05-3:15					2:05-3:15	1:10-2:05					
	2001-02 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00		1:10-2:05					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00		1:10-2:05					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	1:10-2:05					
	2004-05 Endurance Time Test Results									1:25-2:00				
	2005-06 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	1:10-2:05	1:25-2:00				
	2005-06 Endurance Time Test Results										3:40-4:00		~~1:10-2:10~~	
	2006-07 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	1:10-2:05	1:25-2:00	3:40-4:00		1:10-2:10	
	2006-07 Endurance Time Test Results												1:25-2:40	1:20-2:15
	2007-08 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	1:10-2:05	1:25-2:00	3:40-4:00		1:25-2:40	1:20-2:15
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	1:05-1:45	2:05-3:15	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	1:10-2:05	1:25-2:00	3:40-4:00		1:25-2:40	1:20-2:15

Table 6.19: Type IV 50/50 Fluid, Freezing Fog, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:45												
HISTORICAL	1997-98 Endurance Time Test Results													
HISTORICAL	1998-99 HOT Table Values	0:20-0:45												
HISTORICAL	1998-99 Endurance TimeTest Results		~~0:30-0:50~~	0:20-0:35										
HISTORICAL	1999-2000 HOT Table Values	0:20-0:35	0:30-0:50	0:20-0:35		0:20-0:35	0:20-0:35							
HISTORICAL	1999-2000 Endurance Time Test Results					0:30-0:45	0:15-0:40							
HISTORICAL	2000-01 HOT Table Values	0:15-0:35	0:30-0:50	0:20-0:35		0:30-0:45	0:15-0:40							
HISTORICAL	2000-01 Endurance Time Test Results		0:55-1:45					0:55-1:45	0:25-0:45					
HISTORICAL	2001-02 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40		0:25-0:45					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40		0:25-0:45					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	0:25-0:45					
HISTORICAL	2004-05 Endurance Time Test Results									0:20-0:40				
HISTORICAL	2005-06 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	0:25-0:45	0:20-0:40				
HISTORICAL	2005-06 Endurance Time Test Results										1:25-2:45		~~0:20-0:40~~	
HISTORICAL	2006-07 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	0:25-0:45	0:20-0:40	1:25-2:45		0:20-0:40	
HISTORICAL	2006-07 Endurance Time Test Results												0:30-0:55	0:35-0:45
HISTORICAL	2007-08 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	0:25-0:45	0:20-0:40	1:25-2:45		0:30-0:55	0:35-0:45
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	0:15-0:35	0:55-1:45	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	0:25-0:45	0:20-0:40	1:25-2:45		0:30-0:55	0:35-0:45

Table 6.20: Type IV Neat Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:40-3:00												
	1997-98 Endurance Time Test Results													
	1998-99 HOT Table Values	0:40-3:00												
	1998-99 Endurance TimeTest Results		~~0:45-1:55~~	0:45-2:05	1:25-3:00									
	1999-2000 HOT Table Values	0:40-1:30	0:45-1:55	0:45-2:05	1:25-3:00	0:40-1:30	0:40-1:30							
	1999-2000 Endurance Time Test Results					0:20-1:20	0:45-1:35							
	2000-01 HOT Table Values	0:20-1:20	0:45-1:55	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35							
	2000-01 Endurance Time Test Results		0:50-2:30					0:50-2:30	0:45-1:45					
	2001-02 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35		0:45-1:35					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35		0:45-1:35					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	0:45-1:35					
	2004-05 Endurance Time Test Results									1:10-2:20				
	2005-06 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	0:45-1:35	1:10-2:20				
	2005-06 Endurance Time Test Results										1:00-1:55	1:50-3:20	~~0:40-1:25~~	
	2006-07 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	0:45-1:35	1:10-2:20	1:00-1:55	1:50-3:20	0:40-1:25	
	2006-07 Endurance Time Test Results												0:55-3:30	1:00-2:25
	2007-08 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	0:45-1:45	1:10-2:20	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:20-1:20	0:50-2:30	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	0:45-1:45	1:10-2:20	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25

Table 6.21: Type IV 75/25 Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:35-2:00												
HISTORICAL	1997-98 Endurance Time Test Results													
HISTORICAL	1998-99 HOT Table Values	0:30-2:00												
HISTORICAL	1998-99 Endurance TimeTest Results		~~0:30-1:10~~	0:25-1:00										
HISTORICAL	1999-2000 HOT Table Values	0:25-1:00	0:30-1:10	0:25-1:00		0:25-1:00	0:25-1:00							
HISTORICAL	1999-2000 Endurance Time Test Results					0:25-0:50	0:30-1:00							
HISTORICAL	2000-01 HOT Table Values	0:25-0:50	0:30-1:10	0:25-1:00		0:25-0:50	0:30-1:00							
HISTORICAL	2000-01 Endurance Time Test Results		030-1:05					030-1:05	0:25-1:05					
HISTORICAL	2001-02 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00		0:25-1:05					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00		0:25-1:05					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:25-1:05					
HISTORICAL	2004-05 Endurance Time Test Results									0:40-1:25				
HISTORICAL	2005-06 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:25-1:05	0:40-1:25				
HISTORICAL	2005-06 Endurance Time Test Results										0:40-1:20		~~0:40-1:15~~	
HISTORICAL	2006-07 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:25-1:05	0:40-1:25	0:40-1:20		0:40-1:15	
HISTORICAL	2006-07 Endurance Time Test Results												0:45-1:50	0:50-1:45
HISTORICAL	2007-08 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:25-1:05	0:40-1:25	0:40-1:20		0:45-1:50	0:50-1:45
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	0:25-0:50	0:30-1:05	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:25-1:05	0:40-1:25	0:40-1:20		0:45-1:50	0:50-1:45

Table 6.22: Type IV Neat Fluid, Freezing Fog, Below -14°C to -25°C

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-2:00												
	1997-98 Endurance Time Test Results													
	1998-99 HOT Table Values	0:20-2:00												
	1998-99 Endurance TimeTest Results		~~0:20-0:40~~	0:20-0:40	0:40-2:10									
	1999-2000 HOT Table Values	0:20-0:40	0:20-0:40	0:20-0:40	0:40-2:10	0:20-0:40	0:20-0:40							
	1999-2000 Endurance Time Test Results					0:15-0:40	0:20-0:45							
	2000-01 HOT Table Values	0:15-0:40	0:20-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45							
	2000-01 Endurance Time Test Results		0:20-0:45					0:20-0:45	0:20-0:45					
	2001-02 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45		0:20-0:45					
	2002-03 Endurance Time Test Results													
	2003-04 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45		0:20-0:45					
	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:20-0:45					
	2004-05 Endurance Time Test Results									0:30-1:00				
	2005-06 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:20-0:45	0:30-1:00				
	2005-06 Endurance Time Test Results										0:30-0:50	0:30-1:05	~~0:20-0:45~~	
	2006-07 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:20-0:45	0:30-1:00	0:30-0:50	0:30-1:05	0:20-0:45	
	2006-07 Endurance Time Test Results												0:40-1:00	0:25-0:45
	2007-08 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:20-0:45	0:30-1:00	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45
CURRENT	2007-08 Endurance Time Test Results													
	2008-09 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:20-0:45	0:30-1:00	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45

Table 6.23: Type IV Neat Fluid, Rain on a Cold-Soaked Wing, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	~~0:10-0:50~~												
HISTORICAL	1997-98 Endurance Time Test Results		0:15-1:15	0:20-1:15										
HISTORICAL	1998-99 HOT Table Values	0:10-0:50												
HISTORICAL	1998-99 Endurance TimeTest Results		~~0:10-2:00~~	~~0:30-2:00~~	0:10-1:20									
HISTORICAL	1999-2000 HOT Table Values	0:10-0:50	0:10-1:15	0:20-1:15	0:10-1:20	0:10-0:50	0:10-0:50							
HISTORICAL	1999-2000 Endurance Time Test Results					0:15-1:35	0:15-2:00							
HISTORICAL	2000-01 HOT Table Values	0:10-0:50	0:10-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00							
HISTORICAL	2000-01 Endurance Time Test Results		~~0:20-2:00~~					0:20-2:00	0:10-1:05					
HISTORICAL	2001-02 HOT Table Values	0:10-0:50	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00		0:10-1:05					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	0:10-0:50	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00		0:10-1:05					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	0:10-0:50	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:10-1:05					
HISTORICAL	2004-05 Endurance Time Test Results									0:10-2:00				
HISTORICAL	2005-06 HOT Table Values	0:10-0:50	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:10-1:05	0:10-2:00				
HISTORICAL	2005-06 Endurance Time Test Results										0:15-1:40	0:20-2:00	~~0:15-1:40~~	
HISTORICAL	2006-07 HOT Table Values	0:10-0:50	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:10-1:05	0:10-2:00	0:15-1:40	0:20-2:00	0:15-1:40	
HISTORICAL	2006-07 Endurance Time Test Results												0:25-2:00	0:15-1:25
HISTORICAL	2007-08 HOT Table Values	0:10-0:50	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:10-1:05	0:10-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	0:10-1:05	0:15-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:10-1:05	0:10-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25

Table 6.24: Type IV 75/25 Fluid, Rain on a Cold-Soaked Wing, -3°C and Above

		GENERIC	O-Max	K-ABC-S	Ultra+	S-480	C-2001	O-Max 04	C-2012	O-MFlo	C-Launch	D-E106	K-ABCS+	L-AS
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	~~0:05-0:35~~												
HISTORICAL	1997-98 Endurance Time Test Results		0:10-0:40	0:10-0:50										
HISTORICAL	1998-99 HOT Table Values	0:05-0:35												
HISTORICAL	1998-99 Endurance TimeTest Results		~~0:05-1:15~~	~~0:10-1:15~~										
HISTORICAL	1999-2000 HOT Table Values	0:05-0:35	0:05-0:40	0:10-0:50		0:05-0:35	0:05-0:35							
HISTORICAL	1999-2000 Endurance Time Test Results					0:10-1:15	0:10-1:25							
HISTORICAL	2000-01 HOT Table Values	0:05-0:35	0:05-0:40	0:10-0:50		0:10-1:15	0:10-1:25							
HISTORICAL	2000-01 Endurance Time Test Results		~~0:20-2:00~~					0:20-2:00	0:05-0:40					
HISTORICAL	2001-02 HOT Table Values	0:05-0:35	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25		0:05-0:40					
HISTORICAL	2002-03 Endurance Time Test Results													
HISTORICAL	2003-04 HOT Table Values	0:05-0:35	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25		0:05-0:40					
HISTORICAL	2003-04 Endurance Time Test Results													
HISTORICAL	2004-05 HOT Table Values	0:05-0:35	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:05-0:40					
HISTORICAL	2004-05 Endurance Time Test Results									0:05-1:15				
HISTORICAL	2005-06 HOT Table Values	0:05-0:35	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:05-0:40	0:05-1:15				
HISTORICAL	2005-06 Endurance Time Test Results										0:10-1:45		~~0:05-1:00~~	
HISTORICAL	2006-07 HOT Table Values	0:05-0:35	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:05-0:40	0:05-1:15	0:10-1:45		0:05-1:00	
HISTORICAL	2006-07 Endurance Time Test Results												0:10-1:20	0:05-1:20
HISTORICAL	2007-08 HOT Table Values	0:05-0:35	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:05-0:40	0:05-1:15	0:10-1:45		0:10-1:20	0:05-1:20
CURRENT	2007-08 Endurance Time Test Results													
CURRENT	2008-09 HOT Table Values	0:05-0:40	0:10-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:05-0:40	0:05-1:15	0:10-1:45		0:10-1:20	0:05-1:20

6.5 Fluids Responsible for the Type IV Generic Holdover Time Values

The fluids responsible for the values in each cell of the generic Type IV HOT guidelines in 2008-09 are shown in Table 6.25, along with the year in which they were tested. "U" indicates the fluid is responsible for the upper value in the cell; "L" indicates the fluid is responsible for the lower value in the cell; and "B" indicates the fluid is responsible for both the upper and lower values in the cell.

The removal of the obsolete cold-soaked wing data resulted in increases to two cells in the 2008-09 generic Type IV HOT guidelines.

- Cold-soaked wing, -3°C and above, 100/0, upper limit: from 50 to 65 minutes.
- Cold-soaked wing, -3°C and above, 75/25, upper limit: from 35 to 40 minutes.

Table 6.25: Fluids Responsible for the Type IV Generic Holdover Time Values

OAT		Type IV Fluid Concentration	Approximate Holdover Times Anticipated Under Various Weather Conditions (hours:minutes)					
°C	°F	Neat Fluid/Water (% by volume)	FROST	FREEZING FOG	SNOW	FREEZING DRIZZLE	LIGHT FRZ RAIN	RAIN ON COLD-SOAKED WING
-3 and above	27 and above	**100/0**		C-2012 (00/01) **B**	Ultra+ (98/99) **B** C-2012 (00/01) **U**	C-2012 (00/01) **B**	Ultra+ (98/99) **B** C-2012 (00/01) **L**	C-2012 (00/01) **B** Ultra+ (98/99) **L** O-MFlo (04/05) **L**
		75/25		ABC-S (98/99) **B**	ABC-S (98/99) **U** C-2012 (00/01) **U** O-MFlo (04/05) **B**	C-2012 (00/01) **B** C-2001 (97/98) **L**	C-2012 (00/01) **B**	C-2012 (00/01) **B** O-MFlo (04/05) **L** L-AS (06/07) **L** O-Max (97/98) **U**
		50/50		ABC-S (98/99) **U** C-2001 (99/00) **L**	ABC-S (98/99) **B** O-MFlo (04/05) **B**	C-2012 (00/01) **U** C-2001 (97/98) **B** ABC-S (98/99) **U** O-MFlo (04/05) **B**	C-2012 (00/01) **B** O-MFlo (04/05) **B** ABC-S (98/99) **B** S 480 (99/00) **L** C-2001(97/98) **L**	
below -3 to -14	below 27 to 7	**100/0**		S 480 (99/00) **B**	C-2012 (00/01) **B**	ABC-S (98/99) **L** C-2012 (00/01) **U**	ABC-S (98/99) **L** C-2012 (00/01) **U**	
		75/25		C-2012 (00/01) **L** ABC-S (98/99) **L** S 480 (99/00) **B**	C-2001 (97/98) **U** O-MFlo (04/05) **L**	C-2012 (00/01) **B**	ABC-S (98/99) **L** C-2012 (00/01) **B**	
below -14 to -25	below 7 to -13	**100/0**		S 480 (99/00) **B** ABC-S (98/99) **U**	C-2012 (00/01) **B**			
below -25	below -13	**100/0**	SAE TYPE IV fluid may be used below -25°C (-13°F), provided the freezing point of the fluid is at least 7°C (13°F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of SAE Type I when SAE Type IV fluid cannot be used.				**LEGEND** **L = DRIVES LOWER LIMIT** **U = DRIVES UPPER LIMIT** **B = DRIVES BOTH**	

M:\Groups\PM2103\Reports\HOT\Working Documents\Fluids Responsible for Generic Table Values At:

7. CONCLUSIONS

7.1 Type I Fluids

No changes were made to the Type I fluid HOT guidelines this year.

7.2 Type II Fluids

A fluid-specific table was created for one new Type II fluid, Kilfrost ABC-K Plus, and added to the Type II HOT guidelines. Aviation Xi'an KHF-II was removed from the FAA guidelines, but not the Transport Canada guidelines, for winter 2008-09 operations.

No changes were made to the values in the Type II generic HOT guidelines this year.

7.3 Type III Fluids

No changes were made to the Type III fluid HOT guidelines this year.

7.4 Type IV Fluids

A fluid-specific table for Dow Chemical UCAR™ FlightGuard AD-480, which is identical to ABAX AD-480, was added to the Transport Canada guidelines. The table already exists in the FAA guidelines. This addition did not impact the generic Type IV HOT guidelines.

Obsolete data was removed from the Type IV generic analysis which caused increases to be made to the generic Type IV cold-soaked wing holdover times for winter 2008-09 operations.

This page intentionally left blank.

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.

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. Dawson, P., *Effect of Heat on Endurance Times of Anti-Icing Fluids*, APS Aviation Inc., Transportation Development Centre, Montreal, July 2009, TP 14874E, 106.

This page intentionally left blank.

APPENDIX A

TRANSPORTATION DEVLOPMENT CENTRE
WORK STATEMENT EXCERPT –
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2007-08

TRANSPORTATION DEVLOPMENT CENTRE
WORK STATEMENT EXCERPT –
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2007-08

7.2.2 Aircraft De-Anti-Icing Fluid Endurance Time Testing

Note: This program element will ultimately be charged entirely to the manufacturers of fluids and other agencies external to Transport Canada.

7.2.2.1 Natural Snow Test at Trudeau

a) Prepare a procedure for testing outdoors during snowfalls. Develop more improved and efficient methods to measure snow intensity;

b) Conduct flat plate tests under conditions of natural snow mainly at the Dorval Airport test site to record fluid endurance times. All testing will be performed using the methodology developed in the conduct of similar tests for Transport Canada in past years (ARP5485 and/or proposed ARP5945);

c) Record individual fluid endurance times for snow, based on samples of newly certified or re-certified Type I, Type II, Type III (including dilutions) and Type IV fluids supplied by fluid manufacturers, under as wide a range of temperature, precipitation rate, precipitation type, and wind conditions as can be experienced. (Testing is anticipated with three anti-icing fluids, as well as one Type I fluid). Conduct outdoor tests with Battelle/Octagon Type I fluid provided in Summer 2007; and

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

7.2.2.2 Endurance Time Tests in Simulated Precipitation at NRC

a) Prepare a test procedure for the conduct of endurance time tests in simulated precipitation at NRC Climatic Environment Facility. As the cost for this activity is highly weighted on calibration of precipitation rates, evaluate and if possible, develop more improved and efficient methods to measure intensity;

b) Conduct flat plate tests under conditions of freezing drizzle, light freezing rain, freezing fog, and rain on a cold-soaked surface at the National Research Council Climatic Engineering Facility in Ottawa to record fluid holdover times. All testing will be performed using the methodology developed in the conduct of similar tests for Transport Canada in past years (ARP5485 and/or ARP5945);

c) Testing is anticipated with three anti-icing fluids, as well as one Type I fluid;

d) Record individual fluid endurance times for all simulated precipitation conditions based on samples of newly certified or re-certified fluids supplied by fluid manufacturers under defined test parameters, such as temperature and precipitation rate; and

e) 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, March-April 2008

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)

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) ______ ______ ______ ______ ______ ______

	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6
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						

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) ______ ______ ______ ______ ______ ______

	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12
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

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.

COMMENTS: ______

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 (Δ w*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 1	ColdSoak BOX 2	ColdSoak BOX 3	ColdSoak BOX 4	ColdSoak BOX 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	/			/			/		

OTHER COMMENTS (Fluid Batch, etc):

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	/			/			/		

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

	PRINT	SIGN
FAILURES CALLED 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 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 $(\Delta w * 4.7 / \Delta t)$ $(g/dm^2/h)$

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)

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

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

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 $g/dm^2/h$;
   Droplet median volume diameter: 250 μm;
   Air temperature: +1°C.

4. Moderate Rain on Cold-Soaked Surface:
   Precipitation rate: 75 $g/dm^2/h$;
   Droplet median volume diameter: 1 400 μm;
   Air temperature: +1°C.

5. Freezing Fog:
   Precipitation rate: 2 and 5 $g/dm^2/h$;
   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;

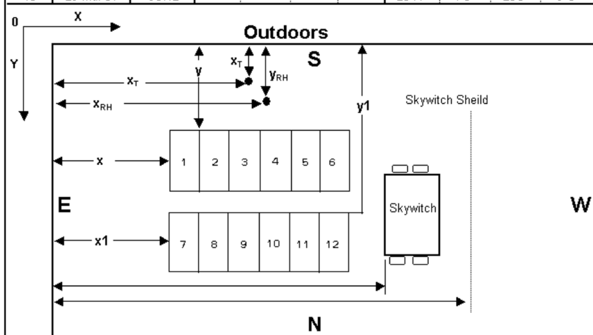
Table 2.1: Condition Checklist

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

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

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

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

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 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

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

6

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

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

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) = $0.0033*X^2 + 3.3605*X - 17.512$

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

M:\Projects\PM1892 (TC Deicing 03-04)\Procedures\HOT-NRC\Version 1.0.doc
Version 1.0, January 04
9

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, MARCH-APRIL 2008

CM2103.001 (07-08)

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

Winter 2007-08

Prepared for

Transportation Development Centre
Transport Canada

for Prepared by: Stephanie Bendickson

Reviewed by: John D'Avirro

Aviation Inc.

March 28, 2008
Final Version 1.0

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

Winter 2007-08

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 March 31 to April 9, 2008.

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 these projects.

A tentative test schedule is included in Figure 1.

2. PROJECTS, PROCEDURES AND OBJECTIVES

The objectives and procedures for each project are detailed in this section. Each project has been given a shortened name (shown in brackets following full title) which is used throughout this document.

The test procedures for some projects are given in separate documents; these documents are listed in Section 9.

2.1 Endurance Times of New Fluids (Endurance Times)

The objective of this project is to measure endurance times of new fluids in simulated freezing precipitation. The procedure for conducting these tests is given in the document *Test Requirements for Simulated Freezing Precipitation Flat Plate Testing* (1).

Four fluids will be tested:

- Kilfrost P2143-3500 (Type II);
- Kilfrost P2143-5000 (Type II);
- Clariant Flight (Type II) – 75% and 50% dilutions only; and
- Clariant MP III (Type III).

Due to time and financial limitations, the Type III fluid will not be tested in freezing fog at -10°C. Instead, it will be tested at freezing fog at -3 and -14°C and interpolation will be used to ascertain the fluid endurance times in freezing fog at -10°C. All other standard Type III test protocol will be followed; test temperatures in other precipitation types will not be altered. This decision has been made in conjunction with Transport Canada.

It should be noted that the lowest operational use temperature (LOUT) of Clariant MP III for low rotation speed aircraft is above -25°C; however, Type III fluids are also certified for use with high rotation speed aircraft, and the LOUT for high rotation speed aircraft is close to -25°C. Therefore, this fluid will be tested in the -25°C conditions.

The test plan for endurance time tests is given in Table 1.

2.2 Endurance Times of Heated Type III Fluid (Heated Type III)

The objective of these tests is to measure endurance times of a Type III fluid (Clariant MP III) when applied using the standard Type I test protocol. The standard endurance time testing procedure and methodology (see Section 2.1) will be followed. The test protocol for Type I fluids differs from the protocol for Type II/III/IV fluids in that fluids are applied heated to 20°C rather than at ambient air temperature. Supplementary tests have been included to examine fluid applied at 60°C as well. During these tests, brix measurements will be taken on 60°C test plate and also on the equivalent 20°C test plate and ambient air temperature test plate.

Tests will be conducted at the standard endurance time testing temperatures, dilutions, precipitation types and precipitation rates. The tests have been included in the endurance time test plan given in Table 1 and are numbered H1 to H78.

2.3 Endurance Times of Type II/IV Fluid at LOUT vs. -25°C (LOUT vs. -25°C)

The objective of these tests is to determine if there is a significant difference in the endurance times of a Type II/IV fluid at -25°C versus at the fluid's lowest operational use temperature (LOUT). The standard endurance time testing procedure and methodology (see Section 2.1) will be followed. To minimize costs, tests will be conducted with only three fluids; if results show large differences, there will be a need to conduct further work. The test plan for these tests is given in Table 2.

2.4 Thickness of New Fluids (Thickness)

The objective of these tests is to measure thicknesses of new fluids on flat plates. The procedure for these tests is entitled *Experimental Program to Establish Film Thickness Profiles for De-Icing and Anti-Icing Fluids on Flat Plates* (2) and can be found in Transport Canada Report TP 13991E, Appendix I. The test plan is given in Table 3.

2.5 Adhesion in Mixed Snow and Rain Conditions (Mixed Snow/Rain)

Transport Canada and the FAA currently do not provide guidelines for operations in mixed snow and rain conditions. However, some aircraft operators have implemented protocols for dealing with such conditions. The purpose of these tests is to identify whether additional work is required in mixed conditions or it the current guidelines can be expanded to include mixed rain and snow conditions.

The objective of this project is to investigate if endurance time testing conducted with neat Type II and Type IV fluids during mixed precipitation conditions (snow/rain) will demonstrate signs of fluid adhesion to aluminum test surfaces. 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 Snow and Rain* (3) and the test plan for these tests is given in Table 4.

2.6 Ice Pellet Allowance Time Expansion (IP Expansion)

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 the results obtained in the Wind Tunnel and with the Falcon 20 aircraft during the winters of 2005-06, 2006-07, and 2007-08. 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 preliminary flat plate tests with Type II and Type III fluids to provide support for the ongoing expansion 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 Snow and Rain (3). The test plan for these tests is given in Table 5.

2.7 Improvement to Snow and Ice Pellet Dispensing Systems (Dispensing System Improvement)

The objective of this project is to conduct work with the ice pellet dispensing system in an attempt to generate a more uniform distribution over the wing surface and improved repeatability for dispensing simulated ice pellets and snow for allowance time testing. This work is being completed in anticipation of further testing in the wind tunnel in the winter of 2008-09.

The procedure for the conduct of these tests is *Procedure: Improvement to Dispensing Systems for Simulated Snow and Ice Pellet Conditions* (4). There is no specific test plan for this work; however, the days on which the work is planned to be conducted are indicated in the test schedule (Figure 1).

3. PERSONNEL REQUIREMENTS/RESPONSIBILITIES

The personnel requirements for each project are as follows:

1. Endurance Times: HOT Team
2. Heated Type III: HOT Team, YOW 1
3. LOUT vs. -25°C: HOT Team
4. Thickness: HOT Team
5. Mixed Snow/Rain: MR, JT, YOW1, Rates Team
6. Ice Pellet Expansion: MR, JT, YOW1
7. Dispensing System Improvement: MR, YOW1

The HOT Team is as follows:

- HOT Manager: JD
- Rate Manager: SB
- Rate Assistant: JT
- Cold-soak Prep: MR, JT, YOW1

In addition, personnel will be designated responsible for:

- Equipment: JT
- Pre-test Setup: JT

- Data Forms: SB
- HOT Data Management: SB

This information is also shown in Table 6.

4. FLUIDS

The required fluids and fluid quantities are shown in Table 7.

5. EQUIPMENT

Table 8 shows the equipment requirements for the following projects:

- Endurance Times
- Heated Type III
- LOUT vs. -25°C
- Thickness

Table 9 shows the equipment requirements for the remaining projects:

- Mixed Snow/Rain
- Ice Pellet Expansion
- Dispensing System Improvement

6. DATA FORMS

1. Endurance Times: The freezing precipitation endurance time data form is required for these tests (Figure 2). The cold-soak wing endurance time data form (Figure 3), is also required.
2. Heated Type III: The freezing precipitation endurance time data form (Figure 2) and the brix and thickness data form () are required for these tests.
3. LOUT vs. -25°C: The freezing precipitation endurance time data form is required for these tests (Figure 2).
4. Thickness: The fluid thickness data form is required (Figure 4).
5. Mixed Snow/Rain: The freezing precipitation endurance time data form (Figure 2), the brix and thickness data form (), the adherence of fluid failure data form (Figure 6) and the position of ice pellet dispenser system data form (Figure 7) are required.

6. Ice Pellet Expansion: The freezing precipitation endurance time data form (Figure 2), the brix and thickness data form (), the adherence of fluid failure data form (Figure 6) and the position of ice pellet dispenser system data form (Figure 7) are required.
7. Dispensing System Improvement: no data forms are required.

7. 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.

8. PRE–TEST SET–UP ACTIVITIES

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

1. Mark plates and boxes.
2. Ensure plates and boxes are equipped with operational and verified thermistors.
3. Install thermistors on cold soak boxes and verify the number of box supports (plywood about the same size area as the box and used to support it on the stand).
4. Determine number of loggers required (loggers are on stands already).
5. Install software on rate PC and on backup laptop.
6. Prepare PC for logging plate temperatures.
7. Ensure fluids are prepared in advance (see Table 7).
8. Prepare labels for pour containers (KB).

9. Empty 1 litre containers must be labelled and cleaned for pouring.
10. Label new rate pans: 4 sets for each #1-12, check for holes, check properly labelled.
11. Rent cube van.
12. Make more 75/25 and 50/50 Clariant MP III fluid based on quantities provided in Table 7.

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

1. Paper towels.
2. White gloves (10 packs of 10).
3. New shelving unit.
4. Scrapers.
5. Floor mats (additional 10) for safety.
6. Large Sharpie markers (2).
7. Printer cartridges (2)

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. Experimental Program: Adhesion of Aircraft De/Anti-Icing Fluids on Aluminum Surfaces During Mixed Precipitation Conditions Snow and Rain, Version 1.0, March 31, 2008.
4. Procedure: Improvement to Dispensing Systems for Simulated Snow and Ice Pellet Conditions, Final Version 1.0, January 30, 2008.

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

FIGURE 1: TEST SCHEDULE

<table>
<tr><th></th><th>Fri Mar 28</th><th>Mon Mar 31</th><th>Tues Apr 1*</th><th>Wed Apr 2*</th><th>Thurs Apr 3</th><th>Fri Apr 4</th><th>Mon Apr 7</th><th>Tue Apr 8*</th><th>Wed Apr 9</th></tr>
<tr><td>8:00</td><td></td><td rowspan="6">**ZF, -25, 2**</td><td rowspan="10">**ZF, -14, 5**</td><td rowspan="12">**ZF, -3, 2**
TH1-TH28</td><td rowspan="6">**ZR, -10, 25**</td><td rowspan="10">**ZR, -3, 25**
RS4 to RS6</td><td rowspan="8">**ZD, -10, 5**</td><td rowspan="9">**ZD, -3, 5**</td><td rowspan="5">**CSW, 1, 5**</td></tr>
<tr><td>8:30</td><td></td></tr>
<tr><td>9:00</td><td rowspan="16">**Setup**</td></tr>
<tr><td>9:30</td></tr>
<tr><td>10:00</td></tr>
<tr><td>10:30</td><td rowspan="4">**CSW, 1, 75**</td></tr>
<tr><td>11:00</td><td rowspan="9">**ZF, -25, 5**
LOUT4 to
LOUT6</td><td rowspan="5">**ZR, -10, 25**
IP3, IP4,
IP3-1, IP4-1</td></tr>
<tr><td>11:30</td></tr>
<tr><td>12:00</td><td rowspan="7">**ZD, -10, 13**</td></tr>
<tr><td>12:30</td><td rowspan="8">**ZD, -3, 13**</td><td rowspan="4">**Pack up**</td></tr>
<tr><td>13:00</td><td rowspan="8">**ZF, -14, 2**</td><td rowspan="8">**ZR, -3, 13**</td></tr>
<tr><td>13:30</td><td>Warm to -5°C</td></tr>
<tr><td>14:00</td><td rowspan="10">**ZF, -3, 5**</td><td rowspan="5">**ZR, -5, 25 + IP**
IP1, IP2,
IP1-1, IP2-1</td></tr>
<tr><td>14:30</td><td></td></tr>
<tr><td>15:00</td><td></td></tr>
<tr><td>15:30</td><td>Cool to -28.5°C</td><td rowspan="6">**ZR, -10, 13**</td><td></td></tr>
<tr><td>16:00</td><td rowspan="4">**ZF, -28.5, 5**
LOUT1 to
LOUT3</td><td></td></tr>
<tr><td>16:30</td><td></td><td></td><td></td></tr>
<tr><td>17:00</td><td></td><td></td><td></td><td rowspan="4">**ZR, -3, 13 + SN**
RS1 to RS3</td><td></td><td></td></tr>
<tr><td>17:30</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>18:00</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>18:30</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

*IP Calibration will take place all day April 1 and April 2

C:\Documents and Settings\Stephanie Bendickson\My Documents\Work\APS\CM2103.001 (07-08)\HOT\NRC Procedure\NRC Procedure - Final Version 1.0.doc
Final Version 1.0, March 08

9 of 30

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

TABLE 1: ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate ($g/dm^2/h$)	Fluid Brand	Dilution	Test Surface	Comments
1	Freezing Fog	-25	5	Clariant MP III	100	Plate	
2	Freezing Fog	-25	5	Clariant MP III	100	Plate	
3	Freezing Fog	-25	5	Kilfrost P2143-3500	100	Plate	Doubles as LOUT 6
4	Freezing Fog	-25	5	Kilfrost P2143-3500	100	Plate	Doubles as LOUT 6A
5	Freezing Fog	-25	5	Kilfrost P2143-5000	100	Plate	
6	Freezing Fog	-25	5	Kilfrost P2143-5000	100	Plate	
7	Freezing Fog	-25	2	Clariant MP III	100	Plate	
8	Freezing Fog	-25	2	Clariant MP III	100	Plate	
9	Freezing Fog	-25	2	Kilfrost P2143-3500	100	Plate	
10	Freezing Fog	-25	2	Kilfrost P2143-3500	100	Plate	
11	Freezing Fog	-25	2	Kilfrost P2143-5000	100	Plate	
12	Freezing Fog	-25	2	Kilfrost P2143-5000	100	Plate	
13	Freezing Fog	-14	5	Clariant MP III	100	Plate	
14	Freezing Fog	-14	5	Clariant MP III	100	Plate	
15	Freezing Fog	-14	5	Kilfrost P2143-3500	100	Plate	
16	Freezing Fog	-14	5	Kilfrost P2143-3500	100	Plate	
17	Freezing Fog	-14	5	Kilfrost P2143-5000	100	Plate	
18	Freezing Fog	-14	5	Kilfrost P2143-5000	100	Plate	
19	Freezing Fog	-14	5	Clariant Flight	75	Plate	
20	Freezing Fog	-14	5	Clariant Flight	75	Plate	
21	Freezing Fog	-14	5	Clariant MP III	75	Plate	
22	Freezing Fog	-14	5	Clariant MP III	75	Plate	
23	Freezing Fog	-14	5	Kilfrost P2143-3500	75	Plate	
24	Freezing Fog	-14	5	Kilfrost P2143-3500	75	Plate	
25	Freezing Fog	-14	5	Kilfrost P2143-5000	75	Plate	
26	Freezing Fog	-14	5	Kilfrost P2143-5000	75	Plate	
27	Freezing Fog	-14	2	Clariant MP III	100	Plate	
28	Freezing Fog	-14	2	Clariant MP III	100	Plate	
29	Freezing Fog	-14	2	Kilfrost P2143-3500	100	Plate	
30	Freezing Fog	-14	2	Kilfrost P2143-3500	100	Plate	
31	Freezing Fog	-14	2	Kilfrost P2143-5000	100	Plate	
32	Freezing Fog	-14	2	Kilfrost P2143-5000	100	Plate	
33	Freezing Fog	-14	2	Clariant Flight	75	Plate	
34	Freezing Fog	-14	2	Clariant Flight	75	Plate	
35	Freezing Fog	-14	2	Clariant MP III	75	Plate	
36	Freezing Fog	-14	2	Clariant MP III	75	Plate	
37	Freezing Fog	-14	2	Kilfrost P2143-3500	75	Plate	
38	Freezing Fog	-14	2	Kilfrost P2143-3500	75	Plate	
39	Freezing Fog	-14	2	Kilfrost P2143-5000	75	Plate	
40	Freezing Fog	-14	2	Kilfrost P2143-5000	75	Plate	
41	Freezing Fog	-3	5	Clariant MP III	100	Plate	
42	Freezing Fog	-3	5	Clariant MP III	100	Plate	
43	Freezing Fog	-3	5	Kilfrost P2143-3500	100	Plate	
44	Freezing Fog	-3	5	Kilfrost P2143-3500	100	Plate	
45	Freezing Fog	-3	5	Kilfrost P2143-5000	100	Plate	
46	Freezing Fog	-3	5	Kilfrost P2143-5000	100	Plate	
47	Freezing Fog	-3	5	Clariant Flight	75	Plate	
48	Freezing Fog	-3	5	Clariant Flight	75	Plate	
49	Freezing Fog	-3	5	Clariant MP III	75	Plate	
50	Freezing Fog	-3	5	Clariant MP III	75	Plate	
51	Freezing Fog	-3	5	Kilfrost P2143-3500	75	Plate	
52	Freezing Fog	-3	5	Kilfrost P2143-3500	75	Plate	
53	Freezing Fog	-3	5	Clariant Flight	50	Plate	
54	Freezing Fog	-3	5	Clariant Flight	50	Plate	

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

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

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	Test Surface	Comments
55	Freezing Fog	-3	5	Clariant MP III	50	Plate	
56	Freezing Fog	-3	5	Clariant MP III	50	Plate	
57	Freezing Fog	-3	5	Kilfrost P2143-3500	50	Plate	
58	Freezing Fog	-3	5	Kilfrost P2143-3500	50	Plate	
59	Freezing Fog	-3	5	Kilfrost P2143-5000	75	Plate	
60	Freezing Fog	-3	5	Kilfrost P2143-5000	75	Plate	
61	Freezing Fog	-3	5	Kilfrost P2143-5000	50	Plate	
62	Freezing Fog	-3	5	Kilfrost P2143-5000	50	Plate	
63	Freezing Fog	-3	2	Clariant MP III	100	Plate	
64	Freezing Fog	-3	2	Clariant MP III	100	Plate	
65	Freezing Fog	-3	2	Kilfrost P2143-3500	100	Plate	
66	Freezing Fog	-3	2	Kilfrost P2143-3500	100	Plate	
67	Freezing Fog	-3	2	Kilfrost P2143-5000	100	Plate	
68	Freezing Fog	-3	2	Kilfrost P2143-5000	100	Plate	
69	Freezing Fog	-3	2	Clariant Flight	75	Plate	
70	Freezing Fog	-3	2	Clariant Flight	75	Plate	
71	Freezing Fog	-3	2	Clariant MP III	75	Plate	
72	Freezing Fog	-3	2	Clariant MP III	75	Plate	
73	Freezing Fog	-3	2	Kilfrost P2143-3500	75	Plate	
74	Freezing Fog	-3	2	Kilfrost P2143-3500	75	Plate	
75	Freezing Fog	-3	2	Clariant Flight	50	Plate	
76	Freezing Fog	-3	2	Clariant Flight	50	Plate	
77	Freezing Fog	-3	2	Clariant MP III	50	Plate	
78	Freezing Fog	-3	2	Clariant MP III	50	Plate	
79	Freezing Fog	-3	2	Kilfrost P2143-3500	50	Plate	
80	Freezing Fog	-3	2	Kilfrost P2143-3500	50	Plate	
81	Freezing Fog	-3	2	Kilfrost P2143-5000	75	Plate	
82	Freezing Fog	-3	2	Kilfrost P2143-5000	75	Plate	
83	Freezing Fog	-3	2	Kilfrost P2143-5000	50	Plate	
84	Freezing Fog	-3	2	Kilfrost P2143-5000	50	Plate	
85	Freezing Drizzle	-10	13	Clariant MP III	100	Plate	Measure brix
86	Freezing Drizzle	-10	13	Clariant MP III	100	Plate	
87	Freezing Drizzle	-10	13	Kilfrost P2143-3500	100	Plate	
88	Freezing Drizzle	-10	13	Kilfrost P2143-3500	100	Plate	
89	Freezing Drizzle	-10	13	Kilfrost P2143-5000	100	Plate	
90	Freezing Drizzle	-10	13	Kilfrost P2143-5000	100	Plate	
91	Freezing Drizzle	-10	13	Clariant Flight	75	Plate	
92	Freezing Drizzle	-10	13	Clariant Flight	75	Plate	
93	Freezing Drizzle	-10	13	Clariant MP III	75	Plate	Measure brix
94	Freezing Drizzle	-10	13	Clariant MP III	75	Plate	
95	Freezing Drizzle	-10	13	Kilfrost P2143-3500	75	Plate	
96	Freezing Drizzle	-10	13	Kilfrost P2143-3500	75	Plate	
97	Freezing Drizzle	-10	13	Kilfrost P2143-5000	75	Plate	
98	Freezing Drizzle	-10	13	Kilfrost P2143-5000	75	Plate	
99	Freezing Drizzle	-10	5	Clariant MP III	100	Plate	
100	Freezing Drizzle	-10	5	Clariant MP III	100	Plate	
101	Freezing Drizzle	-10	5	Kilfrost P2143-3500	100	Plate	
102	Freezing Drizzle	-10	5	Kilfrost P2143-3500	100	Plate	
103	Freezing Drizzle	-10	5	Kilfrost P2143-5000	100	Plate	
104	Freezing Drizzle	-10	5	Kilfrost P2143-5000	100	Plate	
105	Freezing Drizzle	-10	5	Clariant Flight	75	Plate	
106	Freezing Drizzle	-10	5	Clariant Flight	75	Plate	
107	Freezing Drizzle	-10	5	Clariant MP III	75	Plate	
108	Freezing Drizzle	-10	5	Clariant MP III	75	Plate	

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

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	Test Surface	Comments
109	Freezing Drizzle	-10	5	Kilfrost P2143-3500	75	Plate	
110	Freezing Drizzle	-10	5	Kilfrost P2143-3500	75	Plate	
111	Freezing Drizzle	-10	5	Kilfrost P2143-5000	75	Plate	
112	Freezing Drizzle	-10	5	Kilfrost P2143-5000	75	Plate	
113	Freezing Drizzle	-3	13	Clariant MP III	100	Plate	
114	Freezing Drizzle	-3	13	Clariant MP III	100	Plate	
115	Freezing Drizzle	-3	13	Kilfrost P2143-3500	100	Plate	
116	Freezing Drizzle	-3	13	Kilfrost P2143-3500	100	Plate	
117	Freezing Drizzle	-3	13	Kilfrost P2143-5000	100	Plate	
118	Freezing Drizzle	-3	13	Kilfrost P2143-5000	100	Plate	
119	Freezing Drizzle	-3	13	Clariant Flight	75	Plate	
120	Freezing Drizzle	-3	13	Clariant Flight	75	Plate	
121	Freezing Drizzle	-3	13	Clariant MP III	75	Plate	Measure brix
122	Freezing Drizzle	-3	13	Clariant MP III	75	Plate	
123	Freezing Drizzle	-3	13	Kilfrost P2143-3500	75	Plate	
124	Freezing Drizzle	-3	13	Kilfrost P2143-3500	75	Plate	
125	Freezing Drizzle	-3	13	Clariant Flight	50	Plate	
126	Freezing Drizzle	-3	13	Clariant Flight	50	Plate	
127	Freezing Drizzle	-3	13	Clariant MP III	50	Plate	
128	Freezing Drizzle	-3	13	Clariant MP III	50	Plate	Measure brix
129	Freezing Drizzle	-3	13	Kilfrost P2143-3500	50	Plate	
130	Freezing Drizzle	-3	13	Kilfrost P2143-3500	50	Plate	
131	Freezing Drizzle	-3	13	Kilfrost P2143-5000	75	Plate	
132	Freezing Drizzle	-3	13	Kilfrost P2143-5000	75	Plate	
133	Freezing Drizzle	-3	13	Kilfrost P2143-5000	50	Plate	
134	Freezing Drizzle	-3	13	Kilfrost P2143-5000	50	Plate	
135	Freezing Drizzle	-3	5	Clariant MP III	100	Plate	
136	Freezing Drizzle	-3	5	Clariant MP III	100	Plate	
137	Freezing Drizzle	-3	5	Kilfrost P2143-3500	100	Plate	
138	Freezing Drizzle	-3	5	Kilfrost P2143-3500	100	Plate	
139	Freezing Drizzle	-3	5	Kilfrost P2143-5000	100	Plate	
140	Freezing Drizzle	-3	5	Kilfrost P2143-5000	100	Plate	
141	Freezing Drizzle	-3	5	Clariant Flight	75	Plate	
142	Freezing Drizzle	-3	5	Clariant Flight	75	Plate	
143	Freezing Drizzle	-3	5	Clariant MP III	75	Plate	
144	Freezing Drizzle	-3	5	Clariant MP III	75	Plate	
145	Freezing Drizzle	-3	5	Kilfrost P2143-3500	75	Plate	
146	Freezing Drizzle	-3	5	Kilfrost P2143-3500	75	Plate	
147	Freezing Drizzle	-3	5	Clariant Flight	50	Plate	
148	Freezing Drizzle	-3	5	Clariant Flight	50	Plate	
149	Freezing Drizzle	-3	5	Clariant MP III	50	Plate	
150	Freezing Drizzle	-3	5	Clariant MP III	50	Plate	
151	Freezing Drizzle	-3	5	Kilfrost P2143-3500	50	Plate	
152	Freezing Drizzle	-3	5	Kilfrost P2143-3500	50	Plate	
153	Freezing Drizzle	-3	5	Kilfrost P2143-5000	75	Plate	
154	Freezing Drizzle	-3	5	Kilfrost P2143-5000	75	Plate	
155	Freezing Drizzle	-3	5	Kilfrost P2143-5000	50	Plate	
156	Freezing Drizzle	-3	5	Kilfrost P2143-5000	50	Plate	
157	Light Freezing Rain	-10	25	Clariant MP III	100	Plate	Measure brix
158	Light Freezing Rain	-10	25	Clariant MP III	100	Plate	
159	Light Freezing Rain	-10	25	Kilfrost P2143-3500	100	Plate	
160	Light Freezing Rain	-10	25	Kilfrost P2143-3500	100	Plate	
161	Light Freezing Rain	-10	25	Kilfrost P2143-5000	100	Plate	
162	Light Freezing Rain	-10	25	Kilfrost P2143-5000	100	Plate	

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

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	Test Surface	Comments
163	Light Freezing Rain	-10	25	Clariant Flight	75	Plate	
164	Light Freezing Rain	-10	25	Clariant Flight	75	Plate	
165	Light Freezing Rain	-10	25	Clariant MP III	75	Plate	Measure brix
166	Light Freezing Rain	-10	25	Clariant MP III	75	Plate	
167	Light Freezing Rain	-10	25	Kilfrost P2143-3500	75	Plate	
168	Light Freezing Rain	-10	25	Kilfrost P2143-3500	75	Plate	
169	Light Freezing Rain	-10	25	Kilfrost P2143-5000	75	Plate	
170	Light Freezing Rain	-10	25	Kilfrost P2143-5000	75	Plate	
171	Light Freezing Rain	-10	13	Clariant MP III	100	Plate	
172	Light Freezing Rain	-10	13	Clariant MP III	100	Plate	
173	Light Freezing Rain	-10	13	Kilfrost P2143-3500	100	Plate	
174	Light Freezing Rain	-10	13	Kilfrost P2143-3500	100	Plate	
175	Light Freezing Rain	-10	13	Kilfrost P2143-5000	100	Plate	
176	Light Freezing Rain	-10	13	Kilfrost P2143-5000	100	Plate	
177	Light Freezing Rain	-10	13	Clariant Flight	75	Plate	
178	Light Freezing Rain	-10	13	Clariant Flight	75	Plate	
179	Light Freezing Rain	-10	13	Clariant MP III	75	Plate	
180	Light Freezing Rain	-10	13	Clariant MP III	75	Plate	
181	Light Freezing Rain	-10	13	Kilfrost P2143-3500	75	Plate	
182	Light Freezing Rain	-10	13	Kilfrost P2143-3500	75	Plate	
183	Light Freezing Rain	-10	13	Kilfrost P2143-5000	75	Plate	
184	Light Freezing Rain	-10	13	Kilfrost P2143-5000	75	Plate	
185	Light Freezing Rain	-3	25	Clariant MP III	100	Plate	
186	Light Freezing Rain	-3	25	Clariant MP III	100	Plate	
187	Light Freezing Rain	-3	25	Kilfrost P2143-3500	100	Plate	
188	Light Freezing Rain	-3	25	Kilfrost P2143-3500	100	Plate	
189	Light Freezing Rain	-3	25	Kilfrost P2143-5000	100	Plate	
190	Light Freezing Rain	-3	25	Kilfrost P2143-5000	100	Plate	
191	Light Freezing Rain	-3	25	Clariant Flight	75	Plate	
192	Light Freezing Rain	-3	25	Clariant Flight	75	Plate	
193	Light Freezing Rain	-3	25	Clariant MP III	75	Plate	
194	Light Freezing Rain	-3	25	Clariant MP III	75	Plate	
195	Light Freezing Rain	-3	25	Kilfrost P2143-3500	75	Plate	
196	Light Freezing Rain	-3	25	Kilfrost P2143-3500	75	Plate	
197	Light Freezing Rain	-3	25	Clariant Flight	50	Plate	
198	Light Freezing Rain	-3	25	Clariant Flight	50	Plate	
199	Light Freezing Rain	-3	25	Clariant MP III	50	Plate	
200	Light Freezing Rain	-3	25	Clariant MP III	50	Plate	
201	Light Freezing Rain	-3	25	Kilfrost P2143-3500	50	Plate	
202	Light Freezing Rain	-3	25	Kilfrost P2143-3500	50	Plate	
203	Light Freezing Rain	-3	25	Kilfrost P2143-5000	75	Plate	
204	Light Freezing Rain	-3	25	Kilfrost P2143-5000	75	Plate	
205	Light Freezing Rain	-3	25	Kilfrost P2143-5000	50	Plate	
206	Light Freezing Rain	-3	25	Kilfrost P2143-5000	50	Plate	
207	Light Freezing Rain	-3	13	Clariant MP III	100	Plate	
208	Light Freezing Rain	-3	13	Clariant MP III	100	Plate	
209	Light Freezing Rain	-3	13	Kilfrost P2143-3500	100	Plate	
210	Light Freezing Rain	-3	13	Kilfrost P2143-3500	100	Plate	
211	Light Freezing Rain	-3	13	Kilfrost P2143-5000	100	Plate	
212	Light Freezing Rain	-3	13	Kilfrost P2143-5000	100	Plate	
213	Light Freezing Rain	-3	13	Clariant Flight	75	Plate	
214	Light Freezing Rain	-3	13	Clariant Flight	75	Plate	
215	Light Freezing Rain	-3	13	Clariant MP III	75	Plate	
216	Light Freezing Rain	-3	13	Clariant MP III	75	Plate	

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

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

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	Test Surface	Comments
217	Light Freezing Rain	-3	13	Kilfrost P2143-3500	75	Plate	
218	Light Freezing Rain	-3	13	Kilfrost P2143-3500	75	Plate	
219	Light Freezing Rain	-3	13	Clariant Flight	50	Plate	
220	Light Freezing Rain	-3	13	Clariant Flight	50	Plate	
221	Light Freezing Rain	-3	13	Clariant MP III	50	Plate	
222	Light Freezing Rain	-3	13	Clariant MP III	50	Plate	
223	Light Freezing Rain	-3	13	Kilfrost P2143-3500	50	Plate	
224	Light Freezing Rain	-3	13	Kilfrost P2143-3500	50	Plate	
225	Light Freezing Rain	-3	13	Kilfrost P2143-5000	75	Plate	
226	Light Freezing Rain	-3	13	Kilfrost P2143-5000	75	Plate	
227	Light Freezing Rain	-3	13	Kilfrost P2143-5000	50	Plate	
228	Light Freezing Rain	-3	13	Kilfrost P2143-5000	50	Plate	
229	Cold Soak Box	1	75	Clariant MP III	100	Box	
230	Cold Soak Box	1	75	Clariant MP III	100	Box	
231	Cold Soak Box	1	75	Kilfrost P2143-3500	100	Box	
232	Cold Soak Box	1	75	Kilfrost P2143-3500	100	Box	
233	Cold Soak Box	1	75	Kilfrost P2143-5000	100	Box	
234	Cold Soak Box	1	75	Kilfrost P2143-5000	100	Box	
235	Cold Soak Box	1	75	Clariant Flight	75	Box	
236	Cold Soak Box	1	75	Clariant Flight	75	Box	
237	Cold Soak Box	1	75	Clariant MP III	75	Box	
238	Cold Soak Box	1	75	Clariant MP III	75	Box	
239	Cold Soak Box	1	75	Kilfrost P2143-3500	75	Box	
240	Cold Soak Box	1	75	Kilfrost P2143-3500	75	Box	
241	Cold Soak Box	1	75	Kilfrost P2143-5000	75	Box	
242	Cold Soak Box	1	75	Kilfrost P2143-5000	75	Box	
243	Cold Soak Box	1	5	Clariant MP III	100	Box	
244	Cold Soak Box	1	5	Clariant MP III	100	Box	
245	Cold Soak Box	1	5	Kilfrost P2143-3500	100	Box	
246	Cold Soak Box	1	5	Kilfrost P2143-3500	100	Box	
247	Cold Soak Box	1	5	Kilfrost P2143-5000	100	Box	
248	Cold Soak Box	1	5	Kilfrost P2143-5000	100	Box	
249	Cold Soak Box	1	5	Clariant MP III	75	Box	
250	Cold Soak Box	1	5	Clariant MP III	75	Box	
251	Cold Soak Box	1	5	Kilfrost P2143-3500	75	Box	
252	Cold Soak Box	1	5	Kilfrost P2143-3500	75	Box	
253	Cold Soak Box	1	5	Clariant Flight	75	Box	
254	Cold Soak Box	1	5	Clariant Flight	75	Box	
255	Cold Soak Box	1	5	Kilfrost P2143-5000	75	Box	
256	Cold Soak Box	1	5	Kilfrost P2143-5000	75	Box	
H1	Freezing Fog	-25	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H2	Freezing Fog	-25	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H3	Freezing Fog	-25	2	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H4	Freezing Fog	-25	2	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H5	Freezing Fog	-14	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H6	Freezing Fog	-14	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H7	Freezing Fog	-14	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H8	Freezing Fog	-14	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H9	Freezing Fog	-14	2	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H10	Freezing Fog	-14	2	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H11	Freezing Fog	-14	2	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H12	Freezing Fog	-14	2	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H13	Freezing Fog	-3	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H14	Freezing Fog	-3	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C

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

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	Test Surface	Comments
H15	Freezing Fog	-3	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H16	Freezing Fog	-3	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H17	Freezing Fog	-3	5	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H18	Freezing Fog	-3	5	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H19	Freezing Fog	-3	2	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H20	Freezing Fog	-3	2	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H21	Freezing Fog	-3	2	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H22	Freezing Fog	-3	2	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H23	Freezing Fog	-3	2	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H24	Freezing Fog	-3	2	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H25	Freezing Drizzle	-10	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C, measure brix
H26	Freezing Drizzle	-10	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H27	Freezing Drizzle	-10	13	Clariant MP III	100	Plate	Apply 1 L @ 60°C, measure brix
H28	Freezing Drizzle	-10	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C, measure brix
H29	Freezing Drizzle	-10	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H30	Freezing Drizzle	-10	13	Clariant MP III	75	Plate	Apply 1 L @ 60°C, measure brix
H31	Freezing Drizzle	-10	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H32	Freezing Drizzle	-10	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H33	Freezing Drizzle	-10	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H34	Freezing Drizzle	-10	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H35	Freezing Drizzle	-3	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H36	Freezing Drizzle	-3	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H37	Freezing Drizzle	-3	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C, measure brix
H38	Freezing Drizzle	-3	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H39	Freezing Drizzle	-3	13	Clariant MP III	75	Plate	Apply 1 L @ 60°C, measure brix
H40	Freezing Drizzle	-3	13	Clariant MP III	50	Plate	Apply 1 L @ 20°C, measure brix
H41	Freezing Drizzle	-3	13	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H42	Freezing Drizzle	-3	13	Clariant MP III	50	Plate	Apply 1 L @ 60°C, measure brix
H43	Freezing Drizzle	-3	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H44	Freezing Drizzle	-3	5	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H45	Freezing Drizzle	-3	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H46	Freezing Drizzle	-3	5	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H47	Freezing Drizzle	-3	5	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H48	Freezing Drizzle	-3	5	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H49	Light Freezing Rain	-10	25	Clariant MP III	100	Plate	Apply 1 L @ 20°C, measure brix
H50	Light Freezing Rain	-10	25	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H51	Light Freezing Rain	-10	25	Clariant MP III	100	Plate	Apply 1 L @ 60°C, measure brix
H52	Light Freezing Rain	-10	25	Clariant MP III	75	Plate	Apply 1 L @ 20°C, measure brix
H53	Light Freezing Rain	-10	25	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H54	Light Freezing Rain	-10	25	Clariant MP III	75	Plate	Apply 1 L @ 60°C, measure brix
H55	Light Freezing Rain	-10	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H56	Light Freezing Rain	-10	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H57	Light Freezing Rain	-10	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H58	Light Freezing Rain	-10	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H59	Light Freezing Rain	-3	25	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H60	Light Freezing Rain	-3	25	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H61	Light Freezing Rain	-3	25	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H62	Light Freezing Rain	-3	25	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H63	Light Freezing Rain	-3	25	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H64	Light Freezing Rain	-3	25	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H65	Light Freezing Rain	-3	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H66	Light Freezing Rain	-3	13	Clariant MP III	100	Plate	Apply 1 L @ 20°C
H67	Light Freezing Rain	-3	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C
H68	Light Freezing Rain	-3	13	Clariant MP III	75	Plate	Apply 1 L @ 20°C

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

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	Test Surface	Comments
H69	Light Freezing Rain	-3	13	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H70	Light Freezing Rain	-3	13	Clariant MP III	50	Plate	Apply 1 L @ 20°C
H71	Cold Soak Box	1	75	Clariant MP III	100	Box	Apply 1 L @ 20°C
H72	Cold Soak Box	1	75	Clariant MP III	100	Box	Apply 1 L @ 20°C
H73	Cold Soak Box	1	75	Clariant MP III	75	Box	Apply 1 L @ 20°C
H74	Cold Soak Box	1	75	Clariant MP III	75	Box	Apply 1 L @ 20°C
H75	Cold Soak Box	1	5	Clariant MP III	100	Box	Apply 1 L @ 20°C
H76	Cold Soak Box	1	5	Clariant MP III	100	Box	Apply 1 L @ 20°C
H77	Cold Soak Box	1	5	Clariant MP III	75	Box	Apply 1 L @ 20°C
H78	Cold Soak Box	1	5	Clariant MP III	75	Box	Apply 1 L @ 20°C

TABLE 2: TEST PLAN – ENDURANCE TIMES OF TYPE II/IV FLUID AT -25°C VS. LOUT

Test #*	Priority	Fluid Type	Fluid	Dilution	Fluid Temp. [°C]	Test Temp. [°C]	Precip Type	Freezing Fog Precip Rate [g/dm²/h]	-25 / ZF 2 ET [min.]	-25 / ZF 5 ET [min.]	NRC Condition	Timing With HOT Tests	Approx. Testing Time	Objective
LOUT1	2	IV	DOW EG 106	Neat	-28.5	-28.5	ZF	5**	66	32	-28.5 / ZF 5	Invasive (following HOT)		LOUT ET Test
LOUT2	1	IV	Kilfrost ABC-S+	Neat	-28.5	-28.5	ZF	5**	60	38	-28.5 / ZF 5	Invasive (following HOT)	2hrs	LOUT ET Test
LOUT3	1	II	Kilfrost 2143-3500	Neat	-28.5	-28.5	ZF	5**	SEE 2008 DATA	SEE 2008 DATA	-28.5 / ZF 5	Invasive (following HOT)		LOUT ET Test
LOUT4	2	IV	DOW EG 106	Neat	-25	-25	ZF	5**	66	32	-25 / ZF 5	in Conjunction		LOUT Baseline Test
LOUT5	1	IV	Kilfrost ABC-S+	Neat	-25	-25	ZF	5**	60	38	-25 / ZF 5	in Conjunction	2hrs	LOUT Baseline Test
LOUT6***	1	II	Kilfrost 2143-3500	Neat	-25	-25	ZF	5**	SEE 2008 DATA	SEE 2008 DATA	-25 / ZF 5	in Conjunction		LOUT Baseline Test

* Duplicates of each test will be conducted simultaneously. Duplcate tests will be labled "Test #" A. i.e. LOUT1-A
** Can be substituted for a rate of 2 g/dm²/h, however complete set must be done at same rate.
*** Duplicate of ET5 and ET6. Use ET5/ET6 for results.

TABLE 3: TEST PLAN – FLUID THICKNESS

Test #	Fluid Manufacturer	Fluid Name	Fluid Dilution	Ambient Air Temperature
TH1	Clariant	Flight	75/25	-3°C
TH2	Clariant	Flight	75/25	-3°C
TH3	Clariant	Flight	50/50	-3°C
TH4	Clariant	Flight	50/50	-3°C
TH5	Kilfrost	P2143-5000	100/0	-3°C
TH6	Kilfrost	P2143-5000	100/0	-3°C
TH7	Kilfrost	P2143-5000	75/25	-3°C
TH8	Kilfrost	P2143-5000	75/25	-3°C
TH9	Kilfrost	P2143-5000	50/50	-3°C
TH10	Kilfrost	P2143-5000	50/50	-3°C
TH11	Kilfrost	P2143-3500	100/0	-3°C
TH12	Kilfrost	P2143-3500	100/0	-3°C
TH13	Kilfrost	P2143-3500	75/25	-3°C
TH14	Kilfrost	P2143-3500	75/25	-3°C
TH15	Kilfrost	P2143-3500	50/50	-3°C
TH16	Kilfrost	P2143-3500	50/50	-3°C
TH17	Clariant	MP III (OAT)	100/0	-3°C
TH18	Clariant	MP III (OAT)	100/0	-3°C
TH19	Clariant	MP III (OAT)	75/25	-3°C
TH20	Clariant	MP III (OAT)	75/25	-3°C
TH21	Clariant	MP III (OAT)	50/50	-3°C
TH22	Clariant	MP III (OAT)	50/50	-3°C
TH23	Clariant	MP III (20°C)	100/0	-3°C
TH24	Clariant	MP III (20°C)	100/0	-3°C
TH25	Clariant	MP III (20°C)	75/25	-3°C
TH26	Clariant	MP III (20°C)	75/25	-3°C
TH27	Clariant	MP III (20°C)	50/50	-3°C
TH28	Clariant	MP III (20°C)	50/50	-3°C

Notes:
- If the results for one fluid vary by more than 10% repeat the two tests and disregard the highest and lowest values
- The quantity of fluid that will be poured for each test is 1.0 L

TABLE 4: TEST PLAN – ADHERENCE IN MIXED SNOW AND RAIN CONDITIONS

Test #	Priority	Fluid Type	Fluid Brand	Dilution	Fluid Temp. [°C]	Precip Type	Test Temp. [°C]	Water Temp. [°C]	Water Temp Increase	Snow Precip Rate [g/dm²/h]	Freezing Rain Precip Rate [g/dm²/h]	Combined Precip Rate [g/dm²/h]	NRC Condition	Timing With HOT Tests
RS1	1	IV	EG 106	Neat	-3	SN/R	-3	+3	TBD**	12	13	25	R 13, -3	Invasive (following HOT)
RS2	2	IV	ABC-S +	Neat	-3	SN/R	-3	+3	TBD**	12	13	25	R 13, -3	Invasive (following HOT)
RS3	3	II	Kilfrost 2143-3500	Neat	-3	SN/R	-3	+3	TBD**	12	13	25	R 13, -3	Invasive (following HOT)
RS4	1	IV	EG 106	Neat	-3	ZR	-3	-	-	-	25	25	ZR 25, -3	in Conjunction
RS5	2	IV	ABC-S +	Neat	-3	ZR	-3	-	-	-	25	25	ZR 25, -3	in Conjunction
RS6	3	II	Kilfrost 2143-3500	Neat	-3	ZR	-3	-	-	-	25	25	ZR 25, -3	in Conjunction

* Duplicates of each test will be conducted simultaneously. Duplcate tests will be labled "Test #" A. i.e. RS1-A
** Water temperature must be raised incrementally until rain is no longer freezing on cold soaked surfaces.

OVERALL PROGRAM OF TESTS AT NRC, MARCH-APRIL 2008

TABLE 5: TEST PLAN – ICE PELLET ALLOWANCE TIME EXPANSION

Test #*	Fluid Type	Fluid Brand	Dil.	Fluid Temp. [°C]	Test Temp. [°C]	Precip Type	Ice Pellet Diameter [mm]	Freezing Rain Precip Rate [g/dm²/h]	Ice Pellet Precip Rate [g/dm²/h]	Combined Precip Rate [g/dm²/h]	ZR Generic HOT	Allowance Time Target [min.]	NRC Condition	Timing With HOT Tests	Approx. Testing Time	Comments
IP1	II	Kilfrost 2143-3500	Neat	-5	-5	ZR / IP	1-3.75	25	25	50	-	25	-5 / ZR 25	Invasive (following HOT)	2 hrs	All tests can be run simultaneoulsy.
IP2	III	Clariant MP III	Neat	-5	-5	ZR / IP	1-3.75	25	25	50	-	25	-5 / ZR 25	Invasive (following HOT)		
IP1-1	II	Kilfrost 2143-3500	Neat	-5	-5	ZR	-	25	-	25	15	-	-5 / ZR 25	Invasive (following HOT)		
IP2-1	III	Clariant MP III	Neat	-5	-5	ZR	-	25	-	25	8	-	-5 / ZR 25	Invasive (following HOT)		
IP3	II	Kilfrost 2143-3500	Neat	-10	-10	ZR / IP	1-3.75	25	25	50	-	10	-10 / ZR 25	Invasive (following HOT)	1.5 hrs	All tests can be run simultaneoulsy. If necessary, data from IP3-1 and IP4-1 can be used for the HOT data.
IP4	III	Clariant MP III	Neat	-10	-10	ZR / IP	1-3.75	25	25	50	-	10	-10 / ZR 25	Invasive (following HOT)		
IP3-1	II	Kilfrost 2143-3500	Neat	-10	-10	ZR	-	25	-	25	10	-	-10 / ZR 25	Invasive (following HOT)		
IP4-1	III	Clariant MP III	Neat	-10	-10	ZR	-	25	-	25	8	-	-10 / ZR 25	Invasive (following HOT)		

* Duplicates of each test will be conducted simultaneously. Duplcate tests will be labeled "Test #" A. i.e. IP1-A

TABLE 6: PERSONNEL REQUIREMENTS

	Endurance Times	Heated Type III	LOUT vs. -25°C	Thickness	Mixed Rain/Snow	IP Expansion	Dispensing System Improvement
JD	Mgr	Mgr	Mgr	-	-	-	-
SB	Rate Mgr	Rate Mgr	Rate Mgr	Mgr	-	-	-
JT	Rate Ast	Rate Ast	Rate Ast	-	Ast	Ast	-
MR	-	-	-	-	Mgr	Mgr	Mgr
YOW1	Gen Ast	Gen Ast	Gen Ast	-	Ast	Ast	Ast

TABLE 7: LIST OF FLUIDS

Fluid Name	Fluid Type	Dilution	Litres Required						
			Endurance Times	Heated Type III	LOUT vs. -25°C	Thickness	Mixed Rain/Snow	IP Expansion	Total
Kilfrost P2143-5000	II	100	32	-	-	2	-	-	**34**
Kilfrost P2143-5000	II	75	28	-	-	2	-	-	**30**
Kilfrost P2143-5000	II	50	12	-	-	2	-	-	**14**
Kilfrost P2143-3500	II	100	32	-	4	2	4	8	**50**
Kilfrost P2143-3500	II	75	28	-	-	2	-	-	**30**
Kilfrost P2143-3500	II	50	12	-	-	2	-	-	**14**
Clariant Flight	II	75	28	-	-	2	-	-	**30**
Clariant Flight	II	50	12	-	-	2	-	-	**14**
Clariant MP III	III	100	32	34	-	2	-	8	**76**
Clariant MP III	III	75	28	31	-	2	-	-	**61**
Clariant MP III	III	50	12	13	-	2	-	-	**27**
Dow EG 106 (2006001417-12)	IV	100	-	-	4	-	4	-	**8**
Kilfrost ABC-S+ (0131071797A)	IV	100	-	-	4	-	4	-	**8**
			256	**78**	**12**	**22**	**12**	**16**	**396**

TABLE 8: EQUIPMENT LIST #1

EQUIPMENT	LOCATION	STATUS
2 x 2-plate stand & 2 x 1-plate stand	Site	
1L Pour containers (4 filled/4 empty per fluid/d	Site	
Boards for cold-soak test x 10	Site	
Brixometer x 3	Site	
Clipboards x 6	Site	
Close circuit TV camera for rates	Site	
Cold-Soaked Boxes 7.5 cm x10	Site	
Cotton gloves	Site	
Electrical Extension Cords - Many	Site	
Fluids	Site	
Funnels	Site	
Marker for Waste x3	Site	
Hand-held Temperture Probes (Wahl) x3	Site	
Heating equipment and thermoses x2	Site	
Inclinometer (yellow level) x2	Site	
Isopropyl x4	Site	
Large digital clock x 2	Site	
Metal Rate Pans (for outdoor tests)	Site	
Paper for printer (1 pack)	Site	
Paper Towels (lots)	Site	
Pencils + pens + markers	Site	
Plate covers x 12	Site	
Plates x12 (w/logging capability)	Site	
Precipitation Rate Pans x 100	Site	
Printer	Site	
Protective clothing (6)	Site	
Pump (for waste)	Site	
Rubber Mats	Site	
Rubber squeegees x 4	Site	

EQUIPMENT	LOCATION	STATUS
Scrapers x2	Site	
Shop Vac	Site	
Steel Collection Pans	Site	
Still Digital Camera Rebel (suitcase)	Site	
Storage bins for small equipment	Site	
Surface and immersable temperature probes	Site	
Tape measure	Site	
Test Stands (2 x 6-plate stands)	Site	
Thermistor Kit + Logger	Site	
Thickness Gauges x 3 (both types)	Site	
Walkie Talkies x 4	Site	
Waste containers x MANY (10-15)	Site	
Weigh Scale x 2 (sartorius) + wiring	Site	
White Billboard for water run-off	Site	
Yellow Carrying Cases for Pour Containers x	Site	
Accordian Folder	Office	
ARP 5485 and ARP 5945	Office	
Chamber Layout Diagram	SB	
Data Forms (SB to handle)	Office	
Envelopes (9x12)	Office	
HOT Report + HOT Tables	Office	
NRC Flow Settings (SB)	SB	
Laptop Computers x 3	Office/Site	
Precipitation Rate Data Forms (SB)	Office	
Test Procedures x 2 (1 sided)	Office	
Trend Reader Express Software	Office	
Fluid for cold-soak boxes (barrel)	NRC	
Shelving unit x 1 (to purchase)	NRC	

TABLE 9: EQUIPMENT LIST #2

Test Equipment	
Test Procedure, data forms	
Large clock	
Ice pellets dispensing devices x 6 / stands and adapter	
Desktop/Laptop computer with printer with paper	
Temperature Probe x 2 and spare batteries / immersion and surface probes	
Thickness Gauges (large and small)	
Brixometers x 3	
Adherence Probes	
Weigh scale (NCAR and HOT)	
Large Umbrella x2	
Ice Pellets Fabrication Equipment	
Styrofoam containers x 20	
Ice bags + Freezer (Lake Ontario Ice)	
Blenders (x 6)	
Ice pellets sieves (round and square)	
Folding tables	
Scrapers	
Measuring cups	
Rubber mats	

FIGURE 2: 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

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 3: COLD-SOAK WING 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 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 4: 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 5: 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 6: ADHERENCE OF FLUID FAILURE DATA FORM

Date: ____________ Time: ______________ Plate Location: _________

Run #: ____________ Fluid Name: ______________ Fluid Dilution: _________

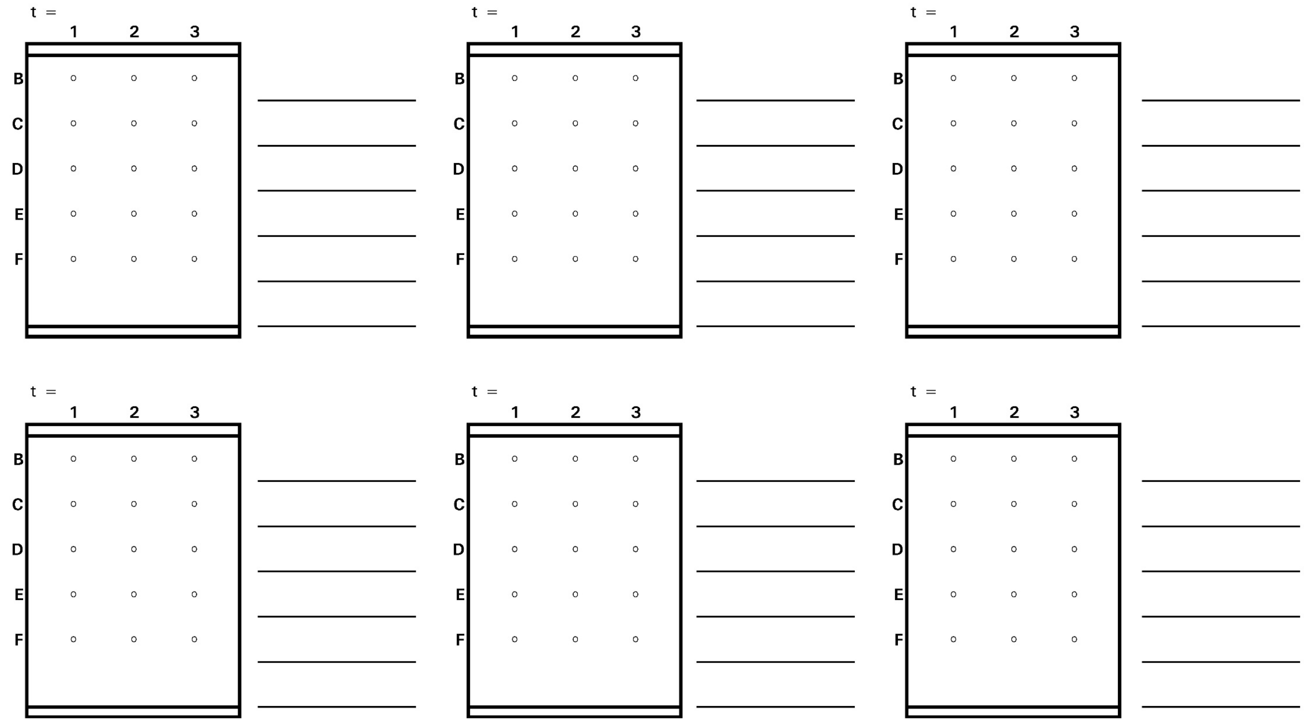


FIGURE 7: POSITION OF ICE PELLET DISPENSER SYSTEM DATA FORM

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

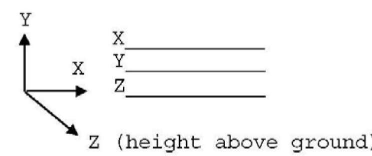
Pos. 7	Pos. 8	Pos. 9	Pos.10	Pos.11	Pos.12
ZR	ZR	ZR	ZR	ZR	ZR
IP	IP	IP	IP	IP	IP
ZR/IP	ZR/IP	ZR/IP	ZR/IP	ZR/IP	ZR/IP

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____________

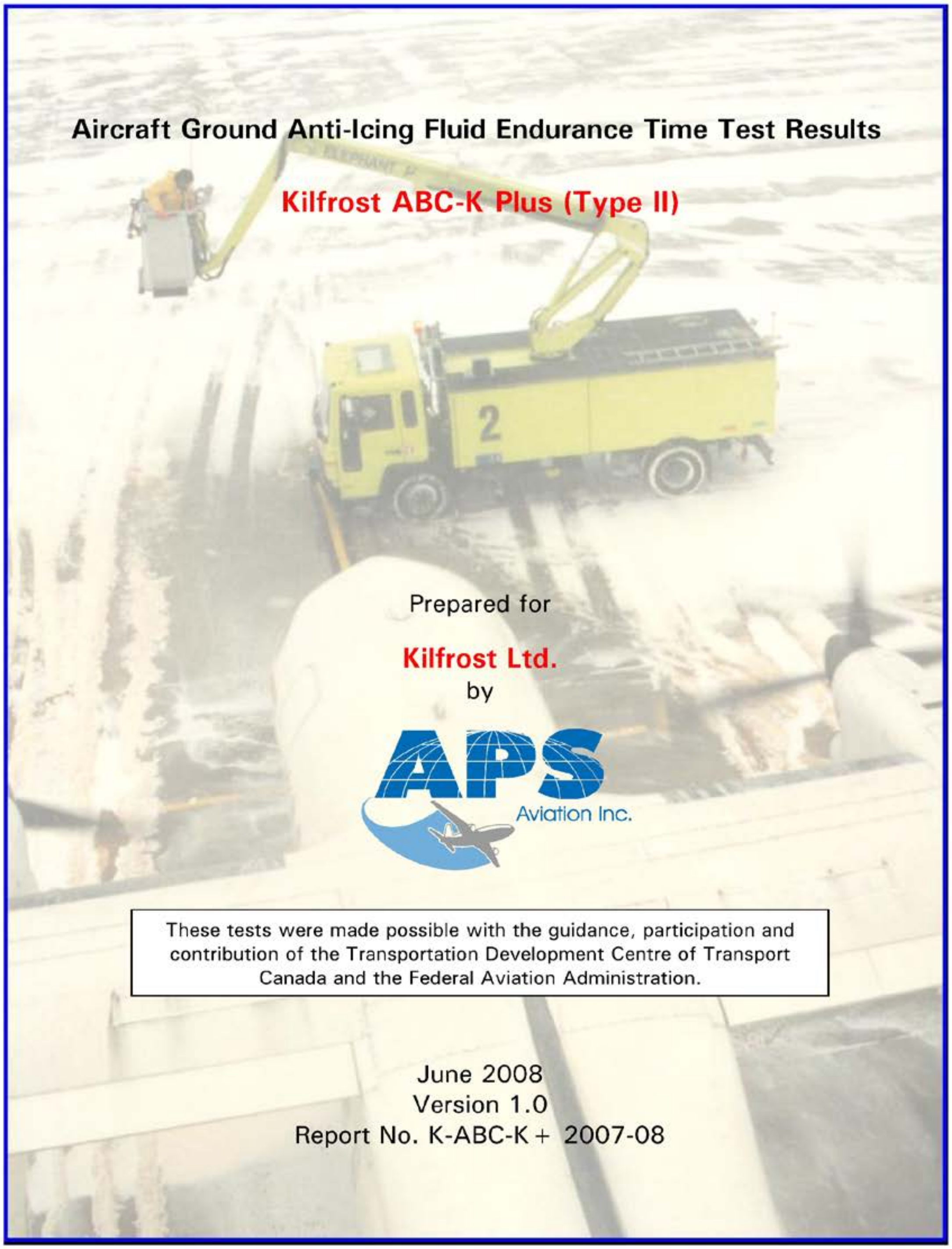
Y____________

Z____________

(1) Origin is bottom left corner of stand

APPENDIX C

FLUID MANUFACTURER REPORT: KILFROST ABC-K PLUS (TYPE II)



Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Kilfrost ABC-K Plus (Type II)

Prepared for

Kilfrost Ltd.

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.

June 2008
Version 1.0
Report No. K-ABC-K + 2007-08

Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Kilfrost ABC-K Plus (Type II)

Prepared for

Kilfrost Ltd.

Prepared by: ______________________ June 20, 2008

Stephanie Bendickson — Date

Project Analyst

Reviewed by: ______________________ June 20, 2008

John D'Avirro — Date

Program Manager, Eng.

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.

June 2008

Version 1.0

Report No. K-ABC-K + 2007-08

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	Kilfrost		
Fluid (Test Name):	P2143-1		
Fluid (Commercial Name):	ABC-K Plus		
Fluid Type / Colour:	Type II / Clear		
Batch #:	P2143		
Date of Receipt:	Neat fluid:	February 14, 2008	
	75/25 dilution:	February 14, 2008	
	50/50 dilution:	February 14, 2008	
Brix Measured:	Neat fluid:	35.75°	
	75/25 dilution:	26.50°	
	50/50 dilution:	20.25°	
Viscosity (Manufacturer Method[1]):		**Manufacturer Stated**	**Measured by APS**
	Neat fluid:	3,500 cP	2,850 cP
	75/25 dilution:	13,500 cP	12,650 cP
	50/50 dilution:	4,000 cP	4,200 cP
Viscosity (AIR 9968 Method):		**Manufacturer Stated**	**Measured by APS**
	Neat fluid[2]:	3,100 cP	2,640 cP
	75/25 dilution[1]:	13,500 cP	12,650 cP
	50/50 dilution[2]:	4,800 cP	5,260 cP
WSET provided by AMIL:	Neat fluid:	63 minutes	

[1] Brookfield Spindle LV2-disc with guard leg, 150 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds
[2] Brookfield Spindle LV1 with guard leg, 500 mL of fluid, at 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 Kilfrost ABC-K Plus 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).

It should be noted that two neat samples, two 75/25 samples and two 50/50 samples of Kilfrost P2143 were submitted for endurance time testing in 2007-08. The samples had been sheared by different amounts and therefore had different viscosities. One set of dilutions will be commercialized as Kilfrost ABC-K Plus. The endurance time results of Kilfrost ABC-K Plus are given in this report. The other set of dilutions will not be commercialized; the endurance time results of those dilutions were provided to the manufacturer in a separate report.

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

De/anti-icing fluid endurance times were determined using a multi-variable regression analysis, resulting in the generation of the fluid-specific HOT table shown below.

Kilfrost ABC-K Plus Type IV Fluid Holdover Times

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	Degrees Fahrenheit		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	8:00	2:15 – 3:45	1:00 – 1:40	1:50 – 2:00	1:00 – 1:25	0:20 – 2:00	
		75/25	5:00	1:40 – 2:30	0:35 – 1:10	1:25 – 2:00	0:50 – 1:10	0:15 – 2:00	
		50/50	3:00	0:35 – 1:05	0:05 – 0:15	0:20 – 0:30	0:10 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00	0:30 – 1:05	0:50 – 1:25	0:25 – 1:00	0:15 – 0:35		
		75/25	5:00	0:25 – 1:25	0:35 – 1:05	0:20 – 0:55	0:05 – 0:30		
below -14 to -25	below 7 to -13	100/0	8:00	0:30 – 0:55	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

This page intentionally left blank.

vi

TABLE OF CONTENTS

This page intentionally left blank.

viii

LIST OF FIGURES

LIST OF TABLES

LIST OF 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
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-icing/anti-icing has been the subject of concentrated industry attention over the past decade due the occurrence of several fatal icing-related aircraft accidents. Recent attention has been placed upon 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 for use by aircraft operators and accepted by regulatory authorities. New anti-icing formulations continue to be developed by leading manufacturers with the specific objective of prolonging fluid HOTs without compromising the aerodynamic features of the airfoil.

Flat plate tests, conducted in natural and simulated precipitation, are used to develop and substantiate fluid HOT tables for current fluids and new formulations. Test procedures to measure the duration of fluid protection against ice formation have evolved into a refined Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5485 that is followed by APS Aviation Inc. (APS).

Testing of aircraft ground de/ant-icing fluids has resulted in the generation of HOT tables. These tables provide guidelines for use in departure planning in adverse winter conditions. They provide the HOT ranges for aircraft treated with any particular qualified deicing or anti-icing fluid.

A new data analysis protocol was developed in 1996-97 wherein the endurance time data for each fluid brand in each cell of the HOT tables was subject to a multi-variable regression treatment. Type II and Type IV fluid HOTs are determined using this method of analysis, resulting in the generation of generic and fluid-specific HOT tables.

This report provides the data and analysis used to determine the fluid HOTs for Kilfrost ABC-K Plus.

This page intentionally left blank.

2

2. METHODOLOGY

This chapter contains a description of the tests, equipment and procedures used to conduct endurance time tests. It is divided into sections dealing with the definition of weather, test sites, test conditions, equipment, procedures, and analysis methodology. A 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 was developed by APS for this testing, based upon the requirements of ARP 5485.

2.1 Definition of Weather Conditions

HOTs are provided as a function of weather condition, fluid dilution and outside air temperature. The objective of the winter test program was to develop HOTs for new fluids based on the most recent test data.

Table 2.1 provides definitions of most weather conditions experienced in winter operations and includes the criteria used to determine precipitation intensity (light, moderate, heavy). 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 2.1 includes definitions for the weather conditions described in the HOT tables (frost, freezing fog, snow, freezing drizzle, light freezing rain and rain). Definitions for snow pellets, hail and ice pellets are also presented, however these are conditions for which HOT guidelines do not exist.

The test methodology used to determine fluid endurance times has included the generally accepted upper and lower limits for precipitation rates for each type of precipitation. These limits were discussed in detail at a 1997 meeting of the SAE G-12 HOT Subcommittee where standard definitions of upper and lower precipitation rate limits were approved for each category of precipitation. These limits are documented and discussed in Subsection 2.6.

2.1.1 Snow

Table 2.1 contains the criteria that were used in the past to estimate the intensity of snow. These criteria are based upon horizontal visibility with three intensity levels. For light snow, visibility is greater than or equal to 1.0 km, moderate snow visibility is 0.5 km to less than 1.0 km, and heavy snow, visibility is less than 0.5 km.

As stated in a cautionary note in Table 2.1, visibility is only an indicator of snow intensity, and the two parameters are not always correlated.

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

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

Table 2.2 is the visibility table which has been published annually by TC since the winter of 2003-04 for use in winter operations. It is based on more recent data than Table 2.1 and provides more detail about snowfall intensity and visibility. APS, NCAR and TC all had input into the formation of this table, which is based on NCAR field data and theoretical work on classes of snow and on extensive field data compiled by APS. The table categorizes snowfall into one of four intensities based on visibility and lighting condition.

The FAA also publishes a visibility table, which is based on the same data set but differs slightly from the TC table.

Table 2.2: Visibility in Snow vs. Snowfall Intensity Chart[1]

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

[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.

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). The intensity of freezing drizzle is estimated, as it is for snow, through the measurement of horizontal visibility.

HOT tables have one column for freezing drizzle; however, Table 2.1 shows three intensity levels (light, moderate and heavy). For example, under moderate freezing drizzle, the rate of precipitation should range between 2.5 and 5.1 g/dm²/h. For heavy freezing drizzle, the definition indicates that the intensity is greater than 5 g/dm²/h. Discussions between United Airlines, NCAR and the National Research Council Canada (NRC) led to the upper limit value of 13 g/dm²/h for freezing drizzle. This value is also used as the lower limit for light freezing rain.

2.1.3 Freezing Rain

This form of precipitation 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 given 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
- 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

Normal natural snow test operations are performed at the APS test site located within 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 Environment Canada's Meteorological Services of Canada automated weather observation station (Photo 2.2).

Tests under conditions of freezing fog, rain on cold-soaked surface, freezing drizzle, and light freezing rain were conducted indoors at the NRC Climatic Engineering Facility (CEF), where precipitation was artificially produced.

The CEF is partitioned into two sections, separated by an insulated dividing door. Each partition can be separately controlled, permitting different tests to be conducted simultaneously. Photo 2.3 provides a general indication of the size of the facility. Photos 2.4 and 2.5 provide interior images of the small and large ends of the facility. The facility was designed and built for the testing of locomotives. The size of the chamber is 30 m by 5.4 m and its total height is 8 m. The lowest temperature achievable is -46ºC.

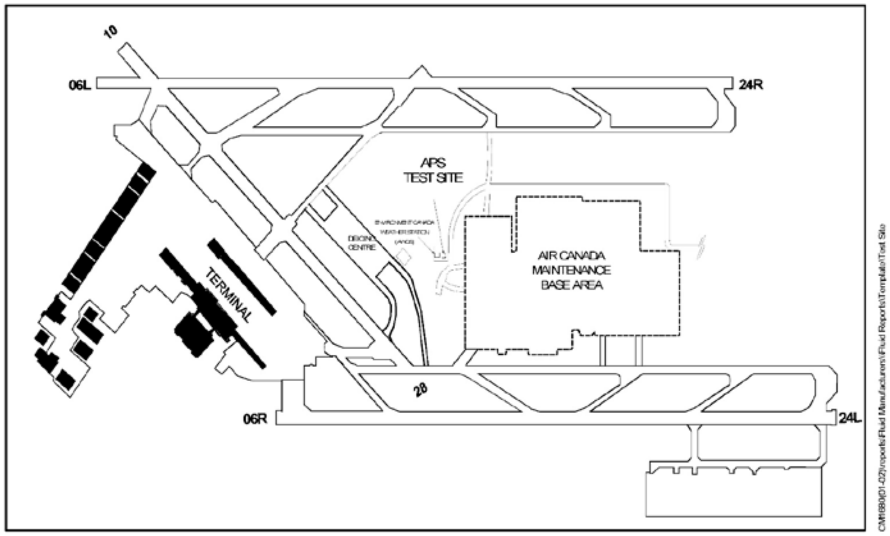


Figure 2.1: Test Site at the Montréal-Pierre-Elliott-Trudeau International Airport

2.3 Test Conditions

Outdoor testing was conducted during natural precipitation events. Supplementary tests to simulate freezing precipitation were carried out at the NRC CEF (see Photo 2.4). Subsections 2.3.1 and 2.3.2 provide descriptions of the spray assembly (see Photo 2.6) and of the methods used to produce and calibrate the fine water droplets in these artificial precipitation tests. Subsection 2.3.3 provides a summary of the categories and characteristics of each precipitation type produced for these tests.

2.3.1 Droplet Size and Rate of Precipitation

In the past few years, more industry attention has been given to the influence of droplet size on HOT. 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.

An improved sprayer assembly was developed in 1997-98 by the NRC and is shown in Photo 2.6. 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 2.7.

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 ARP 5485.

Since 1995, the APS team using a manual dye-stain technique employed by personnel at the NRC has carried 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:	Dorval 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.

Figures 2.2 and 2.3 show an example of the distribution of simulated light freezing rain droplets obtained at the NRC.

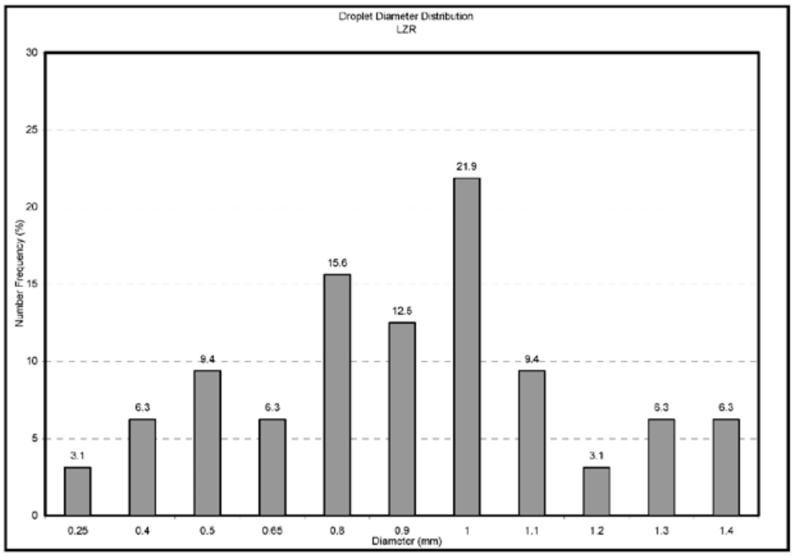


Figure 2.2: Droplet Diameter Distribution, Sample

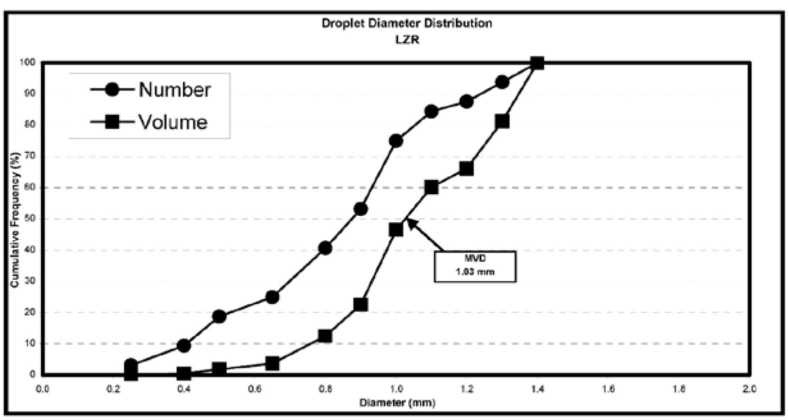


Figure 2.3: Cumulative Frequency of Droplet Diameter, Sample

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 a 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 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 ARP 5485.

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 2.8, 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 2.9 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.

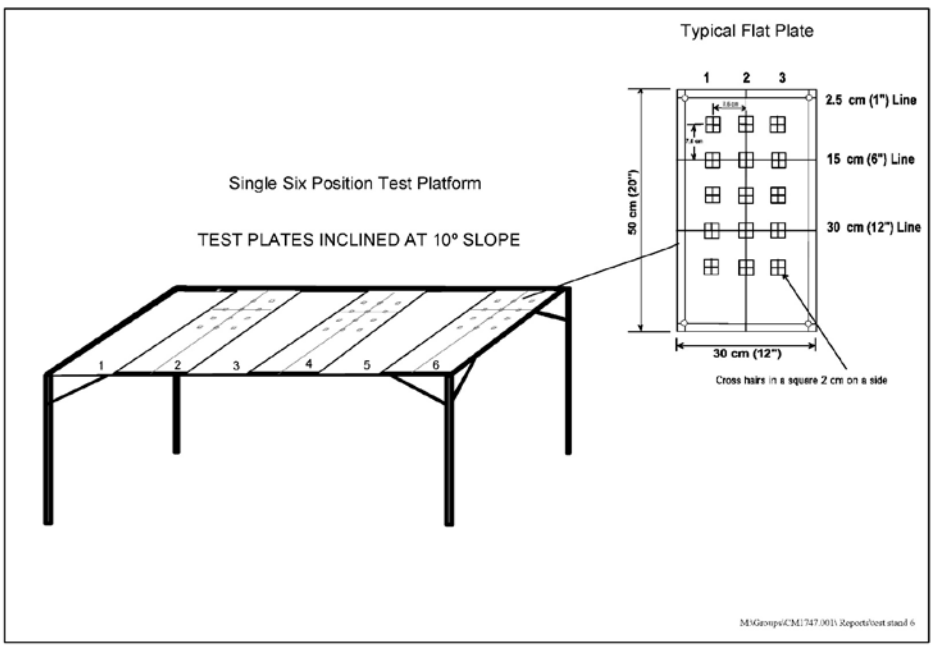
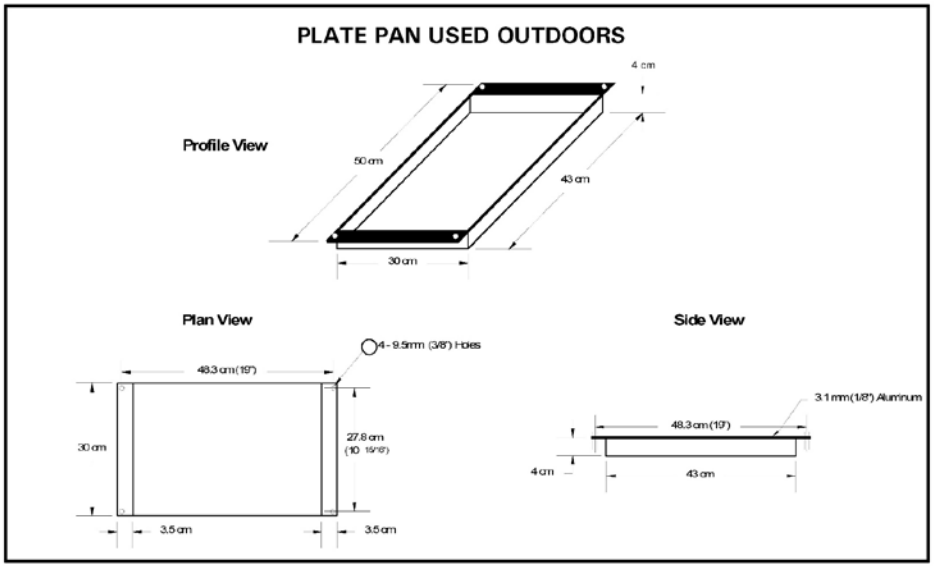
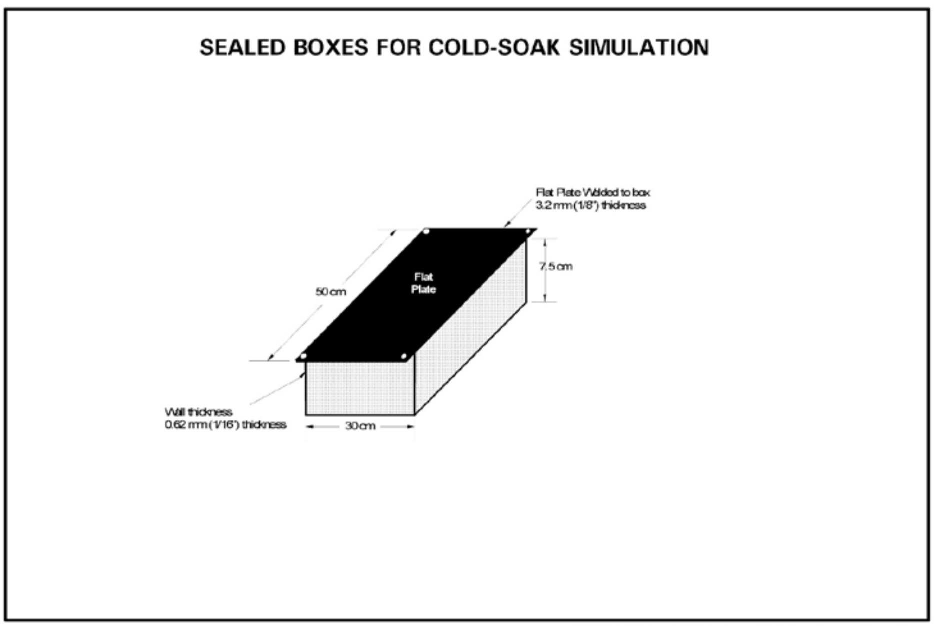


Figure 2.4: Flat Plate Test Set-Up





CM1680(01-02)\Reports\Fluid Manufacturers\Fluid Reports\Template\Pan and Boxes

Figure 2.5: Schematics of Plate Pan and Sealed Boxes

2.5 Test Procedures

Tests consisted of pouring anti-icing fluids directly onto clean test panels (exposed to various winter precipitation conditions) and recording the elapsed time for each crosshair to fail until the test panels reached the defined end condition (see Subsection 2.5.2 below).

2.5.1 Test Protocol (ARP 5485)

A plan 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 was developed by APS, based upon the requirements of ARP 5485. This procedure addresses testing conducted under natural precipitation conditions as well as under simulated freezing precipitation conditions.

Fluids to be evaluated are applied to test plates exposed to 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. All test parameters specified in ARP 5485 are addressed in the procedure developed by APS. 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: discussion of safety issues, test plate material, test plate dimensions, 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 the test stand, synchronization of timing devices, plate and ambient temperature profile files, icing intensity, etc.

As per ARP 5485 requirements, the test surface and ambient temperatures were recorded at a minimum sampling rate of one datum per minute. Figure 2.6 presents an example of a typical endurance time test conducted under simulated freezing drizzle conditions. The graph shows the test surface and chamber temperature profiles over the duration of the test and beyond failure time.

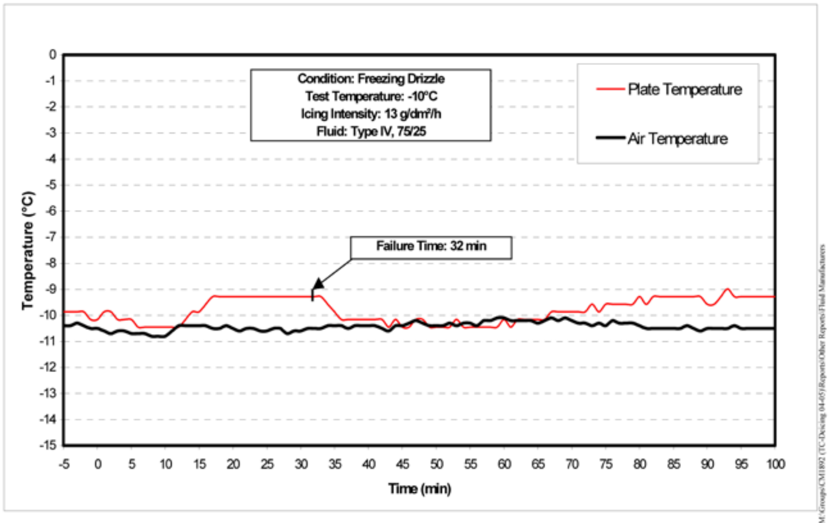


Figure 2.6: Temperature Profiles During a Typical Endurance Time Test

2.5.2 Test Protocol

The SAE G-12 HOT Subcommittee developed the procedure for natural snow flat plate tests.

The major steps in the natural snow flat plate test procedure are:

- Synchronize all timepieces;
- Clean panels and start;
- Apply (pour) fluids to test panels. Type II, Type III, and Type IV fluid are applied at the outdoor ambient temperature. Fluids are poured using a single-step fluid application;
- Record crosshair end condition times;
- Continue testing until at least five crosshairs or 30 percent (1/3) of the plate have failed;
- Record weather conditions; and
- Clean panels and restart.

2.5.3 End Condition Definitions

The test procedures and the determination of defined end conditions evolved from the experience the APS test team has accumulated from previous winter season test programs. Any of the following descriptions provide the general guidelines that observers use to judge when fluid failure occurs and to judge the extent of contamination or failure:

Failure is called when 30 percent (1/3) of the plate is 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.

2.5.4 Precipitation Rate Procedures

2.5.4.1 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 (h: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.

2.5.4.2 Precipitation rate distribution in simulated conditions

Clean test plates are placed on the test stand prior to the rate collection period, and are exposed to the simulated precipitation to verify that an even ice formation occurs over the entire test bed. If this visual inspection proves satisfactory, the rate collection period will begin. If this visual inspection proves unsatisfactory, the test stand must be repositioned under the spray device and the process is then repeated.

In order to verify the rate distribution on the test stand, a continuous rate-monitoring pan is replaced with a detailed rate distribution pan, which consists of 4 small pans of equivalent size. The area of the 4 small pans combined is similar to that of a standard rate collection pan. The small pans are weighed and placed at these locations and re-weighed at fixed intervals. The typical collection period for rate distribution is 60 minutes, however this interval may be shorter if all tests have been completed within 60 minutes. The variation between the rate of any of the 4 small pans and that of the average rate of that location should not be greater than 10 percent.

Two examples of the detailed rate distributions are shown in Table 2.4. Both rate distributions were conducted in freezing drizzle, one at the low rate (5 g/dm^2/h), the other at the high rate (13 g/dm^2/h). The average precipitation rate over the entire position in the low rate example in Table 2.4 was 5.1 g/dm^2/h. The individual rates of the four smaller pans were 5.0, 4.9, 5.2 and 5.3 g/dm^2/h, suggesting a maximum variation of 4.1 percent from the average rate over the entire position.

Table 2.4: Detailed Rate Distribution

Freezing Drizzle (low rate)

ZD AT NRC (-3°C)
DETAILED RATE OF PRECIPITATION

FORM: 1

PAN #	Plate Loc.	t1 TIME BEFORE	t2 TIME AFTER	w1 WEIGHT BEFORE	w2 WEIGHT AFTER	w2-w1 (g)	t2-t1 (min)	RATE (g/dm²/h)
3	2-top left	14:02	14:34	81.6	88.8	7.2	31.9	5.0
4	2-top right	14:02	14:34	81.6	88.6	7	31.9	4.9
5	2-bottom left	14:02	14:34	81.8	89.2	7.4	31.9	5.2
6	2-bottom righ	14:02	14:34	81.6	89.2	7.6	31.9	5.3

	3	4	5		STDDEV
	5.0	4.9	-1.4%	-4.1%	0.181
	5.2	5.3	1.4%	4.1%	
	5	6			

X Axis	Area	Full	Y
		Partial	
	Speed	High	Y
		Low	
Y Axis	Area	Full	Y
		Partial	
	Speed	High	Y
		Low	

Freezing Drizzle (high rate)

ZD AT NRC (-3°C)
DETAILED RATE OF PRECIPITATION

FORM: 1

PAN #	Plate Loc.	t1 TIME BEFORE	t2 TIME AFTER	w1 WEIGHT BEFORE	w2 WEIGHT AFTER	w2-w1 (g)	t2-t1 (min)	RATE (g/dm²/h)
3	5-top left	12:12	12:43	81.8	98.8	17	30.8	12.3
4	5-top right	12:12	12:43	81.6	98.8	17.2	30.8	12.5
5	5-bottom left	12:12	12:43	81.6	100.2	18.6	30.8	13.5
6	5-bottom righ	12:12	12:43	81.6	100.2	18.6	30.8	13.5

	3	4	12.9		STDDEV
	12.3	12.5	-4.8%	-3.6%	0.631
	13.5	13.5	4.2%	4.2%	
	5	6			

X Axis	Area	Full	Y
		Partial	
	Speed	High	Y
		Low	
Y Axis	Area	Full	Y
		Partial	
	Speed	High	Y
		Low	

2.5.4.3 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 2.7. 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 t_1, t_2, and t_3 (minutes). The calculated rates for each collection period are indicated by R_1, R_2, and R_3 (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 2.4, 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.

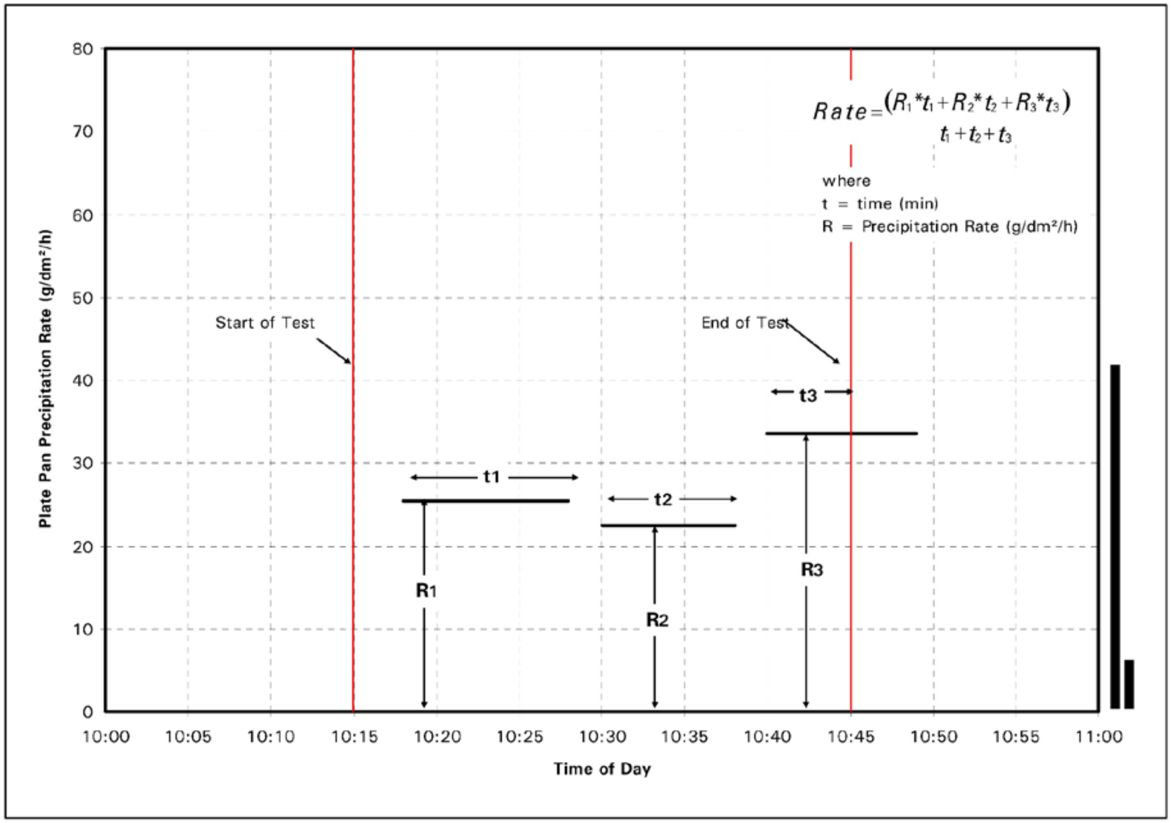


Figure 2.7: Calculation of Outdoor Precipitation Rate

2.6 Analysis Methodology

2.6.1 General

This section of the report describes the various categories of precipitation and the precipitation rate limits used during the course of endurance time testing. The process of data analysis used in the determination of fluid HOTs is also described.

2.6.2 Descriptions of Data Ranges and Precipitation Definitions

The test program developed to measure fluid failure times was carried out under five general categories of precipitation:

- Natural snow;
- Freezing drizzle;
- Light freezing rain;
- Freezing fog; and
- Rain on a cold-soaked surface.

Tests were conducted over temperature and precipitation rate ranges specific to each category of precipitation. A multi-variable regression procedure was used to evaluate fluid HOTs (first presented in TC report, TP 13131E) and is based on the refinement of an equation for a curve which best represents the fluid failure time test data, and then solving that equation at the upper and lower limits of a defined precipitation range. To support this procedure, precipitation rate limits for each specific category of precipitation were defined, reviewed and approved.

The precipitation rate limits used for the evaluation of HOT's are represented schematically in Figure 2.8. Detailed definitions and explanations of the data types and ranges are described in the following subsections. Meteorologically accepted definitions of these conditions were outlined in Table 2.1.

2.6.2.1 Natural snow

All fluid failure tests in natural snow were conducted at the APS Dorval Airport test site. Data were collected for precipitation rates that ranged from less than 4 g/dm²/h to greater than 25 g/dm²/h. For Type II and Type IV fluids, upper and lower limits for the snow column were set at rates of 10 and 25 g/dm²/h, respectively. For Type I and Type III fluids, the limits were set at rates of 4, 10 and 25 g/dm²/h (very light, light and moderate snow).

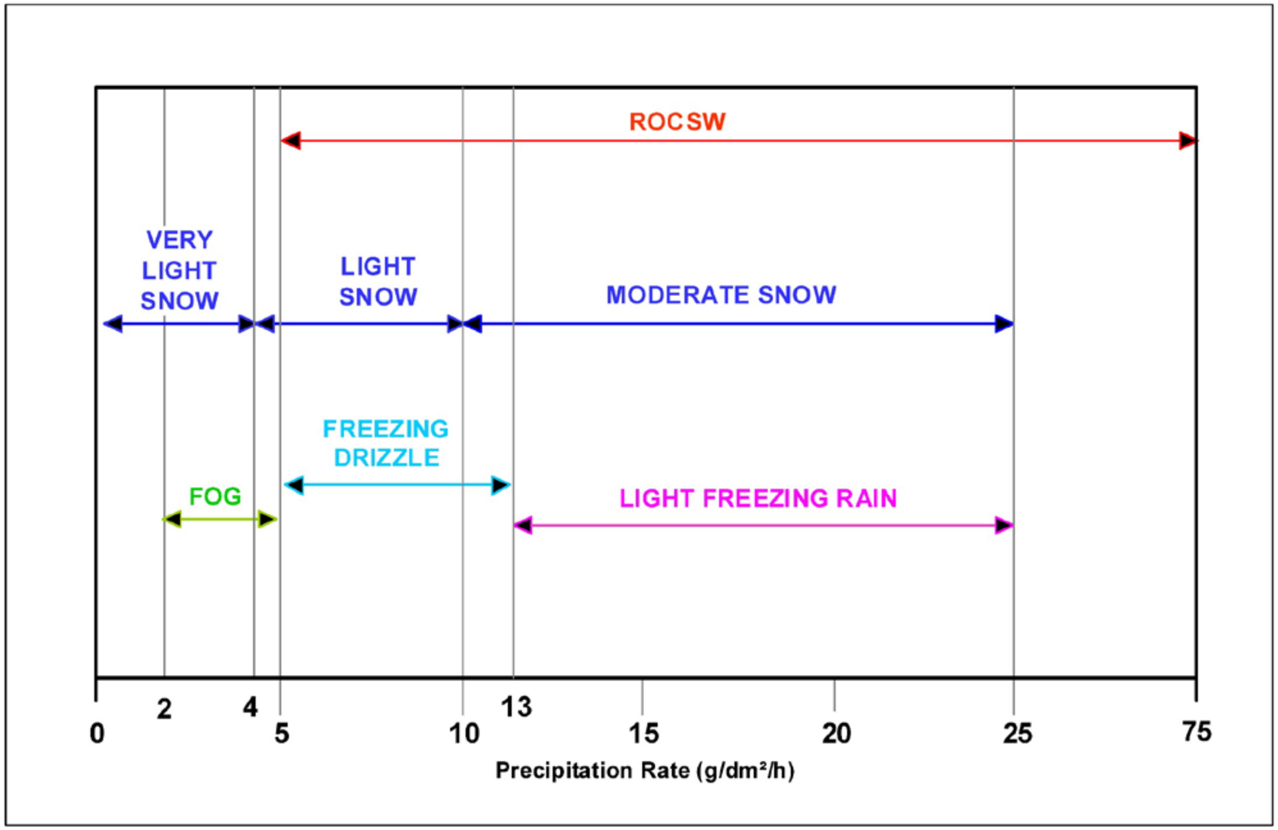


Figure 2.8: Data Range Used for Evaluation of Holdover Time Limits

For all fluid types, the upper precipitation rate limit (25 g/dm^2/h) corresponds to the onset of heavy snow. Above this rate, it is standard practice to refer to the cautionary note included in the HOT tables indicating that the time of protection will be shortened in heavy weather conditions, (i.e., heavy precipitation, or high moisture content).

2.6.2.2 Freezing drizzle

Freezing drizzle is considered to occur over the range of 0 to 13 g/dm^2/h. The upper limit in this range, while not specifically defined in Table 2.1, has been adopted based on discussions with meteorological experts and aircraft operators on the SAE G-12 HOT Subcommittee.

For test purposes, the precipitation rate spectrum for freezing drizzle is constrained to rates between 5 and 13 g/dm^2/h, inclusively. 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.

2.6.2.3 Light freezing rain

With reference to the HOT tables, freezing rain conditions span the range of precipitation rates from 13 to 25 g/dm^2/h, inclusively. This range falls in 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.

2.6.2.4 Freezing fog

The precipitation rate limits for freezing fog were arrived at 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/m^3.

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.

Since 1997, the upper and lower HOTs for freezing fog have been evaluated at rates of 5 g/dm^2/h and 2 g/dm^2/h, respectively. In Vienna, during the 1998 SAE G-12 HOT Subcommittee meeting, it was felt that 2 g/dm^2/h was not indicative of low rate natural fog. However, during a meeting of the Workgroup on Laboratory Methods to Derive HOT Guidelines in Montreal in March 1999, it was again agreed upon that the rate of 2 g/dm^2/h would be used in subsequent HOT testing in order to determine the upper HOT limit in freezing fog conditions.

2.6.2.5 Rain on a cold-soaked surface

Data used for the evaluation of HOTs for this category of precipitation were limited to precipitation rates ranging from 5 to 75 g/dm^2/h, which 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). The heavy rain category is covered by the caution note at the bottom of the HOT table regarding heavy weather conditions.

2.6.3 Protocol for the Determination of Holdover Times

Each cell in a HOT table represents a range of time during which a fluid at a specified concentration will provide protection for a particular temperature range in a particular category of precipitation. The Type II and Type IV HOT tables are composed of a maximum of 30 cells. Each cell contains a lower and upper time limit (except in frost) for a maximum of 54 time values.

Cell HOT values are determined by plotting *Failure Time* versus *Rate of Precipitation* and recording the failure time at two pre-selected rate limits. In previous years, several protocols were employed in the determination of HOTs. Due to the subjective natures of these different protocols, different interpretations of the data were possible. A multi-variable regression approach was subsequently devised in 1996/97 (see TC report, TP 13131E) and has since been used to evaluate fluid holdover times.

Data corresponding to each cell in the HOT table were assembled and sorted according to precipitation type, fluid dilution and temperature range. The data for each cell in the HOT table were plotted.

The data points on each plot were used to fit an equation of the form:

$$t = cR^{a}$$

where

t	=	Time (minutes)
R	=	Rate of precipitation (g/dm^2/h)
a,c	=	coefficients determined from the regression.

The coefficient a gives the rate dependency of the failure time.

Sample plots of **Log t** versus **Log R** are shown in Figure 2.9. The plots contain data from one temperature range, for one Neat Type IV fluid 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 2.10. 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 snow.

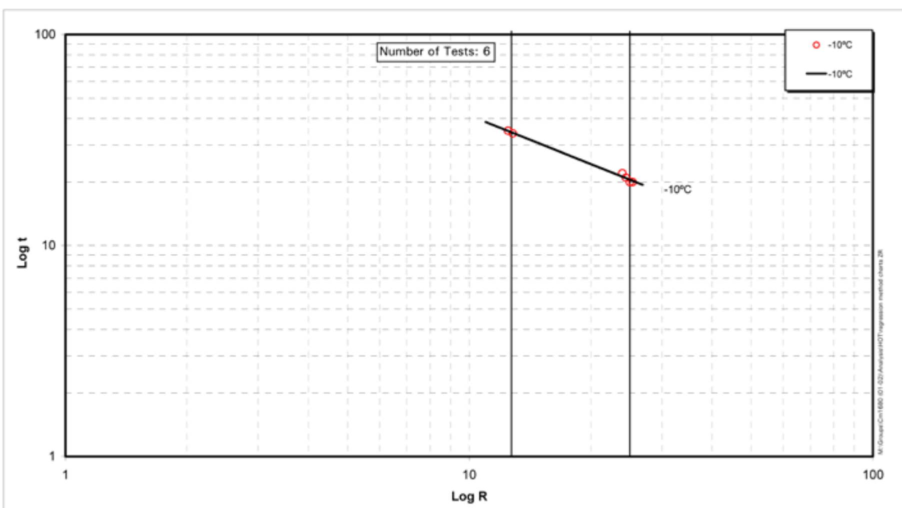


Figure 2.9: Regression Method on Log-Log Chart – Sample Type IV Neat, Freezing Rain

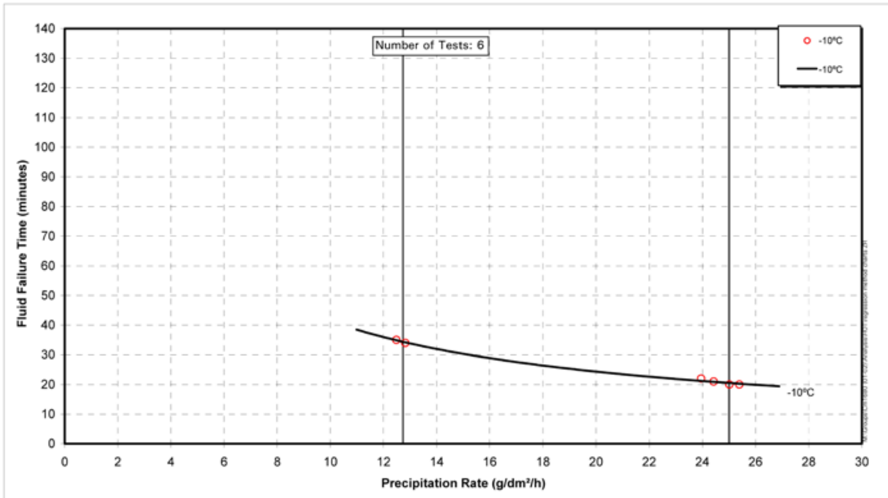


Figure 2.10: Regression Method on Standard Chart – Sample Type IV Neat, Freezing Rain

The HOTs for this fluid at -10°C are 20 minutes at 10 g/dm^2/h and 35 minutes at 25 g/dm^2/h, establishing the HOT range for this particular fluid. This illustrates the general approach used in the determination of a fluid HOT range for any given cell in the HOT table.

The categories of precipitation are separated into five groups: natural snow, freezing drizzle, light freezing rain, freezing fog, and rain on a cold-soaked surface. Each group was subject to a slightly modified version of the general equation given above, as described in the following subsections.

2.6.3.1 Light freezing rain and freezing drizzle

The equation used to treat the data in these categories of precipitation is given by the expression below:

$$t = cR^a$$

- Tests in freezing drizzle and light freezing rain were conducted at predetermined temperature limits (-3 and -10°C). The best-fit curves for data corresponding to a given cell in the HOT table in these conditions were also obtained by using the most restrictive (lowest) cell range temperature.

2.6.3.2 Simulated freezing fog

The equation used to treat freezing fog data is given by the expression below:

$$t = cR^a$$

- Tests in freezing fog were conducted at predetermined temperature limits (-3, -14 and -25°C). The best-fit curves for data corresponding to a given cell in the HOT table in these conditions were obtained by using the most restrictive (lowest) cell range temperature.

2.6.3.3 Natural snow

The general form of the regression equation was modified for natural snow by substituting 2-T for the variable T, in order to prevent taking the log of a negative number as natural snow can occur at temperatures approaching 2°C.

$$t = cR^a(2-T)^b.$$

- Best-fit curves were plotted for each fluid in each cell of the snow column using the most restrictive (lowest) temperature for that cell. For example, in cases of natural snow tests conducted at ambient temperatures above -3°C, the value of temperature used in the fitting procedure was -3°C.

- The upper and lower HOT values were determined from the points at which the best-fit curve intersects the lower and upper precipitation limits, respectively.

2.6.3.4 Rain on a cold-soaked wing

The same method for the evaluation of HOTs in light freezing rain and freezing drizzle was used for this category of precipitation.

2.6.4 Determination of Generic and Fluid Specific Holdover Times

At the SAE HOT Subcommittee meeting in Chicago in July 1997, Type IV fluid HOTs obtained using the multi-variable regression protocol of data analysis were presented. Wide variations in fluid performance among the different Type IV fluid brands forced the development of generic Type II and IV HOT tables as well as fluid-specific Type II and IV HOT tables.

2.6.4.1 Fluid-specific holdover time tables

Fluid-specific HOT table development was prompted by the fact that certain Type IV fluid brands were observed to significantly outperform other fluids under conditions corresponding to specific cells in the HOT tables. In general, any one fluid brand does not globally outperform the other fluid brands, but rather does so at a specific dilution, temperature range, and/or category of precipitation.

At the Chicago meeting in 1997, most members of the SAE G-12 HOT Subcommittee did not favour fluid-specific tables. However, significant reductions to HOTs for the cells corresponding to the most common Type IV fluid usage convinced the committee of the need to consider the development of fluid-specific and generic tables. Furthermore, some members wanted to take advantage of the significant benefits exhibited by some fluids in certain conditions.

A summary of the steps to follow to determine fluid specific values for a Type II or IV fluid is provided below:

- The method used to determine HOTs is generally the same as was agreed upon in Chicago in 1997 at the SAE G-12 HOT Subcommittee meeting;
- For each cell of the HOT tables, four tests are typically conducted at the lowest temperature in the temperature range for that cell. Two tests are conducted at the low precipitation rate condition and at the high precipitation rate condition, for a total of four tests per cell;
- For each cell of the HOT table (except frost), a best-fit power law curve for each fluid is developed from the tests conducted at the low and high precipitation rate condition of that cell;
- Regression-generated HOTs are rounded off to the nearest whole "5" digit. For example, 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 HOTs are below 10 minutes, the numbers are rounded down as a precautionary measure. For example, 9 minutes is rounded down to 5 minutes; and
- Values are capped at 2 hours for all precipitation conditions except freezing fog, which are capped at 4 hours.

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 National Research Council Climatic Engineering Facility

Photo 2.4: Inside View of Small End of Climatic Engineering Facility

Photo 2.5: Inside View of Large End of Climatic Engineering Facility

Photo 2.6: Sprayer Assembly Used at National Research Council

Photo 2.7: Sprayer Nozzle

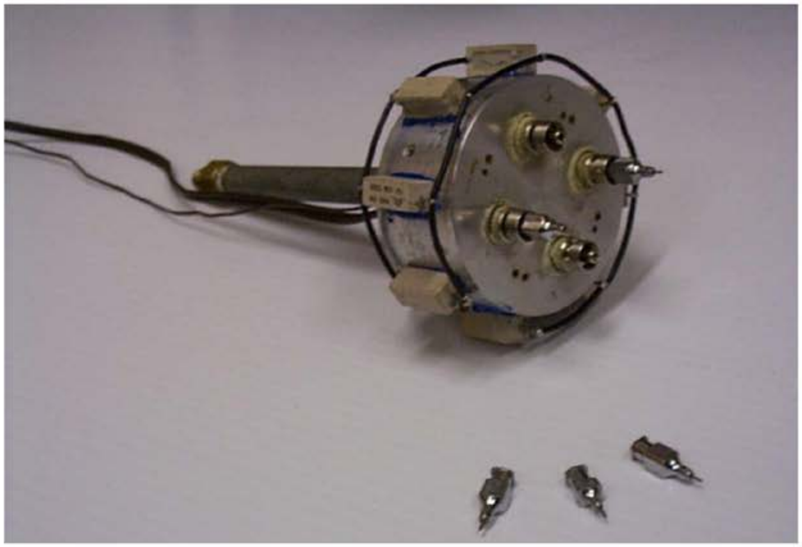


Photo 2.8: Test Plates Mounted on Stand

Photo 2.9: Collection Pans Used Indoors at the National Research Council

This page intentionally left blank.

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 surfaces. Breakdowns are provided for quantity of tests performed by fluid type and temperature.

Summaries of tests conducted in natural snow and in 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 the tests conducted is summarized below by fluid dilution and temperature.

	Above -3°C	-3 to -14°C	-14 to -25°C	Total
Neat	16	13	0	29
75/25	13	14	0	27
50/50	29	0	0	29
				85

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 the 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	4	4	4
50/50	4	0	4	0

3.3 Freezing Fog Tests

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

	-3°C	-14°C	-25°C
Neat	4	4	4
75/25	4	4	0
50/50	4	0	0

3.4 Rain on Cold-Soaked Surface Tests

Cold-soak tests were conducted with Neat and 75/25 dilutions using 7.5 cm deep sealed boxes. Tests were conducted at an ambient temperature of +1°C at the NRC CEF. Duplicate tests were conducted with each dilution at each precipitation rate.

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.

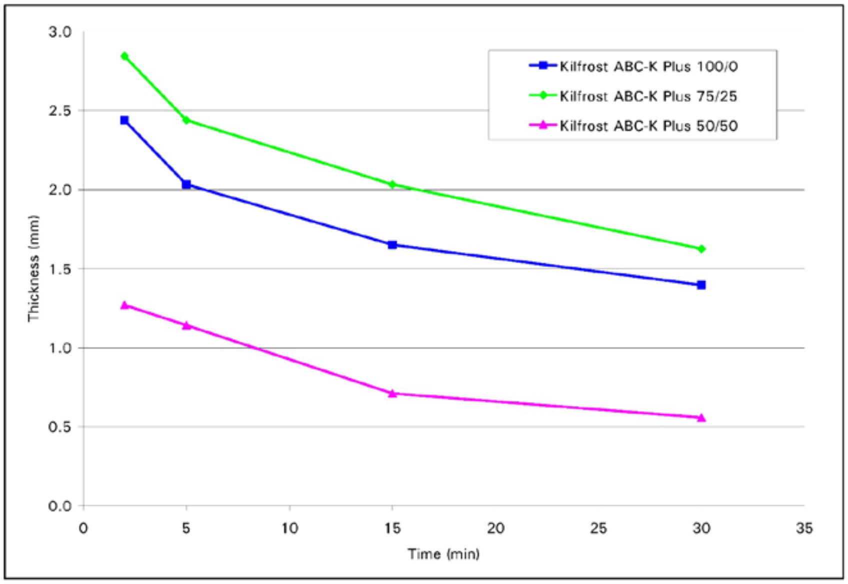


Figure 3.1: Fluid Thickness Profiles of Kilfrost ABC-K Plus

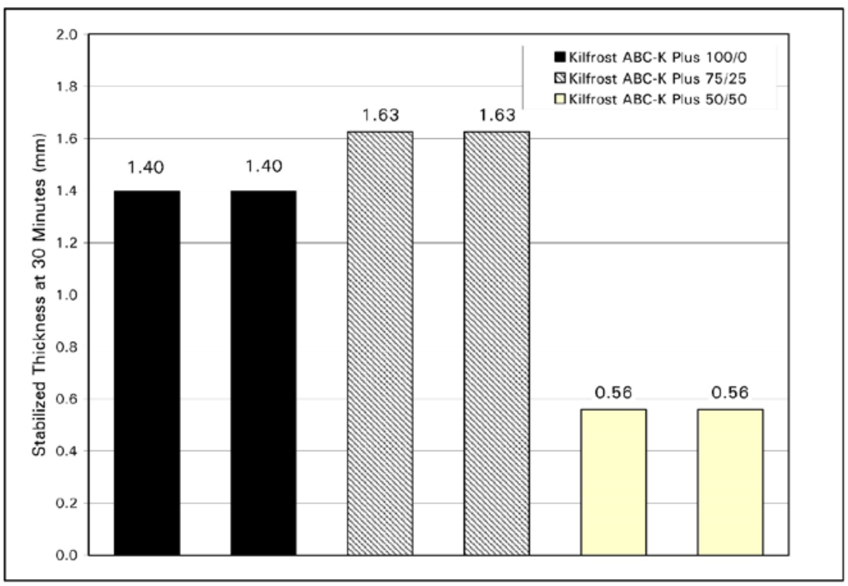


Figure 3.2: Final Fluid Thickness of Kilfrost ABC-K Plus

Table 3.1: Summary of Tests Performed in 2007-08 (Snow)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
226	15-Feb-08	Kilfrost ABC-K Plus	100%	104.9	11.0	-2.9	Natural Snow
228	15-Feb-08	Kilfrost ABC-K Plus	75%	74.2	10.0	-3.3	Natural Snow
232	15-Feb-08	Kilfrost ABC-K Plus	75%	52.7	15.2	-2.8	Natural Snow
237	15-Feb-08	Kilfrost ABC-K Plus	100%	97.8	11.5	-2.8	Natural Snow
238	15-Feb-08	Kilfrost ABC-K Plus	50%	12.8	12.0	-2.9	Natural Snow
239	15-Feb-08	Kilfrost ABC-K Plus	100%	108.8	10.7	-2.9	Natural Snow
241	15-Feb-08	Kilfrost ABC-K Plus	75%	60.8	11.1	-2.8	Natural Snow
246	15-Feb-08	Kilfrost ABC-K Plus	50%	21.0	7.6	-2.8	Natural Snow
249	15-Feb-08	Kilfrost ABC-K Plus	50%	19.3	6.8	-2.9	Natural Snow
250	15-Feb-08	Kilfrost ABC-K Plus	50%	16.2	6.5	-2.9	Natural Snow
252	15-Feb-08	Kilfrost ABC-K Plus	50%	13.7	10.3	-2.9	Natural Snow
253	15-Feb-08	Kilfrost ABC-K Plus	75%	68.8	8.5	-2.9	Natural Snow
258	15-Feb-08	Kilfrost ABC-K Plus	100%	161.2	1.9	-2.6	Natural Snow
267	15-Feb-08	Kilfrost ABC-K Plus	75%	81.3	6.2	-2.6	Natural Snow
270	15-Feb-08	Kilfrost ABC-K Plus	50%	24.5	6.1	-2.6	Natural Snow
273	15-Feb-08	Kilfrost ABC-K Plus	50%	18.5	9.2	-2.4	Natural Snow
274	26-Feb-08	Kilfrost ABC-K Plus	100%	177.9	4.7	-2.0	Natural Snow
275	26-Feb-08	Kilfrost ABC-K Plus	100%	125.2	4.3	-1.9	Natural Snow
278	26-Feb-08	Kilfrost ABC-K Plus	75%	136.1	4.1	-1.9	Natural Snow
279	26-Feb-08	Kilfrost ABC-K Plus	75%	140.2	4.0	-1.9	Natural Snow
280	26-Feb-08	Kilfrost ABC-K Plus	50%	53.7	2.5	-1.9	Natural Snow
284	26-Feb-08	Kilfrost ABC-K Plus	100%	147.3	4.9	-2.1	Natural Snow
285	26-Feb-08	Kilfrost ABC-K Plus	50%	36.1	4.0	-2.1	Natural Snow
288	26-Feb-08	Kilfrost ABC-K Plus	75%	104.3	6.8	-2.5	Natural Snow
291	26-Feb-08	Kilfrost ABC-K Plus	50%	34.2	5.5	-2.4	Natural Snow
292	26-Feb-08	Kilfrost ABC-K Plus	50%	33.7	3.8	-2.3	Natural Snow
294	26-Feb-08	Kilfrost ABC-K Plus	100%	165.9	7.8	-2.5	Natural Snow
295	26-Feb-08	Kilfrost ABC-K Plus	50%	23.5	9.1	-2.9	Natural Snow
298	26-Feb-08	Kilfrost ABC-K Plus	100%	84.7	7.4	-4.7	Natural Snow
299	26-Feb-08	Kilfrost ABC-K Plus	75%	118.3	5.4	-4.5	Natural Snow
302	26-Feb-08	Kilfrost ABC-K Plus	100%	176.1	6.5	-4.5	Natural Snow
304	26-Feb-08	Kilfrost ABC-K Plus	100%	158.0	6.5	-4.5	Natural Snow
308	26-Feb-08	Kilfrost ABC-K Plus	75%	82.0	6.8	-4.7	Natural Snow
309	5-Mar-08	Kilfrost ABC-K Plus	100%	34.6	39.8	-7.7	Natural Snow
311	5-Mar-08	Kilfrost ABC-K Plus	75%	24.8	41.0	-7.7	Natural Snow
315	5-Mar-08	Kilfrost ABC-K Plus	100%	23.7	34.7	-8.2	Natural Snow
316	5-Mar-08	Kilfrost ABC-K Plus	100%	44.5	36.4	-8.6	Natural Snow
322	5-Mar-08	Kilfrost ABC-K Plus	100%	38.9	35.9	-8.5	Natural Snow
324	5-Mar-08	Kilfrost ABC-K Plus	75%	27.5	31.5	-8.5	Natural Snow
327	5-Mar-08	Kilfrost ABC-K Plus	75%	29.6	46.2	-8.5	Natural Snow

Table 3.1 (cont'd): Summary of Tests Performed in 2007-08 (Snow)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
328	7-Mar-08	Kilfrost ABC-K Plus	100%	92.8	18.3	0.4	Natural Snow
330	7-Mar-08	Kilfrost ABC-K Plus	75%	35.2	23.4	0.5	Natural Snow
331	7-Mar-08	Kilfrost ABC-K Plus	50%	14.3	21.2	0.5	Natural Snow
335	7-Mar-08	Kilfrost ABC-K Plus	100%	116.8	13.9	0.5	Natural Snow
337	7-Mar-08	Kilfrost ABC-K Plus	75%	38.2	25.4	0.4	Natural Snow
338	7-Mar-08	Kilfrost ABC-K Plus	50%	11.8	23.3	0.5	Natural Snow
343	8-Mar-08	Kilfrost ABC-K Plus	50%	26.7	8.7	0.3	Natural Snow
347	8-Mar-08	Kilfrost ABC-K Plus	50%	33.5	7.4	0.4	Natural Snow
357	8-Mar-08	Kilfrost ABC-K Plus	100%	135.7	6.9	0.2	Natural Snow
359	8-Mar-08	Kilfrost ABC-K Plus	75%	96.0	7.4	0.2	Natural Snow
361	8-Mar-08	Kilfrost ABC-K Plus	50%	26.8	12.7	0.2	Natural Snow
366	8-Mar-08	Kilfrost ABC-K Plus	100%	156.0	8.3	-4.8	Natural Snow
368	8-Mar-08	Kilfrost ABC-K Plus	75%	57.7	13.0	-5.1	Natural Snow
371	8-Mar-08	Kilfrost ABC-K Plus	100%	83.3	17.1	-5.3	Natural Snow
373	8-Mar-08	Kilfrost ABC-K Plus	75%	35.0	23.6	-5.5	Natural Snow
377	8-Mar-08	Kilfrost ABC-K Plus	75%	112.8	5.6	-4.5	Natural Snow
378	8-Mar-08	Kilfrost ABC-K Plus	100%	120.8	10.4	-4.6	Natural Snow
379	8-Mar-08	Kilfrost ABC-K Plus	75%	103.7	7.6	-4.6	Natural Snow
380	8-Mar-08	Kilfrost ABC-K Plus	75%	29.0	32.2	-3.9	Natural Snow
387	8-Mar-08	Kilfrost ABC-K Plus	100%	42.0	49.3	-3.9	Natural Snow
388	8-Mar-08	Kilfrost ABC-K Plus	75%	24.0	45.0	-3.9	Natural Snow
390	12-Mar-08	Kilfrost ABC-K Plus	100%	139.0	5.2	-1.9	Natural Snow
392	12-Mar-08	Kilfrost ABC-K Plus	75%	107.8	4.0	-2.1	Natural Snow
393	12-Mar-08	Kilfrost ABC-K Plus	50%	68.0	2.1	-2.1	Natural Snow
399	12-Mar-08	Kilfrost ABC-K Plus	100%	145.8	6.3	-2.0	Natural Snow
402	12-Mar-08	Kilfrost ABC-K Plus	50%	37.0	4.5	-2.0	Natural Snow
404	12-Mar-08	Kilfrost ABC-K Plus	100%	123.5	7.3	-1.7	Natural Snow
410	12-Mar-08	Kilfrost ABC-K Plus	50%	23.5	10.2	-1.7	Natural Snow
417	12-Mar-08	Kilfrost ABC-K Plus	50%	42.5	4.6	-1.3	Natural Snow
429	13-Mar-08	Kilfrost ABC-K Plus	100%	148.5	5.8	-7.9	Natural Snow
431	13-Mar-08	Kilfrost ABC-K Plus	75%	102.3	4.1	-8.0	Natural Snow
439	13-Mar-08	Kilfrost ABC-K Plus	100%	92.5	9.7	-7.8	Natural Snow
445	13-Mar-08	Kilfrost ABC-K Plus	75%	60.3	9.5	-7.8	Natural Snow
448	19-Mar-08	Kilfrost ABC-K Plus	100%	96.9	10.5	0.4	Natural Snow
456	19-Mar-08	Kilfrost ABC-K Plus	50%	32.8	8.7	0.4	Natural Snow
458	19-Mar-08	Kilfrost ABC-K Plus	75%	57.5	11.0	0.4	Natural Snow
461	19-Mar-08	Kilfrost ABC-K Plus	50%	32.3	8.9	0.5	Natural Snow
462	19-Mar-08	Kilfrost ABC-K Plus	75%	103.5	5.4	0.4	Natural Snow
464	19-Mar-08	Kilfrost ABC-K Plus	50%	22.0	15.1	0.4	Natural Snow
466	19-Mar-08	Kilfrost ABC-K Plus	100%	132.7	6.3	0.4	Natural Snow

Table 3.1 (cont'd): Summary of Tests Performed in 2007-08 (Snow)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
471	19-Mar-08	Kilfrost ABC-K Plus	50%	22.8	11.9	0.3	Natural Snow
475	19-Mar-08	Kilfrost ABC-K Plus	50%	67.5	3.7	0.4	Natural Snow
481	19-Mar-08	Kilfrost ABC-K Plus	50%	29.0	15.3	0.4	Natural Snow
483	19-Mar-08	Kilfrost ABC-K Plus	50%	20.3	13.7	0.4	Natural Snow
485	19-Mar-08	Kilfrost ABC-K Plus	50%	20.8	17.4	0.4	Natural Snow

3. DESCRIPTION OF DATA

Table 3.2: Summary of Tests Performed in 2007-08 (Freezing Precipitation)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
3	31-Mar-08	Kilfrost ABC-K Plus	100%	30.0	5.1	-24.9	Freezing Fog
4	31-Mar-08	Kilfrost ABC-K Plus	100%	29.8	5.4	-25.0	Freezing Fog
9	31-Mar-08	Kilfrost ABC-K Plus	100%	59.0	1.9	-25.2	Freezing Fog
10	31-Mar-08	Kilfrost ABC-K Plus	100%	55.8	2.0	-25.2	Freezing Fog
15	2-Apr-08	Kilfrost ABC-K Plus	100%	27.0	5.3	-13.9	Freezing Fog
16	2-Apr-08	Kilfrost ABC-K Plus	100%	26.5	5.4	-13.9	Freezing Fog
25	2-Apr-08	Kilfrost ABC-K Plus	75%	24.8	5.0	-14.0	Freezing Fog
26	2-Apr-08	Kilfrost ABC-K Plus	75%	26.2	5.0	-13.9	Freezing Fog
29	2-Apr-08	Kilfrost ABC-K Plus	100%	62.3	2.0	-14.0	Freezing Fog
30	2-Apr-08	Kilfrost ABC-K Plus	100%	64.0	2.1	-14.0	Freezing Fog
39	2-Apr-08	Kilfrost ABC-K Plus	75%	85.3	2.1	-14.0	Freezing Fog
40	2-Apr-08	Kilfrost ABC-K Plus	75%	83.0	2.0	-14.0	Freezing Fog
43	2-Apr-08	Kilfrost ABC-K Plus	100%	143.0	4.6	-3.1	Freezing Fog
44	2-Apr-08	Kilfrost ABC-K Plus	100%	136.8	4.7	-3.1	Freezing Fog
59	2-Apr-08	Kilfrost ABC-K Plus	75%	98.0	5.0	-3.1	Freezing Fog
60	2-Apr-08	Kilfrost ABC-K Plus	75%	97.8	5.2	-3.1	Freezing Fog
61	2-Apr-08	Kilfrost ABC-K Plus	50%	34.0	5.2	-3.1	Freezing Fog
62	2-Apr-08	Kilfrost ABC-K Plus	50%	35.0	5.0	-3.1	Freezing Fog
65	3-Apr-08	Kilfrost ABC-K Plus	100%	222.2	2.0	-3.1	Freezing Fog
66	3-Apr-08	Kilfrost ABC-K Plus	100%	217.0	2.1	-3.2	Freezing Fog
81	3-Apr-08	Kilfrost ABC-K Plus	75%	158.7	2.3	-3.2	Freezing Fog
82	3-Apr-08	Kilfrost ABC-K Plus	75%	132.5	2.0	-3.2	Freezing Fog
83	3-Apr-08	Kilfrost ABC-K Plus	50%	53.0	2.3	-3.1	Freezing Fog
84	3-Apr-08	Kilfrost ABC-K Plus	50%	62.8	2.3	-3.1	Freezing Fog
87	8-Apr-08	Kilfrost ABC-K Plus	100%	23.0	13.1	-10.2	Freezing Drizzle
88	8-Apr-08	Kilfrost ABC-K Plus	100%	23.7	13.3	-10.2	Freezing Drizzle
97	8-Apr-08	Kilfrost ABC-K Plus	75%	18.8	13.0	-10.1	Freezing Drizzle
98	8-Apr-08	Kilfrost ABC-K Plus	75%	18.8	13.5	-10.1	Freezing Drizzle
101	7-Apr-08	Kilfrost ABC-K Plus	100%	65.0	4.6	-10.2	Freezing Drizzle
102	7-Apr-08	Kilfrost ABC-K Plus	100%	65.0	4.8	-10.2	Freezing Drizzle
111	7-Apr-08	Kilfrost ABC-K Plus	75%	50.0	5.3	-10.3	Freezing Drizzle
112	7-Apr-08	Kilfrost ABC-K Plus	75%	50.0	5.4	-10.3	Freezing Drizzle
115	4-Apr-08	Kilfrost ABC-K Plus	100%	108.2	12.9	-3.2	Freezing Drizzle
116	4-Apr-08	Kilfrost ABC-K Plus	100%	107.9	12.8	-3.2	Freezing Drizzle
131	4-Apr-08	Kilfrost ABC-K Plus	75%	80.5	13.2	-3.2	Freezing Drizzle
132	4-Apr-08	Kilfrost ABC-K Plus	75%	87.5	13.5	-3.2	Freezing Drizzle
133	4-Apr-08	Kilfrost ABC-K Plus	50%	18.7	12.8	-3.1	Freezing Drizzle
134	4-Apr-08	Kilfrost ABC-K Plus	50%	20.7	12.7	-3.0	Freezing Drizzle
137	4-Apr-08	Kilfrost ABC-K Plus	100%	>2hrs	5.0	-3.2	Freezing Drizzle
138	4-Apr-08	Kilfrost ABC-K Plus	100%	>2hrs	5.1	-3.2	Freezing Drizzle

Table 3.2 (cont'd): Summary of Tests Performed in 2007-08 (Freezing Precipitation)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
153	4-Apr-08	Kilfrost ABC-K Plus	75%	114.3	5.0	-3.3	Freezing Drizzle
154	4-Apr-08	Kilfrost ABC-K Plus	75%	124.8	4.8	-3.3	Freezing Drizzle
155	4-Apr-08	Kilfrost ABC-K Plus	50%	31.0	4.6	-3.2	Freezing Drizzle
156	4-Apr-08	Kilfrost ABC-K Plus	50%	27.5	4.6	-3.2	Freezing Drizzle
159	7-Apr-08	Kilfrost ABC-K Plus	100%	12.5	25.9	-10.0	Light Freezing Rain
160	7-Apr-08	Kilfrost ABC-K Plus	100%	12.4	25.8	-10.0	Light Freezing Rain
169	7-Apr-08	Kilfrost ABC-K Plus	75%	9.0	25.1	-9.8	Light Freezing Rain
170	7-Apr-08	Kilfrost ABC-K Plus	75%	9.0	24.9	-9.8	Light Freezing Rain
173	8-Apr-08	Kilfrost ABC-K Plus	100%	35.1	13.0	-10.0	Light Freezing Rain
174	8-Apr-08	Kilfrost ABC-K Plus	100%	35.7	13.1	-10.0	Light Freezing Rain
183	8-Apr-08	Kilfrost ABC-K Plus	75%	34.8	12.7	-9.9	Light Freezing Rain
184	8-Apr-08	Kilfrost ABC-K Plus	75%	33.5	12.6	-9.8	Light Freezing Rain
187	9-Apr-08	Kilfrost ABC-K Plus	100%	59.5	24.8	-3.0	Light Freezing Rain
188	9-Apr-08	Kilfrost ABC-K Plus	100%	57.8	24.7	-3.0	Light Freezing Rain
203	9-Apr-08	Kilfrost ABC-K Plus	75%	47.5	25.1	-3.0	Light Freezing Rain
204	9-Apr-08	Kilfrost ABC-K Plus	75%	49.5	25.3	-3.0	Light Freezing Rain
205	9-Apr-08	Kilfrost ABC-K Plus	50%	10.2	25.0	-3.1	Light Freezing Rain
206	9-Apr-08	Kilfrost ABC-K Plus	50%	10.2	25.2	-3.1	Light Freezing Rain
209	8-Apr-08	Kilfrost ABC-K Plus	100%	86.3	12.6	-3.0	Light Freezing Rain
210	8-Apr-08	Kilfrost ABC-K Plus	100%	84.0	12.9	-3.0	Light Freezing Rain
225	8-Apr-08	Kilfrost ABC-K Plus	75%	71.5	12.6	-3.0	Light Freezing Rain
226	8-Apr-08	Kilfrost ABC-K Plus	75%	71.8	12.5	-3.0	Light Freezing Rain
227	8-Apr-08	Kilfrost ABC-K Plus	50%	17.0	12.6	-3.0	Light Freezing Rain
228	8-Apr-08	Kilfrost ABC-K Plus	50%	16.8	12.5	-3.0	Light Freezing Rain
231	9-Apr-08	Kilfrost ABC-K Plus	100%	18.3	74.1	1.0	Cold Soak Box
232	9-Apr-08	Kilfrost ABC-K Plus	100%	18.5	76.3	1.0	Cold Soak Box
241	9-Apr-08	Kilfrost ABC-K Plus	75%	15.5	77.2	1.0	Cold Soak Box
242	9-Apr-08	Kilfrost ABC-K Plus	75%	15.3	76.6	1.0	Cold Soak Box
245	9-Apr-08	Kilfrost ABC-K Plus	100%	>2hrs	5.4	1.0	Cold Soak Box
246	9-Apr-08	Kilfrost ABC-K Plus	100%	>2hrs	5.3	1.0	Cold Soak Box
255	9-Apr-08	Kilfrost ABC-K Plus	75%	113.2	5.3	0.9	Cold Soak Box
256	9-Apr-08	Kilfrost ABC-K Plus	75%	115.3	5.2	0.9	Cold Soak Box

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 in 2007-08. These figures show the effect of temperature and precipitation on fluid endurance times for each condition. Table 4.1 illustrates the outputs from the regression equations run for this fluid under natural snow, freezing fog, freezing drizzle, freezing rain and cold soak conditions.

4.2 Holdover Time Table

A fluid-specific HOT table for Kilfrost ABC-K Plus is shown in Table 4.2 at the end of this section. As Kilfrost intends to commercialize this fluid, the table will be published in the 2008-09 HOT guidelines. Commercialization of this fluid will not impact the generic Type II HOT guidelines.

4.2.1 Holdover Times in Snow, Below -14 to -25°C

In the winter of 2003-04, testing was conducted with artificial snowmakers at temperatures below -14°C. This was done as very limited endurance time data existed for fluids at these temperatures. As a result of this testing, the current propylene Type II and Type IV fluids were given generic values in the -14 to -25°C snow cell. Because no natural snow tests were conducted below -14°C with Kilfrost ABC-K Plus in the winter of 2006-07, generic values have been used in the -14 to -25°C snow cell.

4.2.2 Fluid Viscosity

The viscosity of the fluid sample used in HOT testing, as measured by APS personnel, appears at the front of this document. The viscosity measurement method is also documented. In order for the fluid specific values to be valid, operators must ensure that the viscosity of the fluid used is superior to the published viscosity of that fluid, using the same viscosity measurement method published.

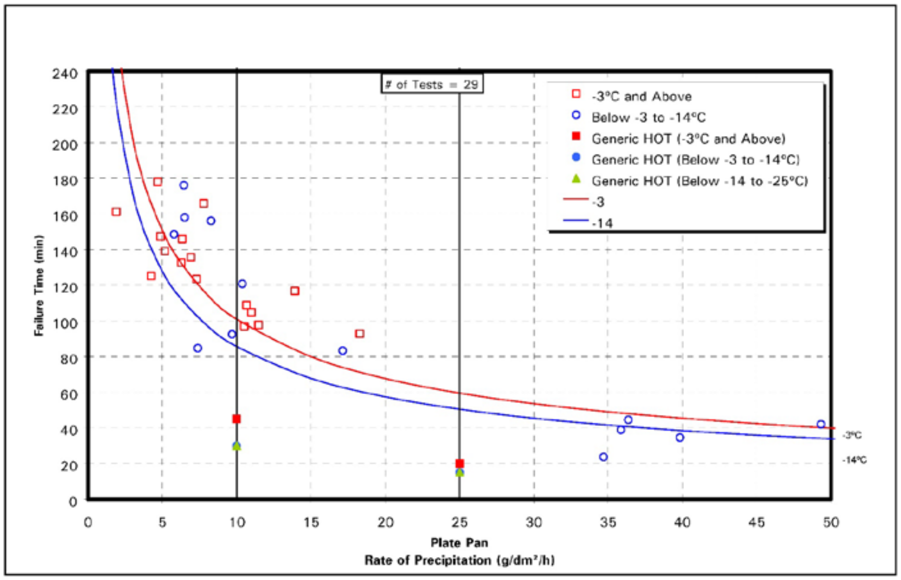


Figure 4.1: Type II Neat – Natural Snow

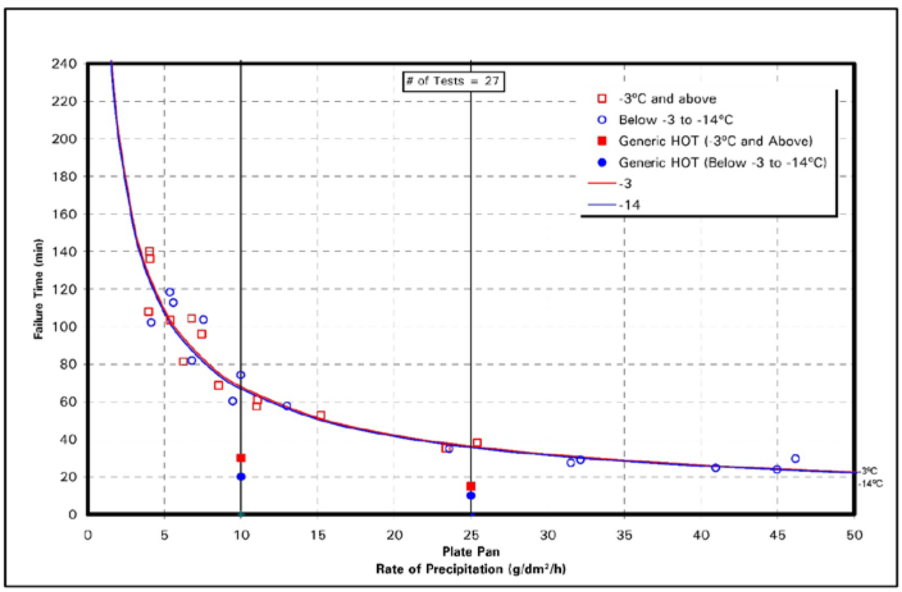


Figure 4.2: Type II 75/25 – Natural Snow

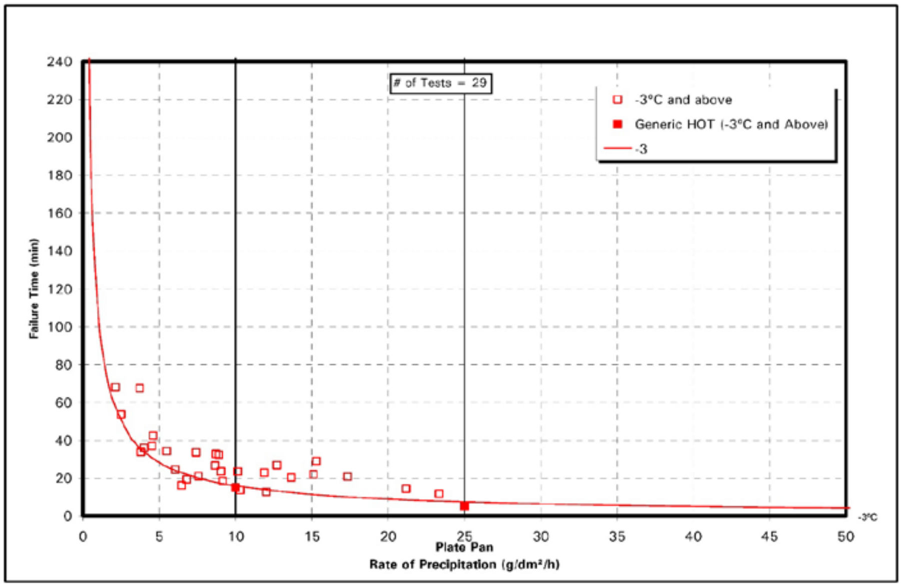


Figure 4.3: Type II 50/50 – Natural Snow

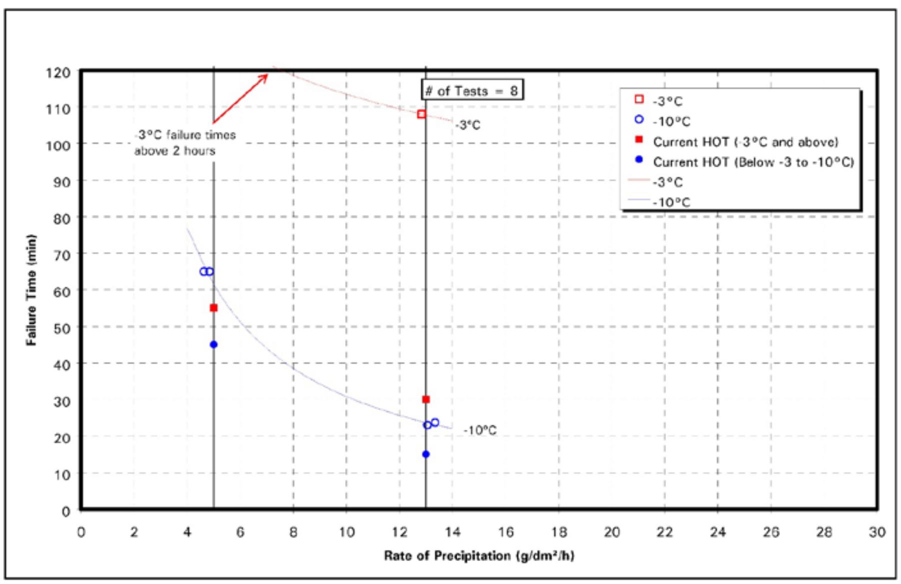


Figure 4.4: Type II Neat – Freezing Drizzle

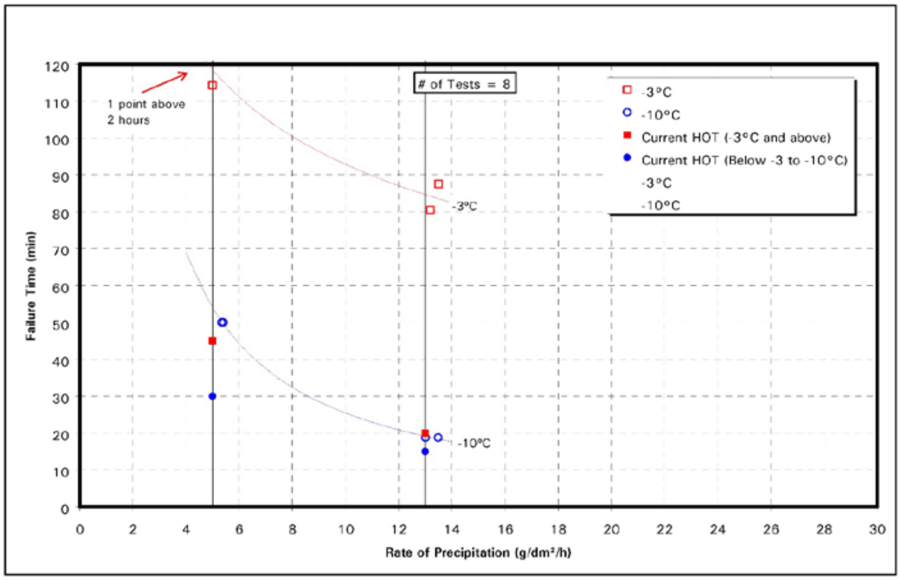


Figure 4.5: Type II 75/25 – Freezing Drizzle

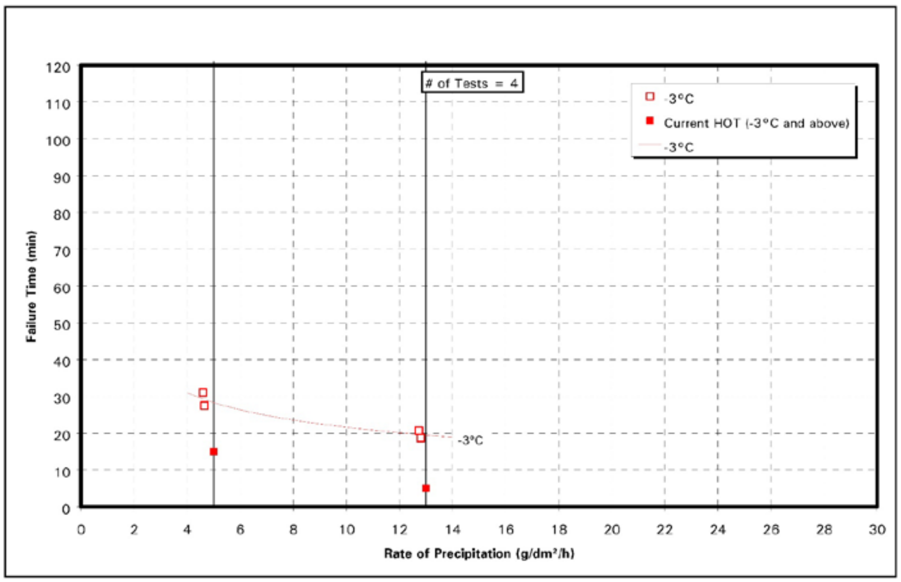


Figure 4.6: Type II 50/50 – Freezing Drizzle

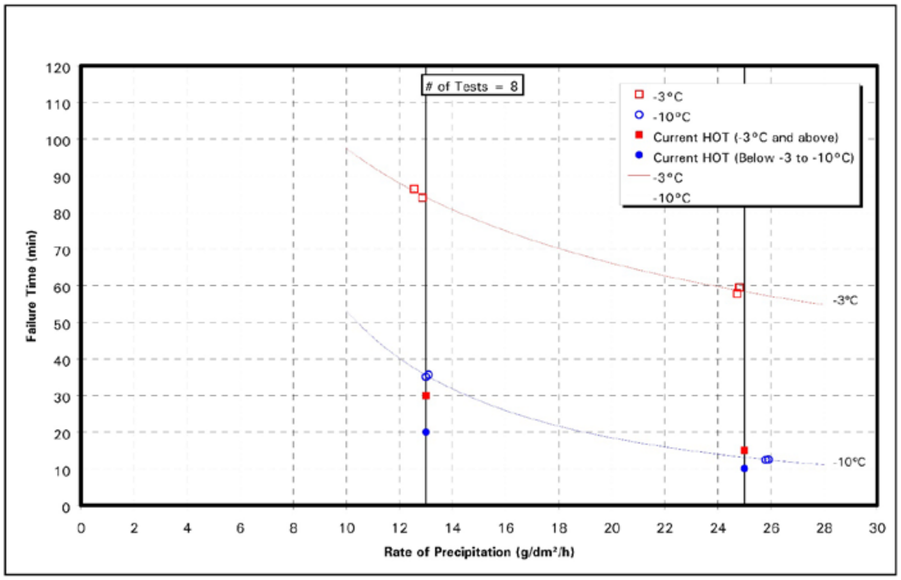


Figure 4.7: Type II Neat – Light Freezing Rain

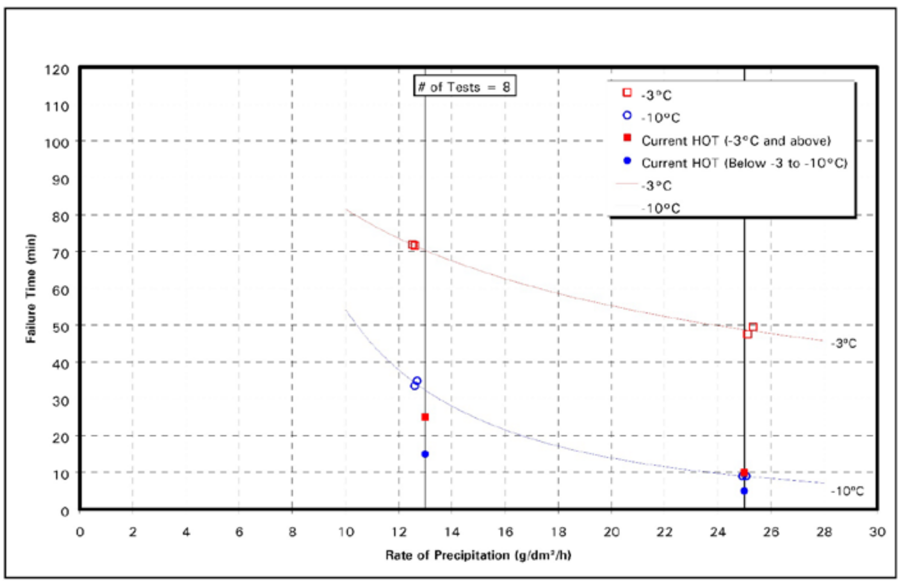


Figure 4.8: Type II 75/25 – Light Freezing Rain

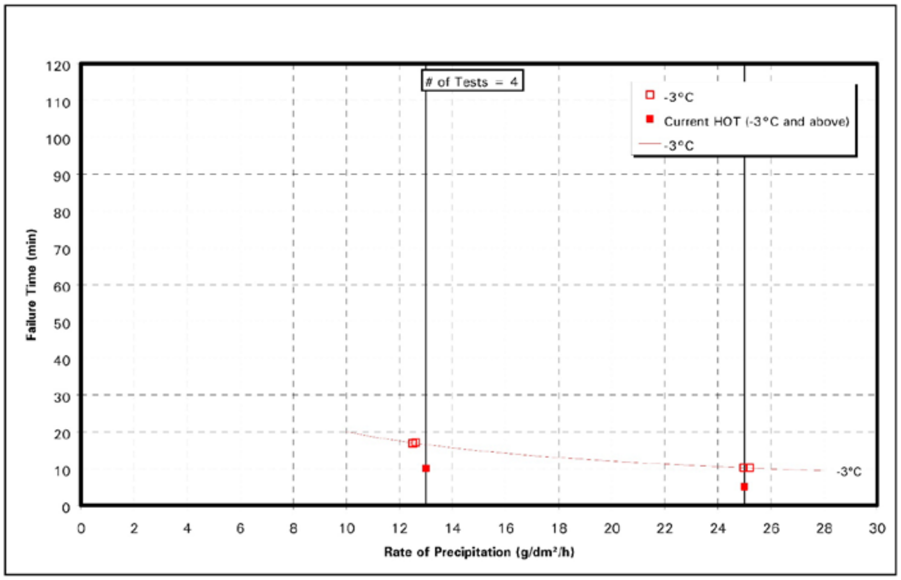


Figure 4.9: Type II 50/50 – Light Freezing Rain

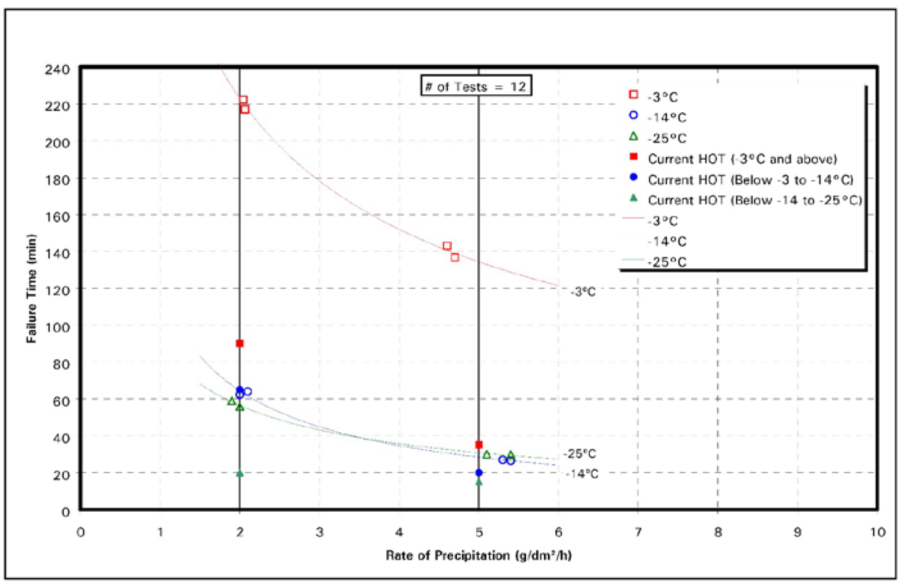


Figure 4.10: Type II Neat – Freezing Fog

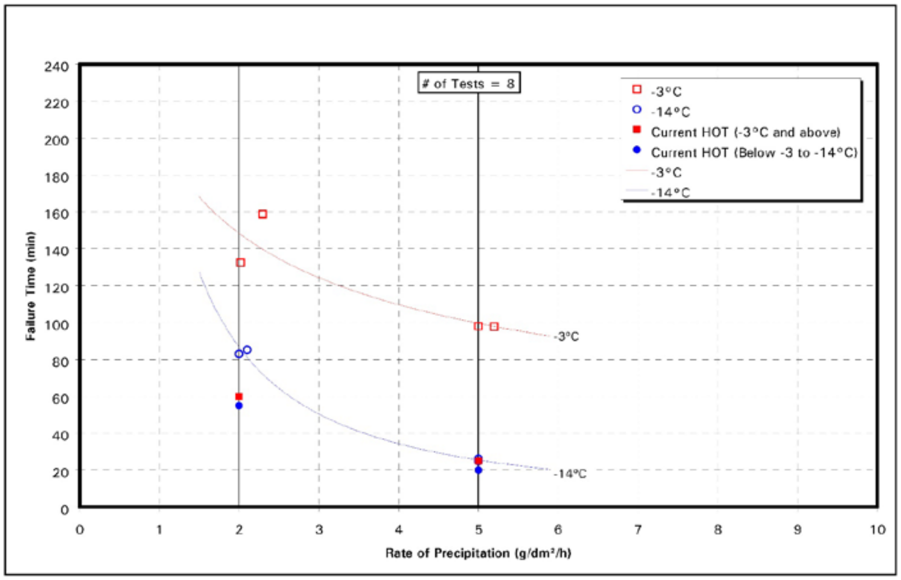


Figure 4.11: Type II 75/25 – Freezing Fog

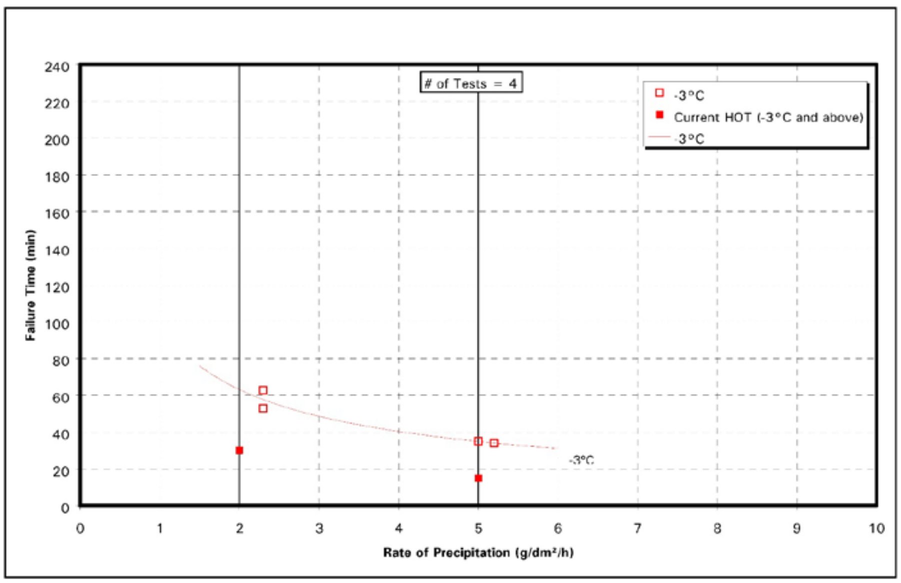


Figure 4.12: Type II 50/50 – Freezing Fog

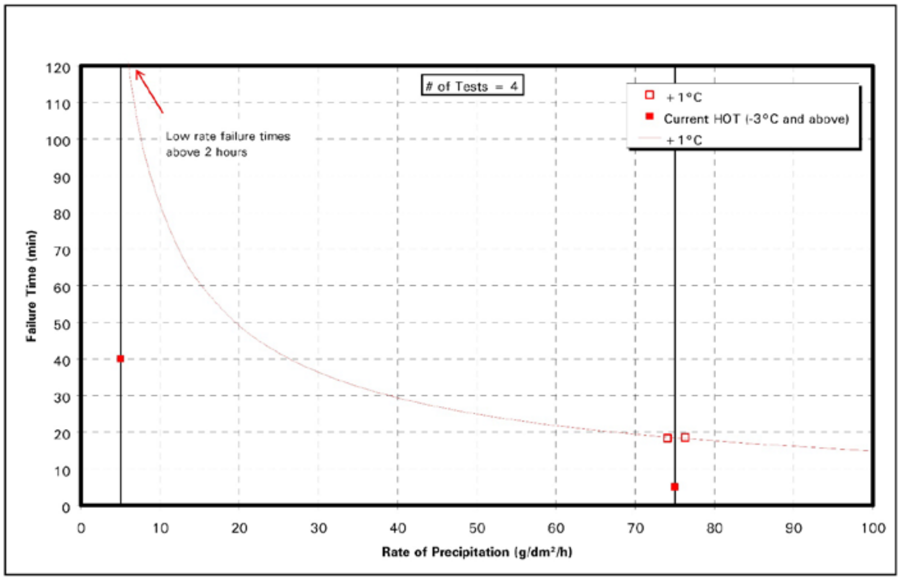


Figure 4.13: Type II Neat – Rain on Cold-Soaked Surface

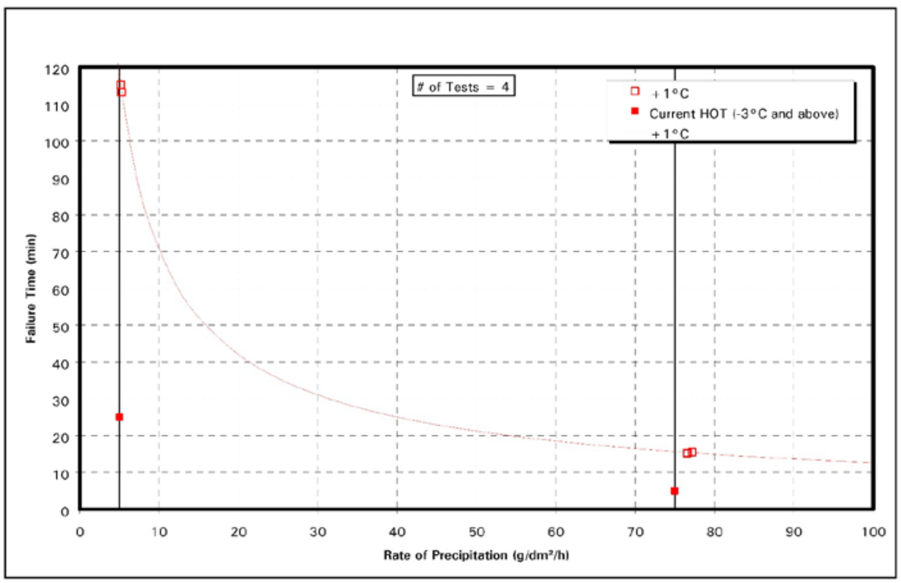


Figure 4.14: Type II 75/25 – Rain on Cold-Soaked Surface

Table 4.1: Regression Equation Coefficient Summary for Kilfrost ABC-K Plus

Natural Snow Conditions

Fluid	Dil	R^2	Intercept I	Coeff. Rate (A)	Coeff. Tem (B)	Total Pts.
Kilfrost ABC-K Plus	Neat	80%	2.7	-0.58	-0.14	29
Kilfrost ABC-K Plus	75%	96%	2.5	-0.68	-0.01	27
Kilfrost ABC-K Plus	50%	88%	2.4	-0.83	-0.53	29

General Equation $t = 10^I R^A (2\text{-}T)^B$

Simulated Freezing Fog

Fluid	Dil	R^2	Temp.	Intercept (I)	Coeff. Rate (A)	Total Pts.
Kilfrost ABC-K Plus	Neat	100%	-3°C	2.5	-0.6	4
Kilfrost ABC-K Plus	75%	83%	-3°C	2.3	-0.4	4
Kilfrost ABC-K Plus	50%	95%	-3°C	2.0	-0.6	4
Kilfrost ABC-K Plus	Neat	100%	-14°C	2.1	-0.9	4
Kilfrost ABC-K Plus	75%	100%	-14°C	2.3	-1.3	4
Kilfrost ABC-K Plus	Neat	100%	-25°C	1.9	-0.7	4

General Equation $t = 10^I R^A$

Simulated Freezing Drizzle

Fluid	Dil	R^2	Temp.	Intercept (I)	Coeff. Rate (A)	Total Pts.
Kilfrost ABC-K Plus	Neat	100%	-3°C	2.3	-0.20	4
Kilfrost ABC-K Plus	75%	95%	-3°C	2.3	-0.35	4
Kilfrost ABC-K Plus	50%	93%	-3°C	1.7	-0.39	4
Kilfrost ABC-K Plus	Neat	100%	-10°C	2.5	-1.00	4
Kilfrost ABC-K Plus	75%	100%	-10°C	2.5	-1.09	4

General Equation $t = 10^I R^A$

Simulated Light Freezing Rain

Fluid	Dil	R^2	Temp.	Intercept (I)	Coeff. Rate (A)	Total Pts.
Kilfrost ABC-K Plus	Neat	100%	-3°C	2.5	-0.56	4
Kilfrost ABC-K Plus	75%	99%	-3°C	2.5	-0.56	4
Kilfrost ABC-K Plus	50%	100%	-3°C	2.0	-0.74	4
Kilfrost ABC-K Plus	Neat	100%	-10°C	3.3	-1.53	4
Kilfrost ABC-K Plus	75%	100%	-10°C	3.7	-1.96	4

General Equation $t = 10^I R^A$

Simulated Rain on Cold Soaked Wing

Fluid	Dil	R^2	Temp.	Intercept (I)	Coeff. Rate (A)	Total Pts.
Kilfrost ABC-K Plus	Neat	100%	+1°C	2.7	-0.74	4
Kilfrost ABC-K Plus	75%	100%	+1°C	2.6	-0.75	4

General Equation $t = 10^I R^A$

Table 4.2: Fluid Specific Type II Fluid Holdover Time Guidelines

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
ABC-K PLUS

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	Degrees Fahrenheit		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	8:00	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	5:00	1:40 – 2:30	0:35 – 1:10	1:25 – 2:00	0:50 – 1:10	0:15 – 2:00	
		50/50	3:00	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	8:00	0:30 – 1:05	0:50 – 1:25	0:25 – 1:00[3]	0:15 – 0:35[3]		
		75/25	5:00	0:25 – 1:25	0:35 – 1:05	0:20 – 0:55[3]	0:05 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	8:00	0:30 – 0:55	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.

CAUTIONS

- **The only acceptable decision criteria time is the shortest 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 deicing/anti-icing do not provide in-flight icing protection.**

APPENDIX D

PROCEDURE FOR SUPPLEMENTAL TESTS: OVERALL PROGRAM OF TESTS AT NRC, JULY 2008

CM2103.001 (07-08)

OVERALL PROGRAM OF TESTS AT NRC, JULY 2008

Winter 2007-08

Prepared for

Transportation Development Centre
Transport Canada

for Prepared by: Katrina Bell VZ

Reviewed by: John D'Avirro

Aviation Inc.

July 3, 2008
Final Version 1.0

OVERALL PROGRAM OF TESTS AT NRC, JULY 2008
Winter 2007-08

1. INTRODUCTION

This document was prepared as an addition to the procedure "Overall Program of Tests at NRC, April 2008". Transport Canada and the FAA have been notified that there were possible viscosity issues with the KHF-II fluid, which was first commercialized for use in Winter 2007-08. Specifically there may still be batches of this fluid on the market with viscosities lower than the published lowest on-wing viscosities for use with the HOT guidelines. Aviation Xi'an have indicated that they will raise their product specification. For this they will requalify their fluid. In addition, they are resubmitting a sample at the same LOWVas originally sent to verify that the HOTs with this new sample are still appropriate.

Therefore a second test session will take place at the National Research Council Climactic Engineering Facility (NRC) in Ottawa from July 4th to 11th, 2008. A tentative test schedule is included in Figure 1.

Research testing with three Dow Type IV PG fluids will also take place.

2. PROJECTS, PROCEDURES AND OBJECTIVES

The work described in this document was driven by the need for Xi'an to test their new formulation prior to Winter 2008-09. Additional tests are being carried out at the same time to take advantage of this situation.

2.1 Endurance Times of New Fluids

The objective of this project is to reconfirm endurance times of the Type II fluid Xi'an KHF-II in simulated freezing precipitation. Additional tests will also be conducted in simulated snow conditions to verify results in snow conditions. The procedure for conducting these tests is given in the document *Test Requirements for Simulated Freezing Precipitation Flat Plate Testing* (1).

The fluid manufacturer sent two fluid samples, A and B, with different viscosities. APS will test with Sample B, which has a Neat viscosity of 8250cP.

The test plan for endurance time tests is given in Table 1.

2.2 Thickness of New Fluids

The objective of these tests is to measure the thickness of the Xi'an fluids. The test plan is given in Table 2.

2.3 Artificial Snowmaker Tests

Verification tests will be conducted with the artificial snowmaker as part of endurance time testing with the KHF-II fluid. In 2006-07 snowmaker tests were done with the Xi'an KHF-II fluid as part of the ongoing snowmaker R&D.

Tests will be conducted at -3°C and -14°C at rates of 10 and 25 g/dm^2/h, for a total of 10 tests with the Xi'an KHF-II fluid. Additional tests may be conducted if results differ significantly from the previous 2006-07 results.

The test plan is given in Table 3. The procedure for conducting the artificial snow tests is given in ARP 5485 (2).

2.4 Dow Research Testing

Dow has indicated that they would like to carry out some limited tests with developmental fluids.

Testing in freezing drizzle will be conducted on three Dow Neat Type IV fluids, DC2210, K57 and K58. The test plan is included in Table 1.

2.5 TRB Testing

Testing of spot deicing application in frost for the Transportation Research Board (TRB) will also take place (is being "piggy-backed") at the NRC from July 4-11, 2008. The objective of these tests is to evaluate the amount of glycol needed during spot deicing at gates and whether the amounts are sufficient to effectively deice/anti-ice an aircraft's contaminated surfaces. The procedure for conducting these tests is given in a separate document developed for this project, *Procedure for Spot Deicing Applications in Frost for Indoor Chamber Testing* (3). Some cost sharing is being provided by the the Airport Cooperative Research Program (ACRP).

3. PERSONNEL REQUIREMENTS/RESPONSIBILITIES

The personnel required are given below. The equipment manager will be MR.

1. Endurance Times of New Fluids: JD assisted by MR and MH

2. Artificial Snowmaker: KB
3. Thickness: JD/MR

4. FLUIDS

The required fluid and fluid quantities are shown in Table 4.

5. EQUIPMENT

A complete list of equipment required for NRC testing is shown in Table 5. For a list of equipment needed for snowmaker testing please refer to the procedure *Endurance Time Test Requirements for Simulated Snow Flat Plate Testing* (4).

The NRC chamber needs to be cooled to the right temperature the day before testing starts.

6. DATA FORMS

1. Endurance Times of New Fluids:
   - Freezing precipitation endurance time data form (Figure 2)
2. Thickness of New Fluids:
   - Fluid thickness data form (Figure 3)
3. NCAR Indoor Snow:
   - NCAR data form (Figure 4)

7. SAFETY ISSUES

Managers must ensure that personnel involved in the set-up and conduct of testing 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 while 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.

8. REFERENCES

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

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

3. Procedure for Spot Deicing Applications in Frost for Indoor Chamber Testing, Version 1.1, June 2008.

4. Endurance Time Test Requirements for Simulated Snow Flat Plate Testing, Version 1.2, January 23, 2008.

FIGURE 1: TEST SCHEDULE

TEST SCHEDULE					
	Mon July 7	Tue July 8	Wed July 9	Thu July 10	Fri July 11
8:00	rates	rates	rates	rates	Drive to Montreal
8:30	rates	rates	rates	rates	
9:00	ZF, -25, 2	ZF, -3, 2 Thickness	ZD, -10, 13	CSW, 1, 5	
9:30			rates		
10:00	rates		rates		
10:30	rates		ZD, -10, 5	rates	Unpack
11:00	ZF, -25, 5			rates	
11:30		rates		CSW, 1, 75	
12:00	rates	rates		rates	
12:30	Warm to -14° ↓	ZF, -3, 5	rates	Pack up	
13:00			rates		
13:30	rates		ZR, -10, 13		
14:00	ZF, -14, 5	rates			
14:30		rates	rates		
15:00		ZD, -3, 5	rates		
15:30	rates		ZR, -10, 25		
16:00	rates		rates		
16:30	ZF, -14, 2	rates	Warm to -3°		
17:00		rates	rates		
17:30		ZD, -3, 13 Dow	ZR, -3, 25		
18:00					
18:30		rates	rates		
19:00		rates			
19:30	rates	ZR, -3, 13			
20:00					
20:30		rates			

PERSONNEL REQUIREMENTS					
	Mon July 7	Tue July 8	Wed July 9	Thu July 10	Fri July 11
MR	RATES	RATES/Thick	RATES	RATES	Packup
JD	HOT	HOT	HOT	HOT	Packup
MH	RATES	RATES	RATES	RATES	Packup

OVERALL PROGRAM OF TESTS AT NRC, JULY 2008

TABLE 1: DETAILED ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution (BRIX)	Test Surface	Average ET (mins)	Comments
1	Freezing Fog	-25	2	Xi'an KHF-II Sample B	100	Plate	48.3	
2	Freezing Fog	-25	2	Xi'an KHF-II Sample B	100	Plate	48.3	
3	Freezing Fog	-25	5	Xi'an KHF-II Sample B	100	Plate	32.5	
4	Freezing Fog	-25	5	Xi'an KHF-II Sample B	100	Plate	32.5	
5	Freezing Fog	-14	5	Xi'an KHF-II Sample B	100	Plate	71.1	
6	Freezing Fog	-14	5	Xi'an KHF-II Sample B	100	Plate	71.1	
7	Freezing Fog	-14	5	Xi'an KHF-II Sample B	75	Plate	42.8	
8	Freezing Fog	-14	5	Xi'an KHF-II Sample B	75	Plate	42.8	
9	Freezing Fog	-14	2	Xi'an KHF-II Sample B	100	Plate	155.5	
10	Freezing Fog	-14	2	Xi'an KHF-II Sample B	100	Plate	155.5	
11	Freezing Fog	-14	2	Xi'an KHF-II Sample B	75	Plate	75.5	
12	Freezing Fog	-14	2	Xi'an KHF-II Sample B	75	Plate	75.5	
13	Freezing Fog	-3	2	Xi'an KHF-II Sample B	100	Plate	132.3	
14	Freezing Fog	-3	2	Xi'an KHF-II Sample B	100	Plate	132.3	
15	Freezing Fog	-3	2	Xi'an KHF-II Sample B	75	Plate	61.3	
16	Freezing Fog	-3	2	Xi'an KHF-II Sample B	75	Plate	61.3	
17	Freezing Fog	-3	2	Xi'an KHF-II Sample B	50	Plate	30.1	
18	Freezing Fog	-3	2	Xi'an KHF-II Sample B	50	Plate	30.1	
19	Freezing Fog	-3	5	Xi'an KHF-II Sample B	100	Plate	77.4	
20	Freezing Fog	-3	5	Xi'an KHF-II Sample B	100	Plate	77.4	
21	Freezing Fog	-3	5	Xi'an KHF-II Sample B	75	Plate	42.8	
22	Freezing Fog	-3	5	Xi'an KHF-II Sample B	75	Plate	42.8	
23	Freezing Fog	-3	5	Xi'an KHF-II Sample B	50	Plate	18.8	
24	Freezing Fog	-3	5	Xi'an KHF-II Sample B	50	Plate	18.8	
25	Freezing Drizzle	-3	5	Xi'an KHF-II Sample B	100	Plate	85.5	
26	Freezing Drizzle	-3	5	Xi'an KHF-II Sample B	100	Plate	85.5	
27	Freezing Drizzle	-3	5	Xi'an KHF-II Sample B	75	Plate	42.2	
28	Freezing Drizzle	-3	5	Xi'an KHF-II Sample B	75	Plate	42.2	
29	Freezing Drizzle	-3	5	Xi'an KHF-II Sample B	50	Plate	16.1	
30	Freezing Drizzle	-3	5	Xi'an KHF-II Sample B	50	Plate	16.1	
31	Freezing Drizzle	-3	13	Xi'an KHF-II Sample B	100	Plate	42.9	
32	Freezing Drizzle	-3	13	Xi'an KHF-II Sample B	100	Plate	42.9	
33	Freezing Drizzle	-3	13	Xi'an KHF-II Sample B	75	Plate	24.6	
34	Freezing Drizzle	-3	13	Xi'an KHF-II Sample B	75	Plate	24.6	
35	Freezing Drizzle	-3	13	Xi'an KHF-II Sample B	50	Plate	9.7	
36	Freezing Drizzle	-3	13	Xi'an KHF-II Sample B	50	Plate	9.7	
37	Freezing Drizzle	-3	13	Dow DC2210	100	Plate	NA	
38	Freezing Drizzle	-3	13	Dow DC2210	100	Plate	NA	
39	Freezing Drizzle	-3	13	Dow K57	100	Plate	NA	
40	Freezing Drizzle	-3	13	Dow K57	100	Plate	NA	
41	Freezing Drizzle	-3	13	Dow K58	100	Plate	NA	
42	Freezing Drizzle	-3	13	Dow K58	100	Plate	NA	
43	Light Freezing Rain	-3	13	Xi'an KHF-II Sample B	100	Plate	49	
44	Light Freezing Rain	-3	13	Xi'an KHF-II Sample B	100	Plate	49	
45	Light Freezing Rain	-3	13	Xi'an KHF-II Sample B	75	Plate	26.6	
46	Light Freezing Rain	-3	13	Xi'an KHF-II Sample B	75	Plate	26.6	
47	Light Freezing Rain	-3	13	Xi'an KHF-II Sample B	50	Plate	10.8	
48	Light Freezing Rain	-3	13	Xi'an KHF-II Sample B	50	Plate	10.8	
49	Freezing Drizzle	-10	13	Xi'an KHF-II Sample B	100	Plate	23.4	
50	Freezing Drizzle	-10	13	Xi'an KHF-II Sample B	100	Plate	23.4	
51	Freezing Drizzle	-10	13	Xi'an KHF-II Sample B	75	Plate	19.6	
52	Freezing Drizzle	-10	13	Xi'an KHF-II Sample B	75	Plate	19.6	
53	Freezing Drizzle	-10	5	Xi'an KHF-II Sample B	100	Plate	91.3	
54	Freezing Drizzle	-10	5	Xi'an KHF-II Sample B	100	Plate	91.3	

TABLE 1 (CONT'D): DETAILED ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate ($g/dm^2/h$)	Fluid Brand	Dilution (BRIX)	Test Surface	Previous HOT (mins)	Comments
55	Freezing Drizzle	-10	5	Xi'an KHF-II Sample B	75	Plate	44.3	
56	Freezing Drizzle	-10	5	Xi'an KHF-II Sample B	75	Plate	44.3	
57	Light Freezing Rain	-10	13	Xi'an KHF-II Sample B	100	Plate	39.7	
58	Light Freezing Rain	-10	13	Xi'an KHF-II Sample B	100	Plate	39.7	
59	Light Freezing Rain	-10	13	Xi'an KHF-II Sample B	75	Plate	20.3	
60	Light Freezing Rain	-10	13	Xi'an KHF-II Sample B	75	Plate	20.3	
61	Light Freezing Rain	-10	25	Xi'an KHF-II Sample B	100	Plate	27.4	
62	Light Freezing Rain	-10	25	Xi'an KHF-II Sample B	100	Plate	27.4	
63	Light Freezing Rain	-10	25	Xi'an KHF-II Sample B	75	Plate	13.1	
64	Light Freezing Rain	-10	25	Xi'an KHF-II Sample B	75	Plate	13.1	
65	Light Freezing Rain	-3	25	Xi'an KHF-II Sample B	100	Plate	30.7	
66	Light Freezing Rain	-3	25	Xi'an KHF-II Sample B	100	Plate	30.7	
67	Light Freezing Rain	-3	25	Xi'an KHF-II Sample B	75	Plate	14.2	
68	Light Freezing Rain	-3	25	Xi'an KHF-II Sample B	75	Plate	14.2	
69	Light Freezing Rain	-3	25	Xi'an KHF-II Sample B	50	Plate	5.3	
70	Light Freezing Rain	-3	25	Xi'an KHF-II Sample B	50	Plate	5.3	
71	Cold Soak Box	1	5	Xi'an KHF-II Sample B	100	Box	75.4	
72	Cold Soak Box	1	5	Xi'an KHF-II Sample B	100	Box	75.4	
73	Cold Soak Box	1	5	Xi'an KHF-II Sample B	75	Box	42.5	
74	Cold Soak Box	1	5	Xi'an KHF-II Sample B	75	Box	42.5	
75	Cold Soak Box	1	75	Xi'an KHF-II Sample B	100	Box	12.3	
76	Cold Soak Box	1	75	Xi'an KHF-II Sample B	100	Box	12.3	
77	Cold Soak Box	1	75	Xi'an KHF-II Sample B	75	Box	5.4	
78	Cold Soak Box	1	75	Xi'an KHF-II Sample B	75	Box	5.4	

TABLE 2: FLUID THICKNESS TEST PLAN

Test #	Fluid Manufacturer	Fluid Name	Fluid Dilution	Ambient Air Temperature
TH1	Kilfrost	Xi'an KHF-II	100/0	-3°C
TH2	Kilfrost	Xi'an KHF-II	100/0	-3°C
TH3	Kilfrost	Xi'an KHF-II	75/25	-3°C
TH4	Kilfrost	Xi'an KHF-II	75/25	-3°C
TH5	Kilfrost	Xi'an KHF-II	50/50	-3°C
TH6	Kilfrost	Xi'an KHF-II	50/50	-3°C

Notes:
- If the results for one fluid vary by more than 10% repeat the two tests and disregard the highest and lowest values
- The quantity of fluid that will be poured for each test is 1.0 L

TABLE 3: NCAR SNOW TEST PLAN*

Test #	Fluid	Dilution	Temp. (°C)	Precip. Rate (g/dm2/h)	Natural Snow Regression ET (min)	Prev NCAR Test Time (min)	Fluid Set Temp ±3 (°C)	Room Set Temp Low (°C)**	Room Set Temp High (°C)**	Plate Set Temp ±0.5 (°C)
NCAR1	Xi'an KHF-II	100/0	-3	10	78	69.5	-5	-6.2	-3.7	-4.2
NCAR2	Xi'an KHF-II	100/0	-3	25	45	30.5	-6	-7.1	-4.6	-5.1
NCAR3	Xi'an KHF-II	75/25	-3	10	42	48	-5	-6.2	-3.7	-4.2
NCAR4	Xi'an KHF-II	75/25	-3	25	25	20.5	-6	-7.1	-4.6	-5.1
NCAR5	Xi'an KHF-II	50/50	-3	10	24	21	-5	-6.2	-3.7	-4.2
NCAR6	Xi'an KHF-II	50/50	-3	25	13	5	-6	-7.1	-4.6	-5.1
NCAR7	Xi'an KHF-II	100/0	-14	10	62	53	-5	-6.2	-3.7	-4.2
NCAR8	Xi'an KHF-II	100/0	-14	25	36	24	-6	-7.1	-4.6	-5.1
NCAR9	Xi'an KHF-II	75/25	-14	10	29	28	-5	-6.2	-3.7	-4.2
NCAR10	Xi'an KHF-II	75/25	-14	25	17	12.5	-6	-7.1	-4.6	-5.1

* Duplicate tests will only be done if results differ significantly from previous NCAR results.
** The room temperature should be in the interval between Room Temp. Set Low and Room Set Temp. High

TABLE 4: LIST OF FLUIDS

Fluid Name	Dilution	Litres Required						
		HOT	THICK	COMP	HEAT	NCAR	ICE P	Total
Xi'an KHF-II (Type II)	100	32	2	-	-	6	-	**40**
Xi'an KHF-II (Type II)	75	28	2	-	-	4	-	**34**
Xi'an KHF-II (Type II)	50	12	2	-	-	2	-	**16**
		72	**6**	**-**	**-**	**12**	**-**	**90**

OVERALL PROGRAM OF TESTS AT NRC, JULY 2008

TABLE 5: EQUIPMENT LIST

EQUIPMENT	LOCATION	STATUS	EQUIPMENT	LOCATION	STATUS
2 x 2-plate stand & 2 x 1-plate stand (x=24ft, y=7ft)	Site		Shop Vac	Site	
1L Pour containers (4 filled/4 empty per fluid/dil)	Site		Steel Collection Pans	Site	
Boards for cold-soak test x 10	Site		Still Digital Camera Rebel (suitcase)	Site	
Brixometer x 3	Site		Storage bins for small equipment	Site	
Clipboards x 6	Site		Surface and immersable temperature probes	Site	
Close circuit TV camera for rates	Site		Tape measure	Site	
Cold-Soaked Boxes 7.5 cm x12	Site		Test Stands (2 x 6-plate stands)	Site	
Covers for CSB x 12	Site		Thermistor Kit + Logger	Site	
Cotton gloves	Site		Thickness Gauges x 3 (both types)	Site	
Electrical Extension Cords - Many	Site		Walkie Talkies x 4	Site	
Fluids (CSW fluid must be left in chamber to cool before testing, or the 8 boxes can be filled & cooled in freezer the day before testing)	Site		Waste containers x MANY (10-15)	Site	
Funnels	Site		Weigh Scale x 2 (sartorius) + wiring	Site	
Marker for Waste x3	Site		White Billboard for water run-off	Site	
Hand-held Temperture Probes (Wahl) x3	Site		Yellow Carrying Cases for Pour Containers x 2	Site	
Heating equipment and thermoses x2	Site				
Inclinometer (yellow level) x2	Site		Accordian Folder	Office	
Isopropyl x4	Site		ARP 5485 and ARP 5945	Office	
Large digital clock x 2	Site		Chamber Layout Diagram	Office	
Metal Rate Pans (for outdoor tests)	Site		Data Forms (KB to handle)	Office	
Paper for printer (1 pack)	Site		Envelopes (9x12)	Office	
Paper Towels (lots)	Site		HOT Report + HOT Tables	Office	
Pencils + pens + markers	Site		NRC Flow Settings	Office	
Plate covers x 12	Site		NRC Chamber Settings (historical data))	Office	
Plates x12 (w/logging capability)	Site		Laptop Computers x 3	Office/Site	
Precipitation Rate Pans x 100	Site		Precipitation Rate Data Forms (SB)	Office	
Printer	Site		Test Procedures x 2 (1 sided)	Office	
Protective clothing (6)	Site		Trend Reader Express Software	Office	
Pump (for waste)	Site		Fluid for cold-soak boxes (barrel)	NRC	
Rubber Mats	Site		Shelving unit x 1 (to purchase)	NRC	
Rubber squeegees x 4	Site		Rate Station Management Form	NRC	
Scrapers x2	Site		Cold-Soaked Box Procedure	NRC	
Buckets for mixing Cold-soak Fluid	Site		Cold-soak Box Filling Stand	NRC	
Yellow Ice Pick	Site		Cold-soak fluid pump	NRC	

NOTE: The NRC chamber needs to be cooled the day before testing starts.
The Snow fence (orange) will be placed near the stands by NRC for all tests.

FIGURE 2: 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:

This page intentionally left blank.

APPENDIX E

TRANSPORT CANADA AND FEDERAL AVIATION ADMINISTRATION 2008-09 HOLDOVER TIME GUIDELINES

TRANSPORT CANADA
HOLDOVER TIME (HOT) GUIDELINES
WINTER 2008-2009

Transport Canada
Holdover Time (HOT) Guidelines
Winter 2008-2009

Original Issue, July 2008

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 the 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/CivilAviation/commerce/HoldoverTime/menu.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.

Type I Fluid

The Type I holdover time guideline values are unchanged.

Type II Fluid

A fluid-specific table has been created for one new Type II fluid: Kilfrost ABC-K Plus. This fluid is currently in the qualification process. The Type II generic holdover time guideline values are unchanged.

Transport Canada and the FAA have been notified that there were possible viscosity issues with the Aviation Xi'an High-Tech KHF II fluid, which was first commercialized for use in winter 2007-2008.

> Specifically, there may still be batches of this fluid on the market that were shipped/delivered with viscosities lower than the published Lowest On-Wing Viscosities for use with the HOT guidelines.
>
> We have been advised that the fluid manufacturer is taking measures to correct this situation.
>
> A fluid-specific holdover time guideline table has been retained for this fluid; however, Table 5 "Currently Qualified Fluids (2008-2009)" was amended to indicate that this fluid is currently in re-qualification.
>
> It is highly recommended that operators intending to utilize holdover time guidelines associated with this fluid:
>
> 1) Contact the vendor for further details; and
> 2) Carefully assess this fluid's on-wing viscosity at time of use.

Type III Fluid

The Type III holdover time guideline values are unchanged.

Type IV Fluid

Removal of obsolete Type IV data has resulted in increases to the values in the cold soaked wing cells of the generic holdover time guidelines.

A fluid-specific table has been added for Dow Chemical UCAR™ FlightGuard AD-480. This product is identical to ABAX (ex SPCA) AD-480; therefore, the holdover time guideline values for these tables are the same.

Holdover Times in Frost Conditions

A note has been included in the Type II and Type IV generic and fluid-specific tables to advise that radiational cooling during active frost conditions may reduce holdover time when operating close to the lower end of the outside air temperature range.

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 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 and SAE Type II, III and IV fluids described in tables 6 & 7 of the Transport Canada HOT Guidelines document.

Delete Sub-Paragraph 10.13.3.1 Item g) only.

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 decision making criteria, 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 Paragraph 11.1.8 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) Snow Pellets; b) Hail; c) Moderate and Heavy Freezing Rain; and d) Heavy Snow.

Notes: Operators need to assess whether operations can be safely conducted under these conditions.

Additionally, holdover time guidelines have not been assessed for the 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 has yet been identified for ice pellet conditions. Instead, an allowance time based upon research has been developed for operations during ice pellet conditions.

Replace Paragraph 12.1.2 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 yet 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.

HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2008-2009

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 1

SAE TYPE I[3] FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[5]		Approximate Holdover Times Under Various Weather Conditions (minutes)								
Degrees Celsius	Degrees Fahrenheit	Active Frost	Freezing Fog	Snow or Snow Grains[1] Very Light	Snow or Snow Grains[1] Light	Snow or Snow Grains[1] Moderate	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	45	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	45	8 – 13	14	8 – 14	5 – 8	5 – 9	4 – 6	CAUTION: No holdover time guidelines exist	
below -6 to -10	below 21 to 14	45	6 – 10	11	6 – 11	4 – 6	4 – 7	2 – 5		
below -10	below 14	45	5 – 9	7	4 – 7	2 – 4				

NOTES

1 To use these times, the fluid must be heated to a minimum temperature providing 60°C (140°F) at the nozzle and an average rate of at least 1 litre/m^2 (2 gal./100 sq. ft.) must be applied to deiced surfaces, OTHERWISE TIMES WILL BE SHORTER.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 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.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Ensure that the lowest operational use temperature (LOUT) is respected.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 2-Generic

SAE TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	0:35 – 1:30	0:20 – 0:45	0:30 – 0:55	0:15 – 0:30	0:05 – 0:40	CAUTION: No holdover time guidelines exist
		75/25	5:00	0:25 – 1:00	0:15 – 0:30	0:20 – 0:45	0:10 – 0:25	0:05 – 0:25	
		50/50	3:00[5]	0:15 – 0:30	0:05 – 0:15	0:05 – 0:15	0:05 – 0:10		
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:20 – 1:05	0:15 – 0:30	0:15 – 0:45[3]	0:10 – 0:20[3]		
		75/25	5:00[5]	0:20 – 0:55	0:10 – 0:20	0:15 – 0:30[3]	0:05 – 0:15[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5,6]	0:15 – 0:20[6]	0:15 – 0:30[6]				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 Based on the lowest holdover times of the Type II fluids listed in Table 5-2.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.
6 Ensure that the lowest operational use temperature (LOUT) is respected.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 2-A-E26

ABAX (ex SPCA) TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
ECOWING 26

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	1:25 – 2:35	0:40 – 1:00	0:50 – 1:35	0:40 – 0:50	0:20 – 1:25	
		75/25	5:00	1:05 – 1:55	0:25 – 0:45	0:45 – 1:05	0:25 – 0:35	0:10 – 1:00	
		50/50	3:00[5]	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:05 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:45 – 2:15	0:35 – 0:55	0:30 – 1:10[3]	0:15 – 0:35[3]		
		75/25	5:00[5]	0:35 – 1:15	0:25 – 0:40	0:20 – 0:50[3]	0:15 – 0:25[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:25 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 2-A-KHF-II

AVIATION XI'AN HIGH-TECH TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
KHF-II

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	1:15 – 2:15	0:45 – 1:20	0:50 – 1:30	0:30 – 0:45	0:10 – 1:15	
		75/25	5:00	0:45 – 1:00	0:25 – 0:40	0:25 – 0:45	0:15 – 0:25	0:05 – 0:45	
		50/50	3:00[5]	0:20 – 0:30	0:15 – 0:25	0:10 – 0:15	0:05 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00[5]	1:10 – 2:40	0:35 – 1:00	0:20 – 1:35[3]	0:25 – 0:40[3]		
		75/25	5:00[5]	0:45 – 1:20	0:15 – 0:30	0:20 – 0:45[3]	0:15 – 0:20[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:35 – 0:50	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 2-C-2025

CLARIANT TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
SAFEWING MP II 2025 ECO

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	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	5:00	0:55 – 1:45	0:25 – 0:45	0:25 – 0:45	0:20 – 0:25	0:05 – 0:50	
		50/50	3:00[5]	0:20 – 0:35	0:05 – 0:15	0:10 – 0:15	0:05 – 0:10		
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:45 – 1:50	0:35 – 1:00	0:35 – 1:05[3]	0:20 – 0:35[3]		
		75/25	5:00[5]	0:40 – 1:20	0:25 – 0:45	0:30 – 0:40[3]	0:15 – 0:25[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:25 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 2-C-Flight

CLARIANT TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
SAFEWING MP II FLIGHT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	Degrees Fahrenheit		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	8:00	3:30 – 4:00	1:00 – 1:35	1:20 – 2:00	0:45 – 1:25	0:10 – 1:30	
		75/25	5:00	2:30 – 4:00	0:40 – 1:20	1:15 – 2:00	0:30 – 0:55	0:05 – 1:20	
		50/50	3:00[5]	0:55 – 1:45	0:10 – 0:25	0:20 – 0:30	0:10 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:55 – 1:45	0:40 – 1:05	0:35 – 1:30[3]	0:25 – 0:45[3]		
		75/25	5:00[5]	0:40 – 1:10	0:20 – 0:40	0:25 – 1:10[3]	0:30 – 0:40[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:30 – 0:50	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 2-K-ABC-2000

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
ABC-2000

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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 %)**	**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	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	5:00	1:40 – 3:30	0:30 – 1:05	0:45 – 1:15	0:40 – 0:50	0:15 – 1:40	
		50/50	3:00[5]	1:00 – 2:10	0:15 – 0:30	0:15 – 0:25	0:05 – 0:15		
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:35 – 1:25	0:25 – 0:45	0:25 – 0:50[3]	0:10 – 0:30[3]		
		75/25	5:00[5]	0:35 – 1:15	0:25 – 0:50	0:25 – 0:55[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:20 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 2-K-ABC-II+

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
ABC-II PLUS

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	Degrees Fahrenheit		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	8:00	1:10 – 2:25	0:25 – 0:55	0:35 – 1:10	0:30 – 0:40	0:05 – 1:00	
		75/25	5:00	1:10 – 2:25	0:25 – 0:50	0:30 – 1:00	0:20 – 0:40	0:05 – 0:50	
		50/50	3:00[5]	0:15 – 0:45	0:15 – 0:35	0:05 – 0:25	0:05 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:30 – 1:05	0:15 – 0:35	0:15 – 0:45[3]	0:10 – 0:30[3]		
		75/25	5:00[5]	0:20 – 0:55	0:15 – 0:35	0:15 – 0:30[3]	0:10 – 0:20[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:15 – 0:20	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines **Winter 2008-2009**

TABLE 2-K-ABC-K+

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

ABC-K PLUS

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	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	5:00	1:40 – 2:30	0:35 – 1:10	1:25 – 2:00	0:50 – 1:10	0:15 – 2:00	
		50/50	3:00[5]	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	8:00[5]	0:30 – 1:05	0:50 – 1:25	0:25 – 1:00[3]	0:15 – 0:35[3]		
		75/25	5:00[5]	0:25 – 1:25	0:35 – 1:05	0:20 – 0:55[3]	0:05 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:30 – 0:55	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 2-N-FCY-2

NEWAVE AEROCHEMICAL TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
FCY-2

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	1:15 – 2:25	0:30 – 0:55	0:35 – 1:05	0:25 – 0:35	0:05 – 0:45	
		75/25	5:00	0:50 – 1:30	0:20 – 0:40	0:25 – 0:45	0:15 – 0:25	0:05 – 0:25	
		50/50	3:00[5]	0:25 – 0:35	0:15 – 0:25	0:10 – 0:20	0:05 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:45 – 1:30	0:15 – 0:30	0:20 – 0:45[3]	0:15 – 0:20[3]		
		75/25	5:00[5]	0:30 – 1:05	0:10 – 0:20	0:15 – 0:30[3]	0:05 – 0:15[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:25 – 0:35	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 2-O-EM-II

OCTAGON TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
E MAX II

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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 %)**	**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	8:00	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	5:00	1:25 – 2:50	0:25 – 0:55	0:40 – 1:10	0:20 – 0:30	0:10 – 1:05	
		50/50	3:00[5]	0:30 – 0:55	0:10 – 0:25	0:15 – 0:30	0:10 – 0:15		
below -3 to -14	below 27 to 7	100/0	8:00[5]	0:50 – 1:45	0:35 – 1:10	0:35 – 1:00[3]	0:20 – 0:30[3]		
		75/25	5:00[5]	0:30 – 1:20	0:25 – 0:50	0:35 – 1:05[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	8:00[5]	0:20 – 0:35	0:15 – 0:30				
below -25	below -13	100/0	Type II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

NOTES
1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 3

SAE TYPE III FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[3]		Approximate Holdover Times Under Various Weather Conditions (minutes)									
Degrees Celsius	Degrees Fahrenheit	Type III Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Active Frost	Freezing Fog	Snow or Snow Grains: Very Light	Snow or Snow Grains: Light	Snow or Snow Grains: Moderate	Freezing Drizzle[1]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	120	20 – 40	35	20 – 35	10 – 20	10 – 20	8 – 10	6 – 20	
		75/25	60	15 – 30	25	15 – 25	8 – 15	8 – 15	6 – 10	2 – 10	
		50/50	30	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	120	20 – 40	30	15 – 30	9 – 15	10 – 20	8 – 10		
		75/25	60	15 – 30	25	10 – 25	7 – 10	9 – 12	6 – 9		
below -10	below 14	100/0	120	20 – 40	30	15 – 30	8 – 15				

NOTES

1 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type III fluid cannot be used.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 4-Generic

SAE TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	1:15 – 2:30	0:35 – 1:15	0:40 – 1:10	0:25 – 0:40	0:10 – 1:05	CAUTION: No holdover time guidelines exist
		75/25	5:00	1:05 – 1:45	0:20 – 0:55	0:35 – 0:50	0:15 – 0:30	0:05 – 0:40	
		50/50	3:00[5]	0:15 – 0:35	0:05 – 0:15	0:10 – 0:20	0:05 – 0:10		
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:20 – 1:20	0:20 – 0:40	0:20 – 0:45[3]	0:10 – 0:25[3]		
		75/25	5:00[5]	0:25 – 0:50	0:15 – 0:35	0:15 – 0:30[3]	0:10 – 0:20[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5,6]	0:15 – 0:40[6]	0:15 – 0:30[6]				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 Based on the lowest holdover times of the Type IV fluids listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.
6 Ensure that the lowest operational use temperature (LOUT) is respected.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 4-A-AD-480

ABAX (ex SPCA) TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
AD-480

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	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	5:00	1:30 – 2:45	0:30 – 1:05	0:50 – 1:15	0:30 – 0:45	0:10 – 1:15	
		50/50	3:00[5]	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:05 – 0:15		
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:20 – 1:20	0:30 – 0:55	0:25 – 1:20[3]	0:15 – 0:30[3]		
		75/25	5:00[5]	0:25 – 0:50	0:20 – 0:45	0:25 – 1:05[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:15 – 0:40	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 4-C-2001

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

SAFEWING MP IV 2001

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**	**Neat Fluid/Water (Volume %/Volume %)**	**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	1:20 – 3:20	1:00 – 1:55	0:55 – 1:55	0:40 – 1:00	0:15 – 2:00	
		75/25	5:00	1:20 – 2:00	0:35 – 1:00	0:35 – 1:10	0:25 – 0:35	0:10 – 1:25	
		50/50	3:00[5]	0:15 – 0:40	0:10 – 0:20	0:10 – 0:20	0:05 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:45 – 1:35	0:30 – 0:50	0:55 – 1:35[3]	0:30 – 0:45[3]		
		75/25	5:00[5]	0:30 – 1:00	0:20 – 0:35	0:40 – 1:10[3]	0:20 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:20 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 4-C-2012

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
SAFEWING MP IV 2012 PROTECT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	1:15 – 2:30	0:40 – 1:15	0:40 – 1:10	0:25 – 0:45	0:10 – 1:05	CAUTION: No holdover time guidelines exist
		75/25	5:00	1:10 – 2:05	0:25 – 0:55	0:35 – 0:50	0:15 – 0:30	0:05 – 0:40	
		50/50	3:00[5]	0:25 – 0:45	0:15 – 0:25	0:15 – 0:20	0:05 – 0:10		
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:45 – 1:45	0:20 – 0:40	0:25 – 0:45[3]	0:15 – 0:25[3]		
		75/25	5:00[5]	0:25 – 1:05	0:20 – 0:40	0:15 – 0:30[3]	0:10 – 0:20[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:20 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 4-C-Launch

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
SAFEWING MP IV LAUNCH

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	12:00	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	5:00	3:40 – 4:00	1:00 – 1:45	1:40 – 2:00	0:45 – 1:15	0:10 – 1:45	
		50/50	3:00[5]	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	12:00[5]	1:00 – 1:55	0:50 – 1:20	0:35 – 1:40[3]	0:25 – 0:45[3]		
		75/25	5:00[5]	0:40 – 1:20	0:45 – 1:25	0:25 – 1:10[3]	0:25 – 0:45[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:30 – 0:50	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 4-D-ULTRA+

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
UCAR™ ADF/AAF ULTRA+

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	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	12:00[5]	1:25 – 3:00	0:25 – 0:55	0:45 – 1:25[3]	0:30 – 0:45[3]		
		75/25							
below -14 to -25	below 7 to -13	100/0	12:00[5,6]	0:40 – 2:10[6]	0:20 – 0:45[6]				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met.[5] Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.
6 These holdover times only apply to outside air temperatures to -24°C (-11°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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 4-D-E106

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
UCAR™ ENDURANCE EG106

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	12:00	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							
		50/50							
below -3 to -14	below 27 to 7	100/0	12:00[5]	1:50 – 3:20	0:30 – 1:05	0:55 – 1:50[3]	0:45 – 1:10[3]		
		75/25							
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:30 – 1:05	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines Winter 2008-2009

TABLE 4-D-AD-480

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
UCAR™ FLIGHTGUARD AD-480

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	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	5:00	1:30 – 2:45	0:30 – 1:05	0:50 – 1:15	0:30 – 0:45	0:10 – 1:15	
		50/50	3:00[5]	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:05 – 0:15		
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:20 – 1:20	0:30 – 0:55	0:25 – 1:20[3]	0:15 – 0:30[3]		
		75/25	5:00[5]	0:25 – 0:50	0:20 – 0:45	0:25 – 1:05[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:15 – 0:40	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Page 25 of 42 July 2008

TABLE 4-K-ABC-S

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

ABC-S

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	12:00	2:35 – 4:00	1:00 – 1:40	1:20 – 1:50	1:00 – 1:25	0:20 – 1:15	
		75/25	5:00	1:05 – 1:45	0:30 – 0:55	0:45 – 1:10	0:35 – 0:50	0:10 – 0:50	
		50/50	3:00[5]	0:20 – 0:35	0:05 – 0:15	0:15 – 0:20	0:05 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:45 – 2:05	0:45 – 1:20	0:20 – 1:00[3]	0:10 – 0:30[3]		
		75/25	5:00[5]	0:25 – 1:00	0:25 – 0:50	0:20 – 1:10[3]	0:10 – 0:35[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:20 – 0:40	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 4-K-ABC-S PLUS

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
ABC-S PLUS

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	12:00	2:10 – 4:00	1:15 – 2:00	1:50 – 2:00	1:05 – 2:00	0:25 – 2:00	
		75/25	5:00	1:25 – 2:40	0:45 – 1:15	1:00 – 1:20	0:30 – 0:50	0:10 – 1:20	
		50/50	3:00[5]	0:30 – 0:55	0:15 – 0:30	0:15 – 0:40	0:15 – 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:55 – 3:30	1:00 – 1:45	0:25 – 1:35[3]	0:20 – 0:30[3]		
		75/25	5:00[5]	0:45 – 1:50	0:35 – 1:00	0:20 – 1:10[3]	0:15 – 0:25[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:40 – 1:00	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 4-L-ARCTIC Shield

LYONDELL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
ARCTIC SHIELD™

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**	**Neat Fluid/Water (Volume %/Volume %)**	**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	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	5:00	1:20 – 2:15	0:40 – 1:05	0:55 – 1:25	0:30 – 0:45	0:05 – 1:20	
		50/50	3:00[5]	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	12:00[5]	1:00 – 2:25	0:45 – 1:15	0:25 – 1:30[3]	0:25 – 0:30[3]		
		75/25	5:00[5]	0:50 – 1:45	0:35 – 0:55	0:30 – 1:15[3]	0:25 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:25 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 4-O-MF

OCTAGON TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

MAX-FLIGHT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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		Active Frost	Freezing Fog	Snow or Snow Grains	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	100/0	12:00	2:40 – 4:00	0:50 – 1:35	0:55 – 2:00	0:35 – 1:00	0:15 – 1:15	CAUTION: No holdover time guidelines exist
		75/25	5:00	2:05 – 3:15	0:45 – 1:45	1:15 – 2:00	0:35 – 1:10	0:10 – 0:40	
		50/50	3:00[5]	0:55 – 1:45	0:25 – 1:15	0:35 – 1:00	0:15 – 0:30		
below -3 to -14	below 27 to 7	100/0	12:00[5]	0:50 – 2:30	0:25 – 0:50	0:25 – 1:10[3]	0:20 – 0:40[3]		
		75/25	5:00[5]	0:30 – 1:05	0:20 – 0:50	0:20 – 1:00[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:20 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

TABLE 4-O-MF-04

OCTAGON TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]

MAX-FLIGHT 04

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

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**		**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	2:40 – 4:00	1:25 – 2:00	2:00 – 2:00	1:10 – 1:30	0:20 – 2:00	
		75/25	5:00	2:05 – 3:15	1:05 – 2:00	1:50 – 2:00	1:00 – 1:20	0:20 – 2:00	
		50/50	3:00[5]	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	12:00[5]	0:50 – 2:30	0:35 – 1:10	0:25 – 1:30[3]	0:20 – 0:40[3]		
		75/25	5:00[5]	0:30 – 1:05	0:40 – 1:20	0:20 – 1:00[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:20 – 0:45	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines — Winter 2008-2009

TABLE 4-O-MFLO

OCTAGON TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2008-2009[1]
MAXFLO

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
Degrees Celsius	**Degrees Fahrenheit**	**Neat Fluid/Water (Volume %/Volume %)**	**Active Frost**	**Freezing Fog**	**Snow or Snow Grains**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing**	**Other[2]**
-3 and above	27 and above	100/0	12:00	2:20 – 3:35	0:40 – 1:30	1:20 – 2:00	0:30 – 1:00	0:10 – 2:00	CAUTION: No holdover time guidelines exist
		75/25	5:00	1:25 – 2:00	0:20 – 0:55	0:40 – 1:05	0:20 – 0:35	0:05 – 1:15	
		50/50	3:00[5]	0:20 – 0:40	0:05 – 0:15	0:10 – 0:20	0:05 – 0:10		
below -3 to -14	below 27 to 7	100/0	12:00[5]	1:10 – 2:20	0:25 – 1:00	0:35 – 1:45[3]	0:30 – 0:50[3]		
		75/25	5:00[5]	0:40 – 1:25	0:15 – 0:40	0:35 – 1:15[3]	0:15 – 0:30[3]		
below -14 to -25	below 7 to -13	100/0	12:00[5]	0:30 – 1:00	0:15 – 0:30				
below -25	below -13	100/0	Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the outside air temperature and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
3 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 deicing/anti-icing do not provide in-flight icing protection.**

Page 31 of 42 July 2008

TABLE 5
CURRENTLY QUALIFIED FLUIDS (2008-2009)

Table 5-1: Qualified Type I Anti-icing Fluids(1) (2)			
#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
1-1	ABAX Industries (ex SPCA)	ABAX DE-950	12-06-25
1-2	ABAX Industries (ex SPCA)	ABAX DE-950 Colorless	12-06-26
1-3	*Arcton Ltd.*	*Arctica DG*	*08-04-10*(3)
1-4	Aviation Xi'an High-Tech	Aviation Xi'an KHF-1	11-09-20
1-5	*Battelle*	*D^3: Degradable by Design Deicer™ ADF 1006A*	*08-01-13*(3)
1-6	Beijing Wangye Aviation Chemical Product Co. Ltd.	KLA-1	11-09-20
1-7	Beijing Wangye Aviation Chemical Product Co. Ltd.	YJF-1	09-02-23
1-8	Clariant GmbH	Clariant Safewing MP I 1938 TF	08-08-21
1-9	*Clariant GmbH*	*Clariant Safewing MP I 1938 TF Pre-Mix*	*07-09-14*(3)
1-10	Clariant GmbH	Clariant Safewing MP I 1938 ECO (80)	12-06-10
1-11	Clariant GmbH	Clariant Safewing MP I 1938 ECO (80) Pre-Mix	09-03-01
1-12	Clariant GmbH	Clariant Safewing MP I 1938 ECO	12-06-10
1-13	Clariant GmbH	Clariant Safewing EG I 1996	12-06-10
1-14	*Chemical Specialists and Development Inc.*	*Prist Wing De-Icer*	*08-05-17*(3)
1-15	Dow Chemical Company	Dow UCAR™ Aircraft Deicing Fluid Concentrate	11-09-10
1-16	Dow Chemical Company	Dow UCAR™ ADF XL-54	09-02-01
1-17	Dow Chemical Company	Dow UCAR™ PG ADF Aircraft Deicing Fluid Concentrate	12-02-05
1-18	Dow Chemical Company	Dow UCAR™ PG ADF Dilute 55/45	12-02-05
1-19	*HOC Industries*	*SafeTemp I ES*	*07-10-27*(3)
1-20	HOC Industries	SafeTemp ES Plus	11-10-04
1-21	*Inland Technologies Inc.*	*Inland Duragly-P ready to use*	*05-09-11*(3)
1-22	*Inland Technologies Inc.*	*Inland Duragly-E ready to use*	*05-10-20*(3)
1-23	Kilfrost Limited	Kilfrost DF Plus	11-09-27
1-24	Kilfrost Limited	Kilfrost DF Plus (80)	08-07-12(4)
1-25	Kilfrost Limited	Kilfrost DF Plus (88)	11-09-27
1-26	Kilfrost Limited	Kilfrost DF^{sustain™}	09-01-26
1-27	*Lyondell Chemical Co.*	*Lyondell ARCOPlus®*	*08-02-14*(3)
1-28	*Lyondell Chemical Co.*	*Lyondell ARCTIC Plus®*	*08-04-10*(3)
1-29	Newave Aerochemical Co. Ltd.	Newave FCY-1A	11-08-21
1-30	Octagon Process Inc.	Octagon EcoFlo	09-07-30
1-31	Octagon Process Inc.	Octagon Octaflo EF	11-07-11
1-32	*Octagon Process Inc.*	*Octagon Octaflo EG*	*07-05-12*(3)
1-33	*Viterbo S.A.*	*Jarkleer SAE Type I*	*07-01-20*(3)

(1)Qualified solely with respect to anti-icing performance and aerodynamic acceptance by the Anti-icing Materials International Laboratory, Université du Québec à Chicoutimi. Web site: http://www.uqac.ca/amil/index.htm
For other specification requirements for Type I fluids, see SAE AMS 1424 (latest version). Fluids that successfully qualify after the issuance of this list will appear in a later update.
(2)Concentrate fluids have also been qualified 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 qualification/re-qualification process.

TABLE 5 (cont.)

CURRENTLY QUALIFIED FLUIDS (2008-2009)

Table 5-2: Qualified[1] Type II Anti-icing Fluids

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
2-1	ABAX Industries (ex SPCA)	Ecowing 26	09-08-21
2-2	Aviation Xi'an High-Tech	Aviation Xi'an KHF-II	08-06-15[3]
2-3	Clariant GmbH	Clariant Safewing MP II 1951	09-05-08
2-4	*Clariant GmbH*	*Clariant Safewing MP II 2025 ECO*	*08-06-28*[2]
2-5	Clariant GmbH	Clariant Safewing MP II Flight	10-06-16
2-6	*Kilfrost Limited*	*Kilfrost ABC-II PLUS*	*05-10-29*[2]
2-7	Kilfrost Limited	Kilfrost ABC-3	10-07-16
2-8	Kilfrost Limited	Kilfrost ABC-2000	08-07-12[3]
2-9	Kilfrost Limited	Kilfrost ABC-K PLUS	Y-M-D[3]
2-10	Newave Aerochemical Co. Ltd.	Newave FCY-2	09-01-11
2-11	Octagon Process Inc.	Octagon E Max II	08-10-31

Table 5-3: Qualified[1] Type III Anti-icing Fluids

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
3-1	Clariant GmbH	Clariant Safewing MP III 2031 ECO	09-05-02
	CAUTION: The lowest operational use temperature (LOUT) is -16.5°C (2°F) for aircraft with rotation speeds less than 100 knots or -29°C (-20°F) for aircraft with higher rotation speeds.		

Table 5-4: Qualified[1] Type IV Anti-icing Fluids

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
4-1	ABAX Industries (ex SPCA)	ABAX AD-480	09-07-30
4-2	*Clariant GmbH*	*Clariant Safewing MP IV 2001*	*08-06-26*[2]
4-3	*Clariant GmbH*	*Clariant Safewing MP IV 2012 Protect*	*07-07-12*[2]
4-4	Clariant GmbH	Clariant Safewing MP IV Launch	10-06-18
4-5	Dow Chemical Company	Dow UCAR ADF/AAF ULTRA+	08-08-21
4-6	Dow Chemical Company	UCAR™ Endurance EG106	09-09-04
4-7	Dow Chemical Company	UCAR FlightGuard AD-480	10-04-30
4-8	*Ely Chemical Company*	*Octagon Max-Flight*	*06-07-06*[2]
4-9	Kilfrost Limited	Kilfrost ABC-S	09-06-29
4-10	Kilfrost Limited	ABC-S PLUS	09-03-07
4-11	Lyondell Chemical Co.	Lyondell ARCTIC Shield™	10-05-21
4-12	*Octagon Process Inc.*	*Octagon Max-Flight*	*06-07-06*[2]
4-13	Octagon Process Inc.	Octagon Max-Flight 04	10-04-29
4-14	*Octagon Process Inc.*	*Octagon MaxFlo*	*07-03-24*[2]

[1] Qualified solely with respect to anti-icing performance and aerodynamic acceptance by the Anti-icing Materials International Laboratory, Université du Québec à Chicoutimi. Web site: http://www.uqac.ca/amil/index.htm
For other specification requirements for Type II, III or IV fluids, see SAE AMS 1428 (latest version). Fluids that successfully qualify 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 qualification/re-qualification process.

Transport Canada Holdover Time Guidelines Winter 2008-2009

TABLE 6

SAE TYPE I DEICING 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 Deicing/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 in snow conditions, 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.**

Transport Canada Holdover Time Guidelines Winter 2008-2009

TABLE 7

SAE TYPE II, TYPE III and TYPE IV 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 Deicing/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.
- 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 should not be used for the anti-icing step because fluid freezing may occur.**
- **An insufficient amount of anti-icing fluid may cause a substantial loss of holdover time. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.**

TABLE 8

VISIBILITY IN SNOW VS. SNOWFALL INTENSITY CHART[1]

Lighting	Temperature Range		Visibility in Snow (Statute Miles)			
	ºC	ºF	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

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 THE TABLE

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.

TABLE 9

LOWEST ON-WING VISCOSITY VALUES FOR ANTI-ICING FLUIDS

(See Table 9 endnotes)

Table 9-1: Type II 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 (ex 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 Xi'An Hi-Tech KHF-II	100/0	8 750 [c]	7 690 [g]
	75/25	6 400 [c]	6 890 [g]
	50/50	2 950 [c]	3 150 [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	17 500 [g]	17 500 [g]
	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-II Plus	100/0	3 600 [c]	3 600 [g]
	75/25	4 000 [c]	4 000 [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 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
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 ANTI-ICING FLUIDS

(See Table 9 endnotes)

Table 9-3: Type IV Anti-Icing Fluids

FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	AIR 9968 REVISION A METHOD
ABAX (ex SPCA) 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]
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 2012 Protect	100/0	7 800 [b]	7 250 [g]
	75/25	17 800 [b]	17 700 [c]
	50/50	4 500 [b]	4 250 [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]
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]
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]
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	100/0	5 540 [d]	5 540 [g]
	75/25	15 000 [g]	15 000 [g]
	50/50	5 200 [g]	5 200 [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]
Octagon MaxFlo	100/0	8 670 [g]	8 670 [g]
	75/25	8 200 [g]	8 200 [g]
	50/50	2 200 [g]	2 200 [g]

TABLE 9 (cont.)

LOWEST ON-WING VISCOSITY VALUES FOR ANTI-ICING FLUIDS

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 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.

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.

ICE PELLET ALLOWANCE TIMES FOR WINTER 2008-2009

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 when 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 the 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) would be 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 the aerodynamic surfaces during takeoff.

3) The allowance times were developed based on this aerodynamic testing and are contained in Table 10.

4) 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 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;

   e) If the takeoff is not accomplished within the applicable allowance time in Table 10, 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 limits of the applicable allowance time in Table 10 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. However, under conditions of light ice pellets mixed with light freezing rain, the OAT must not decrease during the 90-minute period.

5) 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 takeoff without any further action up to 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, and 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 takeoff without any further action up to 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, 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 end of the allowance time at 10:25, the aircraft may takeoff without any further action up to 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, 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.

TABLE 10

ICE PELLET ALLOWANCE TIMES FOR WINTER 2008-2009

<table>
<tr><th></th><th>OAT -5°C and above</th><th>OAT less than -5°C to -10°C</th><th>OAT less than -10°C</th></tr>
<tr><td>Light Ice Pellets</td><td>50 minutes</td><td>30 minutes</td><td>30 minutes</td></tr>
<tr><td>Moderate Ice Pellets</td><td>25 minutes</td><td>10 minutes</td><td>10 minutes</td></tr>
<tr><td>Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle</td><td>25 minutes</td><td>10 minutes</td><td rowspan="4">Caution: No allowance times currently exist</td></tr>
<tr><td>Light Ice Pellets Mixed with Light Freezing Rain</td><td>25 minutes</td><td>10 minutes</td></tr>
<tr><td>Light Ice Pellets Mixed with Light Rain</td><td>25 minutes</td><td rowspan="2"></td></tr>
<tr><td>Light Ice Pellets Mixed with Light or Moderate Snow</td><td>25 minutes</td></tr>
</table>

FAA
HOLDOVER TIME GUIDELINES
WINTER 2008-2009

OFFICIAL FAA HOLDOVER TIME TABLES

WINTER 2008-2009

NOTE: These HOT tables will be published in the FAA-Approved Deicing Program Updates for Winter 2008 – 2009 Notice. Operators may use these tables now in their ground deicing / anti-icing programs. The FAA does not expect to make any changes to these tables for the Winter of 2008 – 2009.

SUMMARY OF CHANGES FROM 2007-2008

1. TYPE I FLUIDS.

The Type I fluid holdover time table values are unchanged.

2. TYPE II FLUIDS.

One new Type II fluid, Kilfrost ABC-K Plus, has been added to the list of qualified Type II fluids. The addition of this fluid did not cause any of the values to change in the Type II generic holdover time table, Table 2. A brand specific table has been added for this new fluid (Table 2G).

The FAA and Transport Canada have been notified that there were possible viscosity issues with the Aviation Xi'an High-Tech KHF II fluid which was first commercialized for use in winter 2007-08.

Specifically, there may still be batches of this fluid in the field that were shipped or delivered with viscosities lower than the published Lowest On-Wing Viscosity (LOWV) for use with the holdover time guidelines.

The FAA and Transport Canada have been advised that the fluid manufacturer is taking measures to correct this situation.

It is highly recommended that operators intending to use generic or fluid-specific holdover time guidelines associated with this fluid contact the vendor for further details, and carefully assess this fluid's on-wing viscosity at time of use.

3. TYPE III FLUIDS.

The Type III fluid holdover time table values are unchanged.

TYPE IV FLUIDS.

In the Type IV generic holdover time tables, the values were increased in the Rain on Cold Soaked Wing cells due to the removal of obsolete data.

TABLE OF CONTENTS FOR HOT GUIDELINES

FOR WINTER 2008-2009

Page 3

TABLE **PAGE**

Page 5

FAA TYPE I HOLDOVER TIME GUIDELINE

TABLE 1. FAA GUIDELINES FOR HOLDOVER TIMES SAE TYPE I 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 PRE-TAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Approximate Holdover Times Under Various Weather Conditions (hours: minutes)								
				Snow/Snow Grains						
Degrees Celsius	Degrees Fahren-heit	Active Frost	Freezing Fog	Very Light◆◆	Light ◆◆	Moderate◆◆	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	0:45	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	0:45	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	0:45	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	0:45	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, snow pellets, ice pellets, moderate and heavy freezing rain, hail
◆◆ **TO USE THESE TIMES, THE FLUID MUST BE HEATED TO A MINIMUM TEMPERATURE OF 60 °C (140 °F) AT THE NOZZLE AND AT LEAST 1 LITER/M^2 (≈ 2 GALS/100FT^2) MUST BE APPLIED TO DEICED SURFACES**
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.

August 2008

TABLE 1A. FAA GUIDELINES FOR THE APPLICATION OF SAE TYPE I FLUID MIXTURE 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	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 in snow conditions, 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 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) can be used under these conditions.**

August 2008

Page 6

Page 7

TABLE 1B. SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY

Time of Day	Temp.		Visibility (Statute Mile)							
	Degrees Celsius	Degrees Fahrenheit	≥ 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 fluid guidelines. It may also be used with Type II, III, or IV fluid guidelines.

HEAVY = Caution—No Holdover Time Guidelines Exist

August 2008

Page 8

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 PRE-TAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	**Approximate Holdover Times Under Various Weather Conditions (hours: minutes)**						
Degrees Celsius	Degrees Fahrenheit		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	0:35-1:30	0:20-0:45	0:30-0:55	0:15-0:30	0:05-0:40	
		75/25	5:00	0:25-1:00	0:15-0:30	0:20-0:45	0:10-0:25	0:05-0:25	
		50/50	3:00†	0:15-0:30	0:05-0:15	0:05-0:15	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	8:00†	0:20-1:05	0:15-0:30	***0:15-0:45	***0:10-0:20	CAUTION: No holdover time guidelines exist	
		75/25	5:00†	0:20-0:55	0:10-0:20	***0:15-0:30	***0: 05-0: 15		
below -14 to -25	below 7 to -13	100/0	8:00†	0:15-0:20	0:15-0:30				
below -25	below -13	100/0	**SAE Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **SAE Type II** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

Page 9

TABLE 2A. FAA GUIDELINES FOR HOLDOVER TIMES ABAX (SPCA) 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	1:25-2:35	0:40-1:00	0:50-1:35	0:40-0:50	0:20-1:25	
		75/25	5:00	1:05-1:55	0:25-0:45	0:45-1:05	0:25-0:35	0:10-1:00	
		50/50	3:00†	0:30-0:45	0:10-0:20	0:15-0:25	0:05-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:45-2:15	0:35-0:55	***0:30-1:10	***0:15-0:35		
		75/25	5:00†	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	8:00†	0:25-0:45	0:15-0:30				
below -25	below -13	100/0	**ABAX ECOWING 26 Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **ABAX ECOWING 26 Type II** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 2B. FAA GUIDELINES FOR HOLDOVER TIMES AVIATION XI'AN HI-TECH KHF-II 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	1:15-2:15	0:45-1:20	0:50-1:30	0:30-0:45	0:10-1:15	
		75/25	5:00	0:45-1:00	0:25-0:40	0:25-0:45	0:15-0:25	0:05-0:45	
		50/50	3:00†	0:20-0:30	015-0:25	0:10-0:15	0: 05-:010	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	1:10-2:40	0:35-1:00	***0:20-1:35	***0:25-0:40		
		75/25	5:00†	0:45-1:20	0:15-0:30	***0:20-0:45	***0:15-0:20		
below -14 to -25	below 7 to -13	100/0	8:00†	0:35-0:50	0:15-0:30				
below -25	below -13	100/0	**AVIATION XI'AN HIGH-TECH KHF-II Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **AVIATION XI'AN HIGH-TECH KHF-II Type II** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 XI'AN HIGH-TECH KHF-II TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

Page 10

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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	1:30-2:05	0:40-1:10	0:40-1:00	0:25-0:35	0:10-1:15	
		75/25	5:00	0:55-1:45	0:25-0:45	0:25-0:45	0:20-0:25	0:05-0:50	
		50/50	3:00†	0:20-0:35	0:05-0:15	0:10-0:15	0:05-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:45-1:50	0:35-1:00	***0:35-1:05	***0:20-0:35		
		75/25	5:00†	0:40-1:20	0:25-0:45	***0:30-0:40	***0:15-0:25		
below -14 to -25	below 7 to -13	100/0	8:00†	0:25-0:45	0:15-0:30				
below -25	below -13	100/0	**CLARIANT SAFEWING MPII 2025 ECO Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **CLARIANT SAFEWING MPII 2025 ECO Type II** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	3:30-4:00	1:00-1:35	1:20-2:00	0:45-1:25	0:10-1:30	
		75/25	5:00	2:30-4:00	0:40-1:20	1:15-2:00	0:30-0:55	0:05-1:20	
		50/50	3:00†	0:55-1:45	0:10-0:25	0:20-0:30	0:10-:015	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:55-1:45	0:40-1:05	***0:35-1:30	***0:25-0:45		
		75/25	5:00†	0:40-1:10	0:20-0:40	***0:25-1:10	***0:30-0:40		
below -14 to -25	below 7 to -13	100/0	8:00†	0:30-0:50	0:15-0:30				
below -25	below -13	100/0	**CLARIANT SAFEWING MP II FLIGHT Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **CLARIANT SAFEWING MP II FLIGHT Type II** fluid cannot be used.						

Page 12

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 FLIGHT TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

Page 13

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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold **Soaked** Wing**	Other‡
-3 and above	27 and above	100/0	8:00	1:30-3:05	0:30-1:00	0:55-1:35	0:40-0:50	0:15-1:10	
		75/25	5:00	1:40-3:30	0:30-1:05	0:45-1:15	0:40-0:50	0:15-1:40	
		50/50	3:00†	1:00-2:10	0:15-0:30	0:15-0:25	0:05-0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:35-1:25	0:25-0:45	***0:25-0:50	***0:10-0:30		
		75/25	5:00†	0:35-1:15	0:25-0:50	***0:25-0:55	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	8:00†	0:20-0:45	0:15-0:30				
below -25	below -13	100/0	**KILFROST ABC-2000 Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **KILFROST ABC-2000 Type II** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 2F. FAA GUIDELINES FOR HOLDOVER TIMES KILFROST ABC-II 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other ‡
-3 and above	27 and above	100/0	8:00	1:10-2:25	0:25-0:55	0:35-1:10	0:30-0:40	0:05-1:00	
		75/25	5:00	1:10-2:25	0:25-0:50	0:30-1:00	0:20-0:40	0:05-0:50	
		50/50	3:00†	0:15-0:45	0:15-0:35	0:05-0:25	0:05-0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:30-1:05	0:15-0:35	***0:15-0:45	***0:10-0:30		
		75/25	5:00†	0:20-0:55	0:15-0:35	***0:15-0:30	***0:10-0:20		
below -14 to -25	below 7 to -13	100/0	8:00†	0:15-0:20	0:15-0:30				
below -25	below -13	100/0	**KILFROST ABC-II PLUS Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **KILFROST ABC-II PLUS Type II** fluid cannot be used.						

Page 14

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
†Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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-II PLUS TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

TABLE 2G. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other ‡
-3 and above	27 and above	100/0	8:00	2:15-3:45	1:00-1:40	1:50-2:00	1:00-1:25	0:20-2:00	
		75/25	5:00	1:40-2:30	0:35-1:10	1:25-2:00	0:50-1:10	0:15-2:00	
		50/50	3:00†	0:35-1:05	0:05-0:15	0:20-0:30	0:10-0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:30-1:05	0:50-1:25	***0:25-1:00	***0:15-0:35		
		75/25	5:00†	0:25-1:25	0:35-1:05	***0:25-0:55	***0:05-0:30		
below -14 to -25	below 7 to -13	100/0	8:00†	0:30-0:55	0:15-0:30				
below -25	below -13	100/0	**KILFROST ABC-K PLUS Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **KILFROST ABC-K PLUS Type II** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

Page 15

Page 16

TABLE 2H. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	1:15-2:25	0:30-0:55	0:35-1:05	0:25-0:35	0:05-0:45	CAUTION: No holdover time guidelines exist
		75/25	5:00	0:50-1:30	0:20-0:40	0:25-0:45	0:15-0:25	0:05-0:25	
		50/50	3:00†	0:25-0:35	015-0:25	0:10-0:20	0:05-:010		
below -3 to -14	below 27 to 7	100/0	8:00†	0:45-1:30	0:15-0:30	***0:20-0:45	***0:15-0:20		
		75/25	5:00†	0:30-1:05	0:10-0:20	***0:15-0:30	***0:05-0:15		
below -14 to -25	below 7 to -13	100/0	8:00†	0:25-0:35	0:15-0:30				
below -25	below -13	100/0	**NEWAVE AEROCHEMICAL FCY-2 Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **NEWAYE AEROCHEMICAL FCY-2 Type II** 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

*** No holdover time guidelines exist for this condition below -10 °C (14 °F)

‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail

† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 2I. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	8:00	2:05-3:45	0:40-1:20	0:45-1:35	0:30-0:40	0:15-1:30	
		75/25	5:00	1:25-2:50	0:25-0:55	0:40-1:10	0:20-0:30	0:10-1:05	
		50/50	3:00†	0:30-0:55	0:10-0:25	0:15-0:30	0:10-0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	8:00†	0:50-1:45	0:35-1:10	***0:35-1:00	***0:20-0:30		
		75/25	5:00†	0:30-1:20	0:25-0:50	***0:35-1:05	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	8:00†	0:20-0:35	0:15-0:30				
below -25	below -13	100/0	**OCTAGON E-MAX Type II** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **OCTAGON E-MAX Type II** fluid cannot be used.						

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

Page 17

* 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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

Page 18

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 %)	Active Frost	**Freezing Fog**	**Snow/Snow Grains** Very Light	**Snow/Snow Grains** Light	**Snow/Snow Grains** Moderate	**Freezing Drizzle***	**Light Freezing Rain**	**Rain on Cold Soaked Wing****	**Other‡**
-3 and above	27 and above	100/0	2:00	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	1:00	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	0:30	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	2:00	0:20 - 0:40	0:30 - 0:35	0:15 - 0:30	0:09 - 0:15	0:10 - 0:20	0:08 - 0:10		
		75/25	1:00	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	2:00	0:20 - 0:40	0:30 - 0:35	0:15 - 0:30	0:08 - 0:15	CAUTION: No holdover time guidelines exist			

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 are met.

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

‡Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail

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.

August 2008

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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	1:15-2:30	0:35-1:15	0:40-1:10	0:25-0:40	0:10-0:105	CAUTION: No holdover time guidelines exist
		75/25	5:00	1:05-1:45	0:20-0:55	0:35-0:50	0:15-0:30	0:05-0:40	
		50/50	3:00†	0:15-0:35	0:05-0:15	0:10-0:20	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	12:00†	0:20-1:20	0:20-0:40	***0:20-0:45	***0:10-0:25		
		75/25	5:00†	0:25-0:50	0:15-0:35	***0:15-0:30	***0:10-0:20		
below -14 to -25	below 7 to -13	100/0	12:00†	0:15-0:40	0:15-0:30				
below -25	below -13	100/0	**SAE Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **SAE Type IV** fluid cannot be used.						

Page 19

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 4A. FAA GUIDELINES FOR HOLDOVER TIMES ABAX (SPCA) 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	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	5:00	1:30-2:45	0:30-1:05	0:50-1:15	0:30-0:45	0:10-1:15	
		50/50	3:00†	0:30-0:45	0:10-0:20	0:15-0:25	0:05-0:15		
below -3 to -14	below 27 to 7	100/0	12:00†	0:20-1:20	0:30-0:55	***0:25-1:20	***0:15-0:30		
		75/25	5:00†	0:25-0:50	0:20-0:45	***0:25-1:05	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:15-0:40	0:15-0:30				
below -25	below -13	100/0	**ABAX AD-480 Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **ABAX AD-480 Type IV** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

Page 20

Page 21

TABLE 4B. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	1:20-3:20	1:00-1:55	0:55-1:55	0:40-1:00	0:15-2:00	
		75/25	5:00	1:20-2:00	0:35-1:00	0:35-1:10	0:25-0:35	0:10-1:25	
		50/50	3:00†	0:15-0:40	0:10-0:20	0:10-0:20	0:05-0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00†	0:45-1:35	0:30-0:50	***0:55-1:35	***0:30-0:45		
		75/25	5:00†	0:30-1:00	0:20-0:35	***0:40-1:10	***0:20-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:20-0:45	0:15-0:30				
below -25	below -13	100/0	**CLARIANT SAFEWING MP IV 2001 Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **CLARIANT SAFEWING MP IV 2001 Type IV** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 4C. FAA GUIDELINES FOR HOLDOVER TIMES CLARIANT SAFEWING MP IV 2012 PROTECT 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	1:15-2:30	0:40-1:15	0:40-1:10	0:25-0:45	0:10-1:05	CAUTION: No holdover time guidelines exist
		75/25	5:00	1:10-2:05	0:25-0:55	0:35-0:50	0:15-0:30	0:05-0:40	
		50/50	3:00†	0:25-0:45	0:15-0:25	0:15-0:20	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	12:00†	0:45-1:45	0:20-0:40	***0:25-0:45	***0:15-0:25		
		75/25	5:00†	0:25-1:05	0:20-0:40	***0:15-0:30	***0:10-0:20		
below -14 to -25	below 7 to -13	100/0	12:00†	0:20-0:45	0:15-0:30				
below -25	below -13	100/0	**CLARIANT SAFEWING MP IV 2012 PROTECT TYPE IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **CLARIANT SAFEWING MP IV 2012 PROTECT TYPE IV** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 2012 PROTECT TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

Page 22

Page 23

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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	4:00-4:00	1:05-1:45	1:30-2:00	1:00-1:40	0:15-1:40	
		75/25	5:00	3:40-4:00	1:00-1:45	1:40-2:00	0:45-1:15	0:10-1:45	
		50/50	3:00†	1:25-2:45	0:25-0:45	0:30-0:50	0:20-0:25	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00†	1:00-1:55	0:50-1:20	***0:35-1:40	***0:25-0:45		
		75/25	5:00†	0:40-1:20	0:45-1:25	***0:25-1:10	***0:25-0:45		
below -14 to -25	below 7 to -13	100/0	12:00†	0:30-0:50	0:15-0:30				
below -25	below -13	100/0	**CLARIANT SAFEWING MPIV LAUNCH Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **CLARIANT SAFEWING MPIV LAUNCH Type IV** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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

August 2008

TABLE 4E. FAA 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	1:35-3:35	0:35-1:15	0:45-1:35	0:25-0:40	0:10-1:20	
		75/25						CAUTION: No holdover time guidelines exist	
		50/50							
below -3 to -14	below 27 to 7	100/0	12:00†	1:25-3:00	0:25-0:55	***0:45-1:25	***0:30-0:45		
		75/25							
below -14 to -24	below 7 to -12	100/0	12:00†	0:40-2:10	0:20-0:45				
below -24	below -12	100/0	**DOW UCAR ULTRA+ Type IV** fluid may be used below -24 °C (-12 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **DOW UCAR ULTRA+ Type IV** fluid cannot be used.						

Page 24

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
†Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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+ TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

TABLE 4F. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	2:05-3:10	0:40-1:20	1:10-2:00	0:50-1:15	0:20-2:00	
		75/25						CAUTION: No holdover time guidelines exist	
		50/50							
below -3 to -14	below 27 to 7	100/0	12:00†	1:50-3:20	0:30-1:05	***0:55-1:50	***0:45-1:10		
		75/25							
below -14 to -25	below 7 to -13	100/0	12:00†	0:30-1:05	0:15-0:30				
below -25	below -13	100/0	**DOW UCAR ENDURANCE EG 106 Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **DOW UCAR ENDURANCE EG 106 Type IV** fluid cannot be used.						

Page 25

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 EG 106 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

Page 26

TABLE 4G. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	2:00-3:30	0:40-1:20	0:50-1:30	0:35-0:55	0:15-1:35	
		75/25	5:00	1:30-2:45	0:30-1:05	0:50-1:15	0:30-0:45	0:10-1:15	
		50/50	3:00†	0:30-0:45	0:10-0:20	0:15-0:25	0:05-0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00†	0:20-1:20	0:30-0:55	***0:25-1:20	***0:15-0:30		
		75/25	5:00†	0:25-0:50	0:20-0:45	***0:25-1:05	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:15-0:40	0:15-0:30				
below -25	below -13	100/0	**DOW UCAR FLIGHTGUARD AD-480 Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **DOW UCAR FLIGHTGUARD AD-480 Type IV** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 4H. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	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	5:00	1:05-1:45	0:30-0:55	0:45-1:10	0:35-0:50	0:10-0:50	
		50/50	3:00†	0:20-0:35	0:05-0:15	0:15-0:20	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	12:00†	0:45-2:05	0:45-1:20	***0:20-1:00	***0:10-0:30		
		75/25	5:00†	0:25-1:00	0:25-0:50	***0:20-1:10	***0:10-0:35		
below -14 to -25	below 7 to -13	100/0	12:00†	0:20-0:40	0:15-0:30				
below -25	below -13	100/0	**KILFROST ABC-S Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **KILFROST ABC-S Type IV** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

Page 28

TABLE 4I. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	2:10-4:00	1:15-2:00	1:50-2:00	1:05-2:00	0:25-2:00	
		75/25	5:00	1:25-2:40	0:45-1:15	1:00-1:20	0:30-0:50	0:10-1:20	
		50/50	3:00†	0:30-0:55	0:15-0:30	0:15-0:40	0:15-0:20		CAUTION: No holdover time guidelines exist
below -3 to -14	below 27 to 7	100/0	12:00†	0:55-3:30	1:00-1:45	***0:25-1:35	***0:20-0:30		
		75/25	5:00†	0:45-1:50	0:35-1:00	***0:20-1:10	***0:15-0:25		
below -14 to -25	below 7 to -13	100/0	12:00†	0:40-1:00	0:15-0:30				
below -25	below -13	100/0	**KILFROST ABC-S PLUS Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **KILFROST ABC-S PLUS Type IV** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

Page 29

TABLE 4J. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/ Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	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	5:00	1:20-2:15	0:40-1:05	0:55-1:25	0:30-0:45	0:05-1:20	
		50/50	3:00†	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	12:00†	1:00-2:25	0:45-1:15	***0:25-1:30	***0:25-0:30		
		75/25	5:00†	0:50-1:45	0:35-0:55	***0:30-1:15	***0:25-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:25-0:45	0:15-0:30				
below -25	below -13	100/0	**LYONDELL ARCTIC SHIELD Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **LYONDELL ARCTIC SHIELD Type IV** 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 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

Page 30

TABLE 4K. FAA GUIDELINES FOR HOLDOVER TIMES OCTAGON MAX-FLIGHT 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	2:40-4:00	0:50-1:35	0:55-2:00	0:35-1:00	0:15-1:15	CAUTION: No holdover time guidelines exist
		75/25	5:00	2:05-3:15	0:45-1:45	1:15-2:00	0:35-1:10	0:10-0:40	
		50/50	3:00†	0:55-1:45	0:25-1:15	0:35-1:00	0:15-0:30		
below -3 to -14	below 27 to 7	100/0	12:00†	0:50-2:30	0:25-0:50	***0:25-1:10	***0:20-0:40		
		75/25	5:00†	0:30-1:05	0:20-0:50	***0:20-1:00	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:20-0:45	0:15-0:30				
below -25	below -13	100/0	**OCTAGON MAX-FLIGHT Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **OCTAGON MAX-FLIGHT Type IV** 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
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

TABLE 4L. 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 PRE-TAKEOFF 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		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	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	5:00	2:05-3:15	1:05-2:00	1:50-2:00	1:00-1:20	0:20-2:00	
		50/50	3:00†	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	12:00†	0:50-2:30	0:35-1:10	***0:25-1:30	***0:20-0:40		
		75/25	5:00†	0:30-1:05	0:40-1:20	***0:20-1:00	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:20-0:45	0:15-0:30				
below -25	below -13	100/0	**OCTAGON MAX-FLIGHT 04 Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **OCTAGON MAX-FLIGHT 04 Type IV** fluid cannot be used.						

Page 31

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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.

August 2008

TABLE 4M. FAA GUIDELINES FOR HOLDOVER TIMES OCTAGON MAXFLO 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 PRE-TAKEOFF 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		Frost	Freezing Fog	Snow /Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	2:20-3:35	0:40-1:30	1:20-2:00	0:30-1:00	0:10-2:00	
		75/25	5:00	1:25-2:00	0:20-0:55	0:40-1:05	0:20-0:35	0:05-1:15	
		50/50	3:00†	0:20-0:40	0:05-0:15	0:10-0:20	0:05-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00†	1:10-2:20	0:25-1:00	***0:35-1:45	***0:30-0:50		
		75/25	5:00†	0:40-1:25	0:15-0:40	***0:35-1:15	***0:15-0:30		
below -14 to -25	below 7 to -13	100/0	12:00†	0:30-1:00	0:15-0:30				
below -25	below -13	100/0	**OCTAGON MAXFLO Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **OCTAGON MAXFLO Type IV** fluid cannot be used.						

Page 32

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)
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
† Radiational cooling during active frost conditions may reduce holdover times when operating close to the lower end of the outside air temperature range.

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 MAXFLO TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

August 2008

Page 33

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 Types 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 Types 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 Types 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/III/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 Consider the use of **SAE Type I** when **Type II, III, or IV** fluid cannot be used.		

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 Types 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 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.**

TABLE 6

LOWEST ON-WING VISCOSITY VALUES FOR ANTI-ICING FLUIDS
(See Page 36 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 Xi'An Hi-Tech KHF-II	100/0	8,750 [c]	7,690 [g]
	75/25	6,400 [c]	6,890 [g]
	50/50	2,950 [c]	3,150 [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	17,500 [g]	17,500 [g]
	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-II Plus	100/0	3,600 [c]	3,600 [g]
	75/25	4,000 [c]	4,000 [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

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 (SPCA) 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]
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 2012 Protect	100/0	7,800 [b]	7,250 [g]
	75/25	17,800 [b]	17,700 [c]
	50/50	4,500 [b]	4,250 [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]
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]
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]
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	100/0	5,540 [d]	5,540 [g]
	75/25	15,000 [g]	15,000 [g]
	50/50	5,200 [g]	5,200 [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]
Octagon MaxFlo	100/0	8,670 [g]	8,670 [g]
	75/25	8,200 [g]	8,200 [g]
	50/50	2,200 [g]	2,200 [g]

NOTES

- 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 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.

August 2008

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.

TABLE 7. LIST OF QUALIFIED (1) DEICING/ANTI-ICING FLUIDS-WINTER 2008-2009

Qualified Type I Deicing/Anti-Icing Fluids

Company Name	Fluid Name
ABAX Industries (formerly SPCA)	ABAX DE-950
ABAX Industries (formerly SPCA)	ABAX DE-950 Colorless
Arkton Ltd.	Artica DG
Aviation Xi'an High-Tech	KHF-1
Battelle	D^3: Degradable by Design Deicer™ ADF 1006A
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
Clariant GmbH	Safewing MP I 1938 ECO (80)
Clariant GmbH	Safewing MP I 1938 ECO (80) Pre-mix
Clariant GmbH	Safewing MP I 1938 ECO
Clariant GmbH	Safewing EG I 1996
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
HOC Industries	SafeTemp I ES
HOC Industries	SafeTemp I ES Plus
Inland Technologies	Duragly - P ready to use
Inland Technologies	Duragly - E ready to use
Kilfrost	Kilfrost DF PLUS
Kilfrost	Kilfrost DF PLUS (80)
Kilfrost	Kilfrost DF PLUS (88)®
Kilfrost	Kilfrost DF$^{\text{SUSTAIN ™}}$
Lyondell Chemical Company	ARCOPlus®
Lyondell Chemical Company	ARCTIC Plus®
Newave Aerochemical Company	FCY-1A
Octagon Process	EcoFlo
Octagon Process	Octaflo EF
Octagon Process	Octaflo EG
Viterbo S.A.	Jarkleer SAE Type I

Page 38

TABLE 7. LIST OF QUALIFIED (1) DEICING/ANTI-ICING FLUIDS-WINTER 2008-2009 (Continued)

Qualified Type II Deicing/Anti-Icing Fluids

Company Name	Fluid Name
ABAX Industries (formerly SPCA)	ABAX Ecowing 26
Aviation Xi'an High-Tech	KHF-II
Clariant GmbH	Safewing MP II 1951
Clariant GmbH	Safewing MP II 2025 ECO
Clariant GmbH	Safewing MP II Flight
Kilfrost	Kilfrost ABC-II PLUS
Kilfrost	Kilfrost ABC-3
Kilfrost	Kilfrost ABC-2000
Kilfrost	Kilfrost ABC-K PLUS
Newave Aerochemical Technology	FCY-2
Octagon Process	E-Max

Qualified Type III Deicing/Anti-Icing Fluids

Company Name	Fluid Name
Clariant GmbH	Safewing MP III 2031 ECO

Qualified Type IV Deicing/Anti-Icing Fluids

Company Name	Fluid Name
ABAX (formerly SPCA)	ABAX AD-480
Clariant GmbH	Safewing MP IV 2001
Clariant GmbH	Safewing MP IV 2012 Protect
Clariant GmbH	Safewing MP IV Launch
Dow Chemical Company	UCAR™ ADF/AAF ULTRA+
Dow Chemical Company	UCAR™ Endurance EG106
Dow Chemical Company	UCAR™ FlightGuard AD-480
Kilfrost	Kilfrost ABC-S
Kilfrost	Kilfrost ABC-S Plus
Lyondell Chemical Company	ARCTIC Shield™
Octagon Process	Max-Flight
Octagon Process	Max-Flight 04

Page 39

TABLE 7. LIST OF QUALIFIED (1) DEICING/ANTI-ICING FLUIDS–WINTER 2008-2009 (Continued)

Octagon Process	MaxFlo

[1] Qualified indicates that the fluid has been qualified solely to the requirements of the applicable SAE anti-icing and aerodynamic performance specifications in effect at the time of certification, as conducted by the Anti-Icing Materials International Laboratory at the University of Quebec at Chicoutimi, Canada, Web site: http://www.uqac.ca/amil/index.htm. For other specification requirements for Type I fluids, see SAE AMS 1424 (latest version) and for SAE Types II, III, and IV fluids, see SAE AMS 1428 (latest version). Fluids that qualify after the issuance of this list will appear in a later update.

Page 40

ICE PELLET ALLOWANCE TIMES WINTER 2008-2009

The values for the Ice Pellet Allowance Times Winter 2008 – 2009 table remain unchanged from the Winter 2007 – 2008 table. Limited testing was accomplished during the 2007 – 2008 icing season with inconclusive results.

Operations in Light and Moderate Ice Pellets and Light Ice Pellets mixed with other forms of precipitation.

(1) 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.

(2) 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. This flow due to shearing occurs with rotation speeds consistent with Type IV anti-icing fluid recommended applications for up to the applicable allowance time listed in Table-1. 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 effective without any further action up to 90 minutes after the start of the application time of the Type IV anti-icing fluid.

Examples: a) 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.

b) 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.

c) 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.

(3) 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 "Ice Pellet Allowance

Times Winter 2008-2009", 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:

(a) 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.

(b) The allowance time is valid only if the aircraft is anti-iced with undiluted Type IV fluid.

(c) 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.

(d) 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.

(e) 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.

(f) 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.

(g) If the temperature decreases below the temperature on which the allowance time was based,

1. 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.

2. 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 8. Ice Pellet Allowance Times Winter 2008-2009

	OAT -5° C or Warmer	**OAT Colder Than -5° C**
Light Ice Pellets	50 Minutes	30 Minutes
Moderate Ice Pellets	25 Minutes	10 Minutes
Light Ice Pellets Mixed with Light or Moderate Snow	25 Minutes	Operations Not Authorized
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle, or Light Freezing Rain (Operations not authorized below -10° C OAT)	25 Minutes	10 Minutes (Operations Not Authorized below -10° C OAT)
Light Ice Pellets Mixed with Light Rain (Operations not authorized below 0° C OAT)	25 Minutes (Operations Not Authorized below 0° C OAT)	(Operations Not Authorized below 0° C OAT

This page intentionally left blank.