TP 14374E

Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2003-04 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 2004
Final Version 1.0

TP 14374E

Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2003-04 Winter

by

Stephanie Bendickson

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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.

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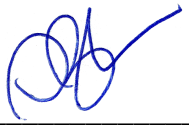

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PREFACE

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 evaluate weather data from previous winters to establish a range of conditions suitable for the evaluation of holdover time limits;
- To compare endurance times from natural snow with those generated from simulations of laboratory snow;
- To compare fluid endurance time, holdover time and protection time;
- To compare snowfall rates obtained with a real-time snow precipitation gauge with rates obtained using rate pans;
- To further develop and to assist with the commercialization of Type III fluids;
- To develop a test procedure for evaluating forced-air assist systems;
- To conduct general and exploratory de/anti-icing research; and
- To evaluate the possibility of using a fluid failure sensor in holdover time testing.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2003-04 are documented in nine reports. The titles of the reports are as follows:

- TP 14374E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2003-04 Winter;
- TP 14375E Winter Weather Impact on Holdover Time Table Format (1995-2004);
- TP 14376E Endurance Time Testing in Snow: Comparison of Indoor and Outdoor Data for 2003-04;
- TP 14377E Adhesion of Aircraft Anti-Icing Fluids on Aluminum Surfaces;
- TP 14378E Evaluation of a Real-Time Snow Precipitation Gauge for Aircraft Deicing Operations (2003-04);
- TP 14379E Development of Holdover Time Guidelines for Type III Fluids;
- TP 14380E A Protocol for Testing Fluids Applied with Forced Air Systems;
- TP 14381E Aircraft Ground Icing General and Exploratory Research Activities for the 2003-04 Winter; and
- TP 14382E A Sensor for Detecting Anti-Icing Fluid Failure: Phase I.

In addition, the following interim report is being prepared:

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

This report, TP 14374E 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 and at mobile test stations in Val-d'Or and Ste-Adele, Quebec.

PROGRAM ACKNOWLEDGEMENTS

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

APS Aviation Inc. would also like to acknowledge the dedication of the research team, whose performance was crucial to the acquisition of hard data. This includes the following people: Stephanie Bendickson, Nicolas Blais, Richard Campbell, Michael Chaput, Sami Chebil, John D'Avirro, Peter Dawson, Marco Di Zazzo, Miljana Horvat, Mark Mayodon, Chris McCormack, Nicoara Moc, Catalin Palamaru, Filomeno Pepe, Marco Ruggi, Joey Tiano, Kim Vepsa, and David Youssef.

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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. Nine reports (including this one) 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 2003-04 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. A total of 258 endurance time tests were performed by APS in natural and simulated conditions with one Type III fluid and one Type II fluid. The Type II fluid was not certified and therefore results are not discussed in detail.

Changes to the holdover time guidelines for the winter of 2004-05 included the introduction of a fluid-specific table for Octagon Max-Flight 04, the removal of the Clariant Safewing Four Type IV fluid-specific table, the placement of generic values in all fluid-specific tables (except Dow UCAR Ultra+) in the -14 to -25ºC snow cell and the introduction of a new Type III fluid and a new Type III generic table. No holdover time tests were conducted with Octagon Max-Flight 04 as it was previously tested under a different name. Neither the addition of the Octagon table, nor the removal of the Clariant table affected the generic Type IV table. The changes made to the -14 to -25ºC snow cell were the result of testing with artificial snowmakers. The values in the new Type III generic table were generally based on the holdover times of the new Type III fluid, Clariant Safewing MP III 2031 ECO.

No new Type I or Type II fluids were introduced this year, nor were any changes made to the generic Type II table.

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 and that Type III fluid be tested in 75/25 and 50/50 dilutions.

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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. Neufs rapports (dont celui-ci) 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 2003-2004 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 258 essais d'endurance ont ainsi été réalisés par APS dans des conditions naturelles et simulées avec un liquide de type III et un liquide de type II. Les résultats obtenus avec le liquide de type II ne sont pas présentés en détail ici, ce liquide n'ayant pas été certifié.

Parmi les changements apportés aux lignes directrices relatives aux durées d'efficacité pour l'hiver 2004-2005, notons la création d'un tableau spécifique au liquide Octagon Max-Flight 04, le retrait du tableau spécifique au liquide de type IV Clariant Safewing Four, l'insertion, pour tous les tableaux spécifiques aux liquides (à l'exception de celui pour Dow UCAR Ultra+), de valeurs génériques dans la cellule « neige, au-dessous de -14 à -25 °C », et l'introduction d'un nouveau liquide de type III ainsi que d'un nouveau tableau générique des liquides de type III. Aucun essai sur les durées d'efficacité n'a été effectué pour le liquide Octagon Max-Flight 04, ce dernier ayant été précédemment évalué sous un autre nom. Ni l'ajout du tableau pour le liquide Octagon, ni le retrait de celui pour le liquide Clariant n'ont modifié le tableau générique des liquides de type IV. Les changements apportés à la cellule « neige, au-dessous de -14 à -25 °C » ont résulté des essais effectués à l'aide d'appareils de fabrication de neige artificielle. Les valeurs du nouveau tableau générique des liquides de type III ont généralement été basées sur les durées d'efficacité du nouveau liquide de type III, le Clariant Safewing MP III 2031 ECO.

Aucun nouveau liquide de type I ou de type II n'a été introduit cette année, et aucun changement n'a été apporté au tableau générique des liquides de type II.

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 et que les liquides de type III soient testés dans des dilutions 75/25 et 50/50.

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

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EXECUTIVE SUMMARY

Under contract to the Transportation Development Centre (TDC) of Transport Canada (TC), 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 tables for new de/anti-icing fluids, is addressed in this report.

The objective was met by conducting holdover time tests. These tests consisted of pouring freezing point depressant fluids onto clean, inclined (10°), standard flat aluminum plates. The plates were mounted on a test stand and systematically exposed to a variety of natural or simulated icing conditions. For every plate, the elapsed time required to reach a predefined end condition was recorded. Test conditions, test parameters, and test bed specifications were determined based on Society of Automotive Engineers (SAE) G-12 Holdover Time Subcommittee guidelines.

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

This project involved the participation of several de/anti-icing fluid manufacturers, TDC, the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) and the FAA.

Data Collection and Testing

During the 2003-04 test season, data was collected for tests conducted during natural precipitation events at the APS test site at Montreal-Trudeau Airport in Montreal and at mobile test sites in Val-d'Or and Ste-Adele, Quebec. Data was also collected in the following simulated precipitation conditions: freezing drizzle, light freezing rain, freezing fog, and rain on cold-soaked surfaces. Simulated precipitation tests were performed indoors at the NRC CEF in Ottawa.

In 2003-04, APS conducted 258 tests with two fluids. The first fluid, a Type II, will not be commercialized and therefore the complete test results are not detailed in this report. The second fluid, Clariant Safewing MP III 2031 ECO, is a Type III fluid. The distribution of tests is listed in Table ES-1 by precipitation condition and fluid type.

TABLE ES-1: Summary of Tests Conducted

Fluid Type	Precipitation Condition					
	Natural Snow	Freezing Drizzle	Light Freezing Rain	Freezing Fog	Rain on Cold-Soaked Wing	Total
Type II (Neat)	36	8	8	12	4	**68**
Type II (75/25)	37	8	8	8	4	**65**
Type II (50/50)	26	6	4	4	0	**40**
Type III	53	8	8	12	4	**85**
Total	**152**	**30**	**28**	**36**	**12**	**258**

Changes to the Holdover Time Guidelines

The changes below were made to the holdover time guidelines for the winter of 2004-05.

1. A Type IV fluid-specific table was added for Octagon Max-Flight 04, a newly certified fluid. This fluid was previously tested under a different name and therefore no holdover time tests were required. The addition of this fluid did not affect the generic Type IV holdover time table.
2. The Type IV fluid-specific table for Clariant Safewing Four was removed from the guidelines because the fluid is no longer available commercially. Its removal did not impact the generic Type IV holdover time table.
3. With the exception of Dow UCAR Ultra+, generic values were placed in all Type II and Type IV fluid-specific tables in the below -14 to -25°C snow cell as the result of testing with artificial snow machines.
4. Clariant Safewing MP III 2031 ECO was certified as a Type III fluid. TC and the FAA produced similar new generic Type III holdover time tables for 2004-05. These tables contain values generally based on the endurance times of Clariant Safewing MP III 2031 ECO. Neither regulator will publish a fluid-specific holdover time table for this fluid.

It should be noted that no new Type I or Type II fluids were introduced this year, nor were any changes made to the generic Type II table.

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 holdover time tables. It is also recommended that Type III fluids be tested in 75/25 and 50/50 dilutions.

SOMMAIRE

En vertu d'un contrat avec le Centre de développement des transports (CDT) de Transports Canada (TC), avec l'appui de la Federal Aviation Administration (FAA) et de plusieurs fabricants de liquides, APS Aviation Inc. (APS) a entrepris des essais et un programme de recherches visant à approfondir la technologie de dégivrage et d'antigivrage d'aéronefs au sol. Le programme poursuivait plusieurs objectifs et les travaux effectués pour atteindre ces objectifs sont documentés dans une suite de rapports connexes. Le principal objectif, le développement de lignes directrices sur les durées d'efficacité de nouveaux liquides de dégivrage et d'antigivrage, fait l'objet du présent rapport.

Pour réaliser cet objectif, des essais sur les durées d'efficacité ont été effectués. Ces derniers 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. Les conditions d'essai, les paramètres d'essai et les spécifications relatives au banc d'essai ont été déterminés en fonction des lignes directrices du sous-comité G-12 de la Society of Automotive Engineers (SAE) sur les durées d'efficacité.

Parmi les variables mesurées dans le cadre de ces essais, on notait : temps de défaillance, type de précipitation, taux de précipitation, précipitation totale, 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.

Plusieurs fabricants de liquides de dégivrage et d'antigivrage, le CDT, le Conseil national de recherches du Canada (CNRC), par l'entremise de son installation d'ingénierie climatique, et la FAA ont participé au programme.

Collecte de données et essais

Les données recueillies au cours de la saison d'essai 2003-2004 concernaient des tests sous précipitations naturelles menés à l'installation d'essai d'APS, à l'aéroport Montréal-Trudeau, à Montréal, ainsi que sur des sites d'essai mobiles situés à Val-d'Or et à Sainte-Adèle, au Québec. Des données ont également été collectées dans les conditions de précipitations simulées suivantes : bruine verglaçante, pluie verglaçante faible, brouillard verglaçant et pluie sur des surfaces imprégnées de froid. Ces derniers essais sous précipitations simulées ont été réalisés à l'intérieur, à l'installation de génie climatique du CNRC, à Ottawa.

En 2003-2004, un total de 258 essais ont été menés par APS, avec deux liquides. Le premier, un liquide de type II, ne sera pas commercialisé ; les détails des résultats d'essai complets qui lui sont associés ne sont donc pas présentés dans ce rapport. Le deuxième liquide, Clariant Safewing MP III 2031 ECO, est un liquide de type III. Le tableau ES-1 présente la répartition des essais réalisés, selon la précipitation et le type de liquide.

TABLEAU ES-1 : Sommaire des essais

Type de liquide	Condition de précipitation					
	Neige naturelle	**Bruine verglaçante**	**Pluie verglaçante faible**	**Brouillard verglaçant**	**Pluie sur aile imprégnée de froid**	**Total**
Type II (pur)	36	8	8	12	4	**68**
Type II (75/25)	37	8	8	8	4	**65**
Type II (50/50)	26	6	4	4	0	**40**
Type III	53	8	8	12	4	**85**
Total	**152**	**30**	**28**	**36**	**12**	**258**

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 2004-2005.

1. Un tableau spécifique a été ajouté pour le liquide de type IV Octagon Max-Flight 04, un liquide nouvellement certifié. Ce dernier ayant été précédemment évalué sous un autre nom, aucun essai sur les durées d'efficacité n'a été requis. L'ajout de ce liquide n'a pas eu pour effet de modifier le tableau générique des durées d'efficacité des liquides de type IV.
2. Le tableau spécifique au liquide de type IV Clariant Safewing Four a été retiré des lignes directrices, ce liquide n'étant plus offert commercialement. Son retrait n'a pas eu d'incidence sur le tableau générique des durées d'efficacité des liquides de type IV.
3. À l'exception du tableau pour Dow UCAR Ultra+, des valeurs génériques ont été insérées dans la cellule « neige, au-dessous de -14 à -25 °C » de tous les tableaux spécifiques aux liquides de type II et de type III à la suite d'essais effectués à l'aide d'appareils de fabrication de neige artificielle.
4. Le liquide Clariant Safewing MP III 2031 ECO a été certifié comme un liquide de type III. TC et la FAA ont produit de nouveaux tableaux génériques

similaires des durées d'efficacité des liquides de type III pour 2004-2005. Ces tableaux renferment des valeurs généralement basées sur les durées d'endurance du liquide Clariant Safewing MP III 2031 ECO. Aucun des deux organismes de réglementation ne publiera de tableau des durées d'efficacité spécifique à ce liquide.

Il convient de noter qu'aucun nouveau liquide de type I ou de type II n'a été introduit cette année, et qu'aucun changement n'a été apporté au tableau générique des liquides de type II.

Recommandations

Il est recommandé que tout nouveau liquide de type I, de type II, de type III ou de type IV soit évalué pour toute la gamme des conditions couvertes par les tableaux des durées d'efficacité. Il est également recommandé que les liquides de type III soient testés dans des dilutions 75/25 et 50/50.

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GLOSSARY

AMIL	Anti-Icing Materials International Laboratory
AMS	Aerospace Material Specification
APS	APS Aviation Inc.
AS	Aerospace Standard
CEF	Climatic Engineering Facility
EG	Ethylene Glycol
FAA	Federal Aviation Administration
MSC	Meteorological Service of Canada
NCAR	National Center for Atmospheric Research
NRC	National Research Council Canada
PG	Propylene Glycol
SAE	Society of Automotive Engineers
TC	Transport Canada
TDC	Transportation Development Centre

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1. INTRODUCTION

Under contract to the Transportation Development Centre (TDC) of Transport Canada (TC), with support from the Federal Aviation Administration (FAA), and the fluid manufacturers, APS Aviation Inc. (APS) has undertaken a research project to further advance ground aircraft de/anti-icing technology. This project involved the participation of TDC, TC, the FAA and several de/anti-icing fluid manufacturers.

1.1 Background

Over the past 14 years, APS has completed considerable testing related to de/anti-icing fluids on behalf of TC. Specifically, research has been conducted to determine fluid holdover times, to substantiate holdover time tables, and to further knowledge and development of deicing technology. A summary of the research activities related to fluid holdover times is provided in Table 1.1.

1.2 Objectives

The detailed objectives of the holdover time test program for the 2003-04 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 record de/anti-icing fluid endurance times, and to develop individual holdover time guidelines based on samples of newly and previously qualified deicing and anti-icing fluids.

1.3 Changes to the Content of this Report

Over the past 13 years, APS has written a report on the holdover time test program. The report has grown in size considerably as additional information was added each year. This year the report has been condensed in order to increase its readability and present the reader with, for the most part, only new and current information. Key changes include:

- Removal of the methodology section. The reader will be directed to the 2002-03 holdover time report, TP 14144E (1), where this information is contained. Any changes to the methodology will be addressed in this report.
- Removal of individual fluid data. This information is contained in the reports provided to the fluid manufacturers. Reports for any fluids that are certified will be included as appendices to this report.
- Removal of the fluid thickness section. This information will now be included in the individual fluid reports that are provided to the fluid manufacturers.

Table 1.1: Summary of APS Holdover Time Testing Activities

Year	Transport Canada Publication #	Conditions Tested	Primary Fluids Tested	Location of Testing
1990-91	TP 11206E	• Natural Precipitation (mostly snow)	Type II (100%)	Mostly Dorval, worldwide
1991-92	TP 11454E	• Natural Precipitation (mostly snow)	Type III	Mostly Dorval, St. John's
1992-93	TP 11836E	• Natural Precipitation (snow) • Simulated Freezing Drizzle (preliminary) • Simulated Freezing Fog (outdoor)	Type I (Standard)	Dorval and 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)	Dorval and 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 (preliminary)	• Type I (Diluted for 10°C buffer) • Type IV (Preliminary)	Dorval and 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	Dorval and 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	Dorval and 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	Dorval and 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	• Low Viscosity Type IVs • Type II • Type I	Dorval and 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	Dorval and 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	Dorval and Ottawa (NRC) Varennes (IREQ)
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	Dorval and Ottawa (NRC) Val D'Or North Bay

M:\Groups\CM1892\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	Primary Fluids Tested	Location of Testing
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	Dorval and 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	Dorval and Ottawa (NRC) Val D'Or Ste-Adele

M:\Groups\CM1892\Reports\HOT\Working Documents\Table 1.1

1.4 Report Format

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

a) Section 2 summarizes 2003-04 testing;

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

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

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

e) Section 6 documents changes to the Type IV holdover time 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

Holdover time guidelines are currently published on the following TC website:

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

For a more thorough understanding of the subject matter, the holdover time guidelines should be used in conjunction with TC report, TP 14052E, *Ground Icing Operations Update* (2), which includes reference material related to ground icing operations. TP 14052E (2) is also available on the TC website.

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2. TESTING IN 2003-04

2.1 Methodology

Test procedures were developed in accordance with the proposed Society of Automotive Engineers (SAE) standard for endurance time testing (Aerospace Recommended Practice 5485) in anticipation of its implementation in the winter of 2003-04. These procedures are included in Appendix B. However, the SAE standard was not approved for the 2003-04 winter; therefore, the procedures developed for the winter of 2002-03 were used. The 2002-03 procedures and test methodology are described in the TC report, TP 14144E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter* (1). It should be noted that the differences between the 2002-03 and 2003-04 methodologies are minor and using one or the other would not likely have impacted the test results.

Several modifications were made for testing in 2003-04.

First, due to a lack of natural snow conditions in Montreal during the 2003-04 winter test season, a mobile test unit was developed for use. The mobile test unit was comprised of a cube van containing all the required test equipment. Weather forecasts in North Bay, Val-d'Or, Rouyn, Quebec, and Ste-Adele were monitored daily, and a two-person crew was mobilized and dispatched to conduct testing when the desired conditions were obtained. Tests were conducted during one snow event in Ste-Adele and one snow event in Val-d'Or. The test site in Val-d'Or was located just outside of the airport property. The test site in Ste-Adele was located on private property.

Second, minute-by-minute temperature information previously available from the Meteorological Service of Canada (MSC) is no longer available. As a result, hourly summaries were used in the processing of data.

2.2 Fluids Tested

During the winter of 2003-04, two fluids were tested: Clariant Safewing MP III 2031 ECO (Type III) and Kilfrost P1491 (Type II). Clariant Safewing MP III 2031 ECO was tested in Neat (100/0) formulation only. Both fluids were formulated with propylene glycol (PG); no ethylene glycol (EG) formulated fluids were tested.

Fluid manufacturer reports containing the test results were produced for both fluids and distributed to the manufacturers. The Clariant Safewing MP III 2031 ECO report is included in Appendix C. Kilfrost P1491 was not commercialized and therefore the

test results are not included in this report. Additional relevant data for Clariant Safewing MP III 2031 ECO is given in Table 2.1.

Table 2.1: List of Fluids Received

Fluid Manufacturer	Fluid Type	Date Received	Brand Name	Batch #	APS Measured Brix	Manufacturer's Stated Viscosity (mPa.s)	APS Measured Viscosity (mPa.s)	Viscosity Measurement Method
Clariant	III-100%	16-Feb-04	Safewing MP III 2031 ECO	TV 390	35.50	740	810	Spindle LV1, 500 mL fluid, 0°C, 0.3 rpm, 33 min

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2.3 Description of Tests

In total, 258 endurance time tests were conducted during the 2003-04 winter. The complete log of endurance time tests conducted with Clariant Safewing MP III 2031 ECO is included in the fluid manufacturer report in Appendix C. A summary of the number of tests conducted by precipitation condition, fluid type and fluid dilution is shown in Table 2.2.

Table 2.2: Summary of Tests Conducted

Fluid Type	Precipitation Condition					
	Natural Snow	Freezing Drizzle	Light Freezing Rain	Freezing Fog	Rain on Cold-Soaked Wing	Total
Type II Neat	36	8	8	12	4	**68**
Type II 75/25	37	8	8	8	4	**65**
Type II 50/50	26	6	4	4	0	**40**
Type III	53	8	8	12	4	**85**
Total	**152**	**30**	**28**	**36**	**12**	**258**

3. TYPE I ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

No tests were conducted with Type I fluids in 2003-04. No changes were made to the Type I holdover time guidelines for 2004-05. The TC and FAA generic Type I holdover time guidelines are included in Appendix D.

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4. TYPE II ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

No new Type II fluids were certified for use in 2004-05. However, changes were made to one Type II fluid-specific holdover time table as a result of tests conducted with the National Center for Atmospheric Research (NCAR) and Anti-Icing Materials International Laboratory (AMIL) artificial snow machines. These changes were presented to the SAE G-12 Holdover Time Subcommittee in Frankfurt in May 2004, where they were discussed and it was agreed they would be implemented worldwide during the 2004-05 winter season. The TC and FAA Type II holdover time guidelines are included in Appendix D.

4.1 New Snow Machine Data, -14°C to -25°C

In the past it has been difficult to obtain fluid-specific data in natural snow at very cold temperatures (-14°C to -25°C). This has occurred for one of two reasons; either snow did not occur at cold temperatures in Montreal during the winter the fluid was tested, or the fluid was received late in the season after the weather had already occurred. Since about 1999, it has been common practice to give any new fluid generic holdover time values for the below -14°C to -25°C holdover time cell in snow when substantiating data is not available. Several fluids tested prior to this time have fluid-specific values in this cell, which are based on regression analysis.

At the SAE G-12 Holdover Time Subcommittee meeting held in Vancouver in May 2003, it was suggested that testing be conducted with the artificial snow machines in order to obtain values in the below -14°C to -25°C snow cell for all Type II and Type IV fluids. It was felt that artificial snow data, even if not as reliable as natural snow data, would be better than no data at all.

Testing was subsequently conducted by APS and by AMIL with all certified Type II and IV fluids. These tests are described in detail in the TC report, TP 14376E, *Endurance Time Testing in Snow: Comparison of Indoor and Outdoor Data for 2003-04* (3).

The conclusion to this testing was that generic numbers should be given to all PG-based Type II and Type IV fluids in the below -14°C to -25°C snow cell. No changes were recommended for EG-based fluids (Dow UCAR Ultra+).

Only one Type II fluid, SPCA Ecowing 26, was affected by this change. The SPCA Ecowing 26 fluid-specific table will incorporate this change for the 2004-05 operating season. All other Type II holdover time guidelines, including the generic holdover time guidelines, will be the same as in 2003-04.

4.2 Evolution of Type II Generic Holdover Time Values

The generic holdover time guidelines for Type II fluid were developed prior to 1996-97 based on the results of endurance time tests with "grandfathered" fluids. A total of six Type II fluids have been tested since then and are listed below. The test data for these new fluids has been used to modify the generic holdover time guidelines, as required, since 1996-97. Although TC and the FAA stopped producing a fluid-specific table for Clariant Safewing MP II 1951 in 2001-02, the fluid is still used in the calculation of the generic Type II values because it is still available for use with the Type II generic holdover time guidelines.

The history of testing with Type II 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 4.1 to 4.27. Each table represents one cell in the holdover time guidelines and the title of each 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 row represents a winter test season. The final line contains the generic and fluid-specific holdover time values for use in 2004-05 winter operations. The underlined values indicate the fluid(s) 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 abbreviations below are used in the tables:

- Kilfrost ABC-II PLUS (ABC-II +);
- Clariant Safewing MP II 1951 (C-1951);
- Clariant Safewing MP II 2025 ECO (C-2025);
- Octagon E Max II (E II);
- Kilfrost ABC-2000 (K2000); and
- SPCA Ecowing 26 (S E26).

4.3 Fluids Responsible for the Type II Generic Holdover Time Values

The fluids responsible for the values in each cell of the generic Type II holdover time guidelines in 2004-05 are shown in Table 4.28. "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, Above 0°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:20-1:00						
	1998-99 Endurance Time Test Results		0:35-1:20					
	1999-00 HOT Table Values	0:20-1:00	0:35-1:20					
	1999-00 Endurance Time Test Results			0:30-0:55				
	2000-01 HOT Table Values	0:20-0:55	0:35-1:20	0:30-0:55				
	2000-01 Endurance Time Test Results							0:40-1:05
	2001-02 HOT Table Values	0:20-0:55	0:35-1:20	0:30-0:55				0:40-1:05
	2001-02 Endurance Time Test Results					0:45-1:30	0:40-1:20	
	2002-03 HOT Table Values	0:20-0:55	0:35-1:20			0:45-1:30	0:40-1:15	0:40-1:05
	2002-03 Endurance Time Test Results				0:45-1:20			
	2003-04 HOT Table Values	0:20-0:55	0:35-1:20		0:45-1:20	0:45-1:30	0:40-1:15	0:40-1:05
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:20-0:55	0:35-1:20		0:45-1:20	0:45-1:30	0:40-1:15	0:40-1:05

Table 4.2: Type II 75/25 Fluid, Snow, Above 0°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:15-0:40						
	1998-99 Endurance Time Test Results		0:35-1:10					
	1999-00 HOT Table Values	0:15-0:40	0:35-1:10					
	1999-00 Endurance Time Test Results			0:20-0:40				
	2000-01 HOT Table Values	0:15-0:40	0:35-1:10	0:20-0:40				
	2000-01 Endurance Time Test Results							0:30-0:50
	2001-02 HOT Table Values	0:15-0:40	0:35-1:10	0:20-0:40				0:30-0:50
	2001-02 Endurance Time Test Results					0:25-0:55	0:40-1:15	
	2002-03 HOT Table Values	0:15-0:40	0:35-1:10			0:25-0:55	0:40-1:15	0:30-0:50
	2002-03 Endurance Time Test Results				0:25-0:45			
	2003-04 HOT Table Values	0:15-0:40	0:35-1:10		0:25-0:45	0:30-1:00	0:40-1:15	0:30-0:50
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:40	0:35-1:10		0:25-0:45	0:30-1:00	0:40-1:15	0:30-0:50

Table 4.3: Type II 50/50 Fluid, Snow, Above 0ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:05-0:15						
	1998-99 Endurance Time Test Results		0:20-0:40					
	1999-00 HOT Table Values	0:05-0:15	0:20-0:40					
	1999-00 Endurance Time Test Results			0:05-0:20				
	2000-01 HOT Table Values	0:05-0:15	0:20-0:40	0:05-0:20				
	2000-01 Endurance Time Test Results							0:10-0:20
	2001-02 HOT Table Values	0:05-0:15	0:20-0:40	0:05-0:20				0:10-0:20
	2001-02 Endurance Time Test Results					0:15-0:30	0:15-0:30	
	2002-03 HOT Table Values	0:05-0:15	0:20-0:40			0:15-0:30	0:15-0:30	0:10-0:20
	2002-03 Endurance Time Test Results				0:10-0:20			
	2003-04 HOT Table Values	0:05-0:15	0:20-0:40		0:10-0:20	0:15-0:30	0:15-0:30	0:10-0:20
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:05-0:15	0:20-0:40		0:10-0:20	0:15-0:30	0:15-0:30	0:10-0:20

Table 4.4: Type II Neat Fluid, Snow, 0ºC to -3ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:40-1:20	0:30-1:00	
	2002-03 HOT Table Values	0:20-0:45	0:25-0:55			0:40-1:20	0:30-1:00	0:40-1:00
	2002-03 Endurance Time Test Results				0:40-1:10			
	2003-04 HOT Table Values	0:20-0:45	0:25-0:55		0:40-1:10	0:40-1:20	0:30-1:00	0:40-1:00
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:20-0:45	0:25-0:55		0:40-1:10	0:40-1:20	0:30-1:00	0:40-1:00

Table 4.5: Type II 75/25 Fluid, Snow, 0ºC to -3ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:15-0:30						
	1998-99 Endurance Time Test Results		0:25-0:50					
	1999-00 HOT Table Values	0:15-0:30	0:25-0:50					
	1999-00 Endurance Time Test Results			0:15-0:35				
	2000-01 HOT Table Values	0:15-0:30	0:25-0:50	0:15-0:35				
	2000-01 Endurance Time Test Results							0:25-0:45
	2001-02 HOT Table Values	0:15-0:30	0:25-0:50	0:15-0:35				0:25-0:45
	2001-02 Endurance Time Test Results					0:25-0:55	0:30-1:05	
	2002-03 HOT Table Values	0:15-0:30	0:25-0:50			0:25-0:55	0:30-1:05	0:25-0:45
	2002-03 Endurance Time Test Results				0:25-0:45			
	2003-04 HOT Table Values	0:15-0:30	0:25-0:50		0:25-0:45	0:25-0:55	0:30-1:05	0:25-0:45
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:30	0:25-0:50		0:25-0:45	0:25-0:55	0:30-1:05	0:25-0:45

Table 4.6: Type II 50/50 Fluid, Snow, 0ºC to -3ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:05-0:15						
	1998-99 Endurance Time Test Results		0:15-0:35					
	1999-00 HOT Table Values	0:05-0:15	0:15-0:35					
	1999-00 Endurance Time Test Results			0:05-0:15				
	2000-01 HOT Table Values	0:05-0:15	0:15-0:35	0:05-0:15				
	2000-01 Endurance Time Test Results							0:10-0:20
	2001-02 HOT Table Values	0:05-0:15	0:15-0:35	0:05-0:15				0:10-0:20
	2001-02 Endurance Time Test Results					0:10-0:25	0:15-0:30	
	2002-03 HOT Table Values	0:05-0:15	0:15-0:35			0:10-0:25	0:15-0:30	0:10-0:20
	2002-03 Endurance Time Test Results				0:05-0:15			
	2003-04 HOT Table Values	0:05-0:15	0:15-0:35		0:05-0:15	0:10-0:25	0:15-0:30	0:10-0:20
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:05-0:15	0:15-0:35		0:05-0:15	0:10-0:25	0:15-0:30	0:10-0:20

Table 4.7: Type II Neat Fluid, Snow, Below -3ºC to -14ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:15-0:40						
	1998-99 Endurance Time Test Results		0:15-0:35					
	1999-00 HOT Table Values	0:15-0:35	0:15-0:35					
	1999-00 Endurance Time Test Results			0:20-0:40				
	2000-01 HOT Table Values	0:15-0:35	0:15-0:35	0:20-0:40				
	2000-01 Endurance Time Test Results							0:35-0:55
	2001-02 HOT Table Values	0:15-0:35	0:15-0:35	0:20-0:40				0:35-0:55
	2001-02 Endurance Time Test Results					0:35-1:10	0:25-0:45	
	2002-03 HOT Table Values	0:15-0:35	0:15-0:35			0:35-1:10	0:25-0:45	0:35-0:55
	2002-03 Endurance Time Test Results				0:35-1:00			
	2003-04 HOT Table Values	0:15-0:35	0:15-0:35		0:35-1:00	0:35-1:10	0:25-0:45	0:35-0:55
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:35	0:15-0:35		0:35-1:00	0:35-1:10	0:25-0:45	0:35-0:55

Table 4.8: Type II 75/25 Fluid, Snow, Below -3ºC to -14ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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			0:25-0:50	0:25-0:50	0:25-0:40
	2002-03 Endurance Time Test Results				0:25-0:45			
	2003-04 HOT Table Values	0:15-0:25	0:15-0:35		0:25-0:45	0:25-0:50	0:25-0:50	0:25-0:40
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:25	0:15-0:35		0:25-0:45	0:25-0:50	0:25-0:50	0:25-0:40

Table 4.9: Type II Neat Fluid, Snow, Below -14°C to -25°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:15-0:30						
	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							0:30-0:50
	2001-02 HOT Table Values	0:15-0:30	0:15-0:30	0:20-0:35				0:30-0:50
	2001-02 Endurance Time Test Results					0:35-1:05	0:20-0:40	
	2002-03 HOT Table Values	0:15-0:30	0:15-0:30			0:15-0:30	0:15-0:30	0:30-0:50
	2002-03 Endurance Time Test Results				0:15-0:30			
	2003-04 HOT Table Values	0:15-0:30	0:15-0:30		0:15-0:30	0:15-0:30	0:15-0:30	0:30-0:50
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:30	0:15-0:30		0:15-0:30	0:15-0:30	0:15-0:30	0:15-0:30

Table 4.10: Type II Neat Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:30-1:00						
	1998-99 Endurance Time Test Results		0:35-1:10					
	1999-00 HOT Table Values	0:30-1:00	0:35-1:10					
	1999-00 Endurance Time Test Results			0:35-0:55				
	2000-01 HOT Table Values	0:30-0:55	0:35-1:10	0:35-0:55				
	2000-01 Endurance Time Test Results							0:50-1:35
	2001-02 HOT Table Values	0:30-0:55	0:35-1:10	0:35-0:55				0:50-1:35
	2001-02 Endurance Time Test Results					0:45-1:35	0:55-1:35	
	2002-03 HOT Table Values	0:30-0:55	0:35-1:10			0:45-1:35	0:55-1:35	0:50-1:35
	2002-03 Endurance Time Test Results				0:40-1:00			
	2003-04 HOT Table Values	0:30-0:55	0:35-1:10		0:40-1:00	0:45-1:35	0:55-1:35	0:50-1:35
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:30-0:55	0:35-1:10		0:40-1:00	0:45-1:35	0:55-1:35	0:50-1:35

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

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:40-1:10	0:45-1:15	
	2002-03 HOT Table Values	0:20-0:45	0:30-1:00			0:40-1:10	0:45-1:15	0:45-1:05
	2002-03 Endurance Time Test Results				0:25-0:45			
	2003-04 HOT Table Values	0:20-0:45	0:30-1:00		0:25-0:45	0:40-1:10	0:45-1:15	0:45-1:05
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:20-0:45	0:30-1:00		0:25-0:45	0:40-1:10	0:45-1:15	0:45-1:05

Table 4.12: Type II 50/50 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:15-0:30	0:15-0:25	
	2002-03 HOT Table Values	0:05-0:15	0:05-0:25			0:15-0:30	0:15-0:25	0:15-0:25
	2002-03 Endurance Time Test Results				0:10-0:15			
	2003-04 HOT Table Values	0:05-0:15	0:05-0:25		0:10-0:15	0:15-0:30	0:15-0:25	0:15-0:25
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:05-0:15	0:05-0:25		0:10-0:15	0:15-0:30	0:15-0:25	0:15-0:25

Table 4.13: Type II Neat Fluid, Freezing Drizzle, Below -3°C to -10°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:30-1:00						
	1998-99 Endurance Time Test Results		0:15-0:45					
	1999-00 HOT Table Values	0:15-0:45	0:15-0:45					
	1999-00 Endurance Time Test Results			0:25-0:50				
	2000-01 HOT Table Values	0:15-0:45	0:15-0:45	025-0:50				
	2000-01 Endurance Time Test Results							0:30-1:10
	2001-02 HOT Table Values	0:15-0:45	0:15-0:45	025-0:50				0:30-1:10
	2001-02 Endurance Time Test Results					0:35-1:00	0:25-0:50	
	2002-03 HOT Table Values	0:15-0:45	0:15-0:45			0:35-1:00	0:25-0:50	0:30-1:10
	2002-03 Endurance Time Test Results				0:35-1:05			
	2003-04 HOT Table Values	0:15-0:45	0:15-0:45		0:35-1:05	0:35-1:00	0:25-0:50	0:30-1:10
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:45	0:15-0:45		0:35-1:05	0:35-1:00	0:25-0:50	0:30-1:10

Table 4.14: Type II 75/25 Fluid, Freezing Drizzle, Below -3°C to -10°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:35-1:10	0:25-0:55	
	2002-03 HOT Table Values	0:15-0:30	0:15-0:30			0:35-1:10	0:25-0:55	0:20-0:50
	2002-03 Endurance Time Test Results				0:30-0:40			
	2003-04 HOT Table Values	0:15-0:30	0:15-0:30		0:30-0:40	0:35-1:05	0:25-0:55	0:20-0:50
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:30	0:15-0:30		0:30-0:40	0:35-1:05	0:25-0:55	0:20-0:50

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

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:30-0:40	0:40-0:50	
	2002-03 HOT Table Values	0:15-0:30	0:30-0:40			0:30-0:40	0:40-0:50	0:40-0:50
	2002-03 Endurance Time Test Results				0:25-0:35			
	2003-04 HOT Table Values	0:15-0:30	0:30-0:40		0:25-0:35	0:30-0:40	0:40-0:50	0:40-0:50
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:30	0:30-0:40		0:25-0:35	0:30-0:40	0:40-0:50	0:40-0:50

Table 4.16: Type II 75/25 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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			015-0:25				
	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					0:20-0:30	0:40-0:50	
	2002-03 HOT Table Values	0:10-0:25	0:20-0:40			0:20-0:30	0:40-0:50	0:25-0:35
	2002-03 Endurance Time Test Results				0:20-0:25			
	2003-04 HOT Table Values	0:10-0:25	0:20-0:40		0:20-0:25	0:20-0:30	0:40-0:50	0:25-0:35
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:10-0:25	0:20-0:40		0:20-0:25	0:20-0:30	0:40-0:50	0:25-0:35

Table 4.17: Type II 50/50 Fluid, Light Freezing Rain, -3ºC and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:05-0:10						
	1998-99 Endurance Time Test Results		0:05-0:15					
	1999-00 HOT Table Values	0:05-0:10	0:05-0:15					
	1999-00 Endurance Time Test Results			0:05-0:10				
	2000-01 HOT Table Values	0:05-0:10	0:05-0:15	0:05-0:10				
	2000-01 Endurance Time Test Results							0:05-0:10
	2001-02 HOT Table Values	0:05-0:10	0:05-0:15	0:05-0:10				0:05-0:10
	2001-02 Endurance Time Test Results					0:05-0:15	0:05-0:15	
	2002-03 HOT Table Values	0:05-0:10	0:05-0:15			0:05-0:15	0:05-0:15	0:05-0:10
	2002-03 Endurance Time Test Results				0:05-0:10			
	2003-04 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:10-0:15	0:05-0:15	0:05-0:10
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:10-0:15	0:05-0:15	0:05-0:10

Table 4.18: Type II Neat Fluid, Light Freezing Rain, Below -3ºC to -10ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:20-0:30	0:10-0:30	
	2002-03 HOT Table Values	0:10-0:25*	0:10-0:30			0:20-0:30	0:10-0:30	0:15-0:35
	2002-03 Endurance Time Test Results				0:20-0:35			
	2003-04 HOT Table Values	0:10-0:25*	0:10-0:30		0:20-0:35	0:20-0:30	0:10-0:30	0:15-0:35
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:10-0:25*	0:10-0:30		0:20-0:35	0:20-0:30	0:10-0:30	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 4.19: Type II 75/25 Fluid, Light Freezing Rain, Below -3ºC to -10ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:10-0:25						
	1998-99 Endurance Time Test Results		0:10-0:20					
	1999-00 HOT Table Values	0:10-0:20	0:10-0:20					
	1999-00 Endurance Time Test Results			0:15-0:20				
	2000-01 HOT Table Values	0:10-0:20	0:10-0:20	0:15-0:20				
	2000-01 Endurance Time Test Results							0:15-0:25
	2001-02 HOT Table Values	0:10-0:20	0:10-0:20	0:15-0:20				0:15-0:25
	2001-02 Endurance Time Test Results					0:15-0:30	0:15-0:30	
	2002-03 HOT Table Values	0:10-0:20	0:10-0:20			0:15-0:30	0:15-0:30	0:15-0:25
	2002-03 Endurance Time Test Results				0:15-0:25			
	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
CURRENT	2003-04 Endurance Time Test Results							
	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

Table 4.20: Type II Neat Fluid, Freezing Fog, -3ºC and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:35-1:30						
	1998-99 Endurance Time Test Results		1:10-2:25					
	1999-00 HOT Table Values	0:35-1:30	1:10-2:25					
	1999-00 Endurance Time Test Results			0:55-1:40				
	2000-01 HOT Table Values	0:35-1:30	1:10-2:25	0:55-1:40				
	2000-01 Endurance Time Test Results							1:25-2:35
	2001-02 HOT Table Values	0:35-1:30	1:10-2:25	0:55-1:40				1:25-2:35
	2001-02 Endurance Time Test Results					2:05-3:45	1:30-3:05	
	2002-03 HOT Table Values	0:35-1:30	1:10-2:25			2:05-3:45	1:30-3:05	1:25-2:35
	2002-03 Endurance Time Test Results				1:30-2:05			
	2003-04 HOT Table Values	0:35-1:30	1:10-2:25		1:30-2:05	2:05-3:45	1:30-3:05	1:25-2:35
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:35-1:30	1:10-2:25		1:30-2:05	2:05-3:45	1:30-3:05	1:25-2:35

Table 4.21: Type II 75/25 Fluid, Freezing Fog, -3°C and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					1:25-2:50	1:40-3:30	
	2002-03 HOT Table Values	0:25-1:00	1:10-2:25			1:25-2:50	1:40-3:30	1:05-1:55
	2002-03 Endurance Time Test Results				0:55-1:45			
	2003-04 HOT Table Values	0:25-1:00	1:10-2:25		0:55-1:45	1:25-2:50	1:40-3:30	1:05-1:55
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:25-1:00	1:10-2:25		0:55-1:45	1:25-2:50	1:40-3:30	1:05-1:55

Table 4.22: Type II 50/50 Fluid, Freezing Fog, -3°C and Above

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:30-0:55	1:00-2:10	
	2002-03 HOT Table Values	0:15-0:30	0:15-0:45			0:30-0:55	1:00-2:10	0:30-0:45
	2002-03 Endurance Time Test Results				0:20-0:35			
	2003-04 HOT Table Values	0:15-0:30	0:15-0:45		0:20-0:35	0:30-0:55	1:00-2:10	0:30-0:45
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:30	0:15-0:45		0:20-0:35	0:30-0:55	1:00-2:10	0:30-0:45

Table 4.23: Type II Neat Fluid, Freezing Fog, Below -3ºC to -14ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:35-1:30						
	1998-99 Endurance Time Test Results		0:30-1:05					
	1999-00 HOT Table Values	0:30-1:05	0:30-1:05					
	1999-00 Endurance Time Test Results			0:45-1:25				
	2000-01 HOT Table Values	0:20-1:05	0:30-1:05	0:45-1:25				
	2000-01 Endurance Time Test Results							0:45-2:15
	2001-02 HOT Table Values	0:20-1:05	0:30-1:05	0:45-1:25				0:45-2:15
	2001-02 Endurance Time Test Results					0:50-1:45	0:35-1:25	
	2002-03 HOT Table Values	0:20-1:05	0:30-1:05			0:50-1:45	0:35-1:25	0:45-2:15
	2002-03 Endurance Time Test Results				0:45-1:50			
	2003-04 HOT Table Values	0:20-1:05	0:30-1:05		0:45-1:50	0:50-1:45	0:35-1:25	0:45-2:15
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:20-1:05	0:30-1:05		0:45-1:50	0:50-1:45	0:35-1:25	0:45-2:15

Table 4.24: Type II 75/25 Fluid, Freezing Fog, Below -3ºC to -14ºC

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:30-1:20	0:35-1:15	
	2002-03 HOT Table Values	0:20-0:55	0:20-0:55			0:30-1:20	0:35-1:15	0:35-1:15
	2002-03 Endurance Time Test Results				0:40-1:20			
	2003-04 HOT Table Values	0:20-0:55	0:20-0:55		0:40-1:20	0:30-1:20	0:35-1:15	0:35-1:15
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:20-0:55	0:20-0:55		0:40-1:20	0:30-1:20	0:35-1:15	0:35-1:15

Table 4.25: Type II Neat Fluid, Freezing Fog, Below -14°C to -25°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:20-0:35	0:20-0:45	
	2002-03 HOT Table Values	0:15-0:20	0:15-0:20			0:20-0:35	0:20-0:45	0:25-0:45
	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	0:20-0:35	0:20-0:45	0:25-0:45
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:15-0:20	0:15-0:20		0:25-0:45	0:20-0:35	0:20-0:45	0:25-0:45

Table 4.26: Type II Neat Fluid, Cold-Soaked Wing, Above 0°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
HISTORICAL	1998-99 HOT Table Values	0:10-0:40						
	1998-99 Endurance Time Test Results		0:05-1:00					
	1999-00 HOT Table Values	0:05-0:40	0:05-1:00					
	1999-00 Endurance Time Test Results			0:10-0:50				
	2000-01 HOT Table Values	0:05-0:40	0:05-1:00	0:10-0:50				
	2000-01 Endurance Time Test Results							0:20-1:25
	2001-02 HOT Table Values	0:05-0:40	0:05-1:00	0:10-0:50				0:20-1:25
	2001-02 Endurance Time Test Results					0:15-1:30	0:15-1:10	
	2002-03 HOT Table Values	0:05-0:40	0:05-1:00			0:15-1:30	0:15-1:10	0:20-1:25
	2002-03 Endurance Time Test Results				0:10-1:15			
	2003-04 HOT Table Values	0:05-0:40	0:05-1:00		0:10-1:15	0:15-1:30	0:15-1:10	0:20-1:25
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:05-0:40	0:05-1:00		0:10-1:15	0:15-1:30	0:15-1:10	0:20-1:25

Table 4.27: Type II 75/25 Fluid, Cold-Soaked Wing, Above 0°C

		GENERIC	ABC-II +	C-1951	C-2025	E II	K2000	S E26
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					0:10-1:05	0:15-1:40	
	2002-03 HOT Table Values	0:05-0:25	0:05-0:50			0:10-1:05	0:15-1:40	0:10-1:00
	2002-03 Endurance Time Test Results				0:05-0:50			
	2003-04 HOT Table Values	0:05-0:25	0:05-0:50		0:05-0:50	0:10-1:05	0:15-1:40	0:10-1:00
CURRENT	2003-04 Endurance Time Test Results							
	2004-05 HOT Table Values	0:05-0:25	0:05-0:50		0:05-0:50	0:10-1:05	0:15-1:40	0:10-1:00

Table 4.28: Fluids Responsible for the Type II 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
above 0°	above 32°	100/0		Grandfather **(B)**	Grandfather **(L)** C-1951 **(U)**	Grandfather **(L)** C-1951 **(U)**	Grandfather **(B)** C-1951 **(U)**	Grandfather **(U)** ABC II + **(L)**
		75/25		Grandfather **(B)**	Grandfather **(B)** C-1951 **(L)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)**	Grandfather **(B)** ABC II + **(L)** C-1951 **(L)** C-2025 **(L)**
		50/50		Grandfather **(L)** ABC II + **(L)** C-1951 **(U)**	Grandfather **(B)** C-1951 **(L)**	C-1951 **(B)** ABC II + **(L)** C-2025 **(U)**	Grandfather **(B)** C-1951 **(B)** S E26 **(B)** ABC II + **(L)** C-2025 **(L)** K2000 **(L)** E II **(L)**	
0 to -3	32 to 27	100/0		Grandfather **(B)**	Grandfather **(B)** C-1951 **(B)**	Grandfather **(L)** C-1951 **(U)**	Grandfather **(B)** C-1951 **(U)**	
		75/25		Grandfather **(B)**	Grandfather **(B)** C-1951 **(L)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)**	
		50/50		Grandfather **(L)** ABC II + **(L)** C-1951 **(U)**	Grandfather **(B)** C-1951 **(B)** C-2025 **(B)**	C-1951 **(B)** ABC II + **(L)** C-2025 **(U)**	Grandfather **(B)** C-1951 **(B)** S E26 **(B)** ABC II + **(L)** C-2025 **(L)** K2000 **(L)** E II **(L)**	
below -3 to -14	below 27 to 7	100/0		Type IV **(L)*** ABC II + **(U)**	ABC II + **(B)** Grandfather **(L)**	ABC II + **(B)**	Grandfather **(L)** ABC II + **(L)** Type IV **(U)***	
		75/25		ABC II + **(B)**	C-1951 **(B)** Grandfather **(L)** ABC II + **(L)**	ABC II + **(B)**	ABC II + **(B)** Grandfather **(L)** C-1951 **(U)**	
below -14 to -25	below 7 to -13	100/0		ABC II + **(B)**	Grandfather **(B)** ABC II + **(B)** C-2025 **(B)**			
below -25	below -13	100/0	SAE TYPE IV 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 IV generic table can not be less than value in Type II generic table; these values were reduced for this reason

M:\Groups\Cm1892\Reports\HOT\Working Documents\Fluids Responsible for Generic Table Values At: Type II

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5. TYPE III ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

One new Type III fluid was certified for use in the 2004-05 winter. TC and the FAA also produced new Type III generic holdover time tables for 2004-05. Endurance time test results and the new Type III holdover time guidelines were presented to the SAE G-12 Holdover Time Subcommittee in Frankfurt in May 2004, where they were discussed and it was agreed they would be implemented worldwide during the 2004-05 winter season.

5.1 Background

Following the winter of 1999-2000, the need for a different 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 IV fluids. Over the next several winters, TC, the FAA, APS and American Eagle worked together to identify the requirements that this fluid needed to fulfill.

During this process, it was decided that any new fluid created to meet these requirements would be classified as a Type III fluid. The complete history and all related research behind the development of the new Type III fluid is detailed in the TC report, TP 14379E, *Development of Holdover Time Guidelines for Type III Fluids* (4).

5.2 Evolution of Type III Holdover Time Guidelines

In the past, two fluids have been tested as Type III fluids: Union Carbide 250-3 and Union Carbide Ultra+ (66 percent). Union Carbide 250-3 was tested in 1992-93 and produced commercially, but production was later discontinued. Union Carbide Ultra+ (66 percent) was tested in 1996-97, but was never produced commercially.

Even though no Type III fluids were available, TC and the FAA have published generic Type III fluid holdover time tables in the past several winters. The values in the Type III 2003-04 holdover time guidelines were based on testing with Union Carbide Ultra+ (66 percent). The 2003-04 TC Type III generic holdover time guidelines are shown in Table 5.1.

Table 5.1: TC Type III Fluid Holdover Time Guidelines For Winter 2003-04

OAT		Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Frost	Freezing Fog	Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
above 0	above 32	5:00	0:50 – 1:30	0:15 – 0:30	0:25 – 0:50	0:15 – 0:25	0:05 – 0:35	
0 to -3	32 to 27	4:00	0:50 – 1:30	0:15 – 0:25	0:25 – 0:50	0:15 – 0:25	CAUTION: No holdover time	
below -3 to -14	below 27 to 7	4:00	0:30 – 1:00	0:10 – 0:20	0:15 – 0:30[1]	0:10 – 0:20[1]	Guidelines exist	
below -14	below 7	Type III fluid may be used below -14°C (7°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 Type I when Type III fluid cannot be used.						

[1]The lowest use temperature is limited to -10°C (14°F)

5.3 New Type III Holdover Time Guidelines

In February 2004, Clariant submitted a new Type III fluid, Clariant Safewing MP III 2031 ECO, for endurance time testing. The fluid was fully certified to Aerospace Material Specification (AMS) 1428 as a Type III fluid. Test results and analysis of the fluid are given in the fluid manufacturer report, which has been included as Appendix C.

As a result of the introduction of the Clariant fluid, TC and the FAA produced new Type III holdover time tables for inclusion within their 2004-05 operator guidance material. These tables contain values generally based on the endurance times of Clariant Safewing MP III 2031 ECO. Unlike previous Type III tables, which only had a single snow column, these tables include very light, light and moderate snow columns.

The only difference between the TC and FAA tables is in the very light snow columns, where TC has a single value and the FAA provides a holdover time range. Neither regulator will publish a fluid-specific holdover time table for Clariant Safewing MP III 2031 ECO. The TC Type III fluid holdover time guidelines are shown in Table 5.2. The FAA guidelines are included in Appendix D.

Table 5.2: TC Type III Fluid Holdover Time Guidelines For Winter 2004-05

OAT		Approximate Holdover Times Under Various Weather Conditions (minutes)								
°C	°F	Active Frost	Freezing Fog	Very Light Snow	Light Snow	Moderate Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	120	20 - 40	35	20 - 35	10 - 20	10 - 20	8 - 10	6 - 20	
below -3 to -10	below 27 to 14	120	20 - 40	30	15 - 30	9 - 15	10 - 20	8 - 10	CAUTION: No holdover time guidelines exist	
below -10	below 27	120	20 - 40	30	15 - 30	8 - 15				

5.4 Application Procedure for Type III Fluids

At the SAE G-12 Methods Subcommittee meeting held in Frankfurt in May 2004, it was agreed that the application procedure for Type III fluid should be the same as the application procedure for Type II and Type IV fluids. Type III fluid has been added to the Type II and Type IV fluid application procedures table, which is included in the TC Holdover Time Guidelines as Table 7 (see Appendix D).

5.5 Dilutions of Type III Fluids

Dilutions of Type III fluids were not tested in the winter of 2003-04 because the company stimulating the testing was not interested in using them. However, when the Type III test results and tables were presented at the SAE G-12 Holdover Subcommittee meeting in May 2004, other companies showed an interest in using Type III fluids in diluted form. The following arguments were given for making Type III dilutions available:

- It would create consistency between Type II, III and IV fluid application procedures and holdover time guidelines;
- It would reduce the environmental impact of Type III deicing because less concentrate fluid would be used; and
- It would reduce the cost of Type III deicing because less concentrate fluid would be used.

It is therefore recommended that dilutions of Clariant Safewing MP III 2031 ECO be tested in the winter of 2004-05.

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6. TYPE IV ENDURANCE TIME RESULTS AND HOLDOVER TIME GUIDELINES

One new Type IV fluid was certified for use in 2004-05. In addition, changes were made to some of the holdover time tables as a result of tests conducted with the NCAR and AMIL artificial snow machines. These changes were presented to the SAE G-12 Holdover Time Subcommittee in Frankfurt in May 2004, where they were discussed, and it was agreed they would be implemented worldwide during the 2004-05 winter season. The TC and FAA Type IV holdover time guidelines are included in Appendix D.

6.1 New Fluids

Octagon Max-Flight 04 was certified for use in 2004-05. No holdover time tests were conducted with this fluid because it is a re-branding of Octagon Max-Flight, a fluid that is currently certified with established holdover times.

6.1.1 History of Octagon Max-Flight

Four samples of Octagon Max-Flight – with four different viscosities – have been tested since 1996. Following is a chronology of the testing and evolution of the fluid-specific Octagon Max-Flight table. This chronology can also be followed in the tables presented in Section 6.3.

In 1996-97 and 1997-98, initial testing was conducted with Octagon Max-Flight using two fluid samples with viscosities in the middle of the production range. At the end of the two winters, the fluid had been tested in all conditions in the holdover time table guidelines at least once, and many conditions had been tested in both winters.

With the exception of freezing fog and rain on cold-soaked wing cells (where generic numbers where used), the values obtained during this testing were used to create the Octagon Max-Flight fluid-specific holdover time guidelines for the winter of 1998-99. The lowest holdover time from the two test sessions was used in cells in which testing had been conducted in both winters.

Following the winter of 1997-98, the SAE G-12 Holdover Time Subcommittee recommended that all fluid manufacturers submit low viscosity samples for testing in the winter of 1998-99. The subcommittee indicated that the holdover time in each cell of the fluid-specific tables would be the lowest holdover time measured with the low viscosity sample and any previous samples tested.

Octagon accordingly sent a low viscosity (2 900 mPa.s) sample of Max-Flight for testing in the winter of 1998-99. When tests were conducted with this sample, there was a substantial reduction in many Octagon Max-Flight holdover times and subsequently in many cells of its fluid-specific holdover time table.

As a result of the 1998-99 test results, Octagon sent a higher viscosity sample (5 540 mPa.s) for testing in 2000-01. Octagon requested the data from the 1998-99 testing be retracted, as Octagon was prepared to guarantee on-wing viscosities higher than 5 540 mPa.s. As the lowest-wing viscosity would be changed to 5 540 mPa.s, the SAE G-12 requirements were met.

Not surprisingly, tests with the 5 540 mPa.s sample resulted in longer holdover times. For the 2001-02 fluid-specific holdover time table, the lowest value obtained from 1996-97, 1997-98 and 2000-01 testing was used. No further testing has been conducted with this fluid and the 2004-05 Octagon Max-Flight fluid-specific holdover time guidelines still contain these values.

6.1.2 Introduction of Octagon Max-Flight 04

In the summer of 2004, Octagon approached TC and the FAA with a proposal to market the 5 540 mPa.s sample of Octagon Max-Flight as a new fluid, Octagon Max-Flight 04. At the time, Octagon was in the process of certifying the fluid based on the requirements of SAE AMS1428. For holdover time values, Octagon requested that the data collected in 2000-01 with the 5 540 mPa.s sample of Max-Flight be used.

TC and the FAA agreed to this request and, as a result, a fluid-specific table was created for Octagon Max-Flight 04 using fluid endurance time data collected from 2000-01 testing of the 5 540 mPa.s sample of Octagon Max-Flight. This data is presented in detail in the TC report, TP 13826E, *Aircraft Ground De/Anti-icing Fluid Holdover Time Development Program for the 2000-01 Winter* (5).

The TC and FAA Octagon Max-Flight 04 fluid-specific holdover time guidelines can be found in Appendix D.

6.2 New Snow Machine Data, -14ºC to -25ºC

In the past, it has been difficult to obtain fluid-specific data in natural snow at very cold temperatures (-14ºC to -25ºC). This has occurred for one of two reasons: either snow did not occur at cold temperatures in Montreal during the winter the fluid was tested, or the test fluid was received late in the season after the weather had already occurred. Since about 1999, it has been common practice to give any new fluid

generic holdover time values for the below -14°C to -25°C holdover time cell in snow when substantiating data is not available. Several fluids tested prior to this time have fluid-specific values in this cell, which are based on regression analysis.

At the SAE G-12 Holdover Time Subcommittee meeting held in Vancouver in May 2003, it was suggested that testing be conducted with the artificial snow machines in order to obtain values in the below -14°C to -25°C snow cell for all Type II and Type IV fluids. It was felt that artificial snow data, even if not as reliable as natural snow data, would be better than no data at all.

Testing was subsequently conducted by APS and by AMIL with all certified Type II and IV fluids. These tests are described in detail in the TC report, TP 14376E, *Endurance Time Testing in Snow: Comparison of Indoor and Outdoor Data for 2003-04* (3).

The conclusion to this testing was that generic numbers should be given to all PG-based Type II and Type IV fluids in the below -14°C to -25°C snow cell. No changes were recommended for EG-based fluids (Dow UCAR Ultra+). While many Type IV fluids already had generic numbers in this cell, five fluids certified for use in 2004-05 did not. Changes will be made to these fluid-specific tables for the 2004-05 operating season. These fluids include:

- Clariant Safewing MP IV 1957;
- Clariant Safewing MP IV 2001;
- Kilfrost ABC-S;
- SPCA AD-480; and
- Octagon Max-Flight.

The TC and FAA Type IV holdover time guidelines are included in Appendix D.

6.3 Evolution of Type IV Generic Holdover Time Values

Data from Type IV fluids tested since 1996-97 is used to develop the Type IV generic holdover time guidelines. At the SAE G-12 Holdover Time 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 have not been re-certified) would be eliminated from the analysis. Four fluids have since been eliminated for this reason: Hoechst MP IV 1957, diluted forms of Dow UCAR Ultra+, SPCA AD-404 and Clariant Safewing Four. The removal of Clariant Safewing Four this year did not impact the Type IV generic table.

The fluids used in the development of the 2004-05 Type IV generic table include: Clariant Safewing MP IV 1957, Clariant Safewing MP IV 2001, Clariant Safewing MP IV 2012 Protect, Clariant Safewing MP IV 2030 ECO, Dow UCAR Ultra+, Kilfrost ABC-S, Octagon Max-Flight, and SPCA AD-480.

The history of testing with Type IV fluids and the evolution of the fluid-specific and generic Type IV holdover time values are illustrated through a series of tables presented in Tables 6.1 to 6.27. Each table represents one cell in the holdover time guidelines and the title of each table links the table to the appropriate cell.

The first row contains the holdover time values used in 1997-98, produced from tests conducted in 1996-97. Each subsequent row represents a winter test season or winter holdover time table values. It should be noted that, because no Type IV fluids were tested in the winter 2001-02 test season, the generic values did not change. Therefore, no line has been included for the 2001-02 winter test season or the 2002-03 holdover time values. The final line contains the generic and fluid-specific holdover time values for use in 2004-05 winter operations.

The underlined values indicate the fluid(s) responsible for the generic holdover time. If no value is underlined, it implies that the 1997-98 SAE Type IV values are responsible.

Strikethrough values indicate data that is no longer valid. This includes data for fluids which are no longer in the holdover time guidelines and data for fluids that underwent testing in multiple years (details of multiple year testing are typically provided in the holdover time report written in the most recent year the fluid was tested).

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

- Clariant MP IV 1957 (C-1957);
- Clariant MP IV 2001 (C-2001);
- Dow UCAR Ultra+ (Ultra+);
- Clariant Safewing MP IV 2030 ECO (C-2030);
- Clariant Safewing MP IV Protect 2012 (C-2012);
- Hoechst MP IV 1957 (H-1957);
- Kilfrost ABC-S (K-ABC-S);
- Octagon Max-Flight (O-Max);
- Octagon Max-Flight 04 (O-Max 04);
- SPCA AD-480 (S-480); and
- SPCA AD-404 (S-404).

Table 6.1: Type IV Neat Fluid, Snow, Above 0°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:45-1:25	1:15-2:00		1:10-2:00		~~0:45-1:25~~		0:50-1:40					
	1997-98 Endurance Time Test Results					1:05-2:00				~~1:10-2:00~~	1:55-2:00			~~1:40-2:00~~
	1998-99 HOT Table Values	0:45-1:25	1:15-2:00		1:10-2:00	1:05-2:00			0:50-1:40	1:10-2:00	1:55-2:00			1:40-2:00
	1998-99 Endurance TimeTest Results		~~1:00 1:30~~		1:10-2:00	0:35-1:05			0:40-1:25	1:45-2:00				
	1999-2000 HOT Table Values	0:35-1:05	1:00-1:30		1:10-2:00	0:35-1:05			0:40-1:25	1:10-2:00	1:55-2:00			
	1999-2000 Endurance Time Test Results							~~0:45-1:45~~		0:55-1:50				
	2000-01 HOT Table Values	0:35-1:05	1:00-1:30		1:10-2:00	0:35-1:05		0:45-1:45	0:40-1:25	0:55-1:50	1:55-2:00			
	2000-01 Endurance Time Test Results		2:00-2:00	2:00-2:00								1:05-2:00		
	2001-02 HOT Table Values	0:35-1:05	1:15-2:00		1:10-2:00	0:35-1:05		0:45-1:45	0:40-1:25	0:55-1:50	1:55-2:00	1:05-2:00		
	2002-03 Endurance Time Test Results												0:50-1:35	
	2003-04 HOT Table Values	0:35-1:05	1:15-2:00		1:10-2:00	0:35-1:05		0:45-1:45	0:40-1:25	0:55-1:50	1:55-2:00	1:05-2:00	0:50-1:35	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:35-1:05	1:15-2:00	2:00-2:00	1:10-2:00	0:35-1:05			0:40-1:25	0:55-1:50	1:55-2:00	1:05-2:00	0:50-1:35	

Table 6.2: Type IV 75/25 Fluid, Snow, Above 0°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:40	1:20-2:00		0:35-1:05		~~0:35-1:10~~		~~0:20-0:40~~					
	1997-98 Endurance Time Test Results					0:45-1:25				~~1:00-1:55~~	0:50-1:25			~~0:50-1:45~~
	1998-99 HOT Table Values	0:20-0:40	1:20-2:00		0:35-1:05	0:45-1:25				1:00-1:55	0:50-1:25			0:50-1:45
	1998-99 Endurance TimeTest Results		~~0:40-1:30~~		0:30-1:05	0:35-1:05				0:45-1:25				
	1999-2000 HOT Table Values	0:20-0:40	0:40-1:30		0:30-1:05	0:35-1:05				0:45-1:25	0:50-1:25			
	1999-2000 Endurance Time Test Results							~~0:40-1:25~~		0:40-1:20				
	2000-01 HOT Table Values	0:20-0:40	0:40-1:30		0:30-1:05	0:35-1:05		0:40-1:25		0:40-1:20	0:50-1:25			
	2000-01 Endurance Time Test Results		1:35-2:00	1:35-2:00								0:35-1:10		
	2001-02 HOT Table Values	0:30-1:05	1:20-2:00		0:30-1:05	0:35-1:05		0:40-1:25		0:40-1:20	0:50-1:25	0:35-1:10		
	2002-03 Endurance Time Test Results												0:35-1:05	
	2003-04 HOT Table Values	0:30-1:05	1:20-2:00		0:30-1:05	0:35-1:05		0:40-1:25		0:40-1:20	0:50-1:25	0:35-1:10	0:35-1:05	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:30-1:05	1:20-2:00	1:35-2:00	0:30-1:05	0:35-1:05				0:40-1:20	0:50-1:25	0:35-1:10	0:35-1:05	

Table 6.3: Type IV 50/50 Fluid, Snow, Above 0°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:05-0:20	0:40-1:20		0:05-0:20		~~0:15-0:25~~		~~0:05-0:20~~					
	1997-98 Endurance Time Test Results					0:15-0:30				0:15-0:35	0:10-0:20			~~0:20-0:45~~
	1998-99 HOT Table Values	0:05-0:20	0:40-1:20		0:05-0:20	0:15-0:30				0:15-0:35	0:10-0:20			0:20-0:45
	1998-99 Endurance TimeTest Results		~~0:15-0:35~~		0:10-0:20	0:15-0:30								
	1999-2000 HOT Table Values	0:05-0-20	0:15-0:35		0:05-0:20	0:15-0:30				0:15-0:35	0:10-0:20			
	1999-2000 Endurance Time Test Results							~~0:15-0:25~~		0:15-0:30				
	2000-01 HOT Table Values	0:05-0-20	0:15-0:35		0:05-0:20	0:15-0:30		0:15-0:25		0:15-0:30	0:10-0:20			
	2000-01 Endurance Time Test Results		0:40-2:00	0:40-2:00								0:15-0:25		
	2001-02 HOT Table Values	0:05-0:20	0:40-1:20		0:05-0:20	0:15-0:30		0:15-0:25		0:15-0:30	0:10-0:20	0:15-0:25		
	2002-03 Endurance Time Test Results												0:15-0:25	
	2003-04 HOT Table Values	0:05-0:20	0:40-1:20		0:05-0:20	0:15-0:30		0:15-0:25		0:15-0:30	0:10-0:20	0:15-0:25	0:15-0:25	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:05-0:20	0:40-1:20	0:40-2:00	0:05-0:20	0:15-0:30				0:15-0:30	0:10-0:20	0:15-0:25	0:15-0:25	

Table 6.4: Type IV Neat Fluid, Snow, 0°C to -3°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:35-1:00	0:50-1:35		1:00-1:40		~~0:35-1:00~~		0:35-1:15					
	1997-98 Endurance Time Test Results					0:45-1:25				~~1:05-2:00~~	1:00-1:55			~~1:00-1:45~~
	1998-99 HOT Table Values	0:35-1:00	0:50-1:35		1:00-1:40	0:45-1:25			0:35-1:15	1:05-2:00	1:00-1:55			1:00-1:45
	1998-99 Endurance TimeTest Results		~~0:50 1:20~~		1:00-1:40	0:30-0:55			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	0:30-0:55			0:35-1:15	1:05-1:50	1:00-1:55			
	1999-2000 Endurance Time Test Results							~~0:35-1:20~~		0:40-1:20				
	2000-01 HOT Table Values	0:30-0:55	0:50-1:20		1:00-1:40	0:30-0:55		0:35-1:20	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	0:30-0:55		0:35-1:20	0:35-1:15	0:40-1:20	1:00-1:55	0:40-1:15		
	2002-03 Endurance Time Test Results												0:50-1:30	
	2003-04 HOT Table Values	0:30-0:55	0:50-1:35		1:00-1:40	0:30-0:55		0:35-1:20	0:35-1:15	0:40-1:20	1:00-1:55	0:40-1:15	0:50-1:30	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:30-0:55	0:50-1:35	1:25-2:00	1:00-1:40	0:30-0:55			0:35-1:15	0:40-1:20	1:00-1:55	0:40-1:15	0:50-1:30	

Table 6.5: Type IV 75/25 Fluid, Snow, 0ºC to -3ºC

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:35	0:45-1:45		0:35-1:05		~~0:25-0:50~~		~~0:20-0:35~~					
	1997-98 Endurance Time Test Results					0:30-1:00				~~0:45-1:25~~	0:35-1:00			~~0:25-1:00~~
	1998-99 HOT Table Values	0:20-0:35	0:45-1:45		0:35-1:05	0:30-1:00				0:45-1:25	0:35-1:00			0:25-1:00
	1998-99 Endurance TimeTest Results		~~0:30 1:00~~		0:30-0:55	0:30-0:50				0:45-1:25				
	1999-2000 HOT Table Values	0:20-0:35	0:30-1:00		0:30-0:55	0:30-0:50				0:45-1:25	0:35-1:00			
	1999-2000 Endurance Time Test Results							~~0:30-1:05~~		0:30-1:05				
	2000-01 HOT Table Values	0:20-0:35	0:30-1:00		0:30-0:55	0:30-0:50		0:30-1:05		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	0:30-0:50		0:30-1:05		0:30-1:05	0:35-1:00	0:25-0:55		
	2002-03 Endurance Time Test Results												0:35-1:05	
	2003-04 HOT Table Values	0:25-0:50	0:45-1:45		0:30-0:55	0:30-0:50		0:30-1:05		0:30-1:05	0:35-1:00	0:25-0:55	0:35-1:05	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:25-0:50	0:45-1:45	1:05-2:00	0:30-0:55	0:30-0:50				0:30-1:05	0:35-1:00	0:25-0:55	0:35-1:05	

Table 6.6: Type IV 50/50 Fluid, Snow, 0°C to -3°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:05-0:15	0:40-1:20		0:05-0:15		~~0:15-0:25~~		~~0:05-0:15~~					
	1997-98 Endurance Time Test Results		0:40-1:20		0:05-0:15	0:10-0:20				0:10-0:30	0:10-0:20			~~0:15-0:30~~
	1998-99 HOT Table Values	0:05-0:15	0:40-1:20		0:05-0:15	0:10-0:20				0:10-0:30	0:10-0:20			0:15-0:30
	1998-99 Endurance TimeTest Results	0:05-0:15	~~0:15-0:30~~		0:05-0:15	0:10-0:20								
	1999-2000 HOT Table Values	0:05-0:15	0:15-0:30		0:05-0:15	0:10-0:20				0:10-0:30	0:10-0:20			
	1999-2000 Endurance Time Test Results							~~0:10-0:20~~		0:10-0:20				
	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		0:10-0:20	0:10-0:20			
	2000-01 Endurance Time Test Results		0:25-1:15	0:25-1:15								0:15-0:25		
	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		0:10-0:20	0:10-0:20	0:15-0:25		
	2002-03 Endurance Time Test Results												0:15-0:25	
	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		0:10-0:20	0:10-0:20	0:15-0:25	0:15-0:25	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:05-0:15	0:25-1:15	0:25-1:15	0:05-0:15	0:10-0:20				0:10-0:20	0:10-0:20	0:15-0:25	0:15-0:25	

Table 6.7: Type IV Neat Fluid, Snow, Below -3°C to -14°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:40	0:25-0:50		0:45-1:20		~~0:20-0:40~~		0:25-0:55					
	1997-98 Endurance Time Test Results					0:30-0:55				~~0:20-0:40~~	0:30-0:50			~~0:35-1:00~~
	1998-99 HOT Table Values	0:20-0:40	0:25-0:50		0:45-1:20	0:30-0:55			0:25-0:55	0:20-0:40	0:30-0:50			0:35-1:00
	1998-99 Endurance TimeTest Results		~~0:45-1:05~~		0:45-1:20	0:30-0:50			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	0:30-0:50			0:25-0:55	0:30-0:55	0:30-0:50			
	1999-2000 Endurance Time Test Results							~~0:25-0:55~~		0:30-0:55				
	2000-01 HOT Table Values	0:20-0:40	0:25-0:50		0:45-1:20	0:30-0:50		0:25-0:55	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	0:30-0:50		0:25-0:55	0:25-0:55	0:30-0:55	0:30-0:50	0:20-0:40		
	2002-03 Endurance Time Test Results												0:45-1:25	
	2003-04 HOT Table Values	0:20-0:40	0:25-0:50		0:45-1:20	0:30-0:50		0:25-0:55	0:25-0:55	0:30-0:55	0:30-0:50	0:20-0:40	0:45-1:25	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-0:40	0:25-0:50	0:35-1:10	0:45-1:20	0:30-0:50			0:25-0:55	0:30-0:55	0:30-0:50	0:20-0:40	0:45-1:25	

Table 6.8: Type IV 75/25 Fluid, Snow, Below -3°C to -14°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
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~~		~~0:15-0:30~~					
	1997-98 Endurance Time Test Results					0:20-0:40				~~0:15-0:25~~	0:20-0:35			~~0:15-0:25~~
	1998-99 HOT Table Values	0:15-0:25	0:20-0:50		0:35-1:05	0:20-0:40				0:15-0:25	0:20-0:35			0:15-0:25
	1998-99 Endurance TimeTest Results		~~0:20 0:40~~		0:25-0:50	0:20-0:40				0:25-0:45				
	1999-2000 HOT Table Values	0:15-0:25	0:20-0:40		0:25-0:50	0:20-0:40				0:25-0:45	0:20-0:35			
	1999-2000 Endurance Time Test Results							~~0:20-0:45~~		0:20-0:45				
	2000-01 HOT Table Values	0:15-0:25	0:20-0:40		0:25-0:50	0:20-0:40		0:20-0:45		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	0:20-0:40		0:20-0:45		0:20-0:45	0:20-0:35	0:20-0:40		
	2002-03 Endurance Time Test Results												0:35-1:05	
	2003-04 HOT Table Values	0:20-0:35	0:20-0:50		0:25-0:50	0:20-0:40		0:20-0:45		0:20-0:45	0:20-0:35	0:20-0:40	0:35-1:05	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-0:35	0:20-0:50	0:40-1:20	0:25-0:50	0:20-0:40				0:20-0:45	0:20-0:35	0:20-0:40	0:35-1:05	

Table 6.9: Type IV Neat Fluid, Snow, Below -14°C to -25°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	0:20-0:40		0:40-1:10		~~0:15-0:30~~		0:20-0:45					
	1997-98 Endurance Time Test Results					0:25-0:45				~~0:15-0:30~~	0:20-0:35			~~0:15-0:30~~
	1998-99 HOT Table Values	0:15-0:30	0:20-0:40		0:40-1:10	0:25-0:45			0:20-0:45	0:15-0:30	0:20-0:35			0:15-0:30
	1998-99 Endurance TimeTest Results		~~0:40 1:00~~		0:40-1:10	0:25-0:45			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	0:25-0:45			0:20-0:45	0:25-0:40	0:20-0:35			
	1999-2000 Endurance Time Test Results							~~0:20-0:45~~		0:25-0:50				
	2000-01 HOT Table Values	0:15-0:30	0:20-0:40		0:40-1:10	0:25-0:45		0:20-0:45	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	0:25-0:45		0:20-0:45	0:20-0:45	0:25-0:40	0:20-0:35	0:15-0:30		
	2002-03 Endurance Time Test Results												0:15-0:30	
	2003-04 HOT Table Values	0:15-0:30	0:20-0:40		0:40-1:10	0:25-0:45		0:20-0:45	0:20-0:45	0:25-0:40	0:20-0:35	0:15-0:30	0:15-0:30	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:30	0:15-0:30	0:15-0:30	0:15-0:30	0:15-0:30			0:20-0:45	0:15-0:30	0:15-0:30	0:15-0:30	0:15-0:30	

Table 6.10: Type IV Neat Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:40-1:00	0:55-2:00		1:20-1:50		~~0:40-1:00~~		1:00-2:00					
	1997-98 Endurance Time Test Results		1:10-2:00		1:55-2:00	0:50-1:40				1:05-2:00	0:55-1:55			~~1:40-2:00~~
	1998-99 HOT Table Values	0:40-1:00	0:55-2:00		1:20-1:50	0:50-1:40			1:00-2:00	1:05-2:00	0:55-1:55			1:40-2:00
	1998-99 Endurance TimeTest Results		~~1:00 1:55~~		2:00-2:00	0:40-1:10			0:45-1:35					
	1999-2000 HOT Table Values	0:40-1:00	0:55-1:55		1:20-1:50	0:40-1:10			0:45-1:35	1:05-2:00	0:55-1:55			
	1999-2000 Endurance Time Test Results							~~1:05-1:45~~		0:50-1:30				
	2000-01 HOT Table Values	0:40-1:00	0:55-1:55		1:20-1:50	0:40-1:10		1:05-1:45	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	0:40-1:10		1:05-1:45	0:45-1:35	0:50-1:30	0:55-1:55	0:40-1:10		
	2002-03 Endurance Time Test Results												0:55-2:00	
	2003-04 HOT Table Values	0:40-1:10	0:55-2:00		1:20-1:50	0:40-1:10		1:05-1:45	0:45-1:35	0:50-1:30	0:55-1:55	0:40-1:10	0:55-2:00	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:40-1:10	0:55-2:00	2:00-2:00	1:20-1:50	0:40-1:10			0:45-1:35	0:50-1:30	0:55-1:55	0:40-1:10	0:55-2:00	

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

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-1:00	1:15-2:00		0:50-1:25		~~0:40-1:05~~		~~0:30-1:00~~					
	1997-98 Endurance Time Test Results		1:20-2:00		0:50-1:10	0:45-1:15				0:50-1:20	0:35-1:10			~~0:50-1:50~~
	1998-99 HOT Table Values	0:30-1:00	1:15-2:00		0:50-1:10	0:45-1:15				0:50-1:20	0:35-1:10			0:50-1:50
	1998-99 Endurance TimeTest Results		~~0:50 1:20~~		0:45-1:10	0:35-1:05								
	1999-2000 HOT Table Values	0:30-1:00	0:50-1:20		0:45-1:10	0:35-1:05				0:50-1:20	0:35-1:10			
	1999-2000 Endurance Time Test Results							~~0:50-1:30~~		0:50-1:15				
	2000-01 HOT Table Values	0:30-1:00	0:50-1:20		0:45-1:10	0:35-1:05		0:50-1:30		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	0:35-1:05		0:50-1:30		0:50-1:15	0:35-1:10	0:35-0:50		
	2002-03 Endurance Time Test Results												0:40-1:05	
	2003-04 HOT Table Values	0:35-0:50	1:15-2:00		0:45-1:10	0:35-1:05		0:50-1:30		0:50-1:15	0:35-1:10	0:35-0:50	0:40-1:05	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:35-0:50	1:15-2:00	1:50-2:00	0:45-1:10	0:35-1:05				0:50-1:15	0:35-1:10	0:35-0:50	0:40-1:05	

Table 6.12: Type IV 50/50 Fluid, Freezing Drizzle, -3ºC and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:10-0:20	0:55-1:40		0:15-0:25		~~0:20-0:35~~		~~0:10-0:20~~					
	1997-98 Endurance Time Test Results		0:35-1:00		0:15-0:20	0:15-0:25				0:15-0:35	0:10-0:20			~~0:25-0:55~~
	1998-99 HOT Table Values	0:10-0:20	0:35-1:00		0:15-0:20	0:15-0:25				0:15-0:35	0:10-0:20			0:25-0:55
	1998-99 Endurance TimeTest Results		~~0:15-0:25~~		0:15-0:20	0:15-0:25								
	1999-2000 HOT Table Values	0:10-0:20	0:15-0:25		0:15-0:20	0:15-0:25				0:15-0:35	0:10-0:20			
	1999-2000 Endurance Time Test Results							~~0:15-0:25~~		0:15-0:25				
	2000-01 HOT Table Values	0:10-0:20	0:15-0:25		0:15-0:20	0:15-0:25		0:15-0:25		0:15-0:25	0:10-0:20			
	2000-01 Endurance Time Test Results		0:35-1:10	0:35-1:10								0:15-0:20		
	2001-02 HOT Table Values	0:10-0:20	0:35-1:00		0:15-0:20	0:15-0:25		0:15-0:25		0:15-0:25	0:10-0:20	0:15-0:20		
	2002-03 Endurance Time Test Results												0:15-0:25	
	2003-04 HOT Table Values	0:10-0:20	0:35-1:00		0:15-0:20	0:15-0:25		0:15-0:25		0:15-0:25	0:10-0:20	0:15-0:20	0:15-0:25	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:10-0:20	0:35-1:00	0:35-1:10	0:15-0:20	0:15-0:25				0:15-0:25	0:10-0:20	0:15-0:20	0:15-0:25	

Table 6.13: Type IV Neat Fluid, Freezing Drizzle, Below -3ºC to -10ºC

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-1:00	0:30-1:10		0:35-1:00		~~0:40-1:00~~		~~0:50-1:35~~					
	1997-98 Endurance Time Test Results		0:30-1:25		0:40-1:20	0:55-1:25				0:25-1:20	0:55-1:35			~~1:05-2:00~~
	1998-99 HOT Table Values	0:25-1:00	0:30-1:10		0:35-1:00	0:55-1:25			0:50-1:35	0:25-1:20	0:55-1:35			1:05-2:00
	1998-99 Endurance TimeTest Results		~~0:25-1:15~~		0:20-1:30	0:35-0:55			0:45-1:25					
	1999-2000 HOT Table Values	0:20-0:55	0:25-1:10		0:20-1:00	0:35-0:55			0:45-1:25	0:25-1:20	0:55-1:35			
	1999-2000 Endurance Time Test Results							~~0:25-1:05~~		0:25-1:20				
	2000-01 HOT Table Values	0:20-0:55	0:25-1:10		0:20-1:00	0:35-0:55		0:25-1:05	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	0:35-0:55		0:25-1:05	0:45-1:25	0:25-1:20	0:55-1:35	0:25-0:45		
	2002-03 Endurance Time Test Results												0:30-1:10	
	2003-04 HOT Table Values	0:20-0:45	0:25-1:10		0:20-1:00	0:35-0:55		0:25-1:05	0:45-1:25	0:25-1:20	0:55-1:35	0:25-0:45	0:30-1:10	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-0:45	0:25-1:10	0:25-1:30	0:20-1:00	0:35-0:55			0:45-1:25	0:25-1:20	0:55-1:35	0:25-0:45	0:30-1:10	

Table 6.14: Type IV 75/25 Fluid, Freezing Drizzle, Below -3°C to -10°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:30-1:00	0:30-1:05		0:50-1:25		~~0:40-1:05~~							
	1997-98 Endurance Time Test Results		0:25-1:20		0:30-1:10	0:45-1:15				0:30-1:15	0:40-1:10			~~0:30-1:45~~
	1998-99 HOT Table Values	0:30-1:00	0:25-1:05		0:30-1:10	0:45-1:15				0:30-1:15	0:40-1:10			0:30-1:45
	1998-99 Endurance TimeTest Results		~~0:20 1:00~~		0:20-1:30	0:25-0:55								
	1999-2000 HOT Table Values	0:20-0:55	0:20-1:00		0:20-1:10	0:25-0:55				0:30-1:15	0:40-1:10			
	1999-2000 Endurance Time Test Results							~~0:20-0:50~~		0:25-1:05				
	2000-01 HOT Table Values	0:20-0:50	0:20-1:00		0:20-1:10	0:25-0:55		0:20-0:50		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	0:25-0:55		0:20-0:50		0:25-1:05	0:40-1:10	0:15-0:30		
	2002-03 Endurance Time Test Results												0:35-1:20	
	2003-04 HOT Table Values	0:15-0:30	0:20-1:00		0:20-1:10	0:25-0:55		0:20-0:50		0:25-1:05	0:40-1:10	0:15-0:30	0:35-1:20	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:30	0:20-1:00	0:20-1:00	0:20-1:10	0:25-0:55				0:25-1:05	0:40-1:10	0:15-0:30	0:35-1:20	

Table 6.15: Type IV Neat Fluid, Light Freezing Rain, -3ºC and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:35-0:55	0:40-1:15		1:00-1:25		~~0:40-0:55~~		0:35-1:00					
	1997-98 Endurance Time Test Results		0:35-1:00		1:20-2:00	0:40-1:00				0:50-1:10	0:40-1:00			~~0:45-1:20~~
	1998-99 HOT Table Values	0:35-0:55	0:35-1:00		1:00-1:25	0:40-1:00			0:35-1:00	0:50-1:10	0:40-1:00			0:45-1:20
	1998-99 Endurance TimeTest Results		~~0:30 0:50~~		1:20-2:00	0:30-0:45			0:25-0:40					
	1999-2000 HOT Table Values	0:25-0:40	0:30-0:50		1:00-1:25	0:30-0:45			0:25-0:40	0:50-1:10	0:40-1:00			
	1999-2000 Endurance Time Test Results							~~0:50-1:05~~		0:35-0:55				
	2000-01 HOT Table Values	0:25-0:40	0:30-0:50		1:00-1:25	0:30-0:45		0:50-1:05		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	0:30-0:45		0:50-1:05	0:25-0:40	0:35-0:55	0:40-1:00	0:25-0:45		
	2002-03 Endurance Time Test Results												0:40-0:50	
	2003-04 HOT Table Values	0:25-0:40	0:35-1:00		1:00-1:25	0:30-0:45		0:50-1:05	0:25-0:40	0:35-0:55	0:40-1:00	0:25-0:45	0:40-0:50	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:25-0:40	0:35-1:00	1:10-1:30	1:00-1:25	0:30-0:45			0:25-0:40	0:35-0:55	0:40-1:00	0:25-0:45	0:40-0:50	

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

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	0:50-1:15		0:35-0:50		~~0:25-0:40~~		~~0:15-0:30~~					
	1997-98 Endurance Time Test Results		0:35-1:10		0:40-0:55	0:30-0:40				0:35-0:50	0:25-0:35			~~0:30-0:50~~
	1998-99 HOT Table Values	0:15-0:30	0:35-1:10		0:35-0:50	0:30-0:40				0:35-0:50	0:25-0:35			0:30-0:50
	1998-99 Endurance TimeTest Results		~~0:20 0:40~~		0:35-0:50	0:25-0:40								
	1999-2000 HOT Table Values	0:15-0:30	0:20-0:40		0:35-0:50	0:25-0:40				0:35-0:50	0:25-0:35			
	1999-2000 Endurance Time Test Results							~~0:30-0:45~~		0:30-0:45				
	2000-01 HOT Table Values	0:15-0:30	0:20-0:40		0:35-0:50	0:25-0:40		0:30-0:45		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	0:25-0:40		0:30-0:45		0:30-0:45	0:25-0:35	0:15-0:30		
	2002-03 Endurance Time Test Results												0:25-0:35	
	2003-04 HOT Table Values	0:15-0:30	0:35-1:10		0:35-0:50	0:25-0:40		0:30-0:45		0:30-0:45	0:25-0:35	0:15-0:30	0:25-0:35	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:30	0:35-1:10	1:00-1:20	0:35-0:50	0:25-0:40				0:30-0:45	0:25-0:35	0:15-0:30	0:25-0:35	

Table 6.17: Type IV 50/50 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:05-0:10	0:30-0:55		0:10-0:15		~~0:15-0:20~~		~~0:05-0:10~~					
	1997-98 Endurance Time Test Results	0:05-0:10	0:15-0:30		0:10-0:15	0:10-0:15				0:10-0:25	0:10-0:15			~~0:15-0:35~~
	1998-99 HOT Table Values	0:05-0:10	0:15-0:30		0:10-0:15	0:10-0:15				0:10-0:25	0:10-0:15			0:15-0:35
	1998-99 Endurance TimeTest Results	0:05-0:10	~~0:05-0:15~~		0:05-0:10	0:05-0:15								
	1999-2000 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15				0:10-0:25	0:05-0:15			
	1999-2000 Endurance Time Test Results							~~0:10-0:15~~		0:05-0:15				
	2000-01 HOT Table Values	0:05-0:10	0:05-0:15		0:05-0:10	0:05-0:15		0:10-0:15		0:05-0:15	0:05-0:15			
	2000-01 Endurance Time Test Results		0:25-0:35	0:25-0:35								0:05-0:10		
	2001-02 HOT Table Values	0:05-0:10	0:15-0:30		0:05-0:10	0:05-0:15		0:10-0:15		0:05-0:15	0:05-0:15	0:05-0:10		
	2002-03 Endurance Time Test Results												0:05-0:10	
	2003-04 HOT Table Values	0:05-0:10	0:15-0:30		0:05-0:10	0:05-0:15		0:10-0:15		0:05-0:15	0:05-0:15	0:05-0:10	0:05-0:10	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:05-0:10	0:15-0:30	0:25-0:35	0:05-0:10	0:05-0:15				0:05-0:15	0:05-0:15	0:05-0:10	0:05-0:10	

Table 6.18: Type IV Neat Fluid, Light Freezing Rain, Below -3°C to -10°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
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~~		0:30-0:50					
	1997-98 Endurance Time Test Results		0:20-0:40		0:20-0:40	0:30-0:45				0:20-0:40	0:30-0:45			~~0:35-1:20~~
	1998-99 HOT Table Values	0:15-0:30	0:20-0:40		0:20-0:40	0:30-0:45			0:30-0:50	0:20-0:40	0:30-0:45			0:35-1:20
	1998-99 Endurance TimeTest Results		~~0:15-0:40~~		0:10-0:30	0:20-0:35			0:30-0:45					
	1999-2000 HOT Table Values	0:10-0:30	0:15-0:40		0:10-0:30	0:20-0:35			0:30-0:45	0:20-0:40	0:30-0:45			
	1999-2000 Endurance Time Test Results							~~0:15-0:30~~		0:15-0:30				
	2000-01 HOT Table Values	0:10-0:30	0:15-0:40		0:10-0:30	0:20-0:35		0:15-0:30	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	0:20-0:35		0:15-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:15-0:25		
	2002-03 Endurance Time Test Results												0:20-0:35	
	2003-04 HOT Table Values	0:10-0:25	0:20-0:40		0:10-0:30	0:20-0:35		0:15-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:15-0:25	0:20-0:35	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:10-0:25	0:20-0:40	0:20-0:40	0:10-0:30	0:20-0:35			0:30-0:45	0:15-0:30	0:30-0:45	0:15-0:25	0:20-0:35	

Table 6.19: Type IV 75/25 Fluid, Light Freezing Rain, Below -3°C to -10°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:15-0:30	0:25-0:35		0:35-0:50		~~0:25-0:40~~		~~0:15-0:30~~					
	1997-98 Endurance Time Test Results		0:20-0:30		0:25-0:35	0:25-0:35				0:20-0:35	0:20-0:30			~~0:30-0:45~~
	1998-99 HOT Table Values	0:15-0:30	0:20-0:30		0:25-0:35	0:25-0:35				0:20-0:35	0:20-0:30			0:30-0:45
	1998-99 Endurance TimeTest Results		~~0:15-0:30~~		0:10-0:35	0:15-0:30								
	1999-2000 HOT Table Values	0:10-0:30	0:15-0:30		0:10-0:35	0:15-0:30				0:20-0:35	0:20-0:30			
	1999-2000 Endurance Time Test Results							~~0:15-0:25~~		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		0:15-0:25		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		0:15-0:25		0:15-0:30	0:20-0:30	0:10-0:20		
	2002-03 Endurance Time Test Results												0:15-0:30	
	2003-04 HOT Table Values	0:10-0:20	0:15-0:30		0:10-0:35	0:15-0:30		0:15-0:25		0:15-0:30	0:20-0:30	0:10-0:20	0:15-0:30	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:10-0:20	0:15-0:30	0:15-0:30	0:10-0:35	0:15-0:30				0:15-0:30	0:20-0:30	0:10-0:20	0:15-0:30	

Table 6.20: Type IV Neat Fluid, Freezing Fog, -3°C and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	2:20-3:00												
	1997-98 Endurance Time Test Results													
	1998-99 HOT Table Values	2:00-3:00												
	1998-99 Endurance TimeTest Results		~~2:15-4:00~~		2:35-4:00	1:05-2:15			1:35-3:35					
	1999-2000 HOT Table Values	1:05-2:15	2:15-4:00		2:35-4:00	1:05-2:15			1:35-3:35	1:05-2:15	1:05-2:15			
	1999-2000 Endurance Time Test Results							~~1:50-2:45~~		2:00-3:30	1:20-3:20			
	2000-01 HOT Table Values	1:05-2:15	2:15-4:00		2:35-4:00	1:05-2:15		1:50-2:45	1:35-3:35	2:00-3:30	1:20-3:20			
	2000-01 Endurance Time Test Results		2:40-4:00	2:40-4:00								1:15-2:30		
	2001-02 HOT Table Values	1:05-2:15	2:40-4:00		2:35-4:00	1:05-2:15		1:50-2:45	1:35-3:35	2:00-3:30	1:20-3:20	1:15-2:30		
	2002-03 Endurance Time Test Results												1:55-3:20	
	2003-04 HOT Table Values	1:05-2:15	2:40-4:00		2:35-4:00	1:05-2:15		1:50-2:45	1:35-3:35	2:00-3:30	1:20-3:20	1:15-2:30	1:55-3:20	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	1:05-2:15	2:40-4:00	2:40-4:00	2:35-4:00	1:05-2:15			1:35-3:35	2:00-3:30	1:20-3:20	1:15-2:30	1:55-3:20	

Table 6.21: Type IV 75/25 Fluid, Freezing Fog, -3ºC and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
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	1:10-2:10								
	1999-2000 HOT Table Values	1:05-1:45	1:30-2:50		1:05-1:45	1:10-2:10				1:05-1:45	1:05-1:45			
	1999-2000 Endurance Time Test Results							~~1:45-2:25~~		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	1:10-2:10		1:45-2:25		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	1:10-2:10		1:45-2:25		1:30-2:45	1:20-2:00	1:10-2:05		
	2002-03 Endurance Time Test Results												1:15-2:05	
	2003-04 HOT Table Values	1:05-1:45	2:05-3:15		1:05-1:45	1:10-2:10		1:45-2:25		1:30-2:45	1:20-2:00	1:10-2:05	1:15-2:05	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	1:05-1:45	2:05-3:15	2:05-3:15	1:05-1:45	1:10-2:10				1:30-2:45	1:20-2:00	1:10-2:05	1:15-2:05	

Table 6.22: Type IV 50/50 Fluid, Freezing Fog, -3ºC and Above

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:20-0:45												
	1997-98 Endurance Time Test Results													
	1998-99 HOT Table Values	0:20-0:45												
	1998-99 Endurance TimeTest Results		~~0:30 0:50~~		0:20-0:35	0:25-0:50								
	1999-2000 HOT Table Values	0:20-0:35	0:30-0:50		0:20-0:35	0:25-0:50				0:20-0:35	0:20-0:35			
	1999-2000 Endurance Time Test Results							~~0:30-0:45~~		0:30-0:45	0:15-0:40			
	2000-01 HOT Table Values	0:15-0:35	0:30-0:50		0:20-0:35	0:25-0:50		0:30-0:45		0:30-0:45	0:15-0:40			
	2000-01 Endurance Time Test Results		0:55-1:45	0:55-1:45								0:25-0:45		
	2001-02 HOT Table Values	0:15-0:35	0:55-1:45		0:20-0:35	0:25-0:50		0:30-0:45		0:30-0:45	0:15-0:40	0:25-0:45		
	2002-03 Endurance Time Test Results												0:30-0:45	
	2003-04 HOT Table Values	0:15-0:35	0:55-1:45		0:20-0:35	0:25-0:50		0:30-0:45		0:30-0:45	0:15-0:40	0:25-0:45	0:30-0:45	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:35	0:55-1:45	0:55-1:45	0:20-0:35	0:25-0:50				0:30-0:45	0:15-0:40	0:25-0:45	0:30-0:45	

Table 6.23: Type IV Neat Fluid, Freezing Fog, Below -3ºC to -14ºC

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
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	0:45-1:30			1:25-3:00					
	1999-2000 HOT Table Values	0:40-1:30	0:45-1:55		0:45-2:05	0:45-1:30			1:25-3:00	0:40-1:30	0:40-1:30			
	1999-2000 Endurance Time Test Results							~~0:30-1:30~~		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	0:45-1:30		0:30-1:30	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	0:45-1:30		0:30-1:30	1:25-3:00	0:20-1:20	0:45-1:35	0:45-1:45		
	2002-03 Endurance Time Test Results												0:50-2:00	
	2003-04 HOT Table Values	0:20-1:20	0:50-2:30		0:45-2:05	0:45-1:30		0:30-1:30	1:25-3:00	0:20-1:20	0:45-1:35	0:45-1:35	0:50-2:00	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:20-1:20	0:50-2:30	0:50-2:30	0:45-2:05	0:45-1:30			1:25-3:00	0:20-1:20	0:45-1:35	0:45-1:35	0:50-2:00	

Table 6.24: Type IV 75/25 Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:35-2:00												
	1997-98 Endurance Time Test Results													
	1998-99 HOT Table Values	0:30-2:00												
	1998-99 Endurance TimeTest Results		~~0:30 1:10~~		0:25-1:00	0:25-1:10								
	1999-2000 HOT Table Values	0:25-1:00	0:30-1:10		0:25-1:00	0:25-1:10				0:25-1:00	0:25-1:00			
	1999-2000 Endurance Time Test Results							~~0:30-1:05~~		0:25-0:50	0:30-1:00			
	2000-01 HOT Table Values	0:25-0:50	0:30-1:10		0:25-1:00	0:25-1:10		0:30-1:05		0:25-0:50	0:30-1:00			
	2000-01 Endurance Time Test Results		030-1:05	030-1:05								0:25-1:05		
	2001-02 HOT Table Values	0:25-0:50	0:30-1:05		0:25-1:00	0:25-1:10		0:30-1:05		0:25-0:50	0:30-1:00	0:25-1:05		
	2002-03 Endurance Time Test Results												0:40-1:30	
	2003-04 HOT Table Values	0:25-0:50	0:30-1:05		0:25-1:00	0:25-1:10		0:30-1:05		0:25-0:50	0:30-1:00	0:25-1:05	0:40-1:30	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:25-0:50	0:30-1:05	0:30-1:05	0:25-1:00	0:25-1:10				0:25-0:50	0:30-1:00	0:25-1:05	0:40-1:30	

Table 6.25: Type IV Neat Fluid, Freezing Fog, Below -14ºC to -25ºC

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
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	0:25-0:40			0:40-2:10					
	1999-2000 HOT Table Values	0:20-0:40	0:20-0:40		0:20-0:40	0:25-0:40			0:40-2:10	0:20-0:40	0:20-0:40			
	1999-2000 Endurance Time Test Results							~~0:20-0:45~~		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	0:25-0:40		0:20-0:45	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	0:25-0:40		0:20-0:45	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45		
	2002-03 Endurance Time Test Results												0:25-0:45	
	2003-04 HOT Table Values	0:15-0:40	0:20-0:45		0:20-0:40	0:25-0:40		0:20-0:45	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:25-0:45	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:15-0:40	0:20-0:45	0:20-0:45	0:20-0:40	0:25-0:40			0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:25-0:45	

Table 6.26: Type IV Neat Fluid, Cold-Soaked Wing, Above 0°C

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:10-0:50												
	1997-98 Endurance Time Test Results		0:15-1:15		0:20-1:15	0:15-1:20								
	1998-99 HOT Table Values	0:10-0:50												
	1998-99 Endurance TimeTest Results		~~0:10 2:00~~		0:30-2:00	0:15-1:10			0:10-1:20					
	1999-2000 HOT Table Values	0:10-0:50	0:10-1:15		0:20-1:15	0:15-1:10			0:10-1:20	0:10-0:50	0:10-0:50			
	1999-2000 Endurance Time Test Results							~~0:10-1:20~~		0:15-1:35	0:15-2:00			
	2000-01 HOT Table Values	0:10-0:50	0:10-1:15		0:20-1:15	0:15-1:10		0:10-1:20	0:10-1:20	0:15-1:35	0:15-2:00			
	2000-01 Endurance Time Test Results		0:20-2:00	0:20-2:00								0:10-1:05		
	2001-02 HOT Table Values	0:10-0:50	0:15-1:15		0:20-1:15	0:15-1:10		0:10-1:20	0:10-1:20	0:15-1:35	0:15-2:00	0:10-1:05		
	2002-03 Endurance Time Test Results												0:15-1:40	
	2003-04 HOT Table Values	0:10-0:50	0:15-1:15		0:20-1:15	0:15-1:10		0:10-1:20	0:10-1:20	0:15-1:35	0:15-2:00	0:10-1:05	0:15-1:40	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:10-0:50	0:15-1:15	0:20-2:00	0:20-1:15	0:15-1:10			0:10-1:20	0:15-1:35	0:15-2:00	0:10-1:05	0:15-1:40	

Table 6.27: Type IV 75/25 Fluid, Cold-Soaked Wing, Above 0ºC

		GENERIC	O-Max	O-Max 04	K-ABC-S	C-1957	H-1957	C-S4	Ultra+	S-480	C-2001	C-2012	C-2030	S-404
HISTORICAL	1996-97 Test Results and Table Values used in 1997-98	0:05-0:35												
	1997-98 Endurance Time Test Results		0:10-0:40		0:10-0:50	0:10-1:00								
	1998-99 HOT Table Values	0:05-0:35												
	1998-99 Endurance TimeTest Results		~~0:05 1:15~~		0:10-1:15	0:10-1:05								
	1999-2000 HOT Table Values	0:05-0:35	0:05-0:40		0:10-0:50	0:10-1:00				0:05-0:35	0:05-0:35			
	1999-2000 Endurance Time Test Results							~~0:15-1:25~~		0:10-1:15	0:10-1:25			
	2000-01 HOT Table Values	0:05-0:35	0:05-0:40		0:10-0:50	0:10-1:00		0:15-1:25		0:10-1:15	0:10-1:25			
	2000-01 Endurance Time Test Results		0:20-2:00	0:20-2:00								0:05-0:40		
	2001-02 HOT Table Values	0:05-0:35	0:10-0:40		0:10-0:50	0:10-1:00		0:15-1:25		0:10-1:15	0:10-1:25	0:05-0:40		
	2002-03 Endurance Time Test Results												0:10-1:00	
	2003-04 HOT Table Values	0:05-0:35	0:10-0:40		0:10-0:50	0:10-1:00		0:15-1:25		0:10-1:15	0:10-1:25	0:05-0:40	0:10-1:00	
CURRENT	2003-04 Endurance Time Test Results													
	2004-05 HOT Table Values	0:05-0:35	0:10-0:40	0:20-2:00	0:10-0:50	0:10-1:00				0:10-1:15	0:10-1:25	0:05-0:40	0:10-1:00	

6.4 Fluids Responsible for the Type IV Generic Holdover Time Values

The fluids responsible for the values in each cell of the generic Type IV holdover time guidelines in 2004-05 are shown in Table 6.28, along with the year they were tested. A "U" indicates the fluid is responsible for the upper value in the cell, an "L" indicates the fluid is responsible for the lower value in the cell, and a "B" indicates the fluid is responsible for both the upper and lower values in the cell.

Table 6.28: 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
above 0°	above 32°	100/0		C-1957(98/99) **B**	C-1957(98/99) **B**	C-1957 (98/99) **B** C-2012 (00/01) **B**	ULTRA+ (98/99) **B** C-2012 (00/01) **L**	ULTRA+ (98/99) **L** C-2012 (00/01) **L** Old data **U**
		75/25		ABC-S (98/99) **B**	ABC-S (98/99) **B** C-1957(98/99) **U** C-2030 (02-03) **U**	C-1957 (98/99) **L** C-2001 (97/98) **L** C-2012 (00/01) **B**	C-2012 (00/01) **B**	C-2012 (00/01) **L** Old data **B**
		50/50		ABC-S (98/99) **U** C-2001 (99/00) **L**	ABC-S (96/97) **B** C-2001 (97/98) **U**	C-2012 (00/01) **U** C-2001 (97/98) **B** ABC-S (98/99) **U**	C-2012 (00/01) **B** C-1957(98/99) **L** ABC-S (98/99) **B** S 480 (99/00) **L** C-2030 (02/03) **B**	
0 to -3	32 to 27	100/0		C-1957(98/99) **B**	C-1957(98/99) **B**	C-1957 (98/99) **B** C-2012 (00/01) **B**	ULTRA+ (98/99) **B** C-2012 (00/01) **L**	
		75/25		ABC-S (98/99) **B**	C-1957 (98/99) **U** C-2012 (00/01) **L**	C-1957 (98/99) **L** C-2001 (97/98) **L** C-2012 (00/01) **B**	C-2012 (00/01) **B**	
		50/50		ABC-S (98/99) **U** C-2001 (99/00) **L**	ABC-S (98/99) **B**	C-2012 (00/01) **U** C-2001 (97/98) **B** ABC-S (98/99) **U**	C-2012 (00/01) **B** C-1957(98/99) **L** ABC-S (98/99) **B** S 480 (99/00) **L** C-2030 (02/03) **B**	
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** C-1957(98/99) **L** S 480 (99/00) **B**	C-2001 (98/99) **B** O-Max (97-98) **L** C-1957 (97-98) **L** S 480 (99-00) **L** C2012 (00-01) **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** C-1957(98/99) **U** ABC-S (98/99) **U**	C-2012 (00/01) **B** C-2030 (02/03) **B**			
below -25	below -13	100/0	SAE TYPE IV 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**	

M:\Groups\Cm1892\Reports\HOT\Working Documents\Fluids Responsible for Generic Table Values At: Type IV

7. CONCLUSIONS

7.1 Type I Fluids

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

7.2 Type II Fluids

As a result of testing with artificial snow machines, the generic Type II value in the below -14ºC to -25ºC snow cell (15 to 30 minutes) was applied to all Type II fluid-specific tables. This change led to a reduction in the below -14ºC to -25ºC snow cell for one Type II fluid, SPCA Ecowing 26.

7.3 Type III Fluids

In 2003-04, a new Type III fluid, Clariant Safewing MP III 2031 ECO, was certified to AMS1428 as a Type III fluid. TC and the FAA produced similar Type III holdover time tables for inclusion within their operator guidance material for use in 2004-05 winter operations. These tables contain values generally based on the endurance times of Clariant Safewing MP III 2031 ECO, and include very light, light and moderate snow columns. Neither regulator will publish a fluid-specific holdover time table for this fluid.

7.4 Type IV Fluids

One new fluid-specific table was added to the 2004-05 holdover time guidelines. The table is for Octagon Max-Flight 04, a Type IV fluid that has been certified for use in the 2004-05 winter. In addition, one Type IV fluid-specific table, Clariant Safewing Four, was removed because the fluid is no longer commercialized. Neither the removal of Clariant Safewing Four, nor the addition of Octagon Max-Flight 04 had an impact on the generic Type IV holdover guideline values.

As a result of testing with artificial snow machines, the generic Type IV value in the below -14ºC to -25ºC snow cell (15 to 30 minutes) has been applied to all fluid-specific tables for PG fluids. This change has led to a reduction in the below -14ºC to -25ºC snow cell for the following Type IV fluids: Clariant Safewing IV 1957, Clariant Safewing IV 2001, Kilfrost ABC-S, Octagon Max-Flight and SPCA AD-480.

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8. RECOMMENDATIONS

It is recommended that:

a) Any new Type I, II, III or IV fluids should be evaluated over the entire range of conditions of the holdover time tables; and

b) 75/25 and 50/50 dilutions of Type III fluid should be tested.

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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. *Ground Icing Operations Update*, Transport Canada, September 2003, TP 14052E.

3. Moc, N., *Endurance Time Testing in Snow: Comparison of Indoor and Outdoor Data for 2003-04,* APS Aviation Inc., Transportation Development Centre, Montreal, December 2004, TP 14376E, XX (to be published).

4. Chaput, M., *Development of Holdover Time Guidelines for Type III Fluids,* APS Aviation Inc., Montreal, Transportation Development Centre, November 2004, TP 14379E, 44.

5. Campbell, R*.,* Chaput, M., *Aircraft Ground De/Anti-icing Fluid Holdover Time Development Program for the 2000-01 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2001, TP 13826E, 250.

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APPENDIX A

TRANSPORTATION DEVELOPMENT CENTRE
WORK STATEMENT EXCERPT —
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2003-05

TRANSPORTATION DEVELOPMENT CENTRE
WORK STATEMENT EXCERPT —
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2003-05

5.1 Aircraft De/Anti-icing Fluid Endurance Time Testing

5.1.1 Natural Snow Tests at Dorval

a) Prepare a procedure for testing outdoors during snowfalls;

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;

c) Record individual fluid endurance times for snow, based on samples of newly certified or re-certified Type I, Type II, Type III 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 four anti-icing fluids, as well as two Type I fluids); and

d) Analyze the data collected, report the findings, and prepare presentation material.

5.1.2 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;

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;

c) Up to four Type IV and three Type III anti-icing fluids as well as two Type I fluids shall be tested;

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.

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APPENDIX B

PROCEDURES FOR HOLDOVER TIME TESTING

- Test Requirements for Simulated Freezing Precipitation Flat Plate Testing
- Test Requirements for Natural Precipitation Flat Plate Testing
- Overall Program of Tests at NRC, April 2004

TEST REQUIREMENTS
FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

CM1892.001

TEST REQUIREMENTS
FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

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

Winter 2003-04

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Richard Campbell

Reviewed by: John D'Avirro

APS Aviation Inc.

January 15, 2004
Version 1.0

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

Winter 2003-04

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

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

1. CHARACTERISTICS OF SIMULATED PRECIPITATION PRODUCED

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

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

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

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

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

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

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

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

2. DATA FORMS

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

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

Figure 2.2: General Form for Each Session at NRC;

Figure 2.3: General Form for Each Condition at NRC;

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

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

Figure 2.6: Chamber Setting for Each Condition at NRC;

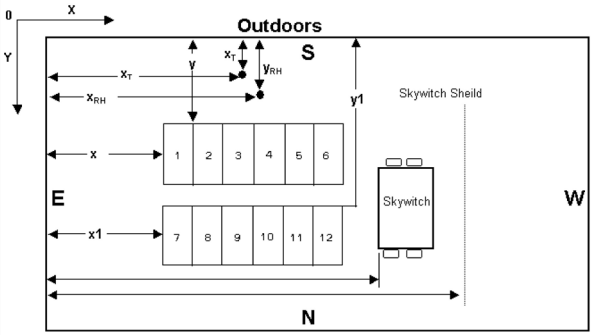
Figure 2.7: Rate Management Form at NRC, and;

Table 2.1: Condition Checklist

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

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

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



Notes:

* - "From X" refers to the distance from the East wall.

** - The nozzle should be between positions 5 and 11

RH - Relative Humidity Sensor

T - Temperature Sensor

WEIGH SCALE TECHNICIAN: _____

LEADER: _____

NEW VALUES (IF DIFFERENT)

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

Figure 2.1: Test Stand Location for Each Condition at NRC

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

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)

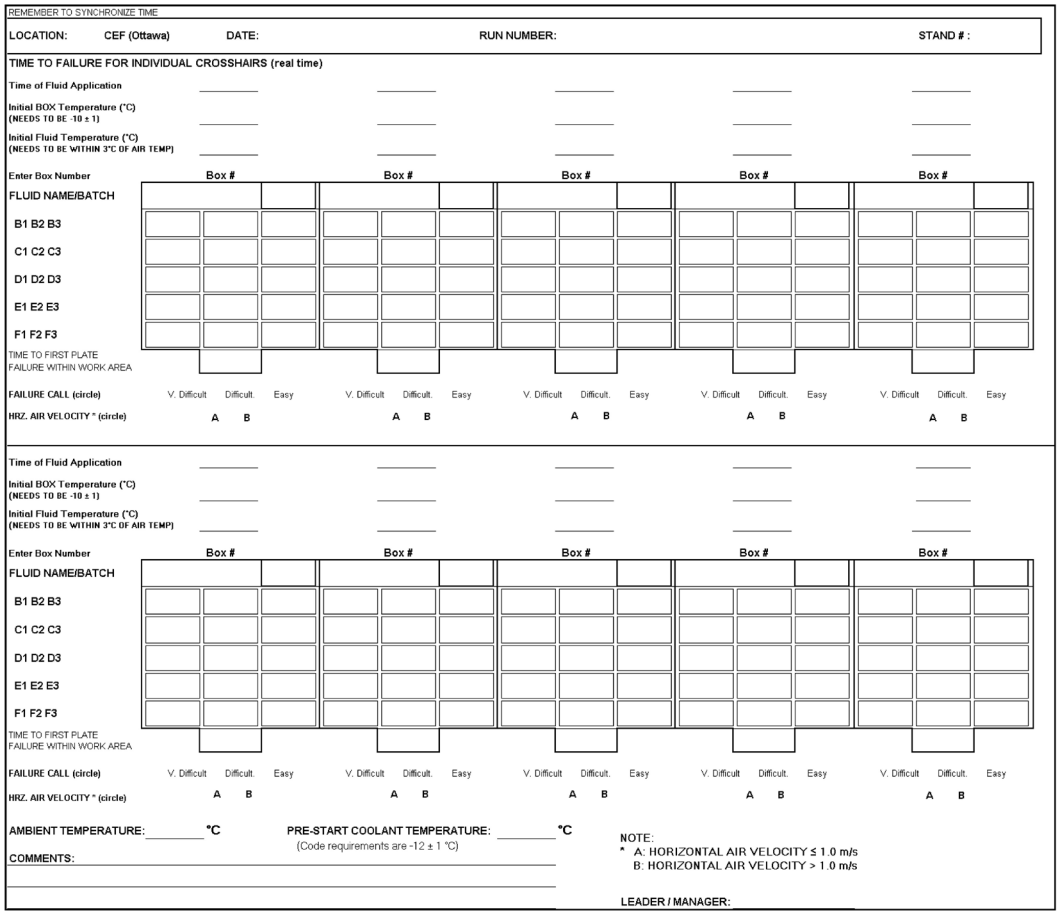
Plate Temperature (°C):
(to be recorded by APS at the end of the each condition, saved on floppy disks and included in the envelope along with the forms)
The plate temperature data is saved to the following files (provide filename and extension):

COMMENTS:

COMPUTER TECHNICIAN: _____

LEADER: _____

Figure 2.3: General Form for Each Condition at NRC



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

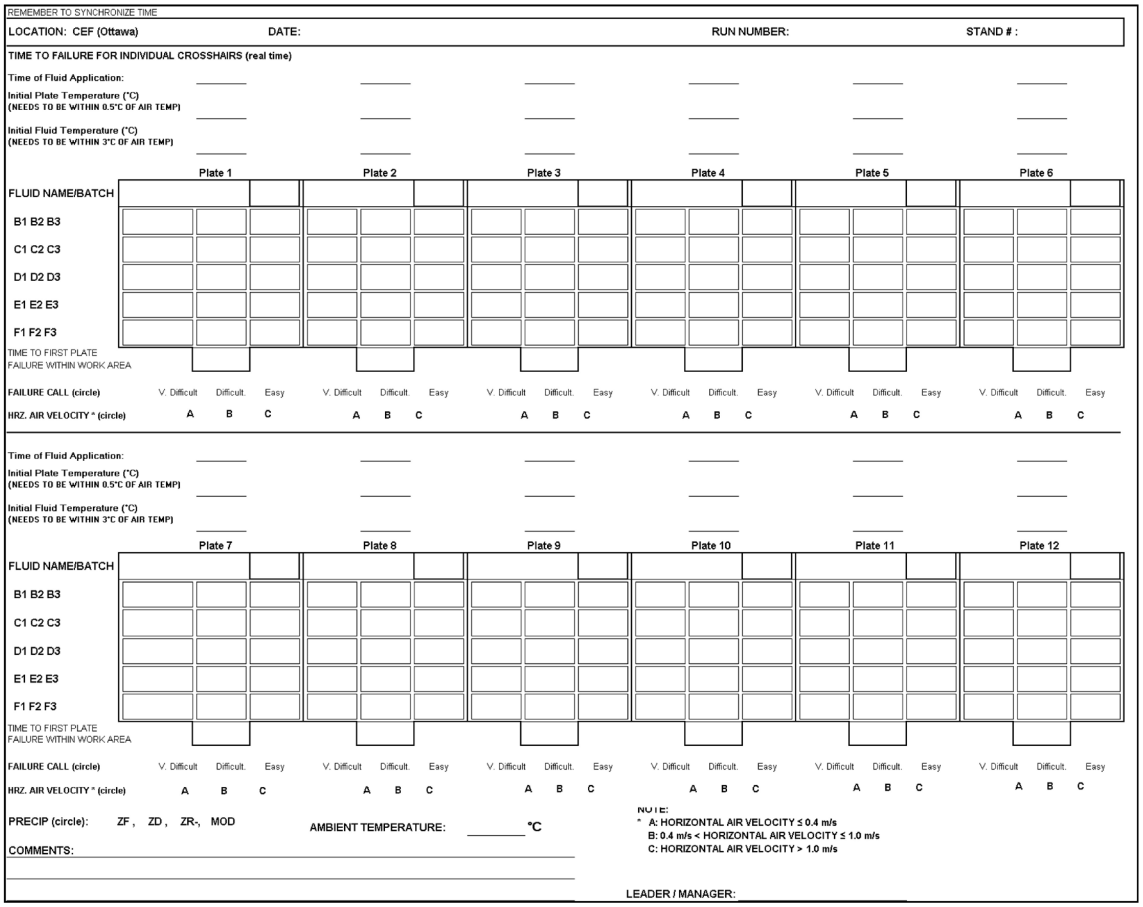
PRE-START COOLANT TEMPERATURE: _____ °C (Code requirements are -12 ± 1 °C)

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



REMEMBER TO SYNCHRONIZE TIME

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

TIME TO FAILURE FOR INDIVIDUAL CROSSHAIRS (real time)

Time of Fluid Application:

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

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

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

Time of Fluid Application:

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

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

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

PRECIP (circle): ZF , ZD , ZR-, MOD AMBIENT TEMPERATURE: _____ °C

COMMENTS:

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

LEADER / MANAGER:

Figure 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 1	2	3	4	5	6	MT'S on 1	2	3	4	5	6	Last Date
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 1	2	3	4	5	6	MT'S on 1	2	3	4	5	6	Date

COMPUTER TECHNICIAN: _____ LEADER: _____

Figure 2.6: Chamber Setting for Each Condition at NRC

RATE MANAGEMENT FORM AT NRC

CONDITION: _____

DATE: _____ WEIGH SCALE TECHNICIAN: _____

PAN #	TIME OUT	1st or 2nd Rate	TIME*	Chamber Temperature	STDEV

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

Figure 2.7: Rate Management Form at NRC

Table 2.1: Condition Checklist

Beginning of the condition

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

End of the condition

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

CO-ORDINATOR / MANAGER _____ **DATE** ___/___/_____

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TEST REQUIREMENTS
FOR NATURAL PRECIPITATION FLAT PLATE TESTING

CM1892.001

TEST REQUIREMENTS FOR NATURAL PRECIPITATION FLAT PLATE TESTING

Winter 2003-04

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Richard Campbell and Nicoara Moc

Reviewed by: Michael Chaput

APS Aviation Inc.

December 19, 2003
Version 1.0

TEST REQUIREMENTS
FOR NATURAL PRECIPITATION FLAT PLATE TESTING
2003-04

This document provides a brief summary of the test requirements and data forms needed for natural precipitation flat plate tests in the 2003-04 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.

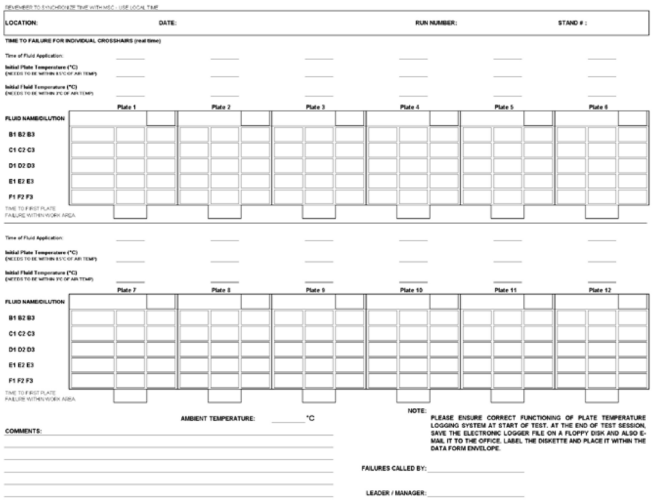
Table 1.1: Natural Snow Precipitation Test Plan New Fluids

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 and 2.2. One data form was developed for the end-condition tester (Table 2.1) and one data form for the meteo/video tester (Table 2.2).

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 ±1°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 ±1°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

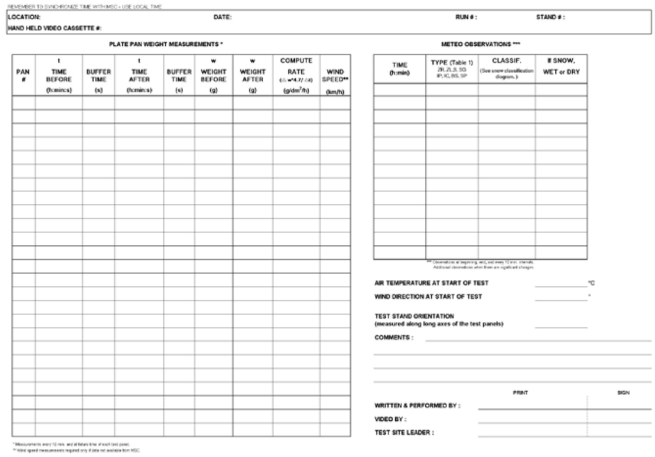
NOTE: PLEASE ENSURE CORRECT FUNCTIONING OF PLATE TEMPERATURE LOGGING SYSTEM AT START OF TEST. AT THE END OF TEST SESSION, SAVE THE ELECTRONIC LOGGER FILE ON A FLOPPY DISK AND ALSO E-MAIL IT TO THE OFFICE. LABEL THE DISKETTE AND PLACE IT WITHIN THE DATA FORM ENVELOPE.

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 (...•4 x / ...t) (g/dm²/h)	WIND SPEED** (km/h)

METEO OBSERVATIONS ***

TIME (h:min)	TYPE (Table 1) (N, ZL,S, SG, IP, IC, RS, SP	CLASSIF. (See snow classification diagram_)	If SNOW, WET or DRY

*** Observation at beginning, and intervals TO END. 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 : _____

* Measurements every 15 min. and at before time of each test panel.

** Wind speed measurement required only if data not available from MSC.

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 Tables 6.1 and 6.2, 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;
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.

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2004

CM1892.001

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2004

Winter 2003-04

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Stephanie Bendickson

Reviewed by: John D'Avirro

APS Aviation Inc.

April 15, 2004
Version 1.0

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2004

Winter 2003-04

1. INTRODUCTION

This document was prepared to bring together several projects that will be "piggy–backed" onto the endurance time of new fluids project. A tentative schedule is included in Figure 1. Tests will be conducted at the National Research Council Climactic Engineering Facility (NRC) in Ottawa from April 19th to 23rd, 2004.

2. PROJECTS, PROCEDURES AND OBJECTIVES

2.1 Endurance Times of New Fluids

The objective of these tests is to measure endurance times of new fluids. The procedure for these tests can be found in the separate procedure entitled "Test Requirements for Simulated Freezing Precipitation Flat Plate Testing" which was produced as part of the 2003-04 winter test program. The test plan is shown in Table 1.

2.2 Thickness of New Fluids

The objective of these tests is to measure thickness of new fluids on flat plates. The procedure for these tests can be found in Transport Canada Report TP 13991E, Appendix I. The test plan is shown in Table 2.

2.3 Measurement of Adherence Time

The objective of these tests is to compare adherence time to endurance time. These tests will be conducted as early as possible during each testing condition as they will be longer than the endurance time tests. For test conditions when available positions are at a premium, consider using positions outside of the stand area. The procedure for these tests can be found in the separate procedure entitled "Experimental Program: Adhesion of Aircraft De/Anti–Icing Fluids on Aluminum Surfaces" which was produced as part of the 2003-04 winter test program. Tests are included in the endurance time test plan (Table 1) and are numbered A1 to A15.

2.4 Comparison of Sensor and Human Observer Endurance Times

The objective of these tests is to compare endurance times measured by a fluid failure sensor to endurance times measured by trained personnel. The procedure for these tests can be found in the separate procedure entitled "Comparison of Endurance Times Measured by Sensor and by Trained Personnel" which was produced as part of the 2003-04 winter test program. Tests are included in the endurance time test plan (Table 1) and are numbered S1 to S28.

2.5 NCAR Snowmaker

The objective of these tests is to conduct endurance time tests of fluids in simulated snow. The procedure for these tests can be found in the separate procedure entitled "Experimental Program Fluid Endurance Time Testing With Artificial Snow" which was produced as part of the 2003-04 winter test program. Tests were conducted at the Centre de Recherche Industrielle du Quebec (CRIQ) in Montreal in March 2004. Tests that were not completed at CRIQ will be attempted at the NRC. Chamber temperatures have an influence on the tests that can be conducted. A test plan is included as Table 3.

2.6 Effect of Fluctuating Conditions on Holdover Time

The objective of this project is to repeat several tests that were conducted previously for the Civil Aviation Authority in Britain. Endurance times will be compared when plates are subjected to the following intermittent precipitation conditions:

a) Constant precipitation;

b) No precipitation for the first 20 minutes;

c) No precipitation from 20 to 40 minutes; and

d) No precipitation for the first 20 minutes or after 40 minutes to 60 minutes.

Tests will be conducted in freezing rain at a rate of 13 g/dm²/h at -3°C. Tests are included in the endurance time test plan (Table 1) and are numbered FC1 to FC8.

2.7 Other Projects

Several other smaller projects will be conducted on a time–permitting basis. These projects are described in the following subsections.

2.7.1 Droplet Size Measurements

The objective of this project is to measure the droplet size of freezing fog and freezing drizzle produced at the NRC chamber. To measure freezing fog the slide impact method with colloidal silver will be used. Aerospace Standard 5485 (Section 4.6.5b) describes the procedure. To measure freezing drizzle the dye stain method will be used. Aerospace Standard 5485 (Section 4.6.5d) describes the procedure. Measurements can be taken at any temperature and precipitation rate in freezing fog and at a rate of 5 g/dm²/h in freezing drizzle.

2.7.2 Residual Ice Characteristics

Experimental work will be conducted under the guidance of representatives from Transportation Development Canada (TDC). The objective of this work is to find out if the roughness of contamination decreases with the application of Type I fluid, and if so by how much.

This work could be carried out by creating contamination on a box and subjecting it to Type I fluid. The contamination could be simulated by applying natural or artificial snow or man–made ice to a box and leaving it at a cold temperature to adhere. After the surface is prepared, the height and characteristics of the contamination would be measured and Type I fluid would be applied with a spreader. Following application, the height and characteristics of the contamination would again be measured.

2.7.3 Polished Surfaces

The objective of this project is to study the effect of test plate surface roughness on the effectiveness of Type I wetting and on the endurance times of Type I and II fluids. The procedure and test plan for these tests can be found in the separate procedure entitled "Exploratory Research on the Effect of Test Surface Roughness on Type I/IV Fluid Properties" which was produced as part of the 2003-04 winter test program.

2.7.4 Drip Rates (Separate Contract)

Tests will be conducted for a separate Transport Canada contract during this test session. The tests are described in a separate procedure. The tests are included here in order to show how they fit in the test schedule. Tests are included in the endurance time test plan (Table 1) and are numbered DR1 to DR26.

3. PERSONNEL REQUIREMENTS

See Table 4 for details of personnel.

1. Endurance Times of New Fluids: MC and HOT team
2. Thickness of New Fluids: NM/SB
3. Measurement of Adherence Time: NM/SB and HOT team
4. Comparison of Sensor and Human Observer Endurance Times: SB and HOT team
5. NCAR Snowmaker: RC
6. Effect of Fluctuating Conditions on Holdover Time: JD and HOT team
7. Other Projects:
   - Droplet Size Measurements: NM
   - Residual Ice Characteristics: NM with BM/FE
   - Polished Surfaces: SC
   - Drip Rates (separate contract): NM/SB and HOT Team

HOT Team:

- MC: manager/failure call
- CM: rate management
- DY: rates

4. FLUIDS

The required fluids and fluid quantities are shown in Table 5. NCAR snowmaker fluids were prepared for previous testing at CRIQ and are not included here.

5. EQUIPMENT (ONLY LISTED IF SPECIAL REQUIREMENTS THAT DEVIATE FROM THE STANDARD ENDURANCE TIME TESTS)

A detailed list of equipment to bring from Montreal to the NRC is shown in Table 6. Three data loggers and one interface are required. Two additional loggers and one additional interface are required as backup.

1. Endurance Times of New Fluids: The equipment required for these tests can be found in Transport Canada Report TP 13991E, Appendix C;
2. Thickness of New Fluids: See separate procedure;

3. Measurement of Adherence Time: See separate procedure;
4. Comparison of Sensor and Human Observer Endurance Times: See separate procedure;
5. NCAR Snowmaker: See separate procedure;
6. Effect of Fluctuating Conditions on Holdover Time: Plate cover extenders; and
7. Other Projects:
   - Droplet Size Measurements: Microscope, colloidal silver, microscope slides, metal blue, felt paper discs, disc holder.
   - Residual Ice Characteristics: two boxes, ice cube trays.
   - Polished Surfaces: Polished aluminum plate.
   - Drip Rates (separate contract): Thickness gauges and brixometers.

6. DATA FORMS

1. Endurance Times of New Fluids: The forms required for these tests can be found in Transport Canada Report TP 13991E, Appendix C;
2. Thickness of New Fluids: See separate procedure;
3. Measurement of Adherence Time: See separate procedure;
4. Comparison of Sensor and Human Observer Endurance Times: See separate procedure;
5. NCAR Snowmaker: See separate procedure;
6. Effect of Fluctuating Conditions on Holdover Time: Standard endurance time forms will be used; and
7. Other Projects:
   - Droplet Size Measurements: Not required.
   - Residual Ice Characteristics: See Figure 2.
   - Polished Surfaces: See separate procedure.
   - Drip Rates (separate contract): See separate procedure.

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 issues.

1. Review MSDS sheets for fluids;
2. Waterproof clothing and gloves are available;
3. Care should be taken when circulating near test stand due to slipperiness;
4. First aid kit, water and fire extinguisher are available at NRC; and
5. Follow all NRC safety guidelines.

8. PRE–TEST SET–UP ACTIVITIES

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

1. Mark plates;
2. Mark boxes;
3. Ensure plates are equipped with operational and verified thermistors;
4. Ensure boxes (for adherence tests) are equipped with operational and verified thermistors;
5. 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);
6. Determine number of loggers required (loggers are on stands already);
7. Install software on rate desktop PC and on backup laptop;
8. Prepare PC for logging plate temperatures;
9. Ensure fluids are prepared in advance (see Table 5);
10. Empty 1 Litre containers must be labelled and cleaned for pouring;
11. Rate pans must be checked: 4 sets for each #1-12, check for holes, check properly labelled;
12. Ensure plate covers are adequate for fluctuating conditions tests;
13. Ensure barrels are put on “horses” (at site to facilitate fluid pouring); and
14. Build new shelving unit.

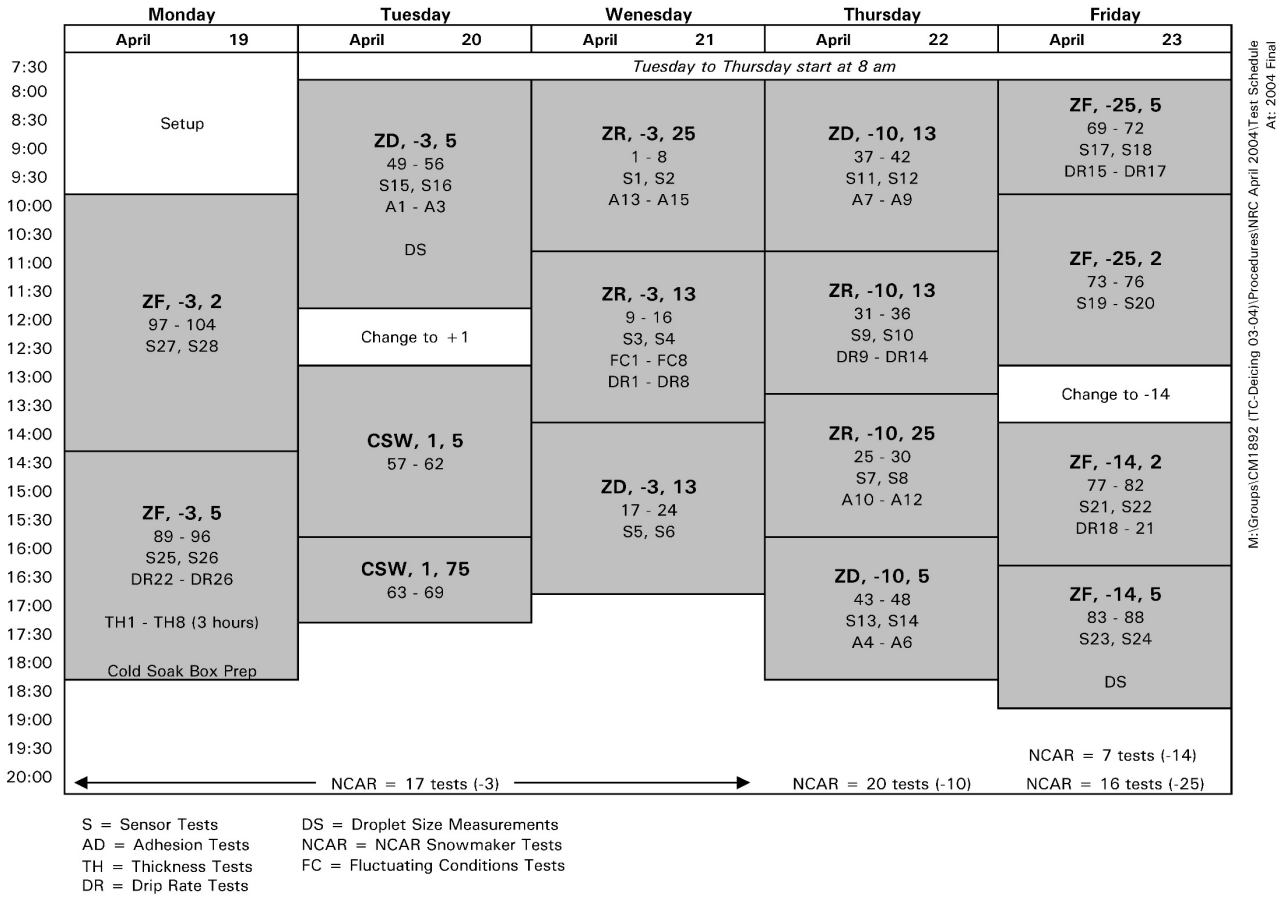
The following items should be purchased prior to arrival at the NRC:

1. Ice melt (NRC standard) – 10 bags;
2. Squeegees;
3. Batteries: AA, AAA, D and 9 V;
4. Paper towels;

5. Pour bottles;
6. White gloves (3 packs of 10);
7. Scrapers;
8. Isopropyl;
9. Duct tape (3 rolls);
10. Butterfly bolts;
11. Methylene blue;
12. Colloidal silver);
13. Shelving unit (70 x 36 x 13″); and
14. Ziploc bags (18″).

A schematic of the NRC equipment layout is shown in Figure 3.

FIGURE 1: TEST SCHEDULE



S = Sensor Tests
AD = Adhesion Tests
TH = Thickness Tests
DR = Drip Rate Tests
DS = Droplet Size Measurements
NCAR = NCAR Snowmaker Tests
FC = Fluctuating Conditions Tests

TABLE 1: DETAILED ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution or BRIX	Test Surface	Comments
1	Light Freezing Rain	-3	25	Kilfrost P1491 (LV)	100	Plates	
2	Light Freezing Rain	-3	25	Kilfrost P1491 (LV)	100	Plates	
3	Light Freezing Rain	-3	25	Kilfrost P1491 (LV)	75	Plates	
4	Light Freezing Rain	-3	25	Kilfrost P1491 (LV)	75	Plates	
5	Light Freezing Rain	-3	25	Kilfrost P1491 (LV)	50	Plates	
6	Light Freezing Rain	-3	25	Kilfrost P1491 (LV)	50	Plates	
7	Light Freezing Rain	-3	25	Clariant Safewing MP III 2031 ECO	100	Plates	
8	Light Freezing Rain	-3	25	Clariant Safewing MP III 2031 ECO	100	Plates	
9	Light Freezing Rain	-3	13	Kilfrost P1491 (LV)	100	Plates	
10	Light Freezing Rain	-3	13	Kilfrost P1491 (LV)	100	Plates	
11	Light Freezing Rain	-3	13	Kilfrost P1491 (LV)	75	Plates	
12	Light Freezing Rain	-3	13	Kilfrost P1491 (LV)	75	Plates	
13	Light Freezing Rain	-3	13	Kilfrost P1491 (LV)	50	Plates	
14	Light Freezing Rain	-3	13	Kilfrost P1491 (LV)	50	Plates	
15	Light Freezing Rain	-3	13	Clariant Safewing MP III 2031 ECO	100	Plates	
16	Light Freezing Rain	-3	13	Clariant Safewing MP III 2031 ECO	100	Plates	
17	Freezing Drizzle	-3	13	Kilfrost P1491 (LV)	100	Plates	
18	Freezing Drizzle	-3	13	Kilfrost P1491 (LV)	100	Plates	
19	Freezing Drizzle	-3	13	Kilfrost P1491 (LV)	75	Plates	
20	Freezing Drizzle	-3	13	Kilfrost P1491 (LV)	75	Plates	
21	Freezing Drizzle	-3	13	Kilfrost P1491 (LV)	50	Plates	
22	Freezing Drizzle	-3	13	Kilfrost P1491 (LV)	50	Plates	
23	Freezing Drizzle	-3	13	Clariant Safewing MP III 2031 ECO	100	Plates	
24	Freezing Drizzle	-3	13	Clariant Safewing MP III 2031 ECO	100	Plates	
25	Light Freezing Rain	-10	25	Kilfrost P1491 (LV)	100	Plates	
26	Light Freezing Rain	-10	25	Kilfrost P1491 (LV)	100	Plates	
27	Light Freezing Rain	-10	25	Kilfrost P1491 (LV)	75	Plates	
28	Light Freezing Rain	-10	25	Kilfrost P1491 (LV)	75	Plates	
29	Light Freezing Rain	-10	25	Clariant Safewing MP III 2031 ECO	100	Plates	
30	Light Freezing Rain	-10	25	Clariant Safewing MP III 2031 ECO	100	Plates	
31	Light Freezing Rain	-10	13	Kilfrost P1491 (LV)	100	Plates	
32	Light Freezing Rain	-10	13	Kilfrost P1491 (LV)	100	Plates	
33	Light Freezing Rain	-10	13	Kilfrost P1491 (LV)	75	Plates	
34	Light Freezing Rain	-10	13	Kilfrost P1491 (LV)	75	Plates	
35	Light Freezing Rain	-10	13	Clariant Safewing MP III 2031 ECO	100	Plates	
36	Light Freezing Rain	-10	13	Clariant Safewing MP III 2031 ECO	100	Plates	
37	Freezing Drizzle	-10	13	Kilfrost P1491 (LV)	100	Plates	
38	Freezing Drizzle	-10	13	Kilfrost P1491 (LV)	100	Plates	
39	Freezing Drizzle	-10	13	Kilfrost P1491 (LV)	75	Plates	
40	Freezing Drizzle	-10	13	Kilfrost P1491 (LV)	75	Plates	
41	Freezing Drizzle	-10	13	Clariant Safewing MP III 2031 ECO	100	Plates	
42	Freezing Drizzle	-10	13	Clariant Safewing MP III 2031 ECO	100	Plates	
43	Freezing Drizzle	-10	5	Kilfrost P1491 (LV)	100	Plates	
44	Freezing Drizzle	-10	5	Kilfrost P1491 (LV)	100	Plates	
45	Freezing Drizzle	-10	5	Kilfrost P1491 (LV)	75	Plates	
46	Freezing Drizzle	-10	5	Kilfrost P1491 (LV)	75	Plates	
47	Freezing Drizzle	-10	5	Clariant Safewing MP III 2031 ECO	100	Plates	
48	Freezing Drizzle	-10	5	Clariant Safewing MP III 2031 ECO	100	Plates	
49	Freezing Drizzle	-3	5	Kilfrost P1491 (LV)	100	Plates	
50	Freezing Drizzle	-3	5	Kilfrost P1491 (LV)	100	Plates	
51	Freezing Drizzle	-3	5	Kilfrost P1491 (LV)	75	Plates	
52	Freezing Drizzle	-3	5	Kilfrost P1491 (LV)	75	Plates	
53	Freezing Drizzle	-3	5	Kilfrost P1491 (LV)	50	Plates	
54	Freezing Drizzle	-3	5	Kilfrost P1491 (LV)	50	Plates	
55	Freezing Drizzle	-3	5	Clariant Safewing MP III 2031 ECO	100	Plates	
56	Freezing Drizzle	-3	5	Clariant Safewing MP III 2031 ECO	100	Plates	
57	Cold Soak Box	1	5	Kilfrost P1491 (LV)	100	Box	
58	Cold Soak Box	1	5	Kilfrost P1491 (LV)	100	Box	
59	Cold Soak Box	1	5	Kilfrost P1491 (LV)	75	Box	
60	Cold Soak Box	1	5	Kilfrost P1491 (LV)	75	Box	
61	Cold Soak Box	1	5	Clariant Safewing MP III 2031 ECO	100	Box	
62	Cold Soak Box	1	5	Clariant Safewing MP III 2031 ECO	100	Box	

TABLE 1: DETAILED ENDURANCE TIME TEST PLAN (continued)

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution or BRIX	Test Surface	Comments
63	Cold Soak Box	1	75	Kilfrost P1491 (LV)	100	Box	
64	Cold Soak Box	1	75	Kilfrost P1491 (LV)	100	Box	
65	Cold Soak Box	1	75	Kilfrost P1491 (LV)	75	Box	
66	Cold Soak Box	1	75	Kilfrost P1491 (LV)	75	Box	
67	Cold Soak Box	1	75	Clariant Safewing MP III 2031 ECO	100	Box	
68	Cold Soak Box	1	75	Clariant Safewing MP III 2031 ECO	100	Box	
69	Freezing Fog	-25	5	Kilfrost P1491 (LV)	100	Plates	
70	Freezing Fog	-25	5	Kilfrost P1491 (LV)	100	Plates	
71	Freezing Fog	-25	5	Clariant Safewing MP III 2031 ECO	100	Plates	
72	Freezing Fog	-25	5	Clariant Safewing MP III 2031 ECO	100	Plates	
73	Freezing Fog	-25	2	Kilfrost P1491 (LV)	100	Plates	
74	Freezing Fog	-25	2	Kilfrost P1491 (LV)	100	Plates	
75	Freezing Fog	-25	2	Clariant Safewing MP III 2031 ECO	100	Plates	
76	Freezing Fog	-25	2	Clariant Safewing MP III 2031 ECO	100	Plates	
77	Freezing Fog	-14	2	Kilfrost P1491 (LV)	100	Plates	
78	Freezing Fog	-14	2	Kilfrost P1491 (LV)	100	Plates	
79	Freezing Fog	-14	2	Kilfrost P1491 (LV)	75	Plates	
80	Freezing Fog	-14	2	Kilfrost P1491 (LV)	75	Plates	
81	Freezing Fog	-14	2	Clariant Safewing MP III 2031 ECO	100	Plates	
82	Freezing Fog	-14	2	Clariant Safewing MP III 2031 ECO	100	Plates	
83	Freezing Fog	-14	5	Kilfrost P1491 (LV)	100	Plates	
84	Freezing Fog	-14	5	Kilfrost P1491 (LV)	100	Plates	
85	Freezing Fog	-14	5	Kilfrost P1491 (LV)	75	Plates	
86	Freezing Fog	-14	5	Kilfrost P1491 (LV)	75	Plates	
87	Freezing Fog	-14	5	Clariant Safewing MP III 2031 ECO	100	Plates	
88	Freezing Fog	-14	5	Clariant Safewing MP III 2031 ECO	100	Plates	
89	Freezing Fog	-3	5	Kilfrost P1491 (LV)	100	Plates	
90	Freezing Fog	-3	5	Kilfrost P1491 (LV)	100	Plates	
91	Freezing Fog	-3	5	Kilfrost P1491 (LV)	75	Plates	
92	Freezing Fog	-3	5	Kilfrost P1491 (LV)	75	Plates	
93	Freezing Fog	-3	5	Kilfrost P1491 (LV)	50	Plates	
94	Freezing Fog	-3	5	Kilfrost P1491 (LV)	50	Plates	
95	Freezing Fog	-3	5	Clariant Safewing MP III 2031 ECO	100	Plates	
96	Freezing Fog	-3	5	Clariant Safewing MP III 2031 ECO	100	Plates	
97	Freezing Fog	-3	2	Kilfrost P1491 (LV)	100	Plates	
98	Freezing Fog	-3	2	Kilfrost P1491 (LV)	100	Plates	
99	Freezing Fog	-3	2	Kilfrost P1491 (LV)	75	Plates	
100	Freezing Fog	-3	2	Kilfrost P1491 (LV)	75	Plates	
101	Freezing Fog	-3	2	Kilfrost P1491 (LV)	50	Plates	
102	Freezing Fog	-3	2	Kilfrost P1491 (LV)	50	Plates	
103	Freezing Fog	-3	2	Clariant Safewing MP III 2031 ECO	100	Plates	
104	Freezing Fog	-3	2	Clariant Safewing MP III 2031 ECO	100	Plates	
S1	Light Freezing Rain	-3	25	Ultra+	100	Sensor Plates	
S2	Light Freezing Rain	-3	25	Ultra+	100	Sensor Plates	
S3	Light Freezing Rain	-3	13	Kilfrost P1491	50	Sensor Plates	
S4	Light Freezing Rain	-3	13	Kilfrost P1491	75	Sensor Plates	
S7	Light Freezing Rain	-10	25	Octagon Maxflight	75	Sensor Plates	
S8	Light Freezing Rain	-10	25	Octagon Maxflight	100	Sensor Plates	
S9	Light Freezing Rain	-10	13	Type I PG	10°buffer	Sensor Plates	
S10	Light Freezing Rain	-10	13	Type I PG	10°buffer	Sensor Plates	
S5	Freezing Drizzle	-3	13	Octagon Maxflight	50	Sensor Plates	
S6	Freezing Drizzle	-3	13	Octagon Maxflight	100	Sensor Plates	
S11	Freezing Drizzle	-10	13	Ultra+	100	Sensor Plates	
S12	Freezing Drizzle	-10	13	Ultra+	100	Sensor Plates	
S13	Freezing Drizzle	-10	5	Kilfrost P1491	50	Sensor Plates	
S14	Freezing Drizzle	-10	5	Kilfrost P1491	75	Sensor Plates	
S15	Freezing Drizzle	-3	5	Type I PG	10°buffer	Sensor Plates	
S16	Freezing Drizzle	-3	5	Type I PG	10°buffer	Sensor Plates	
S17	Freezing Fog	-25	5	Octagon Maxflight	100	Sensor Plates	
S18	Freezing Fog	-25	5	Octagon Maxflight	100	Sensor Plates	
S19	Freezing Fog	-25	2	Ultra+	100	Sensor Plates	
S20	Freezing Fog	-25	2	Ultra+	100	Sensor Plates	

TABLE 1: DETAILED ENDURANCE TIME TEST PLAN (continued)

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution or BRIX	Test Surface	Comments
S21	Freezing Fog	-14	2	Kilfrost P1491	100	Sensor Plates	
S22	Freezing Fog	-14	2	Kilfrost P1491	75	Sensor Plates	
S23	Freezing Fog	-14	5	Ultra+	100	Sensor Plates	
S24	Freezing Fog	-14	5	Ultra+	100	Sensor Plates	
S25	Freezing Fog	-3	5	Octagon Maxflight	75	Sensor Plates	
S26	Freezing Fog	-3	5	Octagon Maxflight	50	Sensor Plates	
S27	Freezing Fog	-3	2	Type I PG	10%buff	Sensor Plates	
S28	Freezing Fog	-3	2	Type I PG	10%buff	Sensor Plates	
A1	Freezing Drizzle	-3	5	Octagon Maxflight	100	Plate	
A2	Freezing Drizzle	-3	5	Kilfrost ABC 2000	100	Plate	
A3	Freezing Drizzle	-3	5	Clariant Safewing MP III 2031	100	Plate	
A4	Freezing Drizzle	-10	5	Octagon Maxflight	100	Plate	
A5	Freezing Drizzle	-10	5	Kilfrost ABC 2000	100	Plate	
A6	Freezing Drizzle	-10	5	Clariant Safewing MP III 2031	100	Plate	
A7	Freezing Drizzle	-10	13	Octagon Maxflight	100	Plate	
A8	Freezing Drizzle	-10	13	Kilfrost ABC 2000	100	Plate	
A9	Freezing Drizzle	-10	13	Clariant Safewing MP III 2031	100	Plate	
A10	Light Freezing Rain	-10	25	Octagon Maxflight	100	Plate	
A11	Light Freezing Rain	-10	25	Kilfrost ABC 2000	100	Plate	
A12	Light Freezing Rain	-10	25	Clariant Safewing MP III 2031	100	Plate	
A13	Light Freezing Rain	-3	25	Octagon Maxflight	100	Plate	
A14	Light Freezing Rain	-3	25	Kilfrost ABC 2000	100	Plate	
A15	Light Freezing Rain	-3	25	Clariant Safewing MP III 2031	100	Plate	
FC1	Freezing Drizzle	-3	13	Kilfrost P1491	100	Plates	
FC2	Freezing Drizzle	-3	13	Kilfrost P1491	75	Plates	
FC3	Freezing Drizzle	-3	13	Kilfrost P1491	100	Plates	Cover from T=0 to T=20
FC4	Freezing Drizzle	-3	13	Kilfrost P1491	75	Plates	Cover from T=0 to T=20
FC5	Freezing Drizzle	-3	13	Kilfrost P1491	100	Plates	Cover from T=20 to T=40
FC6	Freezing Drizzle	-3	13	Kilfrost P1491	75	Plates	Cover from T=20 to T=40
FC7	Freezing Drizzle	-3	13	Kilfrost P1491	100	Plates	Cover from T=0 to T=20 and from T=40 to T=60
FC8	Freezing Drizzle	-3	13	Kilfrost P1491	75	Plates	Cover from T=0 to T=20 and from T=40 to T=60
DR1	Freezing Drizzle	-3	13	Clariant Safewing MP III 2031 ECO	100	Plates	
DR2	Freezing Drizzle	-3	13	UCAR Ultra+	100	Plates	
DR3	Freezing Drizzle	-3	13	Octagon Maxflight	100	Plates	
DR4	Freezing Drizzle	-3	13	Kilfrost ABC 2000	50	Plates	
DR5	Freezing Drizzle	-3	13	Octagon Maxflight	75	Plates	Lower priority
DR6	Freezing Drizzle	-3	13	Kilfrost ABC 2000	50	Plates	25° slope, lower priority
DR7	Freezing Drizzle	-3	13	UCAR Ultra+	100	Plates	25° slope, lower priority
DR8	Freezing Drizzle	-3	13	Octagon Maxflight	100	Plates	25° slope, lower priority
DR9	Light Freezing Rain	-10	13	Clariant Safewing MP III 2031 ECO	100	Plates	
DR10	Light Freezing Rain	-10	13	UCAR Ultra+	100	Plates	
DR11	Light Freezing Rain	-10	13	Octagon Maxflight	100	Plates	
DR12	Light Freezing Rain	-10	13	Octagon Maxflight	75	Plates	Lower priority
DR13	Light Freezing Rain	-10	13	UCAR Ultra+	100	Plates	25° slope, lower priority
DR14	Light Freezing Rain	-10	13	Octagon Maxflight	100	Plates	25° slope, lower priority
DR15	Freezing Fog	-25	5	Clariant Safewing MP III 2031 ECO	100	Plates	DR15 to DR17 can be conducted at rate = 2
DR16	Freezing Fog	-25	5	UCAR Ultra+	100	Plates	DR15 to DR17 can be conducted at rate = 2
DR17	Freezing Fog	-25	5	Octagon Maxflight	100	Plates	DR15 to DR17 can be conducted at rate = 2
DR18	Freezing Fog	-14	2	Clariant Safewing MP III 2031 ECO	100	Plates	DR18 to DR21 can be conducted at rate = 5
DR19	Freezing Fog	-14	2	UCAR Ultra+	100	Plates	DR18 to DR21 can be conducted at rate = 5
DR20	Freezing Fog	-14	2	Octagon Maxflight	100	Plates	DR18 to DR21 can be conducted at rate = 5
DR21	Freezing Fog	-14	2	Octagon Maxflight	75	Plates	DR18 to DR21 can be conducted at rate = 5
DR22	Freezing Fog	-3	5	Clariant Safewing MP III 2031 ECO	100	Plates	DR22 to DR26 can be conducted at rate = 2
DR23	Freezing Fog	-3	5	UCAR Ultra+	100	Plates	DR22 to DR26 can be conducted at rate = 2
DR24	Freezing Fog	-3	5	Octagon Maxflight	100	Plates	DR22 to DR26 can be conducted at rate = 2
DR25	Freezing Fog	-3	5	Kilfrost ABC 2000	50	Plates	DR22 to DR26 can be conducted at rate = 2
DR26	Freezing Fog	-3	5	Octagon Maxflight	75	Plates	DR22 to DR26 can be conducted at rate = 2

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At: ET

TABLE 2: TEST PLAN – THICKNESS

Test #	Fluid Manufacturers	Brand Name	Fluid Dilution	Outside Air Temperature
TH1	Kilfrost	Kilfrost P1491 (LV)	Neat	-3
TH2	Kilfrost	Kilfrost P1491 (LV)	Neat	-3
TH3	Kilfrost	Kilfrost P1491 (LV)	75/25	-3
TH4	Kilfrost	Kilfrost P1491 (LV)	75/25	-3
TH5	Kilfrost	Kilfrost P1491 (LV)	50/50	-3
TH6	Kilfrost	Kilfrost P1491 (LV)	50/50	-3
TH7	Clariant	MP III 2031	Neat	-3
TH8	Clariant	MP III 2031	Neat	-3

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

M:\Groups\Cm1892\Procedures\NRC April 2004\Detailed Test Log
At:Thickness

TABLE 3: TEST PLAN - NCAR SNOWMAKER

	Test No.	Fluid Dilution	Fluid Name	Outdoor Endurance Time (min)	Indoor Endurance Time (min)	Outdoor/Set Icing Intensity ±0.1 (g/dm²/h)	MSC Temp (°C)	Fluid Set Temp (°C)	Room Set Temp ±1.0 (°C)	Plate Set Temp ±0.1 (°C)	NRC Chamber Temp ±0.1 (°C)	Priority
	25C 4	Neat	KILFROST ABC-S	15		25.0	-25.0	-27.1	-29.1	-27.1	-25.0	2
	25C 28	Neat	Clariant Safewing Protect 2012	15		25.0	-25.0	-27.1	-29.1	-27.1	-25.0	2
	25C 24	Neat	KILFROST ABC-II PLUS	15		25.0	-25.0	-27.1	-29.1	-27.1	-25.0	2
	25C 40	Neat	Kilfrost ABC 2000	15		25.0	-25.0	-27.1	-29.1	-27.1	-25.0	2
	25C 44	Neat	C 2025 ECO	15		25.0	-25.0	-27.1	-29.1	-27.1	-25.0	2
	25C 48	Neat	C 2030 ECO	15		25.0	-25.0	-27.1	-29.1	-27.1	-25.0	2
	25C 2	Neat	KILFROST ABC-S	30		10.0	-25.0	-26.2	-28.2	-26.2	-25.0	2
	25C 6	Neat	UCAR ULTRA +	30		10.0	-25.0	-26.2	-28.2	-26.2	-25.0	3
	25C 26	Neat	Clariant Safewing Protect 2012	30		10.0	-25.0	-26.2	-28.2	-26.2	-25.0	3
	25C 22	Neat	KILFROST ABC-II PLUS	30		10.0	-25.0	-26.2	-28.2	-26.2	-25.0	3
	25C 38	Neat	Kilfrost ABC 2000	30		10.0	-25.0	-26.2	-28.2	-26.2	-25.0	3
New fluids @ -25°C	25C 200	Neat	Kilfrost P1491	16		10.0	-25.0	-26.2	-28.2	-26.2	-25.0	1
	25C 201	Neat	Clariant 2031	9		25.0	-18.0	-20.1	-22.1	-20.1	-25.0	1
	25C 202	Neat	Clariant 2031	9		25.0	-18.0	-20.1	-22.1	-20.1	-25.0	1
	25C 203	Neat	Clariant 2031	17		10.0	-18.0	-19.2	-21.2	-19.2	-25.0	1
	25C 204	Neat	Clariant 2031	17		10.0	-18.0	-19.2	-21.2	-19.2	-25.0	1
Outliers	RR 11	Neat	UCAR ULTRA +	79	126.0	8.2	-12.3	-13.3	-15.3	-13.3	-14.0	1
	RR 38	Neat	CLARIANT 2001	30	16.7	37.0	-11.6	-14.5	-16.5	-14.5	-14.0	1
	RR 44	75%	KILFROST ABC-II PLUS	51		6.3	-13.3	-14.2	-16.2	-14.2	-14.0	2
	RR 8	Neat	KILFROST ABC-S	122		4.8	-12.9	-13.7	-15.7	-13.7	-14.0	2
	RR 43	75%	KILFROST ABC-II PLUS	29		7.1	-12.6	-13.6	-15.6	-13.6	-14.0	1
	RR 12	Neat	UCAR ULTRA +	94		5.4	-12.4	-13.3	-15.3	-13.3	-14.0	2
	RR 5	75%	KILFROST ABC-S	71		7.5	-12.2	-13.2	-15.2	-13.2	-14.0	2
	RR 73	75%	Kilfrost ABC 2000	48		10.6	-9.3	-10.5	-12.5	-10.5	-10.0	1
	RR 76	Neat	Kilfrost ABC 2000	58		8.5	-9.0	-10.1	-12.1	-10.1	-10.0	2
	RR 4	75%	KILFROST ABC-S	82		6.0	-7.6	-8.5	-10.5	-8.5	-10.0	2
	RR 3	75%	KILFROST ABC-S	88		5.7	-7.6	-8.5	-10.5	-8.5	-10.0	2
	RR 45	75%	KILFROST ABC-II PLUS	71		4.5	-7.4	-8.2	-10.2	-8.2	-10.0	2
	RR 74	75%	Kilfrost ABC 2000	47		15.4	-6.0	-7.5	-9.5	-7.5	-10.0	1
	RR 2	75%	KILFROST ABC-S	45		12.5	-5.5	-6.8	-8.8	-6.8	-10.0	1
	RR 42	75%	KILFROST ABC-II PLUS	56		6.9	-5.5	-6.5	-8.5	-6.5	-10.0	1
	RR 72	50%	Kilfrost ABC 2000	10.5		26.3	-2.9	-5.1	-7.1	-5.1	-10.0	1
	RR 40	50%	KILFROST ABC-II PLUS	13		28.4	-1.7	-4.1	-6.1	-4.1	-10.0	1
	RR 1	50%	KILFROST ABC-S	9		28.4	-1.7	-4.1	-6.1	-4.1	-10.0	1
	RR 47	Neat	KILFROST ABC-II PLUS	34		25.2	-1.8	-4.0	-6.0	-4.0	-10.0	2
	RR 6	75%	KILFROST ABC-S	34		23.1	-1.8	-3.8	-5.8	-3.8	-10.0	2
RR for new fluids	RR 200	Neat	Kilfrost P1491	30.5		6.1	-7.9	-8.8	-10.8	-8.8	-10.0	1
	RR 201	75%	Kilfrost P1491	31.8		5.4	-8.0	-8.9	-10.9	-8.9	-10.0	1
	RR 202	75%	Kilfrost P1491	46		5.5	-5.0	-5.9	-7.9	-5.9	-10.0	2
	RR 203	Neat	Clariant 2031	31		4.6	-7.9	-8.7	-10.7	-8.7	-10.0	1
	RR 204	Neat	Clariant 2031	23.3		7.3	-8.0	-9.0	-11.0	-9.0	-10.0	2
Outliers	RR 18	75%	Octagon Maxflight	102	50.1	11.8	-8.6	-9.9	-11.9	-9.9	-10.0	1
	RR 36	Neat	CLARIANT 2001	51	20 (fluid lumpy)	22.3	-6.4	-8.4	-10.4	-8.4	-10.0	2
	RR 75	75%	Kilfrost ABC 2000	40		23.2	-0.9	-2.9	-4.9	-2.9	-3.0	2
	RR 41	50%	KILFROST ABC-II PLUS	41		6.6	-1.7	-2.7	-4.7	-2.7	-3.0	2
	RR 10	Neat	UCAR ULTRA +	52		14.9	-0.9	-2.4	-4.4	-2.4	-3.0	1
Variance	RR 32	50%	CLARIANT 2001	29	32.6	4.7	-2.7	-3.5	-5.5	-3.5	-3.0	1
	RR 32	50%	CLARIANT 2001	29	32.6	4.7	-2.7	-3.5	-5.5	-3.5	-3.0	1
	RR 32	50%	CLARIANT 2001	29	32.6	4.7	-2.7	-3.5	-5.5	-3.5	-3.0	1
	RR 32	50%	CLARIANT 2001	29	32.6	4.7	-2.7	-3.5	-5.5	-3.5	-3.0	1
	RR 13	Neat	UCAR ULTRA +	37	29.0	25.6	-1.8	-4.0	-6.0	-4.0	-3.0	1
	RR 13	Neat	UCAR ULTRA +	37	29.0	25.6	-1.8	-4.0	-6.0	-4.0	-3.0	1
	RR 13	Neat	UCAR ULTRA +	37	29.0	25.6	-1.8	-4.0	-6.0	-4.0	-3.0	1
	RR 13	Neat	UCAR ULTRA +	37	29.0	25.6	-1.8	-4.0	-6.0	-4.0	-3.0	1
RR for new fluids	RR 205	Neat	Kilfrost P1491	35		12.1	-1.0	-2.3	-4.3	-2.3	-3.0	2
	RR 206	Neat	Kilfrost P1491	62.5		4.0	-3.2	-4.0	-6.0	-4.0	-3.0	2
	RR 207	75%	Kilfrost P1491	25.5		12.0	-1.0	-2.3	-4.3	-2.3	-3.0	2
	RR 208	50%	Kilfrost P1491	14		17.4	-2.0	-3.6	-5.6	-3.6	-3.0	2
	RR 209	50%	Kilfrost P1491	30		5.7	-2.0	-2.9	-4.9	-2.9	-3.0	2
	RR 210	Neat	Clariant 2031	14.8		17.1	-2.0	-3.6	-5.6	-3.6	-3.0	2

M:\Groups\CM1892 (TC-Deicing 03-04)\Procedures\NRC April 2004\NCAR Log

TABLE 4: PERSONNEL REQUIREMENTS

	HOT Team*			THICK	ADHERENCE			SENSOR			NCAR	Fluctuating Conditions		Drip Rates (separate)		Droplet Size	Polished Surfaces		Residual Ice
	HOT MGR	Fluids Prep.	Rates	Mgr	Mgr	Brix/ Thick	Rates	Mgr	Failure Calls	Rates	NCAR Mgr	Mgr	Rates	Mgr	Rates	Mgr	Mgr	Rates	Mgr
JD												X							
MC	X								X										
RC											X								
NM				X	X									X		X			X
SB				X		X		X						X					
SC																	X		
CM		X	X				X			X			X		X			X	
DY		X	X				X			X			X		X			X	

M:\Groups\CM1892\Procedures\NRC April 2004\Personnel

*NM Responsible for Cold Soak Box Preparation

FIGURE 2: RESIDUAL ICE CHARACTERISTICS DATA FORM

Date: _____

Temperature: _____

Height/ Characteristics (before)	Fluid Applied	Height/ Characteristics (after)	Comments

Comments: _____

_____

_____

FIGURE 3: NRC EQUIPMENT LAYOUT

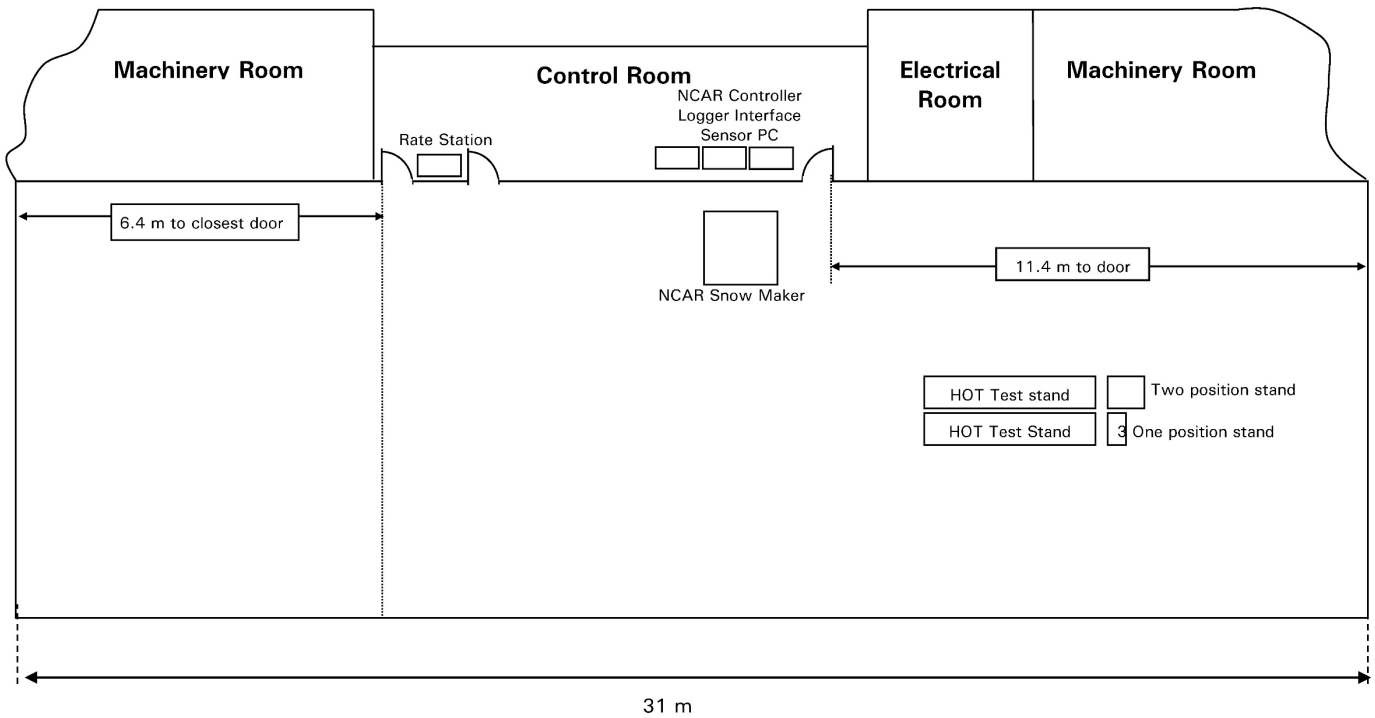

TABLE 5: LIST OF FLUIDS

Fluid Type	Fluid Brand	Dilution or Brix	Sub-Project							Fluids Required (L)
			HOT	S	A	TH	FC	DR	PS	
III	Clariant Safewing MP III 2031	100	32		5	2		5		44
II	Kilfrost P1491	100	32	1		2	4		5	44
II	Kilfrost P1491	75	28	3		2	4		5	42
II	Kilfrost P1491	50	12	2		2			5	21
I	Type I PG	10° buffer		6					5	21*
I	Type I EG	10° buffer							5	5
IV	UCAR Ultra +	100		8				7		15
II	Kilfrost ABC 2000	100			5					5
II	Kilfrost ABC 2000	50						3		3
IV	Octagon Maxflight	100		4	5			7		16
IV	Octagon Maxflight	75		2				4		6
IV	Octagon Maxflight	50		2						2
		Fluids Required (L)	104	28	15	8	8	26	25	224

M:\Groups\CM1892\Procedures\NRC April 2004\Fluid List

*Ten additional litres added for supplementary "flash freeze" tests

TABLE 6: EQUIPMENT TO BRING FROM MONTREAL TO NRC

MEASUREMENT EQUIPMENT	
Refractometers	Site
Thickness Gauges	Site
Temperature Probes (Wahl)	Site
Extra Thermistors (none)	Site
Microscope and Slides	Site
Methyl(ene) Blue	Site
Filter Paper Discs	Site
Disc Holder	Site
Colloidal Silver	Office
RATES	
Computer	Office
Balances/RS-232 cable	Site
White Pans	Site
Printer with extra cartridges	Site
Time lapse video system	Site
TESTING	
Plates (16 with thermistors)	Site
Boxes (8 w/thermistors, 2 without)	Site
HOT Stands (2-six position)	Site
Thickness Stand (1-six position)	Site
Other Stands (2 and 3 position)	Site
Plate Covers (12)	Site
Box Platform supports	Site
Adherence Tester	Site
Polished Plate	Office
Sensor Equipment	Site
Digital Camera	Office
Plate Cover Extenders	Site

DATA COLLECTION	
Data Forms	Office
Floppy Discs	Office
Accordion Folder	Office
Data Loggers (5)	Site
Interfaces (2)	Site
Connection Cables	Site
Dilution Curves	Office
OFFICE SUPPLIES	
Time Cards/Invoices/ Expense Forms	Office
Pencils	Office
Erasers	Office
Markers	Office
Zip Drive	Site
Zip Discs (4)	Site
MISCELLANEOUS	
Extension cords	Site
Barrel Faucets	Site
Barrel Cradles	Site
Construction wire/plywood (4)	Site
Cables	Site
Ice Cube Trays	Site
Ice Melt	Site
Shelving Unit	Site
Backup computer	Office
Extra Lighting	Site
Shop towels	Site/purchase
Kitchen equipment	Site
Microwave	Site

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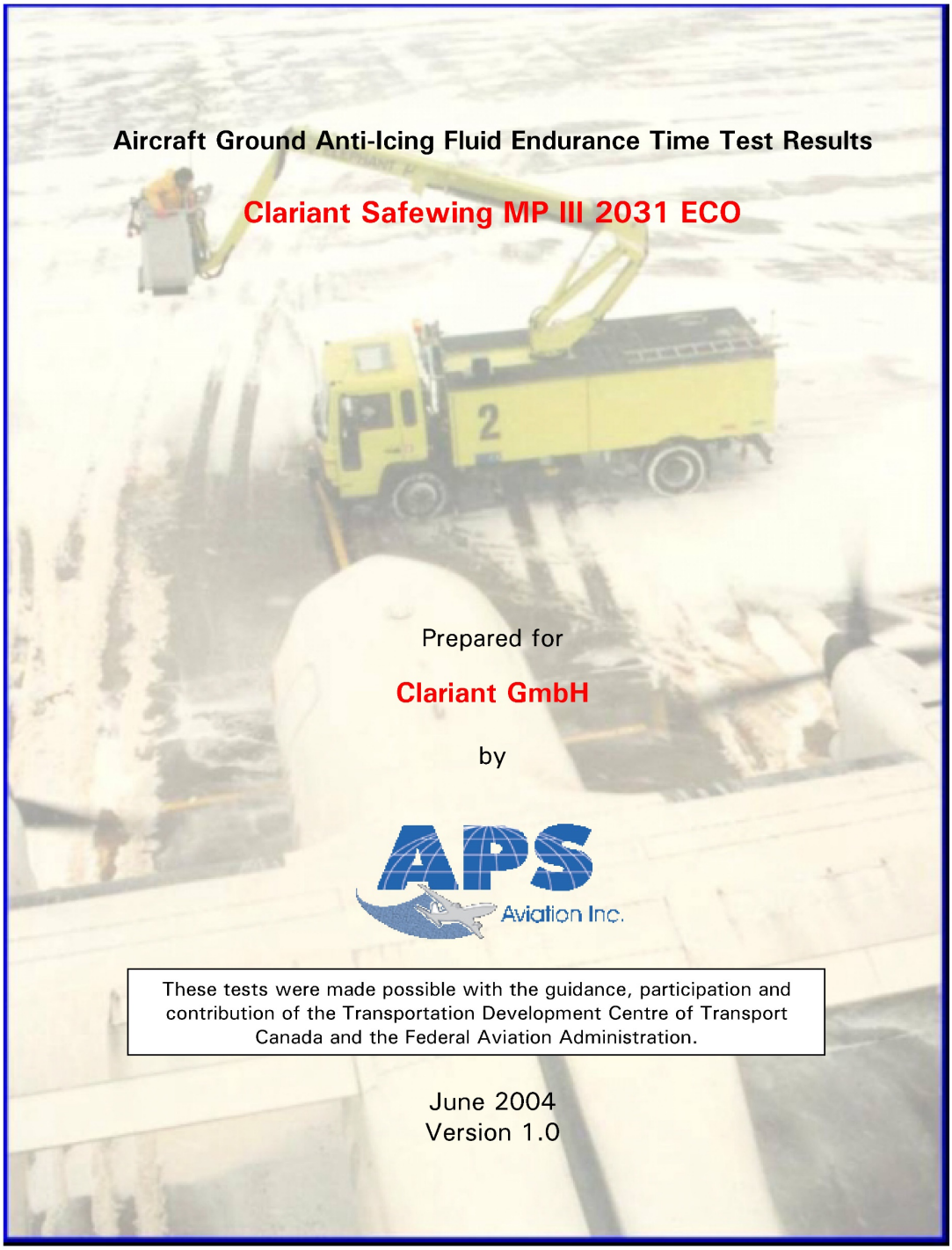
APPENDIX C

FLUID MANUFACTURER REPORT:
CLARIANT SAFEWING MP III 2031 ECO



Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Clariant Safewing MP III 2031 ECO

Prepared for

Clariant GmbH

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 2004
Version 1.0

Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Clariant Safewing MP III 2031 ECO

Prepared for

Clariant GmbH

Prepared by Richard Campbell and John D'Avirro

Reviewed by _____ July 5, 2004
John D'Avirro, Eng. Date
Program Manager

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 2004
Version 1.0

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer: Clariant GmbH

Fluid: Safewing MP III 2031 ECO

Fluid Type/ Colour: Type III/Yellow (this fluid was tested in neat dilution only)

Batch #: TV 390

Date of Receipt: February 16, 2004

Brix Measured: Neat dilution: 35.5°

Viscosity Stated by Manufacturer: Neat dilution: 740 cP
Viscosity Method: Spindle LV1, 500 mL fluid, 0°C, 0.3 rpm, 15 minutes

Viscosity Measured by APS: Neat dilution: 810 cP
Viscosity Method: Spindle LV1, 500 mL fluid, 0°C, 0.3 rpm, 33 minutes

WSET provided by AMIL: Neat dilution: 27 minutes

LOUT (lowest operational use temp.): -18°C for low speed ramp
-29°C for high speed ramp

SUMMARY

The objective of this project was to measure the endurance time performance of Clariant MP III 2031 ECO Type III fluid over the entire range of conditions encompassed by the holdover time tables. This report contains the results of these measurements, completed with the support of Transport Development Centre (TDC) of Transport Canada (TC) and the Federal Aviation Administration (FAA).

The holdover time test procedure consisted of pouring fluids onto clean aluminium test surfaces inclined at 10°; 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 conditions. Eighty-four endurance time tests were performed at the APS test facility located within the Montréal-Pierre-Elliott-Trudeau International Airport and at the National Research Council Canada's (NRC) Climatic Engineering Facility (CEF) in Ottawa.

De/anti-icing fluid endurance times were determined using a multi-variable regression analysis, resulting in the endurance times shown below. Based upon this information, the FAA and TC developed a generic Type III holdover time table.

Clariant Safewing MP III 2031 Endurance Time Test Results

OAT		Approximate Holdover Times Under Various Weather Conditions (minutes)								
°C	°F	Frost	Freezing Fog	Very Light Snow	Light Snow	Moderate Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold-Soak Wing	Other
-3 and above	27 and above	120	25 - 46	39 - 48	21 - 39	11 - 21	14 - 27	9 - 13	7 - 25	
below -3 to -10	below 27 to 14	120	25 - 40	34 - 42	18 - 34	10 - 18	13 - 23	11 - 14	CAUTION: No holdover time guidelines exist	
below -10	below 14	120	24 - 45	30 - 37	16 - 30	9 - 16				

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1. INTRODUCTION

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

Aircraft ground deicing/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 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 holdover times without compromising the aerodynamic features of the airfoil.

Flat plate tests, conducted in natural and simulated precipitation, are used to develop and substantiate fluid holdover time tables for current fluids and new formulations. Test procedures to measure the duration of fluid protection against ice formation have evolved into a refined SAE standard AS 5485 (draft) that is followed by APS.

Testing of aircraft ground de/ant-icing fluids has resulted in the generation of holdover time tables. These tables provide guidelines for use in departure planning in adverse winter conditions. They provide the holdover time 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 failure data for each fluid brand, for each cell of the holdover time tables, were subject to a multi-variable regression treatment. The Type II, and Type IV fluid holdover times were determined using this method of analysis, resulting in the generation of generic and *fluid-specific* holdover time tables.

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2

2. METHODOLOGY

This chapter contains a description of the tests, equipment, and procedures. 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 AS 5485.

2.1 Definition of Weather Conditions

Holdover times are provided as a function of *weather condition*, fluid mixture and outside air temperature. The objective of the winter test program was to substantiate these holdover times or develop new ones 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 holdover time 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 holdover time 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 Holdover Time 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. Viability 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)
Measured Intensity	Up to 0.10 in/hr (2.5 mm or 25 gr/dm²/hr); Maximum 0.01 inch in 6 minutes
Light (-)	
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.
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
Moderate	
Estimated Intensity	Individual drops are not clearly identifiable; spray is observable just above pavement and other hard surfaces.
Measured Intensity	More than 0.30 in/hr (7.6 mm or 76 gr/dm²/hr); More than 0.03 inch in 6 minutes
Heavy (+)	
Estimated Intensity	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

* From World Meteorological Organization Guide to Meteorological Instruments and Methods of Observation (1983)
** From American Meteorological Society, Glossary of Meteorology WSOH #7 MANOBS (3/94)
*** NCAR Proposed Definition for Liquid Equivalent Snowfall Intensity

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

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

Table 2.2 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 extensive field data compiled by APS. The table categorizes snowfall into one of four intensities based on visibility and lighting condition.

This table was first used in the winter of 2003-04. TC publishes the visibility table annually for use in winter operations. The FAA visibility table differs slightly from the TC visibility table, but is based on the same data set.

Table 2.2: 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.

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 for snow, through the measurement of horizontal visibility. The holdover time table has one column for freezing drizzle, but 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 NRC led to the upper limit value of 13 g/dm²/h for freezing drizzle. This value was 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 ≤25 g/dm²/h
- Moderate Precipitation rate is >25 g/dm²/h but ≤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 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 in 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 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 -46°C.

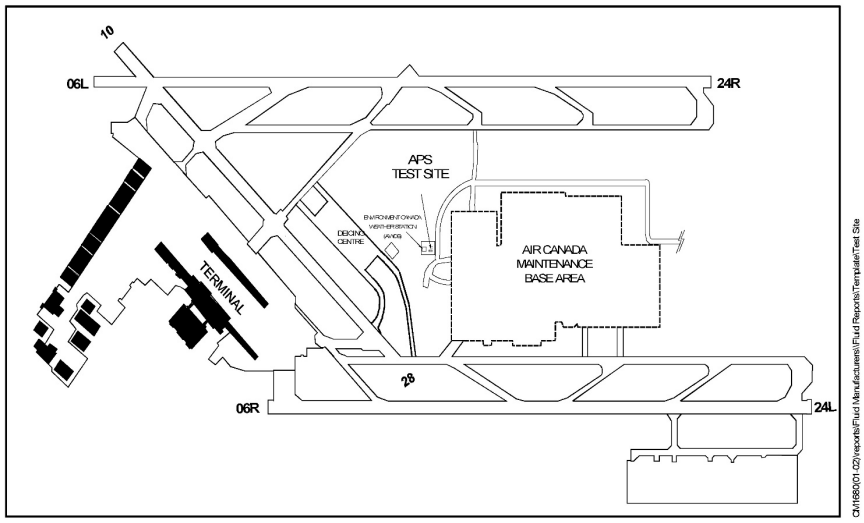

Figure 2.1: Test Site at the Montréal-Pierre-Elliott-Trudeau International Airport

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 holdover time. To explore this relationship further, experiments were performed to measure droplet sizes produced by different nozzles (gauge of hypodermic needle) at various water and air pressures in the spray delivery unit. Although the gauge of the needles is an important factor in the production of water droplets with appropriate dimensions, the air and water pressure levels in the sprayer system are equally important.

An improved sprayer assembly was developed in 1997-98 by the NRC and is shown in Photo 2.6. The new 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 AS 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 the distribution of simulated light freezing rain droplets obtained at the NRC.

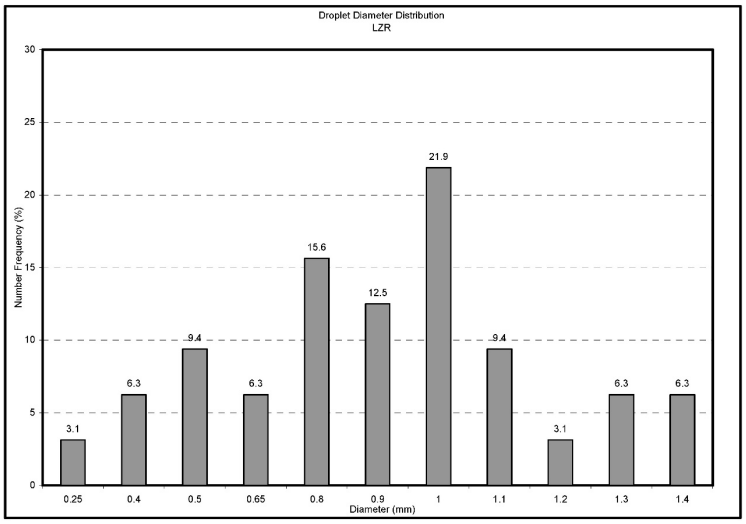

Figure 2.2: Droplet Diameter Distribution

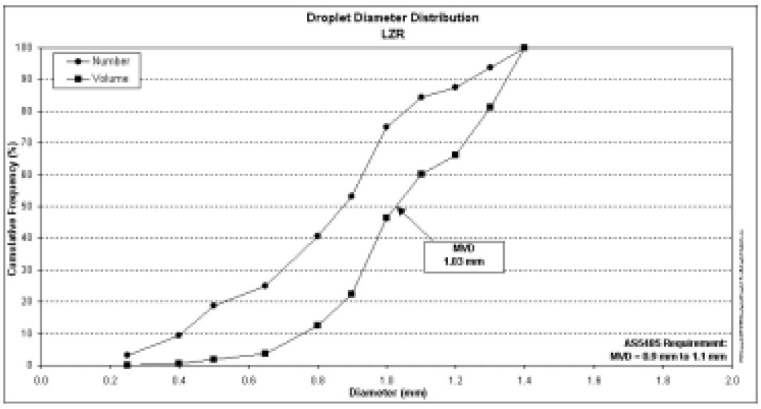

Figure 2.3: Cumulative Frequency of Droplet Diameter

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 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 AS 5485.

Figure 2.4 shows a schematic of the test platform used for in holdover time 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 conjunction. 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.

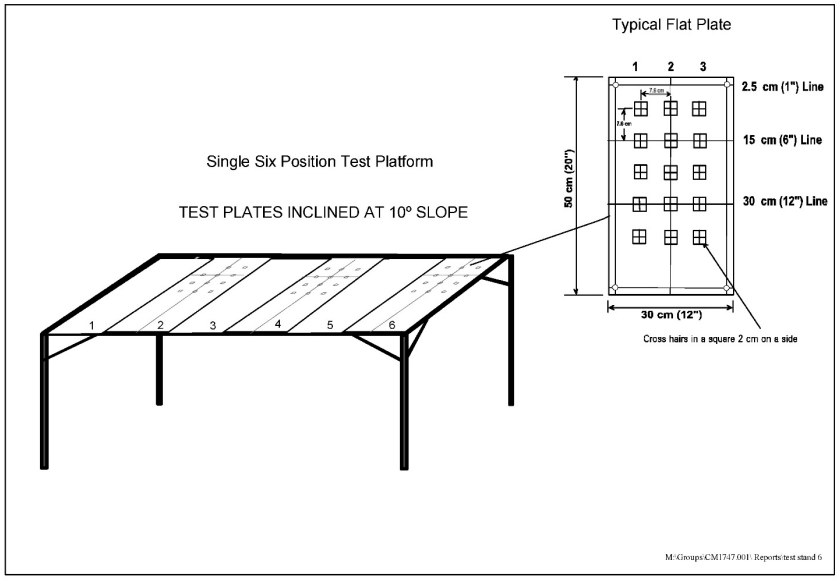

Figure 2.4: Flat Plate Test Set-Up

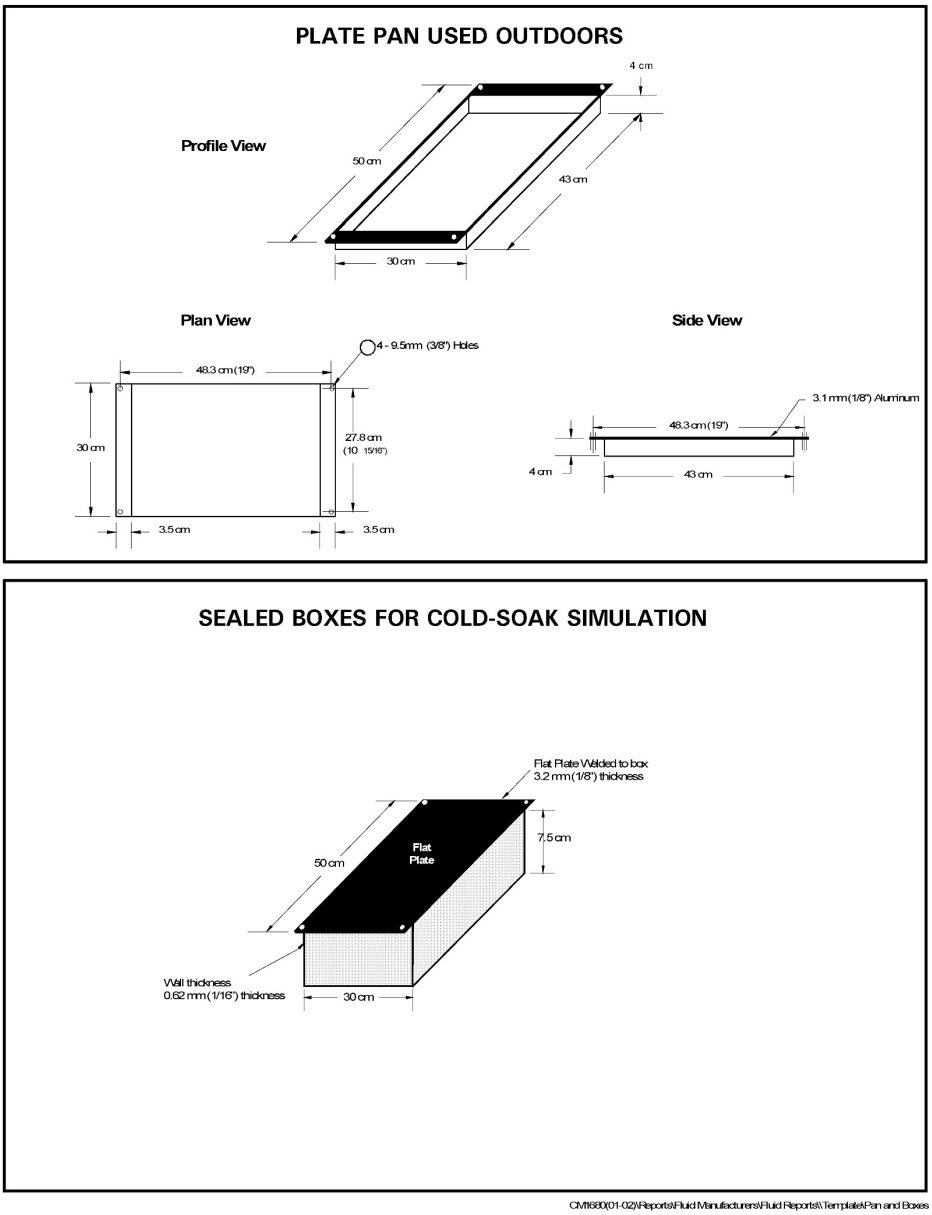

Figure 2.5: Schematics of Plate Pan and Sealed Boxes

2.5 Test Procedures

Tests consisted of pouring deicing or 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

For the tests at the test site, a test stand contained six test plates, each plate representing a flat plate test. During each run with six plates, three different fluids were tested in duplicate.

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

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

- Synchronise 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% (1/3) of the plate have failed;
- Record weather conditions; and
- Clean panels and restart.

2.5.2 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% (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.

2.5.3 Precipitation Rate Procedures

2.5.3.1 Simulated precipitation conditions

Prior to the start of the rate collection period, the proper needles and nozzles are installed in the spray unit, and both the air and water pressures are adjusted. Water spray calibration is performed by placing catch pans on the test stand, each pan marked with a number identifying the collection location on the test stand, and exposing the pans to a predetermined precipitation collection period.

The pans are weighed prior to exposure to precipitation and the weights are recorded. Prior to the start of the precipitation catch period, the exact time (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.

2.5.3.2 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%.

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/dm²/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/dm²/h, suggesting a maximum variation of 4.1% 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 right	14:02	14:34	81.6	89.2	7.6	31.9	5.3

3	4	5		STD DEV
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	81.6	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 right	12:12	12:43	81.6	100.2	18.6	30.8	13.5

3	4	12.9		STD DEV
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	

CM 1680 (01-02)\reports\Fluid Manufacturers\Fluid Reports\Template\Detailed Rate Distribution

2.5.3.3 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 time delay necessary to proceed outside from the rate station is taken into consideration by the person(s) responsible for collecting precipitation rate data.

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

An example of the rate calculation method for tests in natural snow conditions is displayed in Figure 2.6. Typically, two collections pans are used for each test. The start and end times of the test are 10:15 and 10:45, respectively. Precipitation rates for one pan were collected at three periods during this test, indicated by 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 2.6, the rate is calculated as follows:

$$\frac{(25 \times 10 + 22 \times 8 + 34 \times 5)}{10 + 8 + 5}$$

The calculated average rate for this pan is 25.9 g/dm²/h. The average rate for the other collection pan is calculated in similar fashion, and the average of the two rates is then taken.

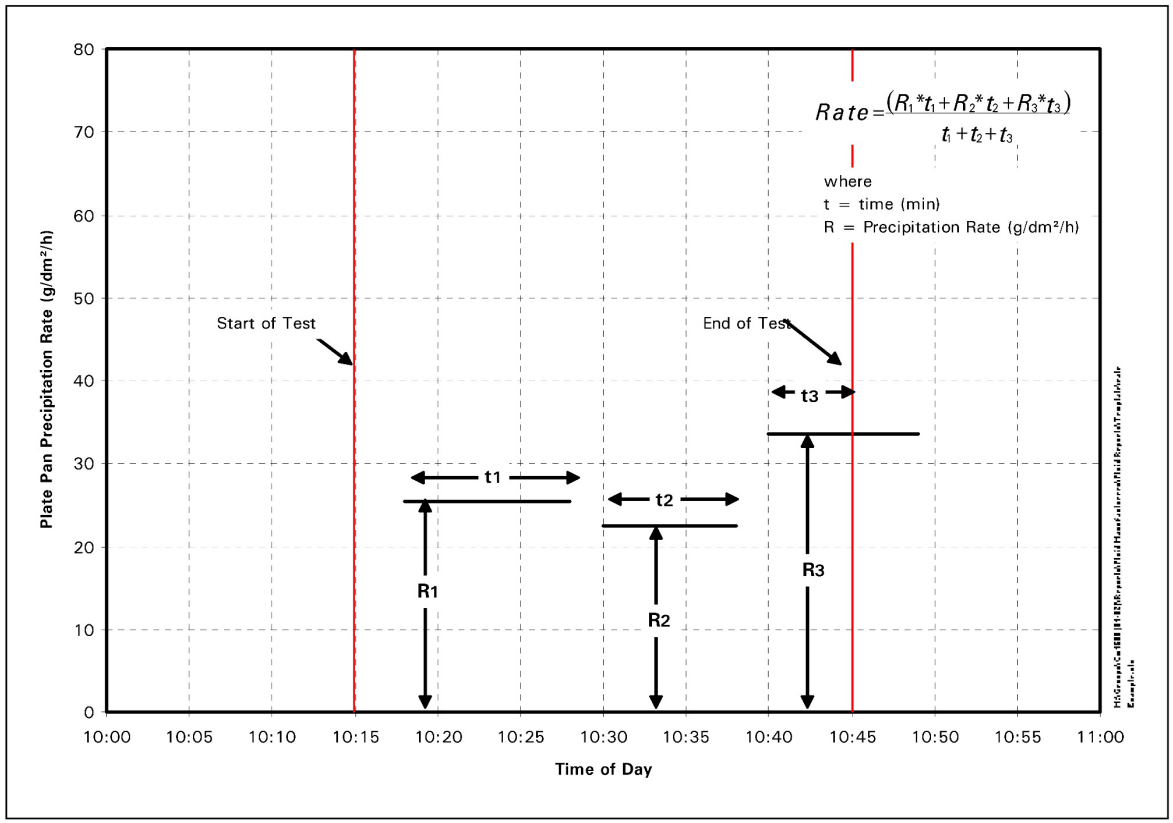

Figure 2.6: Calculation of Outdoor Precipitation Rate

2.6 Analysis Methodology

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 holdover time testing. The process of data analysis used in the evaluation of fluid holdover times 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 holdover times (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 holdover times are represented schematically in Figure 2.7. 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.

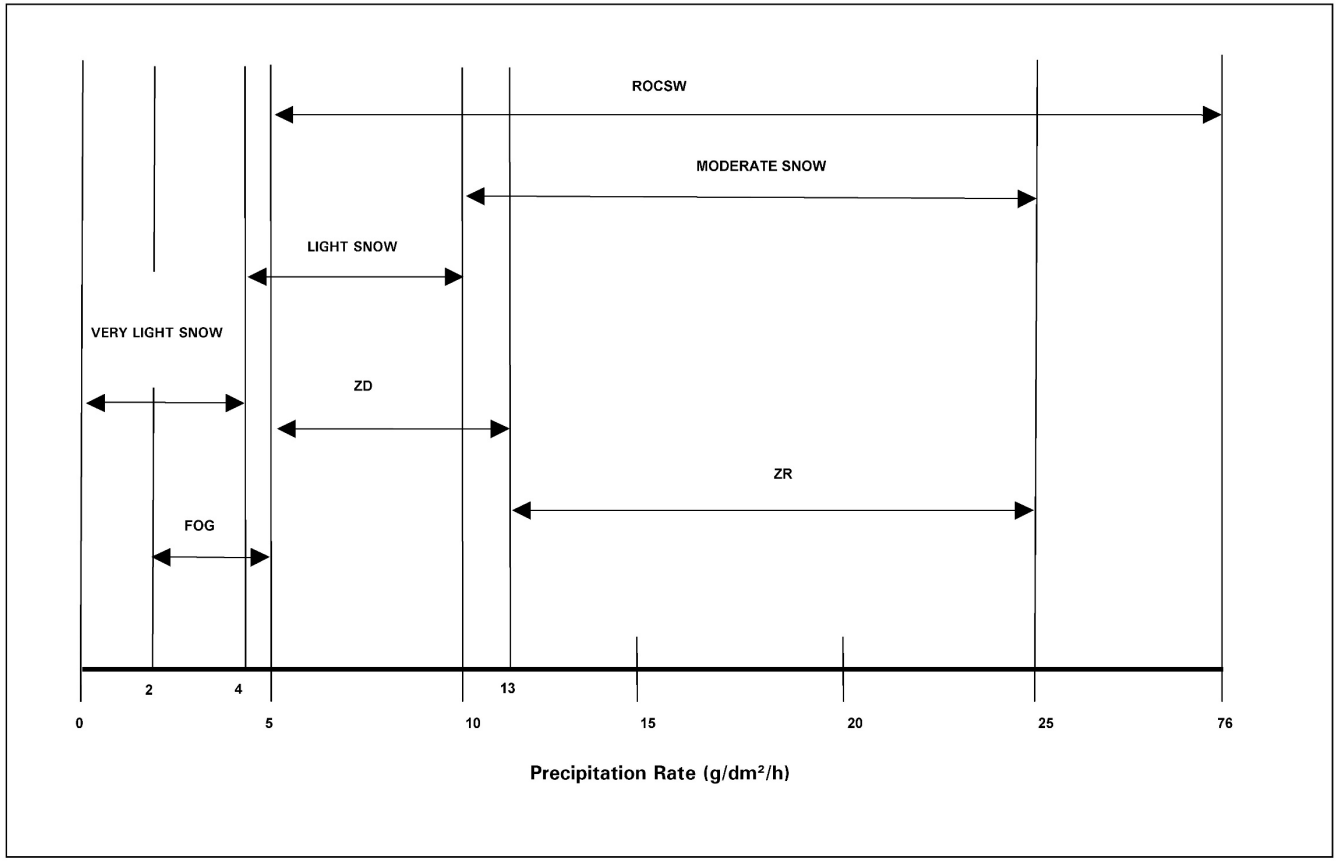

Figure 2.7: Data Range Used for Evaluation of Holdover Time Limits

For Type I and III fluids, the limits for the snow columns were as follows:

a) Very light snow: 4 g/dm²/h;
b) Light snow: 4 g/dm²/h and 10 g/dm²/h; and
c) Moderate snow: 10 g/dm²/h and 25 g/dm²/h.

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 holdover time 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 Holdover Time Subcommittee.

For test purposes, the precipitation rate spectrum for freezing drizzle is constrained to rates between 5 and 13 g/dm^2/h, inclusive. 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 holdover time tables indicating that if positive identification of freezing drizzle is not possible, the light freezing rain holdover time is recommended for use.

2.6.2.3 Light freezing rain

With reference to the holdover time tables, freezing rain conditions span the range of precipitation rates from 13 to 25 g/dm^2/h, inclusive. 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.

The upper and lower holdover times for freezing fog were determined subjectively from the test data in previous years. It was agreed upon (at the 1997 Chicago SAE G-12 Holdover Time Subcommittee meeting) that the lower and upper holdover times for fog be evaluated at rates of 5 g/dm^2/h and 2 g/dm^2/h, respectively. In Vienna, during the 1998 SAE G-12 Holdover Time Subcommittee meeting, it was felt that 2 g/dm²/h was not indicative of low rate natural fog. As a result, the upper holdover times in each of the freezing fog cells of the holdover time tables were left untouched for the 1998/99 winter operating season. During a meeting of the Workgroup on Laboratory Methods to Derive Holdover Time 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 holdover time testing in order to determine the upper holdover time limit in freezing fog conditions.

Substantial improvements were made to the freezing fog spray delivery system during the past test season. This afforded improved control over fog deposition rates during 1998/99 indoor trials. In previous years, freezing fog was sprayed horizontally from the walls of the chamber onto the test plates. In 1998/99, the spray assembly was positioned overhead the test stand, allowing the freezing fog to be sprayed vertically down onto the plates.

2.6.2.5 Rain on a cold-soaked surface

Data used for the evaluation of holdover times 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 holdover time table regarding heavy weather conditions.

2.6.3 Protocol for the Determination of Holdover Times

Each cell in a holdover time 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 holdover time tables are composed of a maximum of 45 cells. Each cell contains a lower and upper time limit (except for frost) for a maximum of 81 time values.

Cell holdover time 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 holdover times. 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 been used to evaluate fluid holdover.

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

Plots of **Log t** versus **Log R** are shown in Figure 2.8. 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 2.9. The curve, generated from the power law form of the equation using the coefficients determined from the fit, is superimposed onto the plot. The holdover time range is determined from the intersections of the curve with the precipitation rate limits defined for snow.

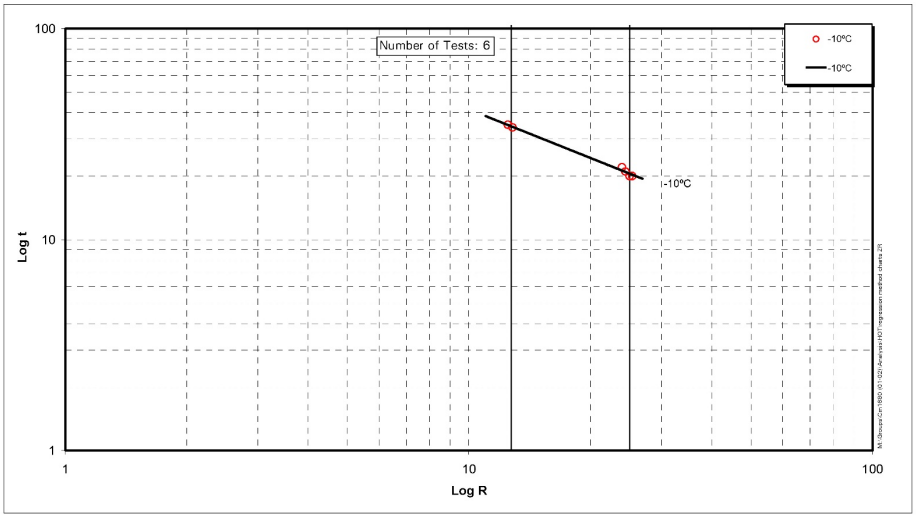

Figure 2.8: Regression Method on Log-Log Chart – Sample Type IV Neat, Freezing Rain

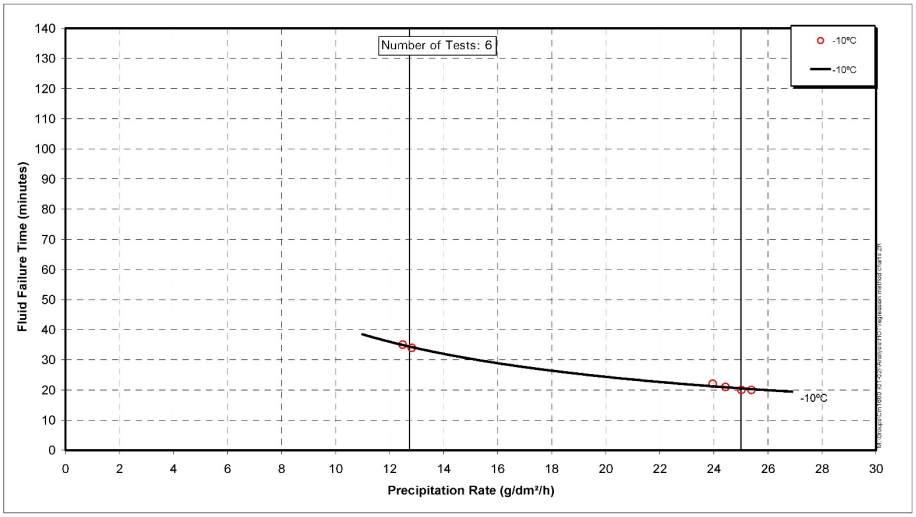

Figure 2.9: Regression Method on Standard Chart – Sample Type IV Neat, Freezing Rain

The holdover times 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 holdover time range for this particular fluid. This illustrates the general approach used in the determination of a fluid holdover time range for any given cell in the holdover time 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 holdover time table in these conditions were also obtained by using the most restrictive (lowest) cell range temperature.

- The exception to this was made for the case of the temperature range above 0°C. Experiments for freezing drizzle and light freezing rain could not be performed artificially at temperatures above 0°C, and as such, the equation could not be calculated at the most restrictive temperature of 0°C. Therefore, holdover times for this temperature range were obtained by using the same values calculated at -3°C.

2.6.3.2 Simulated freezing fog

The same method used to evaluate freezing fog data in 1996/97 (see TC report, TP 13131E) was also used to evaluate freezing fog data. The equation used to treat data is given by the expression below:

$$t = cR^a$$

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 0°C, the value of temperature used in the fitting procedure was 0°C.

- The upper and lower holdover time 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 holdover times 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 Holdover Time Subcommittee meeting in Chicago in July 1997, Type IV fluid holdover times 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 a *generic* or *SAE* Type IV holdover time table as well as *fluid-specific* Type IV holdover time tables. *Generic* and *fluid-specific* holdover time tables have subsequently been generated.

2.6.4.1 Fluid-specific holdover time tables

Fluid-Specific holdover time 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 holdover time 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 Holdover Time Subcommittee did not favour *fluid-specific* tables. However, significant reductions to holdover times 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 determine specific values for each fluid is provided below:

- The method used to determine holdover times is generally the same as was agreed upon in Chicago in 1997 at the SAE G-12 Holdover Time Subcommittee meeting;
- For each cell of the holdover time 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 holdover time table (except frost), a best-fit power law curve for each fluid was developed from the tests conducted at the low and high precipitation rate condition of that cell;
- Regression-generated holdover times were rounded off to the nearest whole "5" digit. For example, 55.1 to 57.4 minutes was rounded down to 55 minutes; 57.5 to 59.9 minutes was rounded up to 60 minutes;
- In all cases where the regression-generated holdover times were below 10 minutes, the numbers were rounded down as a precautionary measure. For example, 9 minutes was rounded down to 5 minutes;
- Cold-soak wing and freezing fog fluid-specific values were used if the data were available. In the past, fluid-specific values were adopted in the snow, freezing drizzle and light freezing rain columns of the holdover time tables only; and
- Values were capped at 2 hours for all precipitation conditions except freezing fog, which were 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

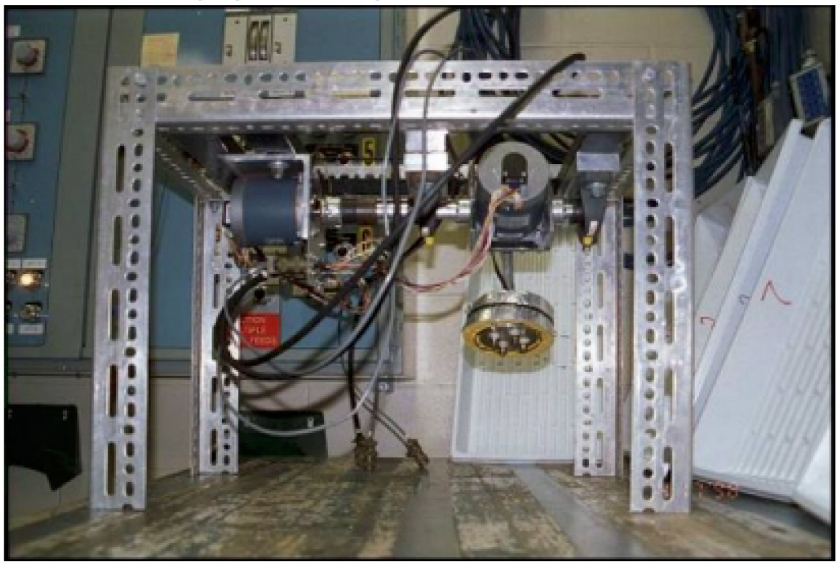

Photo 2.7: Sprayer Nozzle

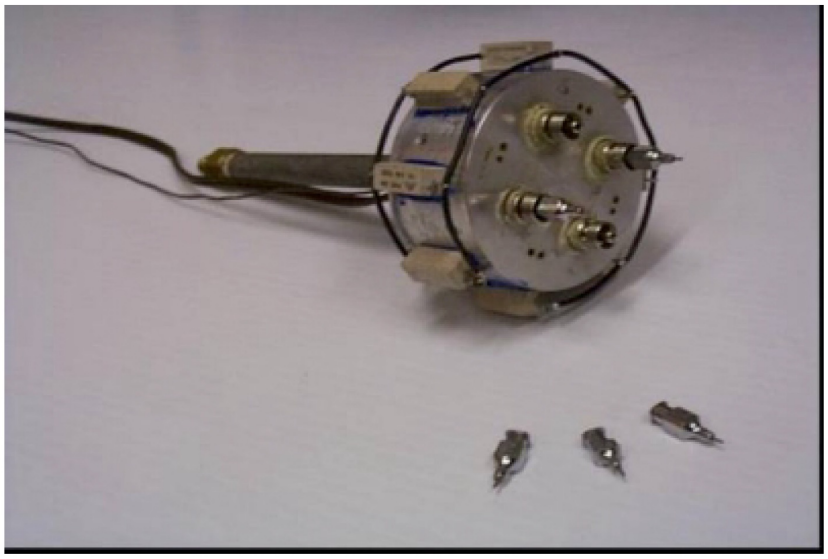

Photo 2.8: Test Plates Mounted on Stand

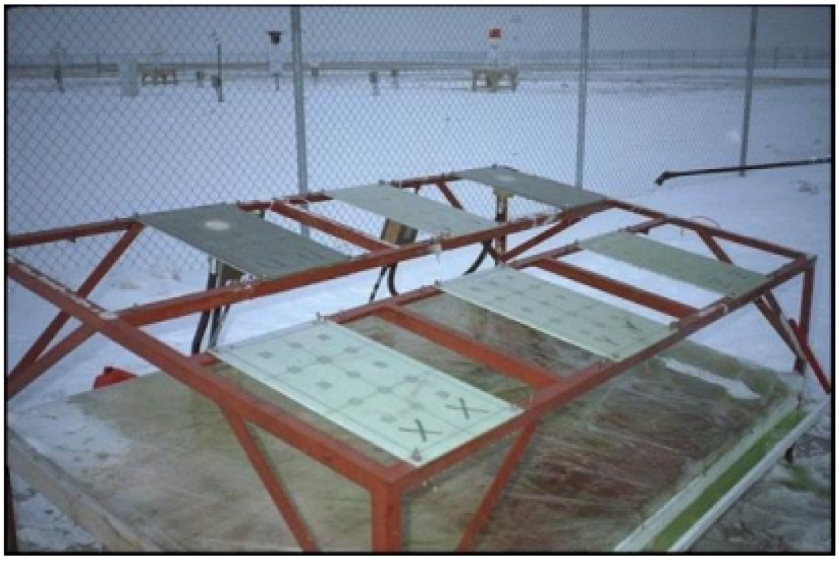

Photo 2.9: Collection Pans Used Indoors at the National Research Council

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted for 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, versus condition and temperature.

A summary of tests conducted in natural snow and at the NRC is provided in Table 3.1 at the end of this section.

3.1 Natural Snow Tests

A total of 53 tests were conducted in natural snow conditions at the APS test site. The breakdown, by temperature, of the tests conducted is summarized below.

	Above 0°C	0 to -3°C	-3 to -7°C	-7 to -14°C	-14 to -25°C	Total
Neat	1	37	8	7	0	53

3.2 Freezing Drizzle and Light Freezing Rain Tests

A total of 16 tests were conducted in freezing drizzle and light freezing rain conditions at the NRC CEF. The breakdown of the tests conducted is summarized below.

	Freezing Drizzle		Light Freezing Rain	
	-3°C	-10°C	-3°C	-10°C
Neat	4	4	4	4

3.3 Freezing Fog Tests

A total of 12 tests were conducted in the freezing fog condition at the NRC CEF. The breakdown, by fluid type, of the tests conducted is summarized below.

	-3°C	-14°C	-25°C
Neat	4	4	4

3.4 Rain on Cold-Soaked Surface Tests

A total of 4 Type III Neat cold-soak tests, using a 7.5 cm deep sealed boxes, were conducted at an ambient temperature of +1°C at the NRC CEF.

3.5 Fluid Thickness Tests

The purpose of these tests was to measure the film thickness profiles of the fluid, under dry conditions.

Two tests were performed. 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 fluid stabilized at 0.13 mm after 30 minutes during both tests.

Table 3.1: Summary of Tests Performed in 2003-04

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time [min.]	Icing Intensity [g/dm²/h]	Test Temperature (°C)	Precipitation Type
1	Feb-20-04	Clariant Type III (2031)	100%	30.0	5.5	-3.2	Natural Snow
2	Feb-20-04	Clariant Type III (2031)	100%	21.0	7.4	-3.2	Natural Snow
3	Feb-21-04	Clariant Type III (2031)	100%	24.8	8.3	-0.2	Natural Snow
4	Feb-21-04	Clariant Type III (2031)	100%	25.3	8.4	-0.2	Natural Snow
5	Feb-21-04	Clariant Type III (2031)	100%	24.5	9.0	-0.3	Natural Snow
6	Feb-21-04	Clariant Type III (2031)	100%	24.3	9.1	-0.3	Natural Snow
7	Feb-21-04	Clariant Type III (2031)	100%	24.5	9.4	-0.3	Natural Snow
8	Feb-21-04	Clariant Type III (2031)	100%	23.8	9.3	-0.3	Natural Snow
9	Feb-21-04	Clariant Type III (2031)	100%	39.3	5.7	-0.2	Natural Snow
10	Feb-21-04	Clariant Type III (2031)	100%	37.3	5.6	-0.2	Natural Snow
11	Feb-21-04	Clariant Type III (2031)	100%	39.2	5.8	-0.3	Natural Snow
12	Feb-21-04	Clariant Type III (2031)	100%	40.0	5.8	-0.3	Natural Snow
13	Feb-21-04	Clariant Type III (2031)	100%	29.7	5.7	-0.3	Natural Snow
14	Feb-21-04	Clariant Type III (2031)	100%	29.5	5.6	-0.3	Natural Snow
16	Mar-14-04	Clariant Type III (2031)	100%	119.8	1.5	-1.5	Natural Snow
17	Mar-20-04	Clariant Type III (2031)	100%	20.7	9.2	-1.5	Natural Snow
22	Mar-20-04	Clariant Type III (2031)	100%	32.3	5.9	-2.0	Natural Snow
27	Mar-20-04	Clariant Type III (2031)	100%	26.3	8.8	-2.6	Natural Snow
32	Mar-20-04	Clariant Type III (2031)	100%	12.0	24.6	-2.0	Natural Snow
37	Mar-20-04	Clariant Type III (2031)	100%	14.8	17.1	-2.0	Natural Snow
42	Mar-20-04	Clariant Type III (2031)	100%	14.5	19.6	-2.0	Natural Snow
50	Mar-20-04	Clariant Type III (2031)	100%	20.0	13.7	-2.0	Natural Snow
52	Mar-20-04	Clariant Type III (2031)	100%	19.9	15.4	-0.3	Natural Snow
55	Mar-20-04	Clariant Type III (2031)	100%	17.7	15.4	-0.3	Natural Snow
59	Mar-20-04	Clariant Type III (2031)	100%	13.2	21.4	-0.9	Natural Snow
62	Mar-20-04	Clariant Type III (2031)	100%	11.3	23.1	-1.0	Natural Snow
65	Mar-20-04	Clariant Type III (2031)	100%	20.6	11.8	-1.0	Natural Snow
67	Mar-20-04	Clariant Type III (2031)	100%	19.7	11.2	-1.0	Natural Snow
72	Mar-20-04	Clariant Type III (2031)	100%	19.0	7.4	-0.5	Natural Snow
75	Mar-20-04	Clariant Type III (2031)	100%	18.8	9.3	-0.5	Natural Snow
79	Mar-20-04	Clariant Type III (2031)	100%	17.8	10.6	-0.3	Natural Snow
81	Mar-20-04	Clariant Type III (2031)	100%	41.0	4.4	0.1	Natural Snow
86	Mar-23-04	Clariant Type III (2031)	100%	23.3	7.3	-8.0	Natural Snow
90	Mar-23-04	Clariant Type III (2031)	100%	23.3	5.1	-8.0	Natural Snow
92	Mar-23-04	Clariant Type III (2031)	100%	20.3	7.6	-8.0	Natural Snow
95	Mar-23-04	Clariant Type III (2031)	100%	31.0	4.6	-7.9	Natural Snow
97	Mar-23-04	Clariant Type III (2031)	100%	39.0	4.4	-7.8	Natural Snow
112	Mar-23-04	Clariant Type III (2031)	100%	115.7	0.5	-11.3	Natural Snow
114	Mar-23-04	Clariant Type III (2031)	100%	111.0	0.8	-10.4	Natural Snow
119	Mar-23-04	Clariant Type III (2031)	100%	123.0	0.5	-5.0	Natural Snow
120	Mar-23-04	Clariant Type III (2031)	100%	83.5	4.0	-1.2	Natural Snow
129	Mar-23-04	Clariant Type III (2031)	100%	17.2	11.0	-1.0	Natural Snow
130	Mar-23-04	Clariant Type III (2031)	100%	22.0	6.8	-1.7	Natural Snow

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Table 3.1 (cont'd): Summary of Tests Performed in 2003-04

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time [min.]	Icing Intensity [g/dm²/h]	Test Temperature (°C)	Precipitation Type
136	Mar-23-04	Clariant Type III (2031)	100%	16.8	10.9	-1.0	Natural Snow
137	Apr-04-04	Clariant Type III (2031)	100%	20.2	16.3	-1.5	Natural Snow
141	Apr-04-04	Clariant Type III (2031)	100%	20.2	13.2	-1.6	Natural Snow
145	Apr-04-04	Clariant Type III (2031)	100%	23.7	10.3	-1.6	Natural Snow
149	Apr-04-04	Clariant Type III (2031)	100%	27.8	6.9	-3.5	Natural Snow
150	Apr-04-04	Clariant Type III (2031)	100%	69.7	2.1	-2.7	Natural Snow
156	Apr-04-04	Clariant Type III (2031)	100%	29.7	8.0	-3.7	Natural Snow
161	Apr-05-04	Clariant Type III (2031)	100%	25.2	10.4	-4.5	Natural Snow
165	Apr-05-04	Clariant Type III (2031)	100%	38.5	6.8	-5.0	Natural Snow
169	Apr-05-04	Clariant Type III (2031)	100%	50.0	5.2	-5.0	Natural Snow
67	20-Apr-04	Clariant Type III (2031)	100%	7.0	76.2	1	Cold-Soak Box
68	20-Apr-04	Clariant Type III (2031)	100%	7.3	74.5	1	Cold-Soak Box
61	20-Apr-04	Clariant Type III (2031)	100%	24.2	5.1	1	Cold-Soak Box
62	20-Apr-04	Clariant Type III (2031)	100%	24.3	5.6	1	Cold-Soak Box
41	20-Apr-04	Clariant Type III (2031)	100%	13.6	12.6	-10	Freezing Drizzle
42	20-Apr-04	Clariant Type III (2031)	100%	13.2	12.6	-10	Freezing Drizzle
47	20-Apr-04	Clariant Type III (2031)	100%	23.5	4.9	-10	Freezing Drizzle
48	20-Apr-04	Clariant Type III (2031)	100%	22.9	5.0	-10	Freezing Drizzle
55	20-Apr-04	Clariant Type III (2031)	100%	27.5	4.8	-3	Freezing Drizzle
56	20-Apr-04	Clariant Type III (2031)	100%	27.8	4.9	-3	Freezing Drizzle
23	20-Apr-04	Clariant Type III (2031)	100%	13.5	13.2	-3	Freezing Drizzle
24	20-Apr-04	Clariant Type III (2031)	100%	33.3	13.6	-3	Freezing Drizzle
75	22-Apr-04	Clariant Type III (2031)	100%	45.2	2.0	-25	Freezing Fog
76	22-Apr-04	Clariant Type III (2031)	100%	44.5	2.0	-25	Freezing Fog
71	22-Apr-04	Clariant Type III (2031)	100%	25.2	4.8	-25	Freezing Fog
72	22-Apr-04	Clariant Type III (2031)	100%	24.8	4.7	-25	Freezing Fog
82	22-Apr-04	Clariant Type III (2031)	100%	44.8	1.5	-14	Freezing Fog
81	22-Apr-04	Clariant Type III (2031)	100%	43.3	1.8	-14	Freezing Fog
87	22-Apr-04	Clariant Type III (2031)	100%	25.3	5.2	-14	Freezing Fog
88	22-Apr-04	Clariant Type III (2031)	100%	24.5	5.2	-14	Freezing Fog
95	19-Apr-04	Clariant Type III (2031)	100%	26.7	4.9	-3	Freezing Fog
96	19-Apr-04	Clariant Type III (2031)	100%	23.8	5.2	-3	Freezing Fog
103	19-Apr-04	Clariant Type III (2031)	100%	45.0	2.1	-3	Freezing Fog
104	19-Apr-04	Clariant Type III (2031)	100%	45.3	2.0	-3	Freezing Fog
35	21-Apr-04	Clariant Type III (2031)	100%	13.8	12.2	-10	Freezing Rain
36	21-Apr-04	Clariant Type III (2031)	100%	14.7	12.4	-10	Freezing Rain
29	21-Apr-04	Clariant Type III (2031)	100%	10.5	24.6	-10	Freezing Rain
30	21-Apr-04	Clariant Type III (2031)	100%	10.7	24.7	-10	Freezing Rain
7	19-Apr-04	Clariant Type III (2031)	100%	9.3	25.5	-3	Freezing Rain
8	19-Apr-04	Clariant Type III (2031)	100%	8.8	25.9	-3	Freezing Rain
15	19-Apr-04	Clariant Type III (2031)	100%	13.2	12.5	-3	Freezing Rain
16	19-Apr-04	Clariant Type III (2031)	100%	13.7	12.4	-3	Freezing Rain

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4. ENDURANCE TIME RESULTS AND DISCUSSIONS

The endurance time data will be presented in this section.

4.1 Background

The commuter aviation industry has traditionally relied heavily on Type I fluid as an aircraft ground anti-icing agent.

Prior to 1992, the Type I fluid holdover time table contained a single value in the snow column, regardless of the ambient temperature: this value was 15 minutes. Beginning in 1992-93, a holdover time range was introduced for Type I fluid in snow, and the values were reduced to 6 to 15 minutes based on worldwide test data. In May 2000, the Holdover Time Subcommittee adopted holdover time values for Type I fluid that were significantly shorter than 6 to 15 minutes; the shorter times were derived using a protocol that is used to test Type II and Type IV fluids with no contribution from the heat that is inherent with Type I fluids.

Many new developments in the test protocol for Type I fluids occurred, contributing to an increase in the Type I holdover times from the May 2000 values. Although the snow values generated by the new test protocol were an improvement over the reduced holdover time values agreed upon in May 2000, the values were, in many cases, below the historical 6 to 15 minute holdover time range for Type I fluid in snow. Commuter operators that had traditionally used Type I fluid as an anti-icing agent continued to express concern that the new snow values would adversely affect their operations. As a result of these concerns, APS began to examine potential solutions to address the holdover time restrictions of anti-icing operations with Type I fluid.

In the fall of 2002, American Eagle Airlines and APS discussed potential solutions to the limitations of Type I anti-icing. Initial discussions centred on the possibility of spraying heated Type IV fluids through existing American Eagle Type I spray equipment as a means of producing a lower viscosity fluid. The idea was based upon the assumption that production samples of heated Type IV fluid would retain sufficient viscosity following a spray through a Type I delivery system to provide the desired 15-minute minimum holdover time.

The endurance time test results of the test samples applied with American Eagle trucks led to the subsequent testing of simulated Type III products. The endurance time tests performed with the simulated Type III products produced very encouraging results.

TC, Bombardier and American Eagle encouraged fluid manufacturers to formulate new Type III fluid formulations, with the following operational desires:

a) Consist of a single product (deicing and anti-icing fluid);

b) Provide holdover times in excess of 15 minutes in snow;

c) Possess fluid freezing point protection from above 0°C to below -25°C, thus allowing for de-frosting operations at cold temperatures;

d) Be applied to aircraft surfaces heated at a high pressure;

e) Be applied using current Type I spray equipment; and

f) Not cause fluid dry-out problems.

4.2 Sample Submitted for Testing

During January 2004, spray tests with a Clariant Type III fluid were conducted in Dallas using an American Eagle Type I fluid truck. These tests helped Clariant in setting the Lowest-On-Wing Viscosity sample that was subsequently sent to APS for Endurance Time testing. The viscosity of the sample sent to APS was as follows:

Viscosity Stated by Manufacturer: Neat dilution: 740 cP
Viscosity Method: Spindle LV1, 500 mL fluid, 0°C, 0.3 rpm, 15 minutes

Viscosity Measured by APS: Neat dilution: 810 cP
Viscosity Method: Spindle LV1, 500 mL fluid, 0°C, 0.3 rpm, 33 minutes

Clariant also provided low and high viscosity samples to AMIL for certification of the fluid based on AMS1428. The results from the AMS1428 certification testing was as follows:

WSET: 27 min with the low viscosity sample

LOUT: The lowest operational use temperature (LOUT) is -18C for the low speed ramp and -29C for the high speed ramp.

4.3 Endurance Time Data

Endurance time values, for all conditions, are those of the 2003-04 tests conducted with this fluid. Figures 4.1 to 4.5 present the data collected in natural snow, freezing drizzle, light freezing rain, freezing fog and rain on cold-soaked surface, and these figures show the effect of temperature and precipitation on fluid endurance times for each condition. Table 4.1 contains the results derived from the endurance time tests. For frost, a conservative endurance time of 120 minutes was selected based on limited outdoor testing and the HHET requirement of 120 minutes. Table 4.2 illustrates the outputs from the regression equations run for this fluid under natural snow, freezing fog, freezing drizzle, freezing rain and cold soak conditions.

4.4 Comparison With Type I Holdover times

A comparison of the Clariant Type III endurance times and the current Type I holdover times is provided in Figures 4.6 to 4.10 for each of the Holdover table conditions. The figures clearly demonstrate the advantage of the Type III fluid.

4.5 Holdover Time Table for 2004-05

Most of the endurance times shown in Table 4.1 with the Type III product were reduced by 10% and those newly reduced values were rounded using current protocols that are used for Type II/IV and Type I fluids. The resulting holdover times are presented in Table 4.3.

Table 4.1: Clariant Safewing MP III 2031 Endurance Time Test Results

OAT		Approximate Holdover Times Under Various Weather Conditions (minutes)								
°C	°F	Frost	Freezing Fog	Very Light Snow	Light Snow	Moderate Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold-Soak Wing	Other
-3 and above	27 and above	120	25 - 46	39 - 48	21 - 39	11 - 21	14 - 27	9 - 13	7 - 25	
below -3 to -10	below 27 to 14	120	25 - 40	34 - 42	18 - 34	10 - 18	13 - 23	11 - 14	CAUTION: No holdover time guidelines exist	
below -10	below 14	120	24 - 45	30 - 37	16 - 30	9 - 16				

Table 4.2: Summary of Regression Equation Coefficients for Clariant MP III 2031

Natural Snow Conditions

Fluid	Dil	R^2	Intercept I	Coeff. Log_Rate A	Coeff. Log_Temp B	Total Pts.
C 2031	Neat	90%	2.1	-0.70	-0.15	53

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

Simulated Freezing Fog

Fluid	Dil	TEMP	R^2	Intercept I	Coeff. Log_Rate A	Total Pts.
C2031	Neat	-3°C	99%	1.9	-0.65	4
C2031	Neat	-14°C	99%	1.7	-0.49	4
C2031	Neat	-25°C	100%	1.9	-0.67	4

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

Simulated Freezing Drizzle

Fluid	Dil	TEMP	R^2	Intercept I	Coeff. Log_Rate A	Total Pts.
C2031	Neat	-3°C	100%	1.9	-0.71	4
C2031	Neat	-10°C	100%	1.8	-0.59	4

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

Simulated Light Freezing Rain

Fluid	Dil	TEMP	R^2	Intercept I	Coeff. Log_Rate A	Total Pts.
C2031	Neat	-3°C	99%	1.7	-0.54	4
C2031	Neat	-10°C	97%	1.6	-0.42	4

General Equation t = 10 I RA (-T)B

Simulated Rain on Cold Soaked Wing

Fluid	Dil	TEMP	R^2	Intercept I	Coeff. Log_Rate A	Total Pts.
C2031	Neat	+1°C	100%	1.7	-0.46	4

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

Table 4.3: Generic Type III Fluid Holdover Times

OAT		Approximate Holdover Times Under Various Weather Conditions (minutes)								
°C	°F	Frost	Freezing Fog	Very Light Snow	Light Snow	Moderate Snow	Freezing Drizzle	Light Freezing Rain	Rain on Cold-Soak Wing	Other
-3 and above	27 and above	120	20 - 40	35 - 40	20 - 35	10 - 20	10 - 20	8 - 10	6 - 20	
below -3 to -10	below 27 to 14	120	20 - 40	30 - 35	15 - 30	9 - 15	10 - 20	8 - 10	CAUTION: No holdover time guidelines exist	
below -10	below 14	120	20 - 40	30 - 35	15 - 30	8 - 15				

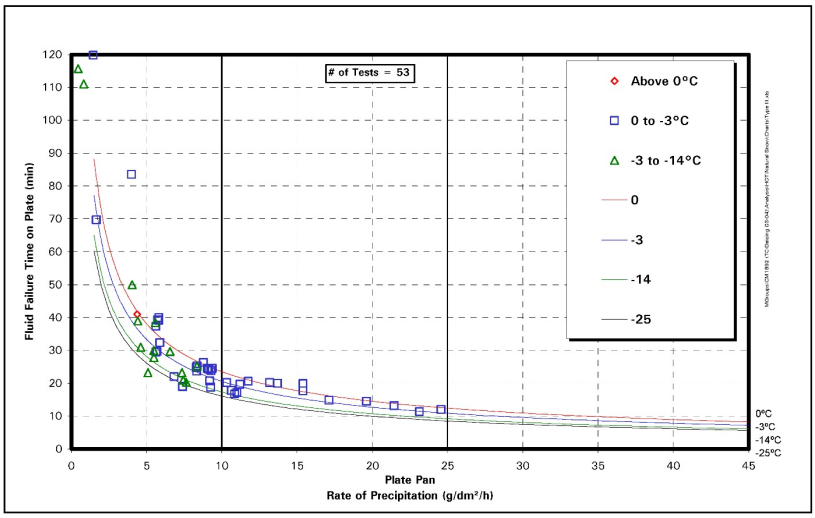

Figure 4.1: Type III Neat – Natural Snow

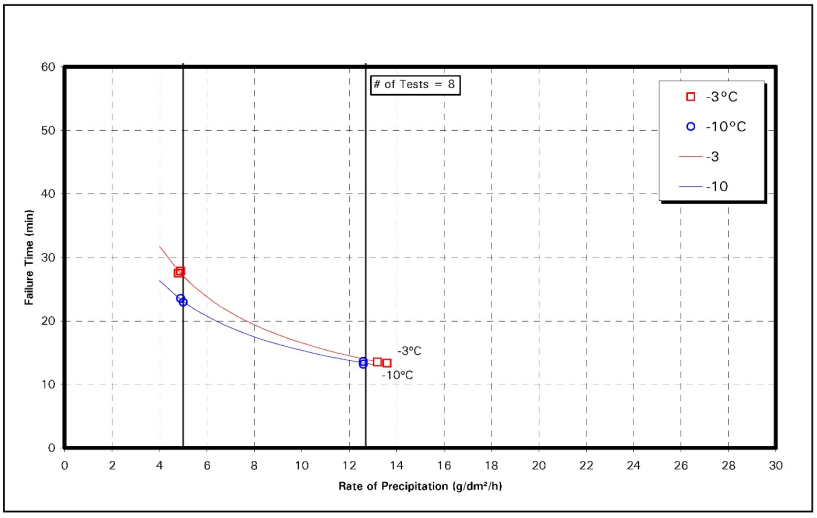

Figure 4.2: Type III Neat – Freezing Drizzle

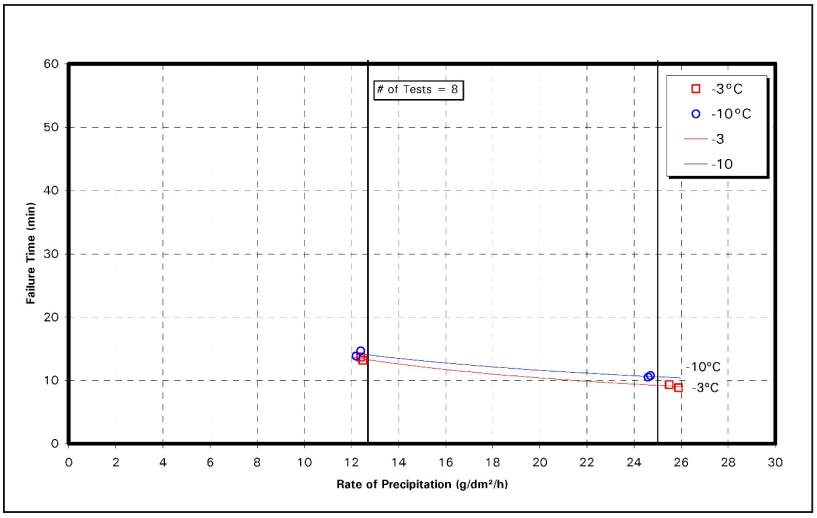

Figure 4.3: Type III Neat – Light Freezing Rain

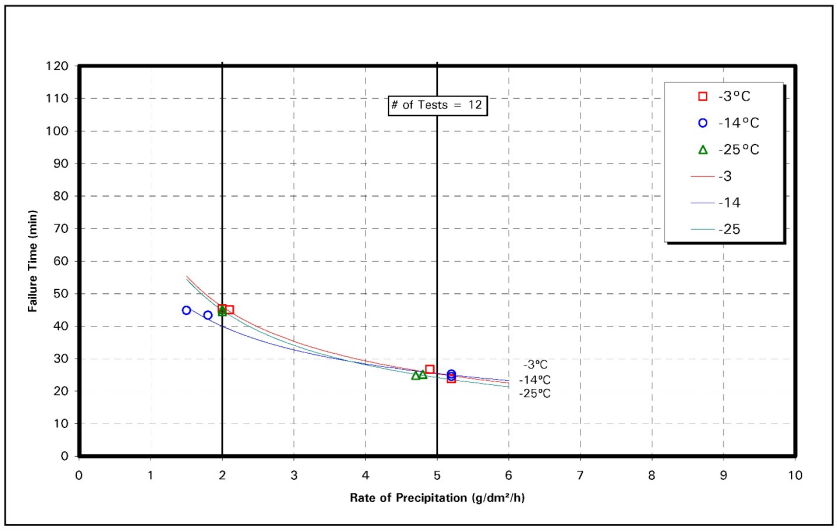

Figure 4.4: Type III Neat – Freezing Fog

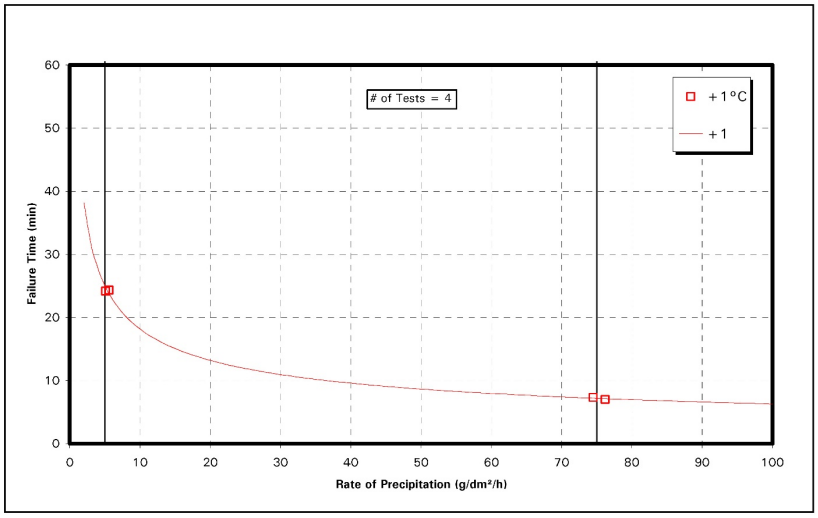

Figure 4.5: Type III Neat – Rain on Cold Soaked Wing

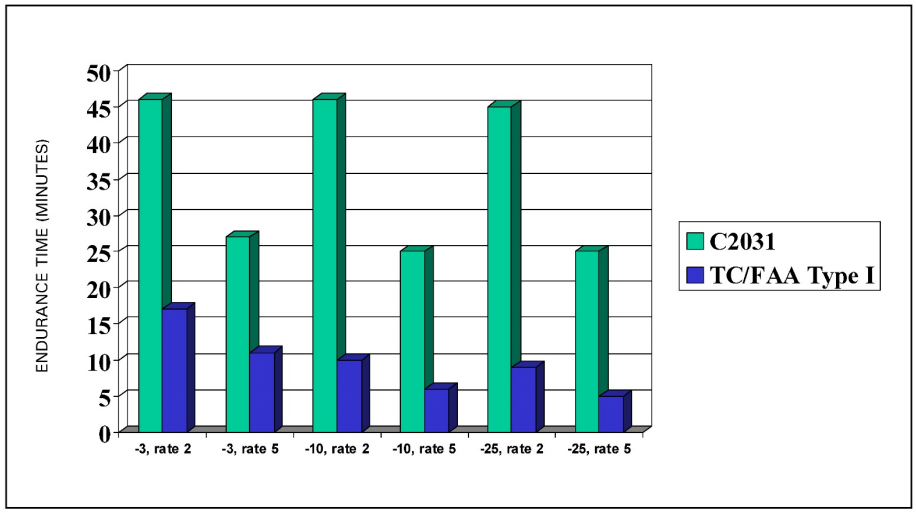

Figure 4.6: Freezing Fog Test Results

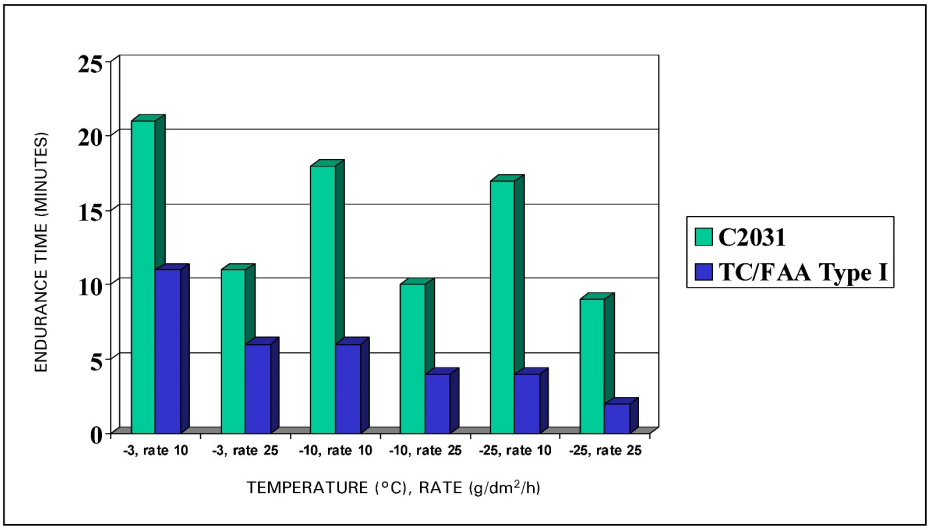

Figure 4.7: Snow Test Results

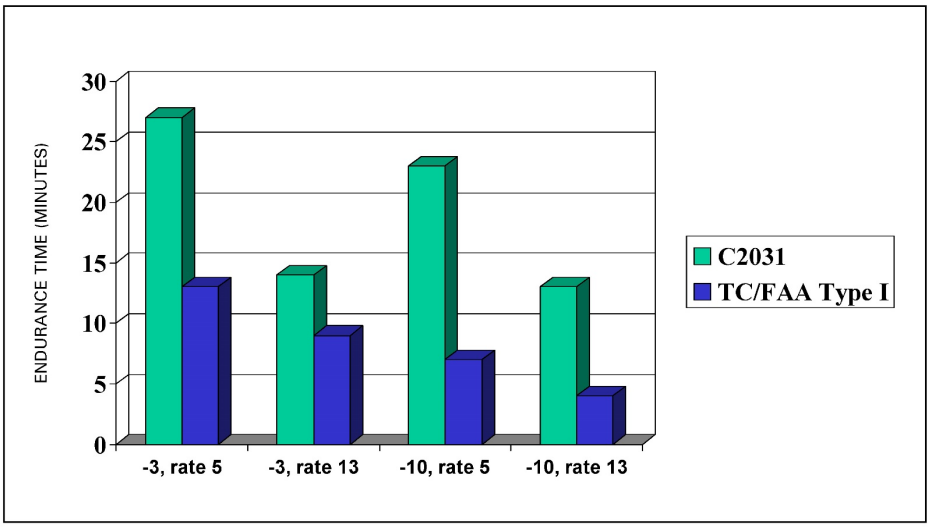

Figure 4.8: Freezing Drizzle Test Results

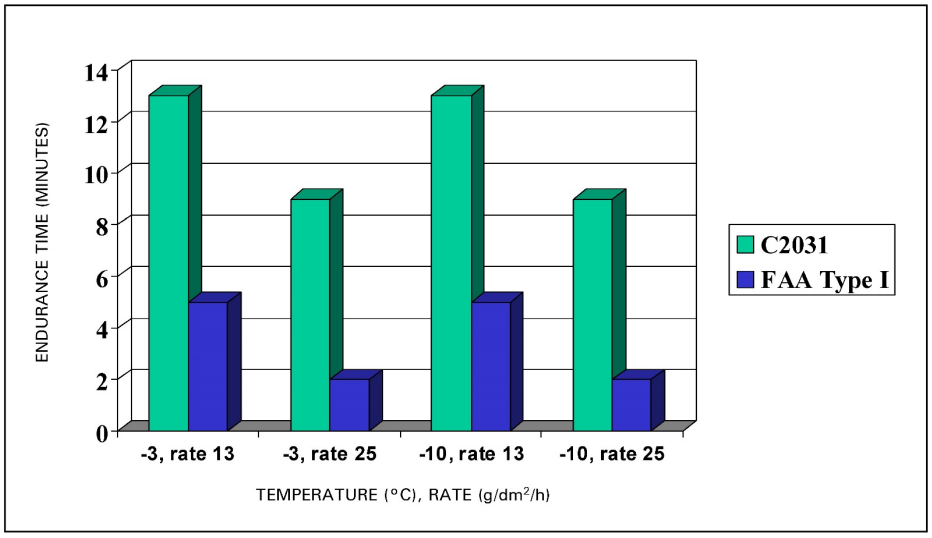

Figure 4.9: Light Freezing Rain Test Results

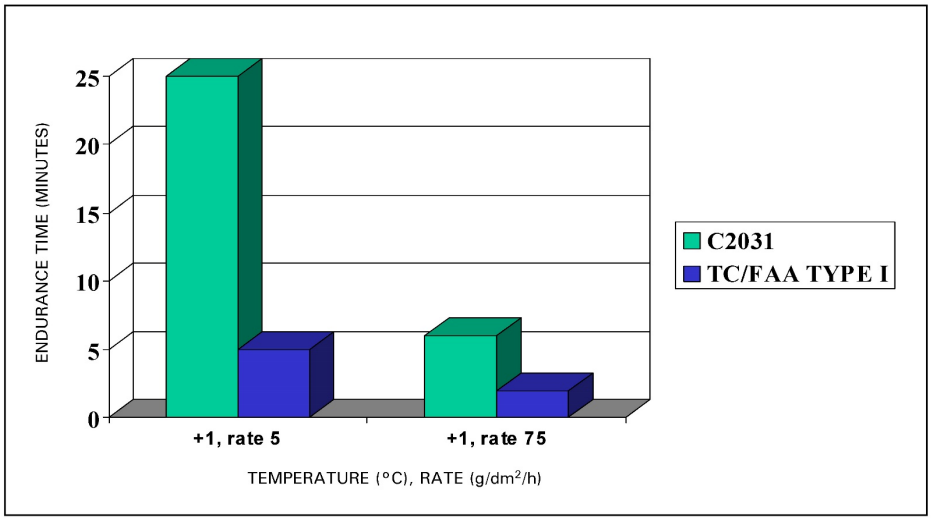

Figure 4.10: Rain on a Cold-Soaked Wing Test Results

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APPENDIX D

TRANSPORT CANADA AND FEDERAL AVIATION ADMINISTRATION 2004-05 HOLDOVER TIME GUIDELINES

TRANSPORT CANADA
HOLDOVER TIME (HOT) GUIDELINES
WINTER 2004-2005

Transport Canada Holdover Time (HOT) Guidelines Winter 2004-2005

Original Issue, July 2004

CHANGE CONTROL RECORDS

A new complete revision of this document will not necessarily be reissued when there are changes. This page will serve to indicate the changes made to individual pages within the document and those changed pages will have the appropriate date in the footer. Sidebars are shown to assist in identifying the changes from the previous version.

It is the responsibility of the end user to periodically check the following website for any Holdover Time Guideline updates: 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.

General

Previously Holdover Time (HOT) Guidelines were attached to the Commercial & Business Aviation Advisory Circular (CBAAC) entitled *Aircraft Ground Icing Update*. The CBAAC contained both reference information relating to Ground Icing Operations and the HOT Guidelines. Last year (2003), a decision was made to do away with the CBAAC, and move the contents of the CBAAC into two separate documents. The two documents complement each other and, for a more thorough understanding of the subject matter, should be used together. The first document (TP 14052E) includes reference material related to Ground Icing Operations. The second document consists of the HOT Guidelines. It was determined that the dissemination of current HOT Guideline information would be accomplished in a more timely and effective manner by the use of a dedicated website. Therefore, for the second consecutive year, the Holdover Time Table Guidelines can be found at this website, and TP 14052E will contain only reference information relating to Ground Icing Operations.

Type I Fluid

No changes were made to the HOT values from last year.

Type II / IV Fluid

One new Type IV fluid, Octagon Max-Flight 04, has been certified and will be introduced for the 2004-05 winter season. A fluid-specific table has been created for this fluid. No new Type II fluids were introduced.

Only very limited data has ever been collected in temperatures below -14°C in snow. In the winter of 2003-04, testing was conducted with artificial snowmakers at these temperatures with certified Type II and Type IV fluids that have fluid-specific tables. As a result, the generic Type II and Type IV value (15 to 30 minutes) has been applied to all fluid-specific tables, with the exception of Dow UCAR ADF/AAF Ultra+. This change has led to a reduction in the -14° to -25°C snow cell for the following fluids: SPCA Ecowing 26, Clariant Safewing MP IV 1957, Clariant Safewing MP IV 2001, Kilfrost ABC-S, Octagon Max-Flight and SPCA AD-480.

In addition, one Type IV fluid-specific table was removed because the fluid is no longer available commercially. The removal of Clariant Safewing Four did not have an impact on the generic Type IV holdover guideline values.

Type III Fluid

A new Type III generic table was produced this year. Several years ago, a need was identified for a de/anti-icing fluid that had longer holdover times than Type I fluid but a lower viscosity than Type II or IV fluid for aircraft with slower rotation speeds. Clariant produced a fluid to meet these requirements and, after undergoing extensive testing by TC and the FAA, this fluid, Clariant Safewing MP III 2031 ECO, has been certified as a Type III fluid. Values in the new generic Type III holdover time guidelines were generally based on the holdover times of this fluid.

The application procedure for Type III fluid is the same as the application procedure for Type II and Type IV fluids. Type III has been added to the Type II/Type IV application procedures table (Table 7).

HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2004-2005

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 1

SAE TYPE I[5] FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005

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

OAT		Approximate Holdover Times Under Various Weather Conditions (minutes)								
°C	°F	Frost[2]	Freezing Fog	Very Light Snow[1]	Light Snow[1]	Moderate Snow[1]	Freezing Drizzle[3]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[4]
-3 and above	27 and above	45	11 – 17	18	11 – 18	6 – 11	9 – 13	4 – 6	2 – 5	
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				

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature FP = Freezing Point

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 During conditions that apply to aircraft protection for ACTIVE FROST.
3 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
4 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
5 Type I Fluid / Water Mixture is selected so that the FP 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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 2-Generic

SAE TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005[1]

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

OAT		Type II Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Neat Fluid/Water (Vol% / Vol%)	Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	12:00	0:35 – 1:30	0:20 – 0:55	0:30 – 0:55	0:15 – 0:30	0:05 – 0:40	
		75/25	6:00	0:25 – 1:00	0:15 – 0:40	0:20 – 0:45	0:10 – 0:25	0:05 – 0:25	
		50/50	4:00	0:15 – 0:30	0:05 – 0:15	0:05 – 0:15	0:05 – 0:10		
0 to -3	32 to 27	100/0	8:00	0:35 – 1:30	0:20 – 0:45	0:30 – 0:55	0:15 – 0:30	CAUTION:	
		75/25	5:00	0:25 – 1:00	0:15 – 0:30	0:20 – 0:45	0:10 – 0:25	No holdover	
		50/50	3:00	0:15 – 0:30	0:05 – 0:15	0:05 – 0:15	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	8:00	0:20 – 1:05	0:15 – 0:35	0:15 – 0:45[3]	0:10 – 0:25[3]	guidelines	
		75/25	5:00	0:20 – 0:55	0:15 – 0:25	0:15 – 0:30[3]	0:10 – 0:20[3]	exist	
below -14 to -25	below 7 to -13	100/0	8:00[7]	0:15 – 0:20[7]	0:15 – 0:30[7]				
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 OAT and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Based on tests of neat fluids with the lowest viscosity deliverable on the aircraft, yet meeting Type II WSET and HHET.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.
7 Ensure that the lowest operational use temperature (LOUT) is respected.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 2-C-2025

CLARIANT TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
SAFEWING MP II 2025 ECO (5,500 mPa.s viscosity)[1]

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

OAT		Type II Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	12:00	1:30 – 2:05	0:45 – 1:20	0:40 – 1:00	0:25 – 0:35	0:10 – 1:15	
		75/25	6:00	0:55 – 1:45	0:25 – 0:45	0:25 – 0:45	0:20 – 0:25	0:05 – 0:50	
		50/50	4:00	0:20 – 0:35	0:10 – 0:20	0:10 – 0:15	0:05 – 0:10		
0 to -3	32 to 27	100/0	8:00	1:30 – 2:05	0:40 – 1:10	0:40 – 1:00	0:25 – 0:35	CAUTION:	
		75/25	5:00	0:55 – 1:45	0:25 – 0:45	0:25 – 0:45	0:20 – 0:25	No holdover	
		50/50	3:00	0:20 – 0:35	0:05 – 0:15	0:10 – 0:15	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	8:00	0:45 – 1:50	0:35 – 1:00	0:35 – 1:05[3]	0:20 – 0:35[3]	guidelines	
		75/25	5:00	0:40 – 1:20	0:25 – 0:45	0:30 – 0:40[3]	0:15 – 0:25[3]	exist	
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	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 Type I when Type II fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 2-K-ABC-2000

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
ABC-2000 (2,350 mPa.s viscosity)[1]

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

OAT		Type II Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	12:00	1:30 – 3:05	0:40 – 1:15	0:55 – 1:35	0:40 – 0:50	0:15 – 1:10	
		75/25	6:00	1:40 – 3:30	0:40 – 1:15	0:45 – 1:15	0:40 – 0:50	0:15 – 1:40	
		50/50	4:00	1:00 – 2:10	0:15 – 0:30	0:15 – 0:25	0:05 – 0:15		
0 to -3	32 to 27	100/0	8:00	1:30 – 3:05	0:30 – 1:00	0:55 – 1:35	0:40 – 0:50	CAUTION:	
		75/25	5:00	1:40 – 3:30	0:30 – 1:05	0:45 – 1:15	0:40 – 0:50	No holdover	
		50/50	3:00	1:00 – 2:10	0:15 – 0:30	0:15 – 0:25	0:05 – 0:15	time	
below -3 to -14	below 27 to 7	100/0	8:00	0:35 – 1:25	0:25 – 0:45	0:25 – 0:50[3]	0:10 – 0:30[3]	guidelines	
		75/25	5:00	0:35 – 1:15	0:25 – 0:50	0:25 – 0:55[3]	0:15 – 0:30[3]	exist	
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	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 Type I when Type II fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle LV2 with guard leg, 150 mL of neat fluid, at 20°C, 0.3 rpm, 10 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 2-K-ABC-II+

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
ABC-II PLUS (3,600 mPa.s viscosity)[1]

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

OAT		Type II Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	12:00	1:10 – 2:25	0:35 – 1:20	0:35 – 1:10	0:30 – 0:40	0:05 – 1:00	
		75/25	6:00	1:10 – 2:25	0:35 – 1:10	0:30 – 1:00	0:20 – 0:40	0:05 – 0:50	
		50/50	4:00	0:15 – 0:45	0:20 – 0:40	0:05 – 0:25	0:05 – 0:15		
0 to -3	32 to 27	100/0	8:00	1:10 – 2:25	0:25 – 0:55	0:35 – 1:10	0:30 – 0:40	CAUTION: No holdover time guidelines exist	
		75/25	5:00	1:10 – 2:25	0:25 – 0:50	0:30 – 1:00	0:20 – 0:40		
		50/50	3:00	0:15 – 0:45	0:15 – 0:35	0:05 – 0:25	0:05 – 0:15		
below -3 to -14	below 27 to 7	100/0	8:00	0:30 – 1:05	0:15 – 0:35	0:15 – 0:45[3]	0:10 – 0:30[3]		
		75/25	5:00	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	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 OAT and the aerodynamic acceptance criteria are met. Consider use of Type I when Type II fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle LV2 with guard leg, 150 mL of neat fluid, at 20°C, 0.3 rpm, 10 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 2-O-EM-II

OCTAGON TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
E MAX II (13,520 mPa.s viscosity)[1]

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

OAT		Type II Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Neat Fluid/Water (Vol% / Vol%)	Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	12:00	2:05 – 3:45	0:45 – 1:30	0:45 – 1:35	0:30 – 0:40	0:15 – 1:30	
		75/25	6:00	1:25 – 2:50	0:30 – 1:00	0:40 – 1:10	0:20 – 0:30	0:10 – 1:05	
		50/50	4:00	0:30 – 0:55	0:15 – 0:30	0:15 – 0:30	0:10 – 0:15		
0 to -3	32 to 27	100/0	8:00	2:05 – 3:45	0:40 – 1:20	0:45 – 1:35	0:30 – 0:40	CAUTION:	
		75/25	5:00	1:25 – 2:50	0:25 – 0:55	0:40 – 1:10	0:20 – 0:30	No holdover	
		50/50	3:00	0:30 – 0:55	0:10 – 0:25	0:15 – 0:30	0:10 – 0:15	time	
below -3 to -14	below 27 to 7	100/0	8:00	0:50 – 1:45	0:35 – 1:10	0:35 – 1:00[3]	0:20 – 0:30[3]	guidelines	
		75/25	5:00	0:30 – 1:20	0:25 – 0:50	0:35 – 1:05[3]	0:15 – 0:30[3]	exist	
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	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 Type I when Type II fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle LV1 with guard leg, 500 mL of neat fluid, at 20°C, 0.3 rpm, 33 minutes 20 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 2-S-E26

SPCA TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
Ecowing 26 (4,900 mPa.s viscosity)[1]

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

OAT		Type II Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	12:00	1:25 – 2:35	0:40 – 1:05	0:50 – 1:35	0:40 – 0:50	0:20 – 1:20	
		75/25	6:00	1:05 – 1:55	0:30 – 0:50	0:45 – 1:05	0:25 – 0:35	0:10 – 1:00	
		50/50	4:00	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:05 – 0:10		
0 to -3	32 to 27	100/0	8:00	1:25 – 2:35	0:40 – 1:00	0:50 – 1:35	0:40 – 0:50	CAUTION:	
		75/25	5:00	1:05 – 1:55	0:25 – 0:45	0:45 – 1:05	0:25 – 0:35	No holdover	
		50/50	3:00	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	8:00	0:45 – 2:15	0:35 – 0:55	0:30 – 1:10[3]	0:15 – 0:35[3]	guidelines	
		75/25	5:00	0:35 – 1:15	0:25 – 0:40	0:20 – 0:50[3]	0:15 – 0:25[3]	exist	
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	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 Type I when Type II fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 30 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 3

SAE TYPE III FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005

Outside Air Temperature[4]		Approximate Holdover Times Under Various Weather Conditions (minutes)								
Degrees Celsius	Degrees Fahrenheit	Active Frost	Freezing Fog	Very Light Snow[3]	Light Snow[3]	Moderate Snow[3]	Freezing Drizzle[1]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[2]
-3 and above	27 and above	120	20 – 40	35	20 – 35	10 – 20	10 – 20	8 – 10	6 – 20	
below -3 to -10	below 27 to 14	120	20 – 40	30	15 – 30	9 – 15	10 – 20	8 – 10	CAUTION: No holdover time guidelines exist	
below -10	below 14	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 Snow includes snow grains.
4 Ensure that the lowest operational use temperature (LOUT) is respected, otherwise consider use of Type I when Type III fluid cannot be used.

CAUTIONS
- **The only acceptable decision criteria time is the shortest 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 do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-Generic

SAE TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005[1]

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

OAT		Type IV Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	1:05 – 2:15	0:35 – 1:05	0:40 – 1:10	0:25 – 0:40	0:10 – 0:50	
		75/25	6:00	1:05 – 1:45	0:30 – 1:05	0:35 – 0:50	0:15 – 0:30	0:05 – 0:35	
		50/50	4:00	0:15 – 0:35	0:05 – 0:20	0:10 – 0:20	0:05 – 0:10		
0 to -3	32 to 27	100/0	12:00	1:05 – 2:15	0:30 – 0:55	0:40 – 1:10	0:25 – 0:40	CAUTION:	
		75/25	5:00	1:05 – 1:45	0:25 – 0:50	0:35 – 0:50	0:15 – 0:30	No holdover	
		50/50	3:00	0:15 – 0:35	0:05 – 0:15	0:10 – 0:20	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:20 – 1:20	0:20 – 0:40	0:20 – 0:45[3]	0:10 – 0:25[3]	guidelines	
		75/25	5:00	0:25 – 0:50	0:20 – 0:35	0:15 – 0:30[3]	0:10 – 0:20[3]	exist	
below -14 to -25	below 7 to -13	100/0	12:00[7]	0:15 – 0:40[7]	0:15 – 0:30[7]				
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 OAT and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Based on tests of neat fluids with the lowest viscosity deliverable on the aircraft, yet meeting Type IV WSET and HHET.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.
7 Ensure that the lowest operational use temperature (LOUT) is respected.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

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Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-C-1957

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
SAFEWING MP IV 1957 (16,200 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Neat Fluid/Water (Vol% / Vol%)	Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	1:05 – 2:15	0:35 – 1:05	0:40 – 1:10	0:30 – 0:45	0:15 – 1:10	
		75/25	6:00	1:10 – 2:10	0:35 – 1:05	0:35 – 1:05	0:25 – 0:40	0:10 – 1:00	
		50/50	4:00	0:25 – 0:50	0:15 – 0:30	0:15 – 0:25	0:05 – 0:15		
0 to -3	32 to 27	100/0	12:00	1:05 – 2:15	0:30 – 0:55	0:40 – 1:10	0:30 – 0:45	CAUTION:	
		75/25	5:00	1:10 – 2:10	0:30 – 0:50	0:35 – 1:05	0:25 – 0:40	No holdover	
		50/50	3:00	0:25 – 0:50	0:10 – 0:20	0:15 – 0:25	0:05 – 0:15	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:45 – 1:30	0:30 – 0:50	0:35 – 0:55[3]	0:20 – 0:35[3]	guidelines	
		75/25	5:00	0:25 – 1:10	0:20 – 0:40	0:25 – 0:55[3]	0:15 – 0:30[3]	exist	
below -14 to -25	below 7 to -13	100/0	12:00	0:25 – 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 OAT and the aerodynamic acceptance criteria are met. Consider use of Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-C-2001

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
SAFEWING MP IV 2001 (18,000 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Neat Fluid/Water (Vol% / Vol%)	Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	1:20 – 3:20	1:55 – 2:00	0:55 – 1:55	0:40 – 1:00	0:15 – 2:00	
		75/25	6:00	1:20 – 2:00	0:50 – 1:25	0:35 – 1:10	0:25 – 0:35	0:10 – 1:25	
		50/50	4:00	0:15 – 0:40	0:10 – 0:20	0:10 – 0:20	0:05 – 0:15		
0 to -3	32 to 27	100/0	12:00	1:20 – 3:20	1:00 – 1:55	0:55 – 1:55	0:40 – 1:00	CAUTION:	
		75/25	5:00	1:20 – 2:00	0:35 – 1:00	0:35 – 1:10	0:25 – 0:35	No holdover	
		50/50	3:00	0:15 – 0:40	0:10 – 0:20	0:10 – 0:20	0:05 – 0:15	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:45 – 1:35	0:30 – 0:50	0:55 – 1:35[3]	0:30 – 0:45[3]	guidelines	
		75/25	5:00	0:30 – 1:00	0:20 – 0:35	0:40 – 1:10[3]	0:20 – 0:30[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-C-2012

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
SAFEWING MP IV 2012 PROTECT (7,800 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	1:15 – 2:30	1:05 – 2:00	0:40 – 1:10	0:25 – 0:45	0:10 – 1:05	
		75/25	6:00	1:10 – 2:05	0:35 – 1:10	0:35 – 0:50	0:15 – 0:30	0:05 – 0:40	
		50/50	4:00	0:25 – 0:45	0:15 – 0:25	0:15 – 0:20	0:05 – 0:10		
0 to -3	32 to 27	100/0	12:00	1:15 – 2:30	0:40 – 1:15	0:40 – 1:10	0:25 – 0:45	CAUTION:	
		75/25	5:00	1:10 – 2:05	0:25 – 0:55	0:35 – 0:50	0:15 – 0:30	No holdover	
		50/50	3:00	0:25 – 0:45	0:15 – 0:25	0:15 – 0:20	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:45 – 1:35	0:20 – 0:40	0:25 – 0:45[3]	0:15 – 0:25[3]	guidelines	
		75/25	5:00	0:25 — 1:05	0:20 – 0:40	0:15 – 0:30[3]	0:10 – 0:20[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-C-2030

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
SAFEWING MP IV 2030 ECO (10,500 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Neat Fluid/Water (Vol% / Vol%)	Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	1:55 – 3:20	0:50 – 1:35	0:55 – 2:00	0:40 – 0:50	0:15 – 1:40	
		75/25	6:00	1:15 – 2:05	0:35 – 1:05	0:40 – 1:05	0:25 – 0:35	0:10 – 1:00	
		50/50	4:00	0:30 – 0:45	0:15 – 0:25	0:15 – 0:25	0:05 – 0:10		
0 to -3	32 to 27	100/0	12:00	1:55 – 3:20	0:50 – 1:30	0:55 – 2:00	0:40 – 0:50	CAUTION:	
		75/25	5:00	1:15 – 2:05	0:35 – 1:05	0:40 – 1:05	0:25 – 0:35	No holdover	
		50/50	3:00	0:30 – 0:45	0:15 – 0:25	0:15 – 0:25	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:50 – 2:00	0:45 – 1:25	0:30 – 1:10[3]	0:20 – 0:35[3]	guidelines	
		75/25	5:00	0:40 – 1:30	0:35 – 1:05	0:35 – 1:20[3]	0:15 – 0:30[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-D-ULTRA+

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
UCAR™ ADF/AAF ULTRA+ (36,000 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	1:35 – 3:35	0:40 – 1:25	0:45 – 1:35	0:25 – 0:40	0:10 – 1:20	
		75/25							
		50/50							
0 to -3	32 to 27	100/0	12:00	1:35 – 3:35	0:35 – 1:15	0:45 – 1:35	0:25 – 0:40	CAUTION: No holdover time guidelines exist	
		75/25							
		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[3]	0:30 – 0:45[3]		
		75/25							
below -14 to -25	below 7 to -13	100/0	12:00[7]	0:40 – 2:10[7]	0:20 – 0:45[7]				
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 OAT and the aerodynamic acceptance criteria are met.[7] Consider use of Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-31/13R, small sample adapter, 10 mL of neat fluid, at 0°C, 0.3 rpm, for 10 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.
7 The lowest operational use temperature (LOUT) for this fluid is -24°C (-11°F).

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-K-ABC-S

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
ABC-S (17,000 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	2:35 – 4:00	1:10 – 2:00	1:20 – 1:50	1:00 – 1:25	0:20 – 1:15	
		75/25	6:00	1:05 – 1:45	0:30 – 1:05	0:45 – 1:10	0:35 – 0:50	0:10 – 0:50	
		50/50	4:00	0:20 – 0:35	0:05 – 0:20	0:15 – 0:20	0:05 – 0:10		
0 to -3	32 to 27	100/0	12:00	2:35 – 4:00	1:00 – 1:40	1:20 – 1:50	1:00 – 1:25	CAUTION:	
		75/25	5:00	1:05 – 1:45	0:30 – 0:55	0:45 – 1:10	0:35 – 0:50	No holdover	
		50/50	3:00	0:20 – 0:35	0:05 – 0:15	0:15 – 0:20	0:05 – 0:10	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:45 – 2:05	0:45 – 1:20	0:20 – 1:00[3]	0:10 – 0:30[3]	guidelines	
		75/25	5:00	0:25 – 1:00	0:25 – 0:50	0:20 – 1:10[3]	0:10 – 0:35[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle LV2 with guard leg, 150 mL of neat fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-O-MF

OCTAGON TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
MAX-FLIGHT (5,540 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F	Neat Fluid/Water (Vol% / Vol%)	Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	2:40 – 4:00	1:15 – 2:00	0:55 – 2:00	0:35 – 1:00	0:15 – 1:15	
		75/25	6:00	2:05 – 3:15	1:20 – 2:00	1:15 – 2:00	0:35 – 1:10	0:10 – 0:40	
		50/50	4:00	0:55 – 1:45	0:40 – 1:20	0:35 – 1:00	0:15 – 0:30		
0 to -3	32 to 27	100/0	12:00	2:40 – 4:00	0:50 – 1:35	0:55 – 2:00	0:35 – 1:00	CAUTION:	
		75/25	5:00	2:05 – 3:15	0:45 – 1:45	1:15 – 2:00	0:35 – 1:10	No holdover	
		50/50	3:00	0:55 – 1:45	0:25 – 1:15	0:35 – 1:00	0:15 – 0:30	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:50 – 2:30	0:25 – 0:50	0:25 – 1:10[3]	0:20 – 0:40[3]	guidelines	
		75/25	5:00	0:30 – 1:05	0:20 – 0:50	0:20 – 1:00[3]	0:15 – 0:30[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle LV1 with guard leg, 500 mL of neat fluid, at 20°C, 0.3 rpm, 33 minutes 20 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-O-MF-04

OCTAGON TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
MAX-FLIGHT 04 (5,540 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	2:40 – 4:00	2:00 – 2:00	2:00 – 2:00	1:10 – 1:30	0:20 – 2:00	
		75/25	6:00	2:05 – 3:15	1:35 – 2:00	1:50 – 2:00	1:00 – 1:20	0:20 – 2:00	
		50/50	4:00	0:55 – 1:45	0:40 – 2:00	0:35 – 1:10	0:25 – 0:35		
0 to -3	32 to 27	100/0	12:00	2:40 – 4:00	1:25 – 2:00	2:00 – 2:00	1:10 – 1:30	CAUTION:	
		75/25	5:00	2:05 – 3:15	1:05 – 2:00	1:50 – 2:00	1:00 – 1:20	No holdover	
		50/50	3:00	0:55 – 1:45	0:25 – 1:15	0:35 – 1:10	0:25 – 0:35	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:50 – 2:30	0:35 – 1:10	0:25 – 1:30[3]	0:20 – 0:40[3]	guidelines	
		75/25	5:00	0:30 – 1:05	0:40 – 1:20	0:20 – 1:00[3]	0:15 – 0:30[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle LV1 with guard leg, 500 mL of neat fluid, at 20°C, 0.3 rpm, 33 minutes 20 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

Transport Canada Holdover Time Guidelines — Winter 2004-2005

TABLE 4-S-AD-480

SPCA TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2004-2005
AD-480 (15,200 mPa.s viscosity)[1]

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

OAT		Type IV Fluid Concentration Neat Fluid/Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
°C	°F		Frost[2]	Freezing Fog	Snow[6]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing	Other[5]
above 0	above 32	100/0	18:00	2:00 – 3:30	0:55 – 1:50	0:50 – 1:30	0:35 – 0:55	0:15 – 1:35	
		75/25	6:00	1:30 – 2:45	0:40 – 1:20	0:50 – 1:15	0:30 – 0:45	0:10 – 1:15	
		50/50	4:00	0:30 – 0:45	0:15 – 0:30	0:15 – 0:25	0:05 – 0:15		
0 to -3	32 to 27	100/0	12:00	2:00 – 3:30	0:40 – 1:20	0:50 – 1:30	0:35 – 0:55	CAUTION:	
		75/25	5:00	1:30 – 2:45	0:30 – 1:05	0:50 – 1:15	0:30 – 0:45	No holdover	
		50/50	3:00	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:05 – 0:15	time	
below -3 to -14	below 27 to 7	100/0	12:00	0:20 – 1:20	0:30 – 0:55	0:25 – 1:20[3]	0:15 – 0:30[3]	guidelines	
		75/25	5:00	0:25 – 0:50	0:20 – 0:45	0:25 – 1:05[3]	0:15 – 0:30[3]	exist	
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	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 Type I when Type IV fluid cannot be used.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature Vol = Volume

NOTES

1 Lowest on-wing viscosity - Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of neat fluid, at 20°C, 0.3 rpm, for 30 minutes 0 seconds.
2 During conditions that apply to aircraft protection for ACTIVE FROST.
3 The lowest use temperature is limited 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 Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, and hail.
6 Snow includes snow grains.

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 also be reduced when aircraft skin temperature is lower than OAT.**
- **The only acceptable decision criteria time is the shortest time within the applicable holdover time table cell.**
- **Fluids used during ground deicing do not provide ice protection during flight.**

TABLE 5

CURRENTLY QUALIFIED FLUIDS (2004-2005)

NOTE:
Concentrate fluids have also been qualified at 50/50 (glycol/water) dilution.

Table 5-1: Qualified Type I Anti-icing Fluids†

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
1-1	Arkton Ltd	Arctica DG	06-03-30
1-2	Aviation Xi' an High-tech	KHF-1	05-02-24
1-3	Beijing Wangye Aviation Chemical Product Co. Ltd.	KLA-1	05-09-26
1-4	Clariant GmbH	Clariant Safewing MP I 1938 TF	06-07-XX *
1-5	Clariant GmbH	Clariant Safewing MP I 1938 PRE-MIX (60%IG) Ready-to-use	04-07-30
1-6	Clariant GmbH	Clariant Safewing MP I 1938 ECO	06-07-XX *
1-7	Clariant GmbH	Clariant Safewing EG I 1996	06-07-XX *
1-8	Dow Chemical Company	Dow UCAR™ Aircraft Deicing Fluid Concentrate	06-02-16
1-9	Dow Chemical Company	Dow UCAR™ ADF XL-54	04-08-07
1-10	Dow Chemical Company	Dow UCAR™ PG Aircraft Deicing Fluid	05-07-15
1-11	Dow Chemical Company	Dow UCAR™ PG ADF Dilute 55/45	06-05-17
1-12	HOC Industries	HOC SafeTemp I ES	04-08-22
1-13	Inland Technologies Inc.	Inland Duragly-P ready to use	05-09-11
1-14	Inland Technologies Inc.	Inland Duragly-E ready to use	05-10-20
1-15	Kilfrost Limited	Kilfrost DF PLUS	05-09-11
1-16	Kilfrost Limited	Kilfrost DF PLUS (80)	06-XX-XX *
1-17	Kilfrost Limited	Kilfrost DF PLUS (88)	05-09-03
1-18	Lyondell Chemical Co.	Lyondell ARCOPlus	06-03-29
1-19	Lyondell Chemical Co.	Lyondell ARCTIC Plus™	06-03-15
1-20	Newave Aerochemical Co. Ltd.	FCY-1A	05-06-04
1-21	Octagon Process Inc.	Octagon Octaflo EF	05-07-25
1-22	Octagon Process Inc.	Octagon Octaflo EG	05-07-24
1-23	SPCA	SPCA DE-950	06-06-08

† 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.uquebec.ca/amil/
For other specification requirements for Type I fluids, see SAE AMS 1424 (latest version).

* Currently in qualification process.

TABLE 5 (cont.)

CURRENTLY QUALIFIED FLUIDS (2004-2005)

Table 5-2: Qualified Type II Anti-icing Fluids†

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
2-1	Clariant GmbH	Clariant Safewing MP II 1951	05-07-11
2-2	Clariant GmbH	Clariant Safewing MP II 2025 ECO	06-07-XX *
2-3	Kilfrost Limited	Kilfrost ABC-II PLUS	05-10-29
2-4	Kilfrost Limited	Kilfrost ABC-3	06-XX-XX *
2-5	Kilfrost Limited	Kilfrost ABC-2000	06-XX-XX *
2-6	Octagon Process Inc.	Octagon E Max II	06-XX-XX *
2-7	SPCA	SPCA Ecowing 26	05-06-03

Table 5-3: Qualified Type III Anti-icing Fluids†

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
3-1	Clariant GmbH	Clariant Safewing MP III 2031 ECO (1)	05-12-08

(1) **CAUTION**: The lowest operational use temperature (LOUT) is -18°C (0°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 Type IV Anti-icing Fluids†

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
4-1	Clariant GmbH	Clariant Safewing MP IV 2001	06-XX-XX *
4-2	Clariant GmbH	Clariant Safewing MP IV 2012 Protect	05-03-31
4-3	Clariant GmbH	Clariant Safewing MP IV 2030 ECO	06-07-XX *
4-4	Dow Chemical Company	Dow UCAR™ ADF/AAF ULTRA+	06-XX-XX *
4-5	Ely Chemical Company	Octagon Max-Flight	04-09-24
4-6	Kilfrost Limited	Kilfrost ABC-S	05-08-06
4-7	Octagon Process Inc.	Octagon Max-Flight	05-08-27
4-8	Octagon Process Inc.	Octagon Max-Flight 04	06-05-05
4-9	SPCA	SPCA AD-480	05-07-01

† 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.uquebec.ca/amil/
For other specification requirements for Type II, III or IV fluids, see SAE AMS 1428 (latest version).

* Currently in qualification process.

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	One-Step Procedure Deicing/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[1]
-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 To be applied before first step fluid freezes, typically within 3 minutes.

NOTE
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.

NOTE
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.

NOTE
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.

CAUTION
- **Wing skin temperatures may differ and in some cases may be lower than OAT; a stronger mix (more glycol) may be needed under these conditions.**

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)	One-Step Procedure Deicing/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[1]
-3°C (27°F) and above	50/50 Heated[2] 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[2] 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[2] 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 freezing point of the fluid is at least 7°C (13°F) below OAT and that aerodynamic acceptance criteria are met. Consider the use of Type I when Type II/III/IV fluid cannot be used (see Table 6).		

1 To be applied before first step fluid freezes, typically within 3 minutes.
2 Clean aircraft may be anti-iced with unheated fluid.

NOTE
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.

CAUTION
- **Wing skin temperatures may differ and in some cases may be lower than OAT; a stronger mix (more glycol) may be needed under these conditions.**
- **Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50/50 dilutions of Type II, 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)			
	°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.

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.

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FEDERAL AVIATION ADMINISTRATION
HOLDOVER TIME GUIDELINES
WINTER 2004-2005

TABLE OF CONTENTS FOR HOT GUIDELINES FOR WINTER 2004-2005

TABLE **PAGE**

Appendix 1

FAA TYPE I HOLDOVER TIME GUIDELINE

Table 1. FAA Guideline for Holdover Times Anticipated for SAE Type I Fluid Mixtures as a Function of Weather Conditions and OAT.
CAUTION: THIS TABLE IS FOR DEPARTURE PLANING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Approximate Holdover Times Under Various Weather Conditions (hours: minutes)								
°C	°F	Frost*	Freezing Fog	Very ♦ Light Snow◆◆	Light ♦ Snow◆◆	Moderate♦ Snow◆◆	**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	CAUTION: No holdover time guidelines exist
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: Clear ice may require touch for confirmation	
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				

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
FP = Freezing Point

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, hail
♦ Snow includes snow grains
◆◆ **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 FP 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 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 I** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR -- AND DOES NOT PROVIDE -- PROTECTION DURING FLIGHT.

Effective: October 1, 2004

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Appendix 1

TABLE 1A - FAA Guidelines for the Application of SAE Type I Fluid Mixtures.
Minimum Concentrations as a Function of Outside Air Temperature (OAT).
Concentrations in % V/V

<table>
<tr><td rowspan="2">OAT</td><td rowspan="2">One-step Procedure
Deicing/Anti-icing</td><td colspan="2">Two-step Procedure</td></tr>
<tr><td>First step: Deicing</td><td>Second step: Anti-icing [1]</td></tr>
<tr><td>-3 °C (27°F)
and above</td><td rowspan="2">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</td><td>Water or a mix of fluid and water heated to 60°C (140 °F) minimum at the nozzle</td><td rowspan="2">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</td></tr>
<tr><td>Below
-3 °C (27 °F)</td><td>Freezing point of heated fluid mixture shall not be more than 3 °C (5 °F) above OAT</td></tr>
<tr><td colspan="4">Note: Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.

Note: 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.

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.</td></tr>
<tr><td colspan="4">1) To be applied before first step fluid freezes, typically within 3 minutes.</td></tr>
</table>

Effective: October 1, 2004

Appendix 1

TABLE 1B. SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY FOR TYPE I HOLDOVER TIME GUIDELINES

Time of Day	Temp.		Visibility (Statute Mile)							
	(°C)	(°F)	≥2 1/2	2	1 1/2	1	3/4	1/2	≤1/4	Snowfall Intensity
Day	colder/equal -1	colder/equal 30	Very Light	Very Light	Light	Light	Moderate	Moderate	**Heavy**	
	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 : Based upon technical report, "The Estimation of Snowfall Rate Using Visibility," Rasmussen, et al., Journal of Applied Meteorology, October 1999 and additional in situ data.

NOTE: This table may be employed in estimating snow intensities for use with Type II, III and Type IV Holdover Time Guidelines.

HEAVY = Caution - no holdover time guidelines exist

Effective: October 1, 2004

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Appendix 1

FAA TYPE II HOLDOVER TIME GUIDELINE

TABLE 2 - FAA Guideline for Holdover Times Anticipated for SAE Type II Fluid Mixtures as a Function of Weather Conditions and OAT.

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

Outside Air Temperature (OAT)		Manufacturer Specific Type II Fluid Concentration	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F	Neat-Fluid/Water (Vol. %/Vol. %)	Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	0:35-1:30	0:20-0:55	0:30-0:55	0:15-0:30	0:05-0:40	CAUTION: No holdover time guidelines exist
		75/25	6:00	0:25-1:00	0:15-0:40	0:20-0:45	0:10-0:25	0:05-0:25	
		50/50	4:00	0:15-0:30	0:05-0:15	0:05-0:15	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	0:35-1:30	0:20-0:45	0:30-0:55	0:15-0:30		
		75/25	5:00	0:25-1:00	0:15-0:30	0:20-0:45	0:10-0:25		
		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	0:15-0:35	**0:15-0:45	**0:10-0:25		
		75/25	5:00	0:20-0:55	0:15-0:25	**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	**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.						

°C = Degrees Celsius °F = Degrees Fahrenheit OAT = Outside Air Temperature VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST

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

*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

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

◆ Snow includes snow grains

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.

Effective: October 1, 2004

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Appendix 1

TABLE 2A - FAA Guideline for Holdover Times Anticipated for KILFROST ABC-II PLUS Type II Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 3,600cP, 20 °C, 0.3 RPM, Spindle LV2, 250ml beaker, 150ml fluid, 10 min. grd. leg.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	1:10-2:25	0:35-1:20	0:35-1:10	0:30-0:40	0:05-1:00	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:10-2:25	0:35-1:10	0:30-1:00	0:20-0:40	0:05-0:50	
		50/50	4:00	0:15-0:45	0:20-0:40	0:05-0:25	0:05-0:15	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	1:10-2:25	0:25-0:55	0:35-1:10	0:30-0:40		
		75/25	5:00	1:10-2:25	0:25-0:50	0:30-1:00	0:20-0:40		
		50/50	3:00	0:15-0:45	0:15-0:35	0:05-0:25	0:05-0:15		
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.						

°C = Degrees Celsius OAT = Outside Air Temperature
°F = Degrees Fahrenheit VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective: October 1, 2004

Appendix 1

TABLE 2B - FAA Guideline for Holdover Times Anticipated for KILFROST ABC-2000 Type II Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 2,350 cP, 20 °C, 0.3 RPM, Spindle LV2, 250ml beaker, 150ml fluid, 10 min. grd. leg.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	1:30-3:05	0:40-1:15	0:55-1:35	0:40-0:50	0:15-1:10	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:40-3:30	0:40-1:15	0:45-1:15	0:40-0:50	0:15-1:40	
		50/50	4:00	1:00-2:10	0:15-0:30	0:15-0:25	0:05-0:15	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	1:30-3:05	0:30-1:00	0:55-1:35	0:40-0:50		
		75/25	5:00	1:40-3:30	0:30-1:05	0:45-1:15	0:40-0:50		
		50/50	3:00	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	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.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective: October 1, 2004

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TABLE 2C - FAA Guideline for Holdover Times Anticipated for Octagon E-MAX II Type II Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 13,520 cP, 20 °C, 0.3 RPM, Spindle LV1, 600 ml beaker, 500 ml fluid, 33 min 20 sec, grd. leg*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	2:05-3:45	0:45-1:30	0:45-1:35	0:30-0:40	0:15-1:30	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:25-2:50	0:30-1:00	0:40-1:10	0:20-0:30	0:10-1:05	
		50/50	4:00	0:30-0:55	0:15-0:30	0:15-0:30	0:10-0:15	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	2:05-3:45	0:40-1:20	0:45-1:35	0:30-0:40		
		75/25	5:00	1:25-2:50	0:25-0:55	0:40-1:10	0:20-0:30		
		50/50	3:00	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	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 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 **Octagon E-MAX II Type II** fluid cannot be used.						

°C = Degrees Celsius OAT = Outside Air Temperature
°F = Degrees Fahrenheit VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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

Effective: October 1, 2004

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TABLE 2D – FAA Guideline for Holdover Times Anticipated for SPCA ECOWING 26 Type II Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% fluid Tested 4,900cP, 20 °C, 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 30 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	1:25-2:35	0:40-1:05	0:50-1:35	0:40-0:50	0:20-1:25	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:05-1:55	0:30-0:50	0:45-1:05	0:25-0:35	0:10-1:00	
		50/50	4:00	0:30-0:45	0:10-0:20	0:15-0:25	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	1:25-2:35	0:40-1:00	0:50-1:35	0:40-0:50		
		75/25	5:00	1:05-1:55	0:25-0:45	0:45-1:05	0:25-0:35		
		50/50	3:00	0:30-0:45	0:10-0:20	0:15-0:25	0:05-0:10		
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	**SPCA 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 **SPCA ECOWING 26 Type II** fluid cannot be used.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.
- **SPCA ECOWING 26 TYPE II** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

Appendix 1

TABLE 2E – FAA Guideline for Holdover Times Anticipated for CLARIANT SAFEWING MP II 2025 ECO Type II Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% fluid Tested 5,500cP, 20 °C, 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 15 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	1:30-2:05	0:45-1:20	0:40-1:00	0:25-0:35	0:10-1:15	CAUTION: No holdover time guidelines exist
		75/25	6:00	0:55-1:45	0:25-0:45	0:25-0:45	0:20-0:25	0:05-0:50	
		50/50	4:00	0:20-0:35	0:10-0:20	0:10-0:15	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	1:30-2:05	0:40-1:10	0:40-1:00	0:25-0:35		
		75/25	5:00	0:55-1:45	0:25-0:45	0:25-0:45	0:20-0:25		
		50/50	3:00	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	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	**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 **SAFEWING MPII 2025 Type II** fluid cannot be used.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective: October 1, 2004

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Appendix 1

FAA TYPE III HOLDOVER TIME GUIDELINE

Table 3. FAA Guideline for Holdover Times Anticipated for SAE Type III Fluid Mixture as a Function of Weather Conditions and OAT.

CAUTION: THIS TABLE IS FOR DEPARTURE PLANING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

Outside Air Temperature (OAT)		Approximate Holdover Times Under Various Weather Conditions (hours: minutes)								
Degrees Celsius (°C)	Degrees Fahrenheit (°F)	Frost*	Freezing Fog	Very ♦ Light Snow	Light ♦ Snow	Moderate♦ Snow	**Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
-3 and above	27 and above	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	CAUTION: No holdover time guidelines exist
below -3 to -10	below 27 to 14	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	CAUTION: Clear ice may require touch for confirmation	
below -10	below 14	2:00	0:20 - 0:40	0:30-0:35	0:15 - 0:30	0:08 - 0:15				

SAE Type III fluid may be used below –10 °C (14°F), provided the freezing point of the fluid is at least 7°C (13°F) below OAT and aerodynamic acceptance criteria 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.

* During conditions that apply to aircraft protection for ACTIVE FROST

** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

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

♦ Snow includes snow grains

CAUTIONS:

- **TO USE THESE TIMES, THE TYPE III FLUID MUST BE APPLIED UNDILUTED**
- 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.

Effective October 1, 2004

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Appendix 1

FAA TYPE IV HOLDOVER TIME GUIDELINE

TABLE 4 - FAA Guideline for Holdover Times Anticipated for SAE Type IV Fluid Mixtures as a Function of Weather Conditions and OAT.

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	1:05-2:15	0:35-1:05	0:40-1:10	0:25-0:40	0:10-0:50	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:05-1:45	0:30-1:05	0:35-0:50	0:15-0:30	0:05-0:35	
		50/50	4:00	0:15-0:35	0:05-0:20	0:10-0:20	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	1:05-2:15	0:30-0:55	0:40-1:10	0:25-0:40		
		75/25	5:00	1:05-1:45	0:25-0:50	0:35-0:50	0:15-0:30		
		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	0:20-0:35	**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.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective: October 1, 2004

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TABLE 4A - FAA Guideline for Holdover Times Anticipated for UCAR ULTRA+ Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 36,000cP, 0 °C, 0.3 RPM, Spindle SC4-31/13R, 10ml fluid, 10 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	1:35-3:35	0:40-1:25	0:45-1:35	0:25-0:40	0:10-1:20	CAUTION: No holdover time guidelines exist
		75/25							
		50/50						CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	1:35-3:35	0:35-1:15	0:45-1:35	0:25-0:40		
		75/25							
		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	**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 **UCAR ULTRA+ Type IV** fluid cannot be used.						

°C = Degrees Celsius OAT = Outside Air Temperature
°F = Degrees Fahrenheit VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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

Effective: October 1, 2004

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TABLE 4B - FAA Guideline for Holdover Times Anticipated for OCTAGON MAX-FLIGHT Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 5,540cP, 20 °C, 0.3 RPM, Spindle LV1, 600ml beaker, 500ml fluid, 33 min 20 sec, grd. leg.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	2:40-4:00	1:15-2:00	0:55-2:00	0:35-1:00	0:15-1:15	CAUTION: No holdover time guidelines exist
		75/25	6:00	2:05-3:15	1:20-2:00	1:15-2:00	0:35-1:10	0:10-0:40	
		50/50	4:00	0:55-1:45	0:40-1:20	0:35-1:00	0:15-0:30	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	2:40-4:00	0:50-1:35	0:55-2:00	0:35-1:00		
		75/25	5:00	2:05-3:15	0:45-1:45	1:15-2:00	0:35-1:10		
		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.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective: October 1, 2004

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Appendix 1

TABLE 4C - FAA Guideline for Holdover Times Anticipated for OCTAGON MAX-FLIGHT 04 Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 5,540cP, 20 °C, 0.3 RPM, Spindle LV1, 600ml beaker, 500ml fluid, 33 min 20 sec, grd. leg.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	2:40-4:00	2:00-2:00	2:00-2:00	1:10-1:30	0:20-2:00	CAUTION: No holdover time guidelines exist
		75/25	6:00	2:05-3:15	1:35-2:00	1:50-2:00	1:00-1:20	0:20-2:00	
		50/50	4:00	0:55-1:45	0:40-2:00	0:35-1:10	0:25-0:35	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	2:40-4:00	1:25-2:00	2:00-2:00	1:10-1:30		
		75/25	5:00	2:05-3:15	1:05-2:00	1:50-2:00	1:00-1:20		
		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.						

°C = Degrees Celsius °F = Degrees Fahrenheit VOL = Volume OAT = Outside Air Temperature

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

* During conditions that apply to aircraft protection for ACTIVE FROST

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

*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

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

◆ Snow includes snow grains

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.

Effective: October 1, 200

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TABLE 4D - FAA Guideline for Holdover Times Anticipated for KILFROST ABC-S Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 17,000cP, 20 °C, 0.3 RPM, Spindle LV2, 250ml beaker, 150ml fluid, 10 min. grd. leg.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	2:35-4:00	1:10-2:00	1:20-1:50	1:00-1:25	0:20-1:15	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:05-1:45	0:30-1:05	0:45-1:10	0:35-0:50	0:10-0:50	
		50/50	4:00	0:20-0:35	0:05-0:20	0:15-0:20	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	2:35-4:00	1:00-1:40	1:20-1:50	1:00-1:25		
		75/25	5:00	1:05-1:45	0:30-0:55	0:45-1:10	0:35-0:50		
		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.						

°C = Degrees Celsius °F = Degrees Fahrenheit VOL = Volume OAT = Outside Air Temperature

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective:

October 1, 2004

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Appendix 1

TABLE 4E - FAA Guideline for Holdover Times Anticipated for CLARIANT SAFEWING MP IV 1957 Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 16,200cP, 20° , 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 15 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	1:05-2:15	0:35-1:05	0:40-1:10	0:30-0:45	0:15-1:10	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:10-2:10	0:35-1:05	0:35-1:05	0:25-0:40	0:10-1:00	
		50/50	4:00	0:25-0:50	0:15-0:30	0:15-0:25	0:05-0:15	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	1:05-2:15	0:30-0:55	0:40-1:10	0:30-0:45		
		75/25	5:00	1:10-2:10	0:30-0:50	0:35-1:05	0:25-0:40		
		50/50	3:00	0:25-0:50	0:10-0:20	0:15-0:25	0:05-0:15		
below -3 to -14	below 27 to 7	100/0	12:00	0:45-1:30	0:30-0:50	**0:35-0:55	**0:20-0:35		
		75/25	5:00	0:25-1:10	0:20-0:40	**0:25-0:55	**0:15-0:30		
below -14 to -25	below 7 to -13	100/0	12:00	0:25-0:40	0:15-0:30				
below -25	below -13	100/0	**SAFEWING® MP IV 1957 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 **SAFEWING MP IV 1957 Type IV** fluid cannot be used.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.
- **SAFEWING MP IV 1957 TYPE IV** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

Effective: October 1, 2004

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TABLE 4F – FAA Guideline for Holdover Times Anticipated for CLARIANT SAFEWING MP IV 2001 Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 18,000cP, 20 °C, 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 15 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	1:20-3:20	1:55-2:00	0:55-1:55	0:40-1:00	0:15-2:00	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:20-2:00	0:50-1:25	0:35-1:10	0:25-0:35	0:10-1:25	
		50/50	4:00	0:15-0:40	0:10-0:20	0:10-0:20	0:05-0:15	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	1:20-3:20	1:00-1:55	0:55-1:55	0:40-1:00		
		75/25	5:00	1:20-2:00	0:35-1:00	0:35-1:10	0:25-0:35		
		50/50	3:00	0:15-0:40	0:10-0:20	0:10-0:20	0:05-0:15		
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	**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 **SAFEWING® MP IV 2001 Type IV** fluid cannot be used.						

°C = Degrees Celsius OAT = Outside Air Temperature
°F = Degrees Fahrenheit VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.
- **SAFEWING MP IV 2001 TYPE IV** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

Effective: October 1, 2004

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Appendix 1

TABLE 4G – FAA Guideline for Holdover Times Anticipated for CLARIANT SAFEWING MP IV 2012 PROTECT Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% fluid Tested 7,800cp, 20 °C, 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 15 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	1:15-2:30	1:05-2:00	0:40-1:10	0:25-0:45	0:10-1:05	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:10-2:05	0:35-1:10	0:35-0:50	0:15-0:30	0:05-0:40	
		50/50	4:00	0:25-0:45	0:15-0:25	0:15-0:20	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	1:15-2:30	0:40-1:15	0:40-1:10	0:25-0:45		
		75/25	5:00	1:10-2:05	0:25-0:55	0:35-0:50	0:15-0:30		
		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.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.

Effective: October 1, 2004

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Appendix 1

TABLE 4H - FAA Guideline for Holdover Times Anticipated for CLARIANT SAFEWING MP IV 2030 ECO Type IV Fluid Mixtures as a function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 10,500 cP, 20 °C, 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 15 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	1:55-3:20	0:50-1:35	0:55-2:00	0:40-0:50	0:15-1:40	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:15-2:05	0:35-1:05	0:40-1:05	0:25-0:35	0:10-1:10	
		50/50	4:00	0:30-0:45	0:15-0:25	0:15-0:25	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	1:55-3:20	0:50-1:30	0:55-2:00	0:40-0:50		
		75/25	5:00	1:15-2:05	0:35-1:05	0:40-1:05	0:25-0:35		
		50/50	3:00	0:30-0:45	0:15-0:25	0:15-0:25	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	12:00	0:50-2:00	0:45-1:25	**0:30-1:10	**0:20-0:35		
		75/25	5:00	0:40-1:30	0:35-1:05	**0:35-1:20	**0:15-0:30		
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	**CLARIANT SAFEWING MPIV 2030 ECO 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 SAFEWING MPIV 2030 ECO **Type IV** fluid cannot be used.						

°C = Degrees Celsius OAT = Outside Air Temperature
°F = Degrees Fahrenheit VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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 2030 ECO TYPE IV** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

Effective: October 1, 2004

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Appendix 1

TABLE 4I - FAA Guideline for Holdover Times Anticipated for SPCA AD-480 Type IV Fluid Mixtures as a Function of Weather Conditions and OAT – *Viscosity of Neat 100% Fluid Tested 15,200cP, 20 °C, 0.3 RPM, Spindle SC4-34/13R, 10ml fluid, 30 min.*

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	18:00	2:00-3:30	0:55-1:50	0:50-1:30	0:35-0:55	0:15-1:35	CAUTION: No holdover time guidelines exist
		75/25	6:00	1:30-2:45	0:40-1:20	0:50-1:15	0:30-0:45	0:10-1:15	
		50/50	4:00	0:30-0:45	0:15-0:30	0:15-0:25	0:05-0:15	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	12:00	2:00-3:30	0:40-1:20	0:50-1:30	0:35-0:55		
		75/25	5:00	1:30-2:45	0:30-1:05	0:50-1:15	0:30-0:45		
		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	**SPCA 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 **SPCA AD-480 Type IV** fluid cannot be used.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

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

* During conditions that apply to aircraft protection for ACTIVE FROST
** No holdover time guidelines exist for this condition below -10 °C (14 °F)
*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail
◆ Snow includes snow grains

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.
- **SPCA AD-480 TYPE IV** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

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Appendix 1

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 (OAT).

Concentrations in % V/V

OAT	One-step Procedure Deicing/Anti-icing	Two-step Procedure	
		First step: Deicing	Second step: Anti-icing[1,2]
-3 °C (27 °F) and above	50/50 Heated[2] Type II/IV or 100/0 Heated[2] Type III	Heated water or a heated mix of Type I, Type II, Type III or Type IV and water	50/50 Type II/IV or 100/0 Type III
Below –3 °C (27 °F) to –14 °C (7 °F)	75/25 Heated[2] Type II/IV or 100/0 Heated[2] Type III	Heated suitable mix of Type I, Type II, Type III, or Type IV, and water with FP not more than 3 °C (5 °F) above actual OAT	75/25 Type II/IV or 100/0 Type III
Below –14 °C (7 °F) to –25 °C (-13 °F)	100/0 Heated[2] Type II/III or IV	Heated suitable mix of Type I, Type II, Type III, or Type IV, and water with FP not more than 3 °C (5 °F) above actual OAT	100/0 Type II/III or IV
Below –25 °C (-13 °F)	**SAE Type II/IV** fluid may be used below –25 °C (-13 °F) provided that the freezing point of the fluid is at least a 7 °C (13 °F) below OAT and that aerodynamic acceptance criteria are met. **SAE Type III** fluid may be used below -10°C (14°F) provided that the freezing point of the fluid is at least 7°C (13°F) below OAT and that aerodynamic criteria are met. Consider the use of **SAE Type I** when **Type II, III or IV** fluid cannot be used.		

1) To be applied before first step fluid freezes, typically within 3 minutes.

2) Clean aircraft may be anti-iced with unheated fluid.

NOTE: 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.

CAUTIONS:

- Wing skin temperatures may differ and, in some cases, be lower than OAT. A stronger mix (more glycol) can be used under these conditions.
- As fluid freezing may occur, 50/50 **Type II 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).

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Table 6. List of Qualified [1] Deicing/Anti-Icing Fluids – Winter 2004-2005

Qualified Type I Deicing/Anti-Icing Fluids

Company Name	Fluid Name
Arkton Ltd	Artica DG
Aviation Xi'an High-Tech	KHF-1
Beijing Wangye Aviation Chem. Prod. Co.	KLA-1
Clariant	Safewing MPI 1938 ECO
Clariant	Safewing MPI 1938 PRE MIX
Clariant	Safewing MP I 1938 TF
Clariant	Safewing EG I 1996
Cryotech Deicing Technology	Kilfrost® DF Plus
Cryotech Deicing Technology	Kilfrost® DF Plus (88)
Dow Chemical Company	UCAR® ADF Concentrate
Dow Chemical Company	UCAR® ADF 50/50
Dow Chemical Company	UCAR® ADF XL-54
Dow Chemical Company	UCAR® PG ADF Concentrate
Dow Chemical Company	UCAR® PG ADF DILUTE 55/45
Home Oil Inc.	SAFETEMP I PG 100
Home Oil Inc.	SAFETEMP I ES
Inland	Duragly – P
Inland	Duragly – E
Kilfrost	Kilfrost® DF
Kilfrost	Kilfrost® DF PLUS
Kilfrost	Kilfrost® DF PLUS (80)
Lyondell Chemical Worldwide, Inc	ARCOPlus Concentrate
Lyondell Chemical Worldwide, Inc	ARCOPlus Dilute
Lyondell Chemical Worldwide, Inc	ARCOPlus Canadian Dilute
Lyondell Chemical Worldwide, Inc	ARCTIC Plus
Newwave Aerochemical Co. Ltd.	FCY-1A
Octagon Process, Inc	OCTAFLO EG
Octagon Process, Inc	OCTAFLO EF
Sanshin Kagaku Kogyo Co.	San-Ai ADF Type 1-A
SPCA	SPCA DE-950

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Table 6. List of Qualified [(1)] Deicing/Anti-Icing Fluids – Winter 2004-2005 (Continued)

Qualified Type II Deicing/Anti-Icing Fluids

Company Name	Fluid Name
Clariant	Safewing MP II 1951
Clariant	Safewing MP II 2025 ECO
Kilfrost	Kilfrost® ABC-II PLUS
Kilfrost	Kilfrost® ABC-3
Kilfrost	Kilfrost® ABC-2000
Octagon Process, Inc	Octagon E-Max
SPCA	SPCA Ecowing 26

Qualified Type III Deicing/Anti-Icing Fluids

Company Name	Fluid Name
Clariant	Safewing MP III 2031 ECO

Qualified Type IV Deicing/Anti-Icing Fluids

Company Name	Fluid Name
Clariant	Safewing MP IV 1957
Clariant	Safewing MP IV 2001
Clariant	Safewing MP IV 2012 PROTECT
Clariant	Safewing MP IV 2030 ECO
Cryotech Deicing Technology	Kilfrost® ABC-S
Kilfrost	Kilfrost® ABC-S
Ely Chemical	Max Flight
Octagon Process, Inc.	Max Flight
Octagon Process, Inc	Max Flight 04
SPCA	SPCA AD-480
Union Carbide Dow Chemical Company	UCAR® ADF/AAF ULTRA+

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(1) NOTE: The qualified fluids on this list have met applicable SAE AMS performance specification requirements, as conducted by the Anti-Icing Materials International Laboratory at the University of Quebec at Chicoutimi, Canada, in effect at the time of certification.
Web site: http://www.uqac.uquebec.ca/amil/
Fluids that successfully qualify after the issuance of this list will appear in a later update.

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