

# REGRESSION COEFFICIENTS AND EQUATIONS USED TO DEVELOP THE WINTER 2013-14 AIRCRAFT GROUND DEICING HOLDOVER TIME TABLES

Outside Air Temperature Degrees Celsius	Degrees Fahrenheit	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
			Freezing Fog	Snow or Snow Grains	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
1000	1000	1000	I = 2.031 A = -0.8545	I = 2.424 A = -0.9155 B = 0.0000	I = 2.203 A = -0.2050	I = 2.070 A = -0.9180	I = 2.244 A = -0.9575	
			I = 2.2678 A = -0.7226	I = 2.3808 A = -0.9201 B = 0.0000	I = 2.1504 A = -0.4811	I = 2.3854 A = -0.6216	I = 2.405 A = -0.7374	
			I = 1.7671 A = -0.7220	I = 2.0891 A = -0.9155 B = -0.2662	I = 1.8067 A = -0.7011	I = 1.8277 A = -0.7025		
7525	7525	7525	I = 2.6388 A = -1.2749	I = 2.4424 A = -0.9155 B = 0.0000	I = 2.5281 A = -1.1376	I = 2.4279 A = -0.4367		CAUTION: No holdover integrations exist
			I = 2.5027 A = -1.4921	I = 2.3000 A = -0.9521 B = 0.0000	I = 2.8173 A = -1.2993	I = 3.1111 A = -1.3000		
			I = 1.2138 A = -0.8034	I = 2.3375 A = -0.7960				

*In cooperation with*

Civil Aviation  
Transport Canada

and

The Federal Aviation Administration  
William J. Hughes Technical Center

Prepared by:



December 2013  
Final Version 1.0



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			I = 2.2676 A = -0.7226	I = 2.3808 A = -0.9203 B = 0.0000	I = 2.1504 A = -0.4811	I = 2.3854 A = -0.6216	I = 2.455 A = -0.7374	
			I = 1.7671 A = -0.7220	I = 2.0891 A = -0.9155 B = -0.0050	I = 1.8067 A = -0.7011	I = 1.8277 A = -0.7025		
7525	136.0	1000	I = 2.6388 A = -1.2749	I = 2.6424 A = -0.9155 B = 0.0000	I = 2.8281 A = -1.1376	I = 2.4779 A = -0.4367		
			I = 2.5827 A = -1.4921	I = 2.3600 A = -0.9521 B = 0.0000	I = 2.8173 A = -1.2993	I = 3.1111 A = -1.3000		
			I = 1.2138 A = -0.8034	I = 2.3374 A = -0.7160				

CAUTION: No holdover time guidelines exist

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December 2013  
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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.

## DOCUMENT ORIGIN AND APPROVAL RECORD

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Un sommaire français se trouve avant la table des matières.

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## PREFACE

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

- To develop holdover time data for all newly-qualified de/anti-icing fluids and update and maintain the website for the holdover time guidelines;
- To evaluate weather data from previous winters that can have an impact on the format of the holdover time guidelines;
- To conduct general and exploratory de/anti-icing research;
- To conduct tests to evaluate the effect of deployed flaps/slats prior to anti-icing;
- To conduct tests and research on surfaces treated with ice phobic products;
- To conduct tests to evaluate holdover times in heavy snow conditions;
- To develop an SAE AIR for the evaluation of aircraft coatings;
- To support the evaluation of the NRC propulsion icing wind tunnel to determine its flow characteristics;
- To develop holdover time guidance for operation in ice crystal conditions;
- To continue research for development of ice detection capabilities for pre-deicing, engine deicing and departing aircraft at the runway threshold;
- To develop a performance specification for electronic holdover time applications;
- To investigate pre-take-off contamination check 5-minute allowance;
- To conduct full-scale general aviation aircraft windshield washer fluid deicing testing to substantiate and support flat plate testing results;
- To update the regression coefficient report with the newly-qualified de/anti-icing fluids; and
- To develop Type II/IV holdover times in light and very light snow conditions.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2012-13 are documented in seven reports. The titles of the reports are as follows:

- TP 15227E Winter Weather Impact on Holdover Time Table Format (1995-2013);
- TP 15228E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter;
- TP 15229E Regression Coefficients and Equations Used to Develop the Winter 2013-14 Aircraft Ground Deicing Holdover Time Tables;
- TP 15230E Aircraft Ground Icing General Research Activities During the 2012-13 Winter;

- TP 15231E Cold Climate Technologies – Investigation of Sensor Technologies as an Alternative Means of Detecting Aircraft Icing (Year 2 of 3);
- TP 15232E Wind Tunnel Trials to Examine Anti-Icing Fluid Flow-Off Characteristics and to Support the Development of Ice Pellet Allowance Times, Winter 2009-10 to 2012-13 – Volumes 1 to 5; and
- TP 15233E Exploratory Wind Tunnel Aerodynamic Research, Winter 2012-13.

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

- *Evaluation of Endurance Times on Extended Flaps and Slats; and*
- *Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates (Year 2 of 3).*

This report, TP15229E, has the following objective:

- To document the regression information required for the winter 2013-14 aircraft ground deicing holdover time tables and to document how and from where the information was obtained.

This objective was met by analysing data from holdover time testing conducted over the winters of 1996-97 through 2012-13.

## **PROGRAM ACKNOWLEDGEMENTS**

This multi-year research program has been funded by Transport Canada with support from the Federal Aviation Administration, William J. Hughes Technical Center, Atlantic City, NJ. This program could not have been accomplished without the participation of many organizations. APS 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 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: Yelyzaveta Asnytska; Brandon Auclair; Steven Baker, Stephanie Bendickson, Kirby Bennett; Patrick Caines; John D’Avirro, Jesse Dybka, Derek Foebel; Benjamin Guthrie, Dany Posteraro, Marco Ruggi, James Smyth, Filippo Suriano; David Youssef and Victoria Zoitakis.

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				14. Project Officer <b>Antoine Lacroix for Yvan Chabot</b>	
15. Supplementary Notes (Funding programs, titles of related publications, etc.) <p>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 (TDC). Several reports were produced as part of this winter's research program. Their subject matter is outlined in the preface. This project was co-sponsored by the Federal Aviation Administration.</p>					
16. Abstract <p>Transport Canada is required to publish the regression equations and related coefficients used in the development of the holdover time guidelines each winter. Since the winter of 2009-10, this information has been published in two documents:</p> <ul style="list-style-type: none"> <li>• an online document published on the Transport Canada Holdover Time (HOT) Guidelines website (<a href="http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm">http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm</a>), which provides users with the regression information for the current winter's HOT Guidelines in a timely manner in a user friendly format; and</li> <li>• this TP report, which documents the source of the regression information and how it was obtained.</li> </ul> <p>For the 2013-14 HOT guidelines, regression data was generated for the two generic Type I HOT tables, eight Type II fluid-specific tables, one Type III fluid-specific table, and thirteen Type IV fluid-specific tables. In addition, regression data was required for Clariant Safewing MP II 1951 and the grandfathered fluid data set in support of the generic Type II HOT Table. The data was predominantly obtained from holdover time testing conducted over the winters of 1996-97 to 2012-13. Much of the data had been documented in a previous Transport Canada report and was therefore collected from that report. Additional data was collected from the results of holdover time testing conducted in the winter of 2012-13.</p> <p>The table of lowest usable precipitation rates for snow was updated for 2013-14. These are the lowest precipitation rates for which sufficient outdoor snow data exists to support use of the regression coefficients</p> <p>It is recommended both regression information publications be updated in one year to reflect any changes made to the holdover time guidelines for the winter of 2014-15</p>					
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				14. Agent de projet <b>Antoine Lacroix pour Yvan Chabot</b>		
15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.) <p>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 (CDT). Plusieurs rapports ont été produits 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.</p>						
16. Résumé <p>Chaque hiver, Transports Canada doit publier les équations de régression et les coefficients connexes utilisés pour l'élaboration de lignes directrices sur les durées d'efficacité. Depuis l'hiver 2009-2010, cette information a été publiée dans deux documents :</p> <ul style="list-style-type: none"> <li>• Un document en ligne publié sur le site Web de Transports Canada sur les lignes directrices des durées d'efficacité : (<a href="http://www.tc.gc.ca/CivilAviation/commerce/HoldoverTime/menu.htm">http://www.tc.gc.ca/CivilAviation/commerce/HoldoverTime/menu.htm</a>), qui donne aux utilisateurs l'information de régression pour les lignes directrices sur les durées d'efficacité pour l'hiver en cour, en temps opportun et dans un format convivial; et</li> <li>• Le présent rapport TP, qui documente les sources de l'information de régression et la façon de l'obtenir.</li> </ul> <p>Pour les lignes directrices sur les durées d'efficacité de 2013-2014, des données de régression ont été produites pour les deux tableaux de durées d'efficacité des liquides génériques de type I, pour huit tableaux spécifiques à des liquides de type II, pour un tableau spécifique à un liquide de type III et pour treize tableaux spécifiques à des liquides de type IV. De plus, des données ont été produites pour le liquide Clariant Safewing MP II 1951 et pour l'ensemble de données existant du tableau de durées d'efficacité des liquides génériques de type II. Les données ont été principalement obtenues à partir d'essais sur les durées d'efficacité tenus au cours des hivers de 1996-1997 à 2012-2013. Plusieurs des données avaient été documentées dans un rapport précédent de Transports Canada et puisées dans ce rapport. Des données additionnelles ont été recueillies à partir des résultats d'essais sur les durées d'efficacité, tenus au cours de l'hiver 2012-2013.</p> <p>Le tableau des plus bas taux de précipitation utilisables a été actualisé pour 2013-2014. Il s'agit des plus bas taux de précipitation pour lesquels les données extérieures sur la neige sont suffisantes pour justifier l'utilisation de coefficients de régression.</p> <p>Il est recommandé que les deux publications de régression soient actualisées dans un an pour refléter tout changement apporté aux lignes directrices sur les durées d'efficacité pour l'hiver 2014-2015</p>						
17. Mots clés <b>Antigivrage, dégivrage, liquide de dégivrage, durées d'efficacité, précipitation, temps d'endurance, Type I, Type II, Type III, Type IV, aéronef, sol, essai, hiver, régression, système de détermination de durées d'efficacité</b>				18. Diffusion <b>Le Centre de développement des transports dispose d'un nombre limité d'exemplaires</b>		
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## EXECUTIVE SUMMARY

In recent years, several companies have been developing systems that measure temperature, precipitation type and precipitation rate in real-time. These systems, referred to as holdover time determination systems (HOTDS), use the weather data they collect and holdover time regression information provided to them to calculate holdover times that are more specific than the ranges currently provided in the holdover time (HOT) guidelines.

In order for HOTDS to be used by operators, regulators must make the regression information underlying the HOT Guidelines available to users. The information is published in several documents:

- Transport Canada and the Federal Aviation Administration (FAA) publish online documents which provide users with the regression information for the current winter's HOT Guidelines in a timely manner in a user-friendly format; and
- Transport Canada publishes this TP report, which documents the source of the regression information and how it was obtained.

For the 2013-14 HOT Guidelines, regression data was required for the two generic Type I HOT tables, nine Type II fluid-specific tables, one Type III fluid-specific table, and thirteen Type IV fluid-specific tables. In addition, regression data was required for Clariant Safewing MP II 1951 and the grandfathered fluid data set in support of the generic Type II HOT Table.

The data was obtained predominantly from holdover time testing conducted over the winters of 1996-97 to 2012-13. Much of the data was already documented in a previous Transport Canada report and was therefore extracted from that report. Additional data was collected from the results of holdover time testing conducted in the winter of 2012-13, including supplemental testing/analysis completed in support of the development of light and very light snow HOTs for select Type II/IV fluids.

The 2013-14 regression information was published online by Transport Canada and the FAA in August 2013. The information can be used by HOTDS to calculate holdover times during the winter of 2013-14.

It is recommended that all regression publications – the online documents and this report – be updated in one year to reflect any changes made to the HOT Guidelines for the winter of 2014-15.

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## SOMMAIRE

Au cours des dernières années, plusieurs entreprises ont élaboré des systèmes qui mesurent la température, le type de précipitation et le taux de précipitation en temps réel. Ces systèmes, appelés systèmes de détermination des durées d'efficacité (HOTDS), utilisent les données météorologiques recueillies et l'information sur la régression des durées d'efficacité qui leur est fournie, pour calculer des durées d'efficacité qui sont plus spécifiques que celles des plages actuellement obtenues dans les lignes directrices sur les durées d'efficacité.

Afin de permettre l'utilisation des HOTDS par les exploitants, les organismes de réglementation doivent mettre à la disposition des utilisateurs l'information de régression sous-jacente aux lignes directrices sur les durées d'efficacité. Cette information est publiée dans plusieurs documents :

- Transports Canada et la Federal Aviation Administration (FAA) publient des documents en ligne qui fournissent aux utilisateurs l'information de régression applicable aux lignes directrices de l'hiver en cours sur les durées d'efficacité, en temps opportun et dans un format convivial; et
- Transports Canada publie ce rapport TP, qui documente les sources de l'information de régression et la façon de l'obtenir.

Pour les lignes directrices de 2013-2014 sur les durées d'efficacité, des données de régression étaient requises pour les tableaux de durées d'efficacité des liquides génériques de type I, pour huit tableaux spécifiques à des liquides de type II, pour un tableau spécifique à un liquide de type III et pour quinze tableaux spécifiques à des liquides de type IV. De plus, des données ont été produites pour le liquide Clariant Safewing MP II 1951 et pour l'ensemble de données existant du tableau de durées d'efficacité des liquides génériques de type II.

Les données ont été principalement obtenues d'essais sur les durées d'efficacité tenus au cours des hivers 1996-1997 à 2012-2013. Plusieurs des données étaient déjà documentées dans un rapport précédent de Transports Canada, d'où elles ont en conséquence été puisées. Des données additionnelles ont été recueillies à partir des résultats d'essais sur les durées d'efficacité, tenus au cours de l'hiver 2012-2013, y compris des essais et analyses supplémentaires effectués pour aider à l'élaboration de durées d'efficacité dans des conditions de neige légère ou très légère, pour des liquides de types II et IV particuliers.

L'information de régression pour 2013-2014 a été publiée en ligne par Transports Canada et la FAA en août 2013. L'information peut servir aux HOTDS pour le calcul des durées d'efficacité pour l'hiver 2013-2014.

Il est recommandé que les deux publications sur la régression – le document en ligne et le présent rapport – soient actualisées dans un an, afin de refléter tout changement apporté aux lignes directrices sur les durées d'efficacité pour l'hiver 2014-2015.

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## **GLOSSARY**

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CAR	Canadian Aviation Regulation
FAA	Federal Aviation Administration
HOT	Holdover Time
HOTDS	Holdover Time Determination Systems
LUPR	Lowest Usable Precipitation Rate
MSC	Meteorological Service of Canada
NRC	National Research Council Canada
SAE	SAE International
TC	Transport Canada
TDC	Transportation Development Centre
WSET	Water Spray Endurance Test

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## 1. INTRODUCTION

Under winter precipitation conditions, aircraft are cleaned with a freezing point depressant fluid and protected against further accumulation by an additional application of such a fluid, possibly thickened to extend the protection time. Until the early 1990s aircraft ground deicing had never been researched; there is still limited understanding of the hazard and of what can be done to reduce the risks posed by the operation of aircraft in winter precipitation conditions. This "winter operations contaminated aircraft ground" program of research is aimed at overcoming this lack of knowledge.

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

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

### 1.1 Background

Determining holdover times for de/anti-icing fluids and developing guidelines for their use has been a focus of the Transport Canada / FAA aircraft ground icing research program since its inception. The Holdover Time (HOT) Guidelines documents provide pilots with tables of the protection times provided by de/anti-icing fluids in winter conditions. The values in the HOT guideline tables are developed by conducting regression analysis of flat-plate test data collected with de/anti-icing fluids. The guidelines are revised and republished annually to account for the results of additional testing with new and current fluids.

Aircraft de/anti-icing fluid holdover time is a function of fluid dilution, precipitation rate, precipitation type and ambient temperature. Although the current methodology for determining holdover times enables values to be calculated at virtually any temperature and precipitation rate, it is neither practical nor feasible to include all of this information in the HOT Guidelines. Instead, holdover times are organized into tables that are divided into cells by precipitation type, temperature range, and fluid dilution. Within each of these cells, upper and lower values are given based on

predetermined lower and upper precipitation rate limits and the lowest temperature in the temperature range.

In recent years, several companies have been developing systems that measure temperature, precipitation type and precipitation rate in real-time. These systems, referred to as holdover time determination systems (HOTDS), use the weather data they collect and holdover time regression information to calculate more specific holdover times than the ranges that are currently provided in the HOT Guidelines. These times can be relayed directly to the cockpit. There are several advantages to be gained by using HOTDS in place of HOT tables:

1. **Extended Holdover Times:** Whereas holdover time table values are calculated based on the lowest temperature in each temperature range and the highest precipitation rate in each precipitation category, HOTDS can calculate values at any temperature or precipitation rate, and therefore they can provide users with longer holdover times in some conditions;
2. **Ease of Use:** HOTDS are more user-friendly than HOT tables as pilots are provided with a single holdover time; they do not have to determine the appropriate holdover time themselves by looking up specific weather conditions in the appropriate HOT table, nor do they have to interpret the range of holdover time provided; and
3. **Environmental and Cost Savings:** The information provided by HOTDS enables pilots to make better fluid selection decisions. This is forecast to increase the use of Type I fluid and decrease the use of Type IV fluid, potentially resulting in cost and environmental savings.

## 1.2 Role of Regulators

In order for HOTDS to be used, Transport Canada and FAA must:

1. Provide regulations that allow operators to use HOTDS; and
2. Publish the regression equations and related coefficients that are used in the development of the HOT tables.

### 1.2.1 Regulations for HOTDS Use

Transport Canada has supported the development of HOTDS and has taken an active role in developing regulations for HOTDS use in Canada. The short-term methodology employed by Transport Canada to implement the use of HOTDS outputs in Canadian air operations included the development of two documents:

1. A **performance standard** defining the minimum quality assurance requirements (quality management system; training and qualifications; installation, siting, operation and maintenance) and minimum performance specifications (system accuracy; technical requirements for data inputs and holdover time determinations) for HOTDS; and
2. An **air carrier exemption** from Canadian Aviation Regulation (CAR) 622.11 for the operational use of the holdover time information provided by the HOTDS.

Transport Canada developed a performance standard in the winter of 2006-07 and an air carrier exemption for WestJet the same winter. Subsequent issues of the exemption were issued as global exemptions applicable to any air operator using a HOTDS. The associated performance standard is provided as an appendix to the exemption document.

FAA has taken a different approach. It will publish an advisory circular for liquid water equivalent systems and HOTDS. The advisory circular is currently being finalized and is expected to be published in 2014.

### 1.2.2 Publication of Regression Equations and Related Coefficients

The regression equations and coefficients used to calculate the values in the HOT tables are required for HOTDS to function. HOTDS manufacturers must obtain this information from regulators or an equally valid source.

Transport Canada first published regression information in the fall of 2008 in the Transport Canada report, TP 14873E, *Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables* (1). The report documented the process that was taken to create the initial regression information database and contains the regression information relevant to the 2008-09 HOT Guidelines.

Following the publication of TP 14873E (1), it was determined that two regression documents needed to be published annually. Two publications are necessary, as users require slightly different information than regulators, and they require this information in a timely manner. Both publications must be updated annually, because the HOT Guidelines are updated annually and changes made to the HOT Guidelines must be reflected in the published regression information.

The two documents are summarized below and in Table 1.1.

1. **Document #1 - Online Publication:** The first document is for HOTDS manufacturers. It provides manufacturers with the current winter's regression information and guidance for its application and use in a user-friendly format. It is published online, which allows the information to be made available in a timely manner, typically in the summer preceding the winter operating season.

Transport Canada has published its version of this document, entitled *Transport Canada Holdover Time (HOT) Guidelines Regression Information [current winter]*, annually since 2009.

FAA first published its version of this document, entitled *Official FAA Holdover Time Regression Information Winter [current winter]*, in 2013.

2. **Document #2 – TP Report:** The second document is a reference document for regulators. Its purpose is to document the source(s) of the regression information provided in the online publication. It is published as a Transport Canada report with a TP number and may take several years to be published and made publicly available. The document is entitled "*Regression Coefficients and Equations Used to Develop the Winter [current winter] Aircraft Ground Deicing Holdover Time Tables*". It is not expected users will refer to this document unless they want a better understanding of how HOT table values are derived (something that does not need to be understood to use the regression information with HOTDS).

### 1.2.3 History of Regression Information Publications

The history of regression publications is provided in Table 1.2. Following the publication of the initial document for the winter of 2008-09, the two document system was introduced for the winter of 2009-10 and has been followed since that time. It should be noted that when new regression documents are created each year, previous publications become obsolete.

The documents that will be published for the winter of 2013-14 are shown in the last row of the table. These documents are currently the only valid regression publications.

**Table 1.1: Regression Information Publications**

	<b>Document 1 (Online Publication)</b>	<b>Document 2 (TP Report)</b>
<b>Publication Name(s)</b>	<ul style="list-style-type: none"> <li>• Transport Canada Holdover Time (HOT) Guidelines Regression Information [Current Winter]</li> <li>• Official FAA Holdover Time Regression Information Winter [Current Winter]</li> </ul>	<ul style="list-style-type: none"> <li>• Regression Coefficients and Equations Used to Develop the [Current Winter] Aircraft Ground Deicing Holdover Time Tables</li> </ul>
<b>Publication Type</b>	<ul style="list-style-type: none"> <li>• Online publication</li> </ul>	<ul style="list-style-type: none"> <li>• Transport Canada TP report</li> </ul>
<b>Publication Location(s)</b>	<ul style="list-style-type: none"> <li>• Transport Canada HOT Guidelines website: <a href="http://www.tc.gc.ca/eng/civilaviation/standards/commence-holdovertime-menu-1877.htm">www.tc.gc.ca/eng/civilaviation/standards/commence-holdovertime-menu-1877.htm</a></li> <li>• FAA Aircraft Ground Deicing website: <a href="http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/">www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/</a></li> </ul>	<ul style="list-style-type: none"> <li>• Available from Transport Canada</li> </ul>
<b>Purpose</b>	<ul style="list-style-type: none"> <li>• To provide regression information and guidance on its use to users in a timely manner in a user-friendly document</li> </ul>	<ul style="list-style-type: none"> <li>• To document the source(s) of the regression information provided in the online publication</li> </ul>
<b>Contents</b>	<ul style="list-style-type: none"> <li>• Regression equations and coefficients required for the current winter’s HOT Guidelines</li> <li>• Guidance for application and use of regression information, including procedures for calculating generic holdover times</li> </ul>	<ul style="list-style-type: none"> <li>• Methodology to derive holdover times using regression analysis</li> <li>• Methodology used to determine HOT table values (fluid-specific and generic)</li> <li>• History of regression information collection</li> <li>• Source locations for current winter’s information</li> <li>• Regression information required for the current winter’s HOT Guidelines (incorporated by including the online publication as an appendix)</li> </ul>

**Table 1.2: History of Regression Information Publications**

Winter	Document 1 (Online Publication)		Document 2 (TP Report)
	Transport Canada	FAA	
2008-09	<ul style="list-style-type: none"> <li>• No online publication</li> </ul>	<ul style="list-style-type: none"> <li>• No online publication</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables (TP 14873E)</li> <li>• <b>Publication:</b> Not yet published</li> <li>• <b>Validity:</b> Obsolete</li> </ul>
2009-10	<ul style="list-style-type: none"> <li>• <b>Title:</b> Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2009-2010</li> <li>• <b>Publication:</b> Jan 2010 (online)</li> <li>• <b>Validity:</b> Obsolete</li> </ul>	<ul style="list-style-type: none"> <li>• No online publication</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Regression Coefficients and Equations Used to Develop the Winter 2009-10 Aircraft Ground Deicing Holdover Time Tables (TP 14937E)</li> <li>• <b>Publication:</b> Not yet published</li> <li>• <b>Validity:</b> Obsolete</li> </ul>
2010-11	<ul style="list-style-type: none"> <li>• <b>Title:</b> Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2010-2011</li> <li>• <b>Publication:</b> July 2010 (online)</li> <li>• <b>Validity:</b> Obsolete</li> </ul>	<ul style="list-style-type: none"> <li>• No online publication</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Regression Coefficients and Equations Used to Develop the Winter 2010-11 Aircraft Ground Deicing Holdover Time Tables (TP 15054E)</li> <li>• <b>Publication:</b> Not yet published</li> <li>• <b>Validity:</b> Obsolete</li> </ul>
2011-12	<ul style="list-style-type: none"> <li>• <b>Title:</b> Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2011-2012</li> <li>• <b>Publication:</b> July 2011 (online)</li> <li>• <b>Validity:</b> Obsolete</li> </ul>	<ul style="list-style-type: none"> <li>• No online publication</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Regression Coefficients and Equations Used to Develop the Winter 2011-12 Aircraft Ground Deicing Holdover Time Tables (TP 15159E)</li> <li>• <b>Publication:</b> Not yet published</li> <li>• <b>Validity:</b> Obsolete</li> </ul>
2012-13	<ul style="list-style-type: none"> <li>• <b>Title:</b> Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2012-2013</li> <li>• <b>Publication:</b> July 2012 (online)</li> <li>• <b>Validity:</b> Obsolete</li> </ul>	<ul style="list-style-type: none"> <li>• No online publication</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Regression Coefficients and Equations Used to Develop the Winter 2012-13 Aircraft Ground Deicing Holdover Time Tables (TP 15198E)</li> <li>• <b>Publication:</b> Not yet published</li> <li>• <b>Validity:</b> Obsolete</li> </ul>



**Table 1.2: History of Regression Information Publications (cont'd)**

Winter	Document 1 (Online Publication)		Document 2 (TP Report)
	Transport Canada	FAA	
2013-14	<ul style="list-style-type: none"> <li>• <b>Title:</b> Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2013-2014</li> <li>• <b>Publication:</b> Aug 2013 (online)</li> <li>• <b>Validity:</b> Current</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Official FAA Holdover Time Regression Information Winter 2013-2014</li> <li>• <b>Publication:</b> Aug 2013 (online)</li> <li>• <b>Validity:</b> Current</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Title:</b> Regression Coefficients and Equations Used to Develop the Winter 2013-14 Aircraft Ground Deicing Holdover Time Tables (TP 15229E)</li> <li>• <b>Publication:</b> Not yet published</li> <li>• <b>Validity:</b> Current</li> </ul>

### 1.3 Objectives

The primary objective of this report is to document how and from where the regression information for the 2013-14 winter aircraft ground deicing holdover time tables was obtained. The report also has several secondary objectives:

- To document the methodology for deriving holdover times using regression analysis;
- To document the methodology used to determine HOT table values (fluid-specific and generic); and
- To provide a history of regression information collection.

The detailed objectives of this project are provided in Appendix A in an excerpt from the Transport Canada statement of work.

### 1.4 Report Format

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

- Section 2 describes the methodology used to derive holdover times using regression analysis;
- Section 3 details the methodologies used to derive fluid-specific and generic HOT table values;
- Section 4 presents the data collected for Winter 2013-14 and a short history of data collected in previous winters;
- Section 5 describes the Winter 2013-14 regression information;
- Section 6 presents conclusions derived from the work; and
- Section 7 lists recommendations for future work.

### 1.5 Note on Frost and Ice Pellets

The HOT Guidelines currently do not provide fluid-specific holdover times in frost conditions; generic holdover times that are not derived from regression analysis are provided for each of the four fluid types in a separate frost HOT table.

The HOT Guidelines currently contain “allowance times” for ice pellets and ice pellets mixed with several other types of precipitation, including freezing rain, freezing

drizzle, rain and snow. The allowance times are not fluid-specific and are not based on regression analysis.

As regression coefficients and equations are not used in the determination of frost holdover times or ice pellet allowance times, regression information is not included for frost, ice pellets or ice pellet mixed conditions in the published regression information.

## **1.6 Note on Transport Canada / FAA Differences**

Several minor differences exist between the Transport Canada and FAA HOT table values, and as a result there are differences in the related regression information. These differences are detailed in Subsections 3.2.2, 3.3.1 and 3.4.1. It remains the responsibility of the user to ensure the appropriate application of the data provided in this report.

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## 2. METHODOLOGY FOR DERIVING HOLDOVER TIMES USING REGRESSION ANALYSIS

The methodology used to derive holdover times using regression analysis is presented in this section. This information is included to provide a better understanding of how holdover time values are derived.

There are two steps to deriving holdover times using regression analysis. The first step is to conduct endurance time testing to enable the collection of an appropriate data set. The second step is to analyse the data set using the regression analysis methodology.

### 2.1 Step 1: Endurance Time Testing

The first step in deriving holdover times using regression analysis is the collection of an appropriate endurance time data set. Endurance time tests measure the amount of protection time that de/anti-icing fluids offer against ice formation. These tests are carried out on flat plates in natural and simulated precipitation conditions.

Procedures for conducting endurance time tests have been refined over a number of years, culminating in the current standard approach which has been followed since the 1990s. Since that time, endurance time testing for the purpose of developing holdover times has been conducted by APS on behalf of Transport Canada and the FAA.

There are some differences in the way endurance time tests are carried out in freezing precipitation and in snow, largely due to the difference in control of test variables in natural and simulated conditions.

#### 2.1.1 Freezing Precipitation

Freezing fog, freezing rain, light freezing drizzle and cold-soaked wing endurance time tests are conducted in simulated (laboratory) conditions. For each cell in the related HOT table, four tests are conducted at the lowest temperature in the temperature range of the cell: two tests are conducted at the low precipitation rate and two tests are conducted at the high precipitation rate.

The low and high precipitation rates are dependent on the precipitation type. The precipitation rate limits for freezing precipitation are as follows<sup>1</sup>:

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<sup>1</sup> Significant research has gone into the selection of these values. See Subsection 2.9.1 of Transport Canada report TP 14144E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter* (5).

- Freezing fog: 2 and 5 g/dm<sup>2</sup>/h;
- Freezing drizzle: 5 and 13 g/dm<sup>2</sup>/h;
- Light freezing rain: 13 and 25 g/dm<sup>2</sup>/h; and
- Rain on cold-soaked wing: 5 and 75 g/dm<sup>2</sup>/h.

### 2.1.2 Snow

Snow endurance time tests are conducted in natural conditions where temperature and precipitation rate cannot be controlled. Therefore, the protocol for measuring endurance times in snow is slightly different – tests are conducted in natural snow in a range of temperatures and precipitation rates. An attempt is made to capture data in all snowfall intensities encompassed in the HOT Guidelines.

Three snowfall intensity categories are provided in the HOT tables. The precipitation rate limits used for the snowfall intensity categories are<sup>2</sup>:

- Very Light Snow (Transport Canada): 4 g/dm<sup>2</sup>/h;
- Very Light Snow (FAA): 3 and 4 g/dm<sup>2</sup>/h;
- Light Snow: 4 and 10 g/dm<sup>2</sup>/h; and
- Moderate Snow: 10 and 25 g/dm<sup>2</sup>/h.

Historically, a single snowfall intensity category was provided in the Type II and Type IV HOT tables. The precipitation rate limits used were 10 and 25 g/dm<sup>2</sup>/h. Some Type II/IV HOT tables retain these limits for historical reasons.

## 2.2 Step 2: Regression Analysis

Once a complete data set has been collected for a fluid, the data set is subjected to regression analysis. This analysis provides the “raw” holdover time values for the fluid.

Due to the differences in the way data is collected in snow and in freezing precipitation, the protocol for conducting regression analysis differs slightly for freezing precipitation and snow. The freezing precipitation protocol is described in Subsection 2.2.1; the snow protocol is described in Subsection 2.2.2.

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<sup>2</sup> These definitions are not directly correlated to meteorological observations.

### 2.2.1 Freezing Precipitation

The following steps are used to calculate freezing precipitation holdover times using regression analysis:

1. For each cell in a holdover table of the given fluid type, a best-fit power law curve is developed from the tests conducted at the low and high precipitation rate condition of that cell using regression analysis. The equation used to treat the data is  $t = 10^I R^A$ , where:
  - $t$  = time (minutes)
  - $R$  = rate of precipitation (g/dm<sup>2</sup>/h)
  - $I, A$  = coefficients determined from the regression;
2. Holdover times are calculated for the low and high precipitation rate limits for each precipitation type (see Subsection 2.1.1) using the resulting regression equation; and
3. Steps 1 and 2 provide “raw” holdover times. Depending on how the times will be used, they may be subject to rounding and capping rules.

### 2.2.2 Snow

The following steps are used to calculate snow holdover times using regression analysis:

1. The data is grouped by fluid dilution. The data set for each fluid dilution is subjected to a multi-variable regression analysis. The general form of the regression equation is  $t = 10^I R^A (2-T)^B$ , where:
  - $t$  = time (minutes)
  - $R$  = rate of precipitation (g/dm<sup>2</sup>/h)
  - $T$  = temperature (°C)
  - $I, A, B$  = coefficients determined from the regression;
2. This results in one regression equation for each fluid dilution in snow. Holdover times are calculated for the precipitation limits of each cell by using the appropriate regression equation and the most restrictive (lowest) temperature in the cell; and
3. Steps 1 and 2 provide “raw” holdover times. Depending on how the times will be used, they may be subject to rounding and capping rules.

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### 3. METHODOLOGIES FOR DETERMINING HOLDOVER TIME TABLE VALUES

The methodologies for determining fluid-specific and generic HOT table values are presented in this section. This information is included to provide a better understanding of how the HOT tables are built. It is also included as the methodologies determine which regression information is required to be published for each fluid type and if it needs to be updated or changed on an annual basis.

#### 3.1 Methodology for Determining Fluid-Specific HOT Table Values

Fluid-specific holdover times are calculated for most fluids submitted for holdover time testing. They are used to develop the Type II and Type IV fluid-specific HOT tables (which in turn are used to develop the generic Type II and Type IV HOT tables) and to ensure new Type III fluids meet the minimum holdover times set in the generic Type III HOT table.

Fluid-specific holdover times are derived directly from regression analysis as described in the methodology detailed in Section 2.

In the case of Type II and Type IV fluids, the regression-generated “raw” holdover times described in Section 2 are subject to rounding to produce the values in the Type II and Type IV fluid-specific tables. The Type II/IV rounding protocol is as follows:

1. Raw values are rounded to the nearest whole “5” digit. For example, 55.1 to 57.4 minutes is rounded down to 55 minutes and 57.5 to 59.9 minutes is rounded up to 60 minutes;
2. In cases where the raw holdover times are below 10.0 minutes, the numbers are rounded down to the nearest 1 minute as a precautionary measure. For example, 9.7 minutes is rounded down to 9 minutes; and
3. The rounded values are capped as follows:
  - Freezing drizzle, freezing rain, and rain on cold-soaked wing values are capped at 2 hours;
  - Freezing fog values are capped at 4 hours; and
  - Snow values are capped at 2 hours by Transport Canada and 3 hours by FAA.

It should also be noted that all Type II and Type IV fluids are given generic values in the “below -14 to -25 °C snow cell”. This decision was made following the winter of 2003-04, due to very limited endurance time test data existing for most fluids at these temperatures.

## 3.2 Methodology for Determining Type II/IV Generic HOT Table Values

The Type II and Type IV generic HOT table values represent the most conservative (shortest) holdover times of all available Type II / Type IV fluids. The purpose of these tables is to provide operators with the minimum amount of holdover time that may be available in a given weather condition when the operator does not know which fluid is being used. Since there is no one fluid that underperforms all other fluids in all weather conditions, an analysis is necessary to develop a table that provides the shortest holdover times of all the relevant fluids in each weather condition represented in the tables.

The list of fluids provided in the Transport Canada and FAA HOT Guidelines is used to determine which fluids are included in the Type II and Type IV generic analyses. These lists are updated on an annual basis as new fluids are added and old fluids are removed (see note on qualified fluids in Subsection 3.2.1.)

It should be noted that SAE International (SAE) standards stipulate that Type IV fluids also qualify as Type II fluids. Therefore, the Type IV fluids are also included in the Type II generic analysis.

### 3.2.1 Note on Qualified Fluids

When the water spray endurance test (WSET) and aerodynamics qualification of a Type II/IV fluid expires and is not renewed, the fluid remains on the Transport Canada and FAA lists of fluids for four years. If the fluid has a fluid-specific HOT table, it remains in the guidelines for four years.

This is done to allow operators who have inventory of these fluids when the fluid qualification expires to use the fluid rather than having to dispose of it (this assumes the fluid passes any required quality control checks).

As the protocol for conducting the Type II and Type IV generic analyses requires all fluids on the Transport Canada and FAA lists of fluids be included in the analyses, the data for these fluids also remains in the generic analyses during the four years.

The result of this protocol is that all fluids included in the HOT Guidelines and in the generic analysis may not be currently qualified fluids. As the regression information is provided in support of the HOT Guidelines, it too must include information for all fluids that appear in the HOT Guidelines, not just fluids that are currently qualified.

The protocol for the removal of obsolete Type II, III and IV fluid data is provided in SAE Aerospace Recommended Practice (ARP) 5718A, Section 5.9 (2). The protocol stipulates that fluids will be removed from the HOT Guidelines four years after fluid WSET/aerodynamics qualification has expired.

### 3.2.2 Differences in Transport Canada and FAA Type II/IV HOT Values

There are differences in the Transport Canada and FAA Type II/IV *very light snow* cell values. The Transport Canada table provides one holdover time in each very light snow cell which is based on a rate of 4 g/dm<sup>2</sup>/h; the FAA table provides two values in each cell based on rates of 3 and 4 g/dm<sup>2</sup>/h.

### 3.3 Evolution of Type I Generic HOT Table Values

Unlike the Type II/IV generic HOT table values, there is no specific protocol in place for determining Type I generic HOT table values. Also, unlike the Type II/IV values, the Type I generic values are relatively static and do not change as new Type I fluids are added and removed from the list of qualified fluids.

The reason for the static nature of the Type I generic table is that a significant body of research and testing has shown that all Type I fluids formulated with glycol perform in a similar manner from an endurance time perspective. New glycol-based fluids are no longer required to undergo endurance time testing.

As a result of extensive research and testing showing that holdover times of Type I fluids are shorter on composite surfaces than on aluminum surfaces, holdover times for Type I fluids on composite surfaces were added to the holdover time guidelines starting in winter 2010-11. The existing Type I holdover times remained in place for aluminum surfaces.

A summary of how the current Type I holdover times were derived and the data sets that were used in their determinations is provided below.

- The **Type I aluminum snow** holdover times are derived from regression analysis of the 2001-02 Type I snow data set. Testing was conducted in the winter of 2001-02 using a new test protocol and a number of representative Type I

fluids. The tests are documented in the Transport Canada report, TP 13994E, *Generation of Holdover Times Using the New Type I Fluid Test Protocol* (3).

- The **Type I aluminum freezing precipitation** holdover times are not derived from regression analysis. They were established in the early 1990s and substantiated by testing conducted up to and including the winter of 1995-96. The values in the “below -3 to -6°C” row were added in the winter of 2003-04 following testing with five representative Type I fluids in the winter of 2002-03. A detailed description of the evolution of the Type I aluminum freezing precipitation holdover times is provided in Appendix B of the Transport Canada report, TP 15052E, *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces* (4). Tests conducted for the “below -3 to -6°C” row are documented in Subsection 8.4.2 of the Transport Canada report, TP 14144E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter* (5).
- The **Type I composite snow** holdover times were derived from regression analysis of the Type I composite snow data set, which includes data collected in the winters of 2006-07, 2007-08 and 2009-10. A detailed description of this data and the derivation of the Type I composite snow holdover times from the data is provided in the Transport Canada report, TP 15052E, *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces* (4).
- The **Type I composite freezing precipitation** holdover times were derived from endurance time testing conducted in 2009-10. Although regression analysis formed part of the analysis that determined the holdover time values, the holdover times were not derived directly from the regression analysis. A detailed description of the data set and the methodology used to derive the Type I composite freezing precipitation holdover times is provided in the Transport Canada report, TP 15052E, *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces* (4).

### 3.3.1 Differences in Transport Canada and FAA Type I HOT Values

It should be noted that the Transport Canada and FAA Type I generic HOT tables differ in two places:

1. **Very Light Snow Cells:** The Transport Canada table provides one holdover time in each very light snow cell which is based on a rate of 4 g/dm<sup>2</sup>/h; the FAA table provides two values in each cell based on rates of 3 and 4 g/dm<sup>2</sup>/h.

2. **Light Freezing Rain “-3°C and above” and “below -3 to -6°C” Cells:** The Transport Canada table gives holdover times for these cells based on testing conducted at -6°C; the FAA table gives holdover times for these cells based on testing conducted at -10°C.

### 3.4 Evolution of Type III Generic HOT Table Values

Like the Type I generic HOT table values, there is no specific protocol in place for determining Type III generic HOT table values. Also, like the Type I values, the Type III generic values are static and have not changed since they were established in the winters of 2004-05 (100/0) and 2005-06 (75/25 and 50/50).

The values in the Type III generic guidelines are based on the endurance times of Clariant Safewing MP III 2031 ECO, which is currently the only Type III fluid on the list of qualified fluids. The following protocol was used to obtain the generic values:

1. Endurance time tests were conducted with Clariant Safewing 2031;
2. Fluid-specific holdover times were calculated for Clariant Safewing 2031;
3. The fluid-specific values were reduced by 10 percent; and
4. Discretion was used to change the reduced values to relatively round values.

At the time the current Type III guidelines were developed, regulators did not intend to produce fluid-specific tables for Type III fluids. This was because they did not believe that any new fluids would perform significantly better than Clariant Safewing 2031 and they thought that by reducing and rounding the test values they could establish minimum holdover times that any new Type III fluids submitted for testing would meet.

#### 3.4.1 Differences in Transport Canada and FAA Type III HOT Values

It should be noted that the FAA Type III generic HOT table differs from the Transport Canada table in the *very light snow* cells. The Transport Canada table provides one holdover time in each very light snow cell which is based on a rate of 4 g/dm<sup>2</sup>/h; the FAA table provides two values in each cell based on rates of 3 and 4 g/dm<sup>2</sup>/h.

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## 4. DATA COLLECTION

The regression information underlying the HOT Guidelines was first collected and published in support of the winter 2008-09 HOT Guidelines. Since then, the regression information has been updated annually to reflect the annual changes made to the HOT Guidelines. This chapter describes the evolution of the regression information (Subsection 4.1) and the data collected for the 2013-14 HOT Guidelines (Subsection 4.2).

Subsection 4.1 includes a year-by-year summary of the data collected, added, and removed and any changes made to the way the information is published.

Subsection 4.2 details the data required, collected and removed for the winter 2013-14 publication and includes the source locations of the data contained in the 2013-14 publication.

### 4.1 Evolution of Regression Information

In the past, the regression information underlying the HOT Guidelines was not published in a format that was appropriate for use with HOTDS. The data was published only as part of the annual report on holdover time testing conducted by APS, and only the regression information for the fluids tested in a given year was published that year. That meant that the regression information was not readily available; multiple publications, some not yet available to the public, had to be consulted to obtain the data. Further complications, such as the testing of some fluids over multiple winters, made it very difficult for HOTDS manufacturers to accurately obtain the correct data.

#### 4.1.1 Initial Data Collection (2008-09 Holdover Time Guidelines)

The first regression information publication was developed over the winters of 2006-07 and 2007-08 in support of the winter 2008-09 HOT Guidelines. As the regression information had not been published in the format required for HOTDS before this time, and because the required data had to be collected and de-archived from a number of locations, several steps were required to produce the initial data set:

1. The fluids for which data was required were identified;
2. The relevant data set(s) for each fluid were identified;
3. The relevant data set(s) were de-archived;

4. The data set responsible for each holdover time value was determined for fluids with multiple data sets;
5. Regression coefficients were created for cell values not derived directly from regression analysis;
6. The data was amalgamated into a series of tables; and
7. A verification exercise was completed to ensure the selected data was correct.

A complete description of the work completed to create the initial database and the complete contents of the initial database are provided in the Transport Canada report, TP 14873E, *Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables* (1).

#### 4.1.2 Changes Required for 2009-10 Holdover Time Guidelines

The regression information was updated in 2009 to reflect changes made to the HOT Guidelines for use in the winter of 2009-10.

1. Data was collected and added to the regression database for three new fluids that were added to the HOT Guidelines in 2009-10:
  - Aviation Shaanxi Hi-tech Cleanwing II (Type II);
  - ABAX Ecowing AD-49 (Type IV); and
  - Kilfrost ABC-4<sup>sustain</sup> (Type IV).
2. Data was removed from the regression publication for two fluids which became obsolete and were removed from the HOT Guidelines in 2009-10:
  - Aviation Xi'an Hi-tech KHF-II (Type II); and
  - Kilfrost ABC-II Plus (Type II).

This work is documented in the Transport Canada report, TP 14937E, *Regression Coefficients and Equations Used to Develop the Winter 2009-10 Aircraft Ground Deicing Holdover Time Tables* (6).

Work was completed in the Fall of 2009 to develop the first online publication for the regression information. The 2009-10 online document, *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2009-2010*, was published on the Transport Canada HOT Guidelines website in January 2010.



### 4.1.3 Changes Required for 2010-11 Holdover Time Guidelines

The regression information was updated in 2010 to reflect changes made to the HOT Guidelines for use in the winter of 2010-11.

1. Data was collected for the Type I fluid composite holdover times which were added to the HOT Guidelines.
2. Data was collected for one new fluid which was added to the HOT Guidelines for the winter of 2010-11: Cryotech Polar Guard® (Type IV).
3. Data was collected for one fluid which had changes made to its fluid-specific holdover time table as a result of undergoing additional holdover time testing in the winter of 2009-10: Clariant Safewing MP II FLIGHT (Type II).
4. Data was removed for one fluid which became obsolete and was removed from the HOT Guidelines for the winter of 2010-11: Octagon Max Flight (Type IV).

This work is documented in the Transport Canada report, TP 15054E, *Regression Coefficients and Equations Used to Develop the Winter 2010-11 Aircraft Ground Deicing Holdover Time Tables* (7). The 2010-11 online document, *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2010-2011*, was published on the Transport Canada HOT Guidelines website in July 2010.

### 4.1.4 Changes Required for 2011-12 Holdover Time Guidelines

The regression information was updated in 2011 to reflect changes made to the HOT Guidelines for use in the winter of 2011-12.

1. Data was collected for one new fluid which was added to the HOT Guidelines for the winter of 2011-12: Cryotech Polar Guard Advance (Type IV).
2. Data was removed for two fluids which became obsolete and were removed from the HOT Guidelines for the winter of 2011-12: Octagon MaxFlo (Type IV) and Clariant Safewing 2012 (Type IV).

This work is documented in the Transport Canada report, TP 15159E, *Regression Coefficients and Equations Used to Develop the Winter 2011-12 Aircraft Ground Deicing Holdover Time Tables* (8). The 2011-12 online document, *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2011-2012*, was published on the Transport Canada HOT Guidelines website in July 2011.

#### 4.1.5 Changes Required for 2012-13 Holdover Time Guidelines

The regression information was updated in 2012 to reflect changes made to the HOT Guidelines for use in the winter of 2012-13.

1. Data was collected for two new fluids which were added to the HOT Guidelines for the winter of 2012-13:
  - Clariant Safewing MP II Flight Plus (Type II); and
  - LNT Solutions P250 (Type II).
2. Data was removed for four fluids which became obsolete and were removed from the HOT Guidelines for the winter of 2012-13:
  - Clariant Safewing MP II 2025 ECO (Type II);
  - Octagon E Max II (Type II);
  - Clariant Safewing MP IV 2001 (Type IV); and
  - Dow Chemical UCAR ADF/AAF Ultra + (Type IV).
3. A table of lowest usable precipitation rates (LUPRs) was added as a result of analysis that showed natural snow test data for some fluids is not sufficient to support extrapolation of the regression curves to very low rates of precipitation.

This work is documented in the Transport Canada report, TP 15198E, *Regression Coefficients and Equations Used to Develop the Winter 2012-13 Aircraft Ground Deicing Holdover Time Tables* (9). The 2012-13 online document, *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2012-2013*, was published on the Transport Canada HOT Guidelines website in July 2012.

#### 4.2 Data for the 2013-14 Holdover Time Guidelines

The data required for the 2013-14 HOT Guidelines is detailed in this section. The data is detailed by fluid type: Type I in Subsection 4.2.1, Type II in Subsection 4.2.2, Type III in Subsection 4.2.3 and Type IV in Subsection 4.2.4. Each subsection includes:

1. Data Required: a description of the data required for the fluid type;
2. Data Source(s): the original source location of the required data;
3. Data Collection: where the data was collected from for the 2013-14 publication; and

4. Data Removal: a description of any data removed from the regression publication for winter 2013-14.

Table 4.1, at the end of this chapter, summarizes the data included in the winter 2013-14 regression publication.

## 4.2.1 Type I

### 4.2.1.1 Data Required

Regression information is required for the two generic Type I HOT tables. As fluid-specific HOT tables are not published for Type I fluids, no additional regression information is required.

### 4.2.1.2 Data Source(s)

The **Type I aluminum snow** holdover times are derived from regression analysis of the 2001-02 Type I snow data set (see Subsection 3.3). The data set is documented in the Transport Canada report, TP 13994E, *Generation of Holdover Times Using the New Type I Fluid Test Protocol* (3).

The **Type I aluminum freezing precipitation** holdover times are not derived from regression analysis (see Subsection 3.3). The Type I aluminum freezing precipitation coefficients were created in 2008 from the values in the 2008-09 Type I HOT table.

The **Type I composite snow** holdover times are derived from regression analysis of the Type I composite snow data set (which includes data from tests conducted in 2006-07, 2007-08 and 2009-10, see Subsection 3.3). The data set is documented in the Transport Canada report, TP 15052E, *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces* (4).

The **Type I composite freezing precipitation** holdover times are based on data collected in 2009-10 but are not derived directly from regression analysis (see Subsection 3.3). The data is documented in the Transport Canada report, TP 15052E, *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces* (4). However, as the holdover times are not derived directly from regression analysis, TP 15052E (4) does not include regression information. Therefore, the Type I freezing precipitation coefficients were created in 2010 from the 2010-11 holdover time values. The calculations are detailed in Appendix C of the Transport Canada report, TP 15054E, *Regression Coefficients and Equations Used to Develop the Winter 2010-11 Aircraft Ground Deicing Holdover Time Tables* (7).

#### 4.2.1.3 Data Collection

The Type I regression information was collected previously (see Table 4.1) and therefore was obtained from the previous regression publication, TP 15198E (9).

#### 4.2.1.4 Data Removed

No Type I data was removed from the HOT Guidelines in 2013-14; therefore, no Type I data was removed from the regression publication.

### 4.2.2 Type II

#### 4.2.2.1 Data Required

Regression information was required for the eight Type II fluid-specific HOT tables in the 2013-14 HOT Guidelines:

1. ABAX Ecowing 26;
2. Aviation Shaanxi Hi-tech Cleanwing II;
3. Clariant Safewing MP II Flight;
4. Clariant Safewing MP II Flight Plus;
5. Cryotech Polar Guard II;
6. Kilfrost ABC-2000;
7. Kilfrost ABC-K Plus; and
8. Newave Aerochemical FCY-2.

Regression information was also required for the Type II generic HOT table. As detailed in Subsection 3.2, the generic Type II HOT table values are based on the shortest holdover times of all fluids on the Transport Canada and FAA lists of Type II and Type fluids<sup>3</sup>. The majority of this data is already collected for the fluid-specific tables as described above; however, there are two fluids on the list of Type II fluids that do not have fluid-specific tables, and obtaining data for these fluids is somewhat more complicated.

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<sup>3</sup> See comment on qualified fluids in Subsection 3.2.1.

- **Clariant Safewing MP II 1951:** Due to concerns that arose with the viscosity of this fluid many years ago, regulators decided to discontinue publishing fluid-specific holdover times for the fluid. However, it remained on the list of qualified fluids and was permitted to be used with the Type II generic HOT Guidelines. Over the years, the Clariant Safewing MP II 1951 fluid-specific data has remained in the Type II generic analysis to account for the performance of the fluid.
- **Kilfrost ABC-3:** When this fluid came to the market in the early 1990s, fluid-specific testing was not completed with Type II fluids and therefore no fluid-specific data exists for it. When the “worst-performing fluid” methodology was adopted for developing the Type II generic table, it was necessary to find a way to incorporate the performance of these early fluids which did not have fluid-specific data in the generic analysis (these fluids were dubbed “grandfathered” fluids). To account for the performance of the grandfathered fluids, the values in the 1998-99 generic guidelines were included in the Type II generic analysis. The 1998-99 data set is now referred to as the grandfathered fluid data set and it must be included in the regression information so long as Kilfrost ABC-3 or any other grandfathered fluid is on the list of qualified fluids.

It should be noted that although the grandfathered fluid data set and Clariant Safewing MP II 1951 regression information is published, it is only for use in the calculation of the generic Type II holdover times and may not be used to derive fluid-specific holdover times for Clariant Safewing MP II 1951, grandfathered fluid Kilfrost ABC-3, or any other fluid.

#### 4.2.2.2 Data Source(s)

The majority of Type II regression information is derived from holdover time testing conducted with the associated Type II fluids. The holdover time testing has been carried out over many years (see Table 4.1). This data is available from the reports on holdover time testing published annually.

The grandfathered fluid data set is an exception. The regression coefficients for this data set were created from the 1998-99 Type II generic HOT table values. This was done for the original regression publication in 2008 (see Subsection 4.1.1, item 5).

#### 4.2.2.3 Data Collection

Most of the Type II regression information was collected previously (see Table 4.1) and was obtained from the previous regression publication, TP 15198E (9).

The new Type II fluid, Cryotech Polar Guard II, is a rebranding of an existing Type IV fluid, Cryotech Polar Guard Advance. Therefore its regression information was taken from the previous regression publication, TP 15198E (9).

Additional testing in snow was carried out with Clariant Safewing MP II Flight Plus in 2012-13. The resulting new snow regression information for this fluid was collected from the Transport Canada Report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (10).

#### 4.2.2.4 Data Removed

One Type II fluid, LNT Solutions P250, was removed from the HOT Guidelines for 2013-14. The regression information for the fluid was correspondingly removed from the regression publication.

### 4.2.3 Type III

#### 4.2.3.1 Data Required

As only one Type III fluid is currently qualified, regulators have elected to publish fluid-specific regression information for the fluid rather than regression information for the generic Type III HOT table. Therefore, the only Type III regression information required is the fluid-specific information for Clariant Safewing MP III 2031 ECO.

#### 4.2.3.2 Data Source(s)

Type III fluid-specific regression information is derived from holdover time testing conducted with Clariant Safewing MP III 2031 ECO. The holdover time testing was carried out over several winters (see Table 4.1). The data is available in the reports on holdover time testing published for the years the fluid was tested.

#### 4.2.3.3 Data Collection

The regression information for Clariant Safewing MP III 2031 ECO was collected previously (see Table 4.1) and therefore was obtained from the previous regression publication, TP 15198E (9).

#### 4.2.3.4 Data Removed

No Type III fluids or data were removed from the HOT Guidelines for 2012-13; therefore, no Type III data was removed from the regression publication.

#### 4.2.4 Type IV

##### 4.2.4.1 Data Required

Regression information was required for the thirteen Type IV fluid-specific HOT tables in the 2013-14 HOT Guidelines:

1. ABAX AD-480;
2. ABAX Ecowing AD-49;
3. Clariant Max-Flight 04;
4. Clariant Safewing MP IV Launch;
5. Clariant Safewing MP IV Launch Plus;
6. Cryotech Polar Guard;
7. Cryotech Polar Guard Advance;
8. Dow Chemical UCAR FlightGuard AD-480;
9. Dow Chemical UCAR AD-49;
10. Dow Chemical UCAR™ Endurance EG106;
11. Kilfrost ABC-S;
12. Kilfrost ABC-S Plus; and
13. Lyondell ARCTIC Shield.

Regression information is also required for the Type IV generic HOT table. As detailed in Subsection 3.2, the generic Type IV HOT table values are based on the shortest holdover times of all fluids on the Transport Canada and FAA lists of Type IV fluids<sup>4</sup>. As all Type IV fluids have fluid-specific HOT tables, and regression information is collected for those tables, no additional regression information is required to calculate the generic Type IV holdover times.

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<sup>4</sup> See comment on qualified fluids in Subsection 3.2.1.

#### 4.2.4.2 Data Source(s)

Type IV fluid-specific regression information is derived from holdover time testing conducted with the associated Type IV fluids. The holdover time testing has been carried out over many years (see Table 4.1). The data is available in the reports on holdover time testing published annually.

#### 4.2.4.3 Data Collection

Regression information for all but one of the Type IV fluids was collected previously (see Table 4.1) and was obtained from the previous regression publication, TP 15198E (9).

Clariant Safewing MP IV Launch Plus is a new fluid which underwent endurance time testing in 2012-13. Regression information was collected from the Transport Canada Report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (10). It should be noted that the fluid was assigned generic holdover times in the “below -3 to -14°C” snow cells and therefore given the regression coefficients of the fluids responsible for the related generic holdover times in winter 2013-14.

#### 4.2.4.4 Data Removed

One Type IV fluid, Kilfrost ABC-4<sup>sustain</sup>, was removed from the HOT Guidelines for 2013-14. The regression information for the fluid was correspondingly removed from the regression publication.

### 4.2.5 Ice Crystals

Ice crystals were added to all freezing fog columns in the HOT guidelines for the winter of 2013-14. Ice crystals have correspondingly been added to the freezing fog columns of the regression coefficients and verification tables. As the freezing fog regression information applies to ice crystals, no additional regression data was required.

### 4.2.6 Light and Very Light Snow Columns in Type II/IV HOT Tables

Changes were made to the snow columns of select Type II and Type IV HOT tables in the 2013-14 HOT Guidelines. Specifically, the “snow” column was renamed “moderate snow” and new columns for “very light snow” and “light snow” were



added. These changes had to be made to the related regression coefficients and verification tables accordingly.

Supplemental testing and analysis was completed with the affected fluids in the winter of 2012-13 to develop light and very light snow holdover times for the HOT Guidelines. This work is documented in the TC report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (10).

With the exception of one fluid/dilution, the supplemental testing/analysis determined that the existing snow regression coefficients could also be used for light and very light snow. Therefore the regression coefficients previously published for the "snow" column were used in the new "moderate," "light," and "very light" columns in the 2013-14 regression publication.

ABAX Ecowing 26 75/25 was an exception. New regression coefficients were developed for this fluid for light and very light snow. These regression coefficients were taken from TP 15228E (10).

#### **4.2.7 Lowest Usable Precipitation Rates for Snow**

Analysis conducted in the winter of 2011-12 determined that natural snow data for some fluids is not sufficient to support extrapolation of the regression curves to very low rates of precipitation. Lowest usable precipitation rates (LUPRs) for snow were subsequently determined for each Type II, III and Type IV fluid brand, fluid dilution and air temperature. This work is documented in the TC report, TP 15202E, *Aircraft Ground Icing General Research Activities During the 2011-12 Winter* (11). As a result of this work, a table of LUPRs was added to the regression publication for winter 2012-13.

Many LUPRs were modified as a result of additional snow data being collected in the winter of 2012-13 to develop light and very light snow holdover times for Type II/IV fluids (see Subsection 4.2.6). The table of LUPRs was updated accordingly in the 2013-14 regression publication. The analysis that resulted in the new LUPRs is documented in the TC report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (10).

#### **4.2.8 Summary**

Table 4.1 lists the regression data sets that are required for the 2013-14 HOT Guidelines and their respective sources. The first column specifies the fluid type and data set name, the second column specifies the source data for the regression

information, and the third column indicates the year the data set was first included in Transport Canada's regression information documents.

It should be noted that multiple data sets exist for some fluids. In these cases, the data was examined to determine which data set is responsible for the fluid-specific values in the associated HOT table. In some cases, the regression coefficients from both data sets have to be included in the final information as the upper and lower values in a cell are derived from different data sets.

Some regression coefficients are not derived directly from regression analysis of holdover time test data (specifically, Type I freezing precipitation values and Type II grandfathered fluid data set values). To obtain regression coefficients for these data sets, each cell value was assumed to be a test data point and these data points were regressed to determine the regression coefficients for the resulting best-fit curves.

#### **4.2.9 Data Verification**

In order to verify the accuracy of the data provided in the regression coefficients tables, the data provided in the tables was used to generate values for a fluid-specific HOT table for each fluid. This information was cross-referenced with the values provided in the published generic and fluid-specific HOT tables. The values were the same, ensuring the regression coefficients are correct.

**Table 4.1: Regression Data Sets Required for 2013-14**

<b>Fluid Type: Data Set Name</b>	<b>Source of Regression Data</b>	<b>Year Added to Regression Publication</b>
Type I: Generic (Aluminum Snow)	HOT Testing: 2001-02	2008-09
Type I: Generic (Composite Snow)	HOT Testing: 2006-07, 2007-08, 2009-10	2010-11
Type I: Generic (Aluminum Freezing Precipitation)	Created from 2008-09 HOT table values	2008-09
Type I: Generic (Composite Freezing Precipitation)	Created from 2010-11 HOT table values	2010-11
Type II: ABAX Ecowing 26	HOT Testing: 2000-01, 2012-13 (NS)	2008-09
Type II: Aviation Shaanxi Cleanwing II	HOT Testing: 2008-09	2009-10
Type II: Clariant Safewing MP II 1951	HOT Testing: 1999-00	2008-09
Type II: Clariant Safewing MP II Flight	HOT Testing: 2005-06, 2009-10	2008-09
Type II: Clariant Safewing MP II Flight Plus	HOT Testing: 2011-12, 2012-13 (NS)	2012-13
Type II: Cryotech Polar Guard II	HOT Testing: 2010-11 (Cryotech Polar Guard Advance)	2013-14
Type II: Grandfathered Fluid Data Set	Created from 1998-99 Type II generic values	2008-09
Type II: Kilfrost ABC-2000	HOT Testing: 2001-02	2008-09
Type II: Kilfrost ABC-K Plus	HOT Testing: 2007-08	2008-09
Type II: Newave Aerochemical FCY-2	HOT Testing: 2006-07	2008-09
Type III: Clariant Safewing MP III ECO	HOT Testing: 2004-05 (100/0), 2005-06 (75/25,50/50)	2008-09

Table 4.1: Regression Data Sets Required for 2013-14 (cont'd)

Fluid Type: Data Set Name	Source of Regression Data	Year Added to Regression Publication
Type IV: ABAX AD-480	HOT Testing: 1997-98 (NS,ZR,ZD), 1998-99 (NS), 1999-00	2008-09
Type IV: ABAX Ecowing AD-49	HOT Testing: 2008-09	2009-10
Type IV: Clariant Max-Flight 04	HOT Testing: 2000-01	2008-09
Type IV: Clariant Safewing MP IV Launch	HOT Testing: 2005-06 (ZF,ZR,ZD,CS), 2006-07 (NS)	2008-09
Type IV: Clariant Safewing MP IV Launch Plus	HOT Testing: 2012-13	2013-14
Type IV: Cryotech Polar Guard	HOT Testing: 2009-10	2010-11
Type IV: Cryotech Polar Guard Advance	HOT Testing: 2010-11	2011-12
Type IV: Dow UCAR FlightGuard AD-480	HOT Testing: 1997-98 (NS,ZR,ZD), 1998-99 (NS), 1999-00	2008-09
Type IV: Dow UCAR FlightGuard AD-49	HOT Testing: 2008-09 (with identical fluid ABAX AD-49)	2010-11
Type IV: Dow UCAR™ Endurance EG106	HOT Testing: 2005-06	2008-09
Type IV: Kilfrost ABC-S	HOT Testing: 1996-97 (NS,ZR,ZD), 1997-98 (ZR,ZD,CS), 1998-99	2008-09
Type IV: Kilfrost ABC-S Plus	HOT Testing: 2006-07	2008-09
Type IV: Lyondell ARCTIC Shield®	HOT Testing: 2006-07	2008-09

## 5. REGRESSION INFORMATION PUBLICATION: 2013-14

The regression information underlying the 2013-14 HOT Guidelines is provided in the Transport Canada document *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2013-2014* and the FAA document *Official FAA Holdover Time Regression Information Winter 2013-2014*.

The contents of these documents are described in this chapter. The documents follow a very similar structure, with nearly identical content (see differences described in Subsections 3.2.2, 3.3.1 and 3.4.1).

The documents were published online in August 2013 (see Subsection 5.7). A copy of the Transport Canada document is included for reference in Appendix B.

### 5.1 Summary of Changes

The summary of changes, included at the front of the document, provides a detailed account of the changes made to the document for 2013-14.

### 5.2 Guidance Material

The regression information publication contains guidance for using the information contained in the document. This includes guidance on how to interpret the information in the regression coefficients tables, its applicability, and how to calculate generic holdover times for each fluid type. It also provides a description of the verification tables and their purpose, and describes several limitations of the data (discussed in this document in Subsection 5.6).

### 5.3 Regression Coefficients Tables

There are 26 regression coefficients tables in the 2013-14 regression information publication. A list of the tables is provided in Table 5.1.

#### 5.3.1 Table Format and Footnotes

Each regression coefficients table is presented in the format of its corresponding HOT table. A footnote is provided at the top of each column to indicate the form of the regression equation for the cells in that column. The regression coefficients required for the equation are given in the corresponding cells below.

**Table 5.1: Regression Coefficients Tables for Winter 2013-14**

Fluid Type	Regression Coefficients Tables
Type I	<ul style="list-style-type: none"> <li>• Generic Type I (Aluminum Wing Surfaces)</li> <li>• Generic Type I (Composite Wing Surfaces)</li> </ul>
Type II	<ul style="list-style-type: none"> <li>• ABAX Ecowing 26</li> <li>• Aviation Shaanxi Hi-tech Cleanwing II</li> <li>• Clariant Safewing MP II 1951 *</li> <li>• Clariant Safewing MP II Flight</li> <li>• Clariant Safewing MP II Flight Plus</li> <li>• Cryotech Polar Guard II</li> <li>• Kilfrost ABC-2000</li> <li>• Kilfrost ABC-K Plus</li> <li>• Newave Aerochemical FCY-2</li> <li>• Type II "Grandfathered" Fluid Data *</li> </ul>
Type III	<ul style="list-style-type: none"> <li>• Clariant Safewing MP III 2031</li> </ul>
Type IV	<ul style="list-style-type: none"> <li>• ABAX AD-480</li> <li>• ABAX Ecowing AD-49</li> <li>• Clariant Max-Flight 04</li> <li>• Clariant Safewing MP IV Launch</li> <li>• Clariant Safewing MP IV Launch Plus</li> <li>• Cryotech Polar Guard</li> <li>• Cryotech Polar Guard Advance</li> <li>• Dow Chemical UCAR Endurance EG106</li> <li>• Dow Chemical UCAR FlightGuard AD-480</li> <li>• Dow Chemical UCAR FlightGuard AD-49</li> <li>• Kilfrost ABC-S</li> <li>• Kilfrost ABC-S Plus</li> <li>• Lyondell ARCTIC Shield</li> </ul>

\* These tables can not be used to derive fluid-specific values for any fluid; they are only to be used in the calculation of generic Type II holdover times. See Subsection 4.2.2.1.

The coefficients provided in each table cell are valid only for the conditions (temperature, precipitation type, fluid dilution) of that cell. In cells where no temperature coefficient (coefficient "B") is provided, temperature is not an input in the equation. The regression coefficients are derived using the lowest temperature in the temperature range of the cell and must be used for all temperatures in the cell.

Additional footnotes are provided for several of the tables. Two sets of coefficients are provided in some table cells because different data sets are responsible for the upper and lower values in the cell (see Subsection 4.2.8). A footnote on these cells indicates that each set of regression coefficients must be used to calculate a holdover time and that the shortest holdover time calculated is the value that must be used.

Footnotes are also used to highlight discrepancies that may be encountered if the regression coefficients are used to calculate the values provided in the Transport Canada HOT Guidelines.

As per the protocol described in Subsection 3.1, generic regression coefficients are included in the "below -14 to -25°C or LOU" snow cell for all Type II and Type IV fluids.

## 5.4 Data Verification Tables

Verification tables are included in the regression information publication. The values in these tables were calculated using the regression coefficients provided in the online publication. There is a verification table provided for each data set listed in Table 5.1.

Verification tables are also provided for the generic Type II and generic Type IV HOT tables. The values in these tables were determined using the methodologies for calculating Type II and Type IV generic holdover times detailed in Subsection 3.2.

Each verification table provides holdover time values for select boundary conditions for each cell in the associated HOT table. The verification tables can be used as an aid for the HOTDS manufacturers during the development process. These tables are not all encompassing and HOTDS manufacturers are cautioned that they must develop comprehensive verification and validation methods covering normal and exceptional conditions (e.g. values outside of the temperature range) to ensure the adequacy of their software algorithms.

## 5.5 Table of Lowest Usable Precipitation Rates in Snow

A table of the lowest usable precipitation rates in snow for each Type II, III and IV fluid, fluid dilution and outside air temperature is provided. These values were determined through examination of the robustness of the snow data sets at low rates of precipitation. The LUPR is the lowest precipitation rate for which sufficient natural snow data exists to support use of the regression coefficients and is the lowest snow precipitation rate that can be input by a HOTDS.

## 5.6 Data Limitations

There are several limitations on the regression coefficients and equations that must be considered by users of the data. These limitations are described in the guidance section of the regression information publication and detailed below.

### 5.6.1 Limitation #1: OAT Greater or Equal to 2°C

The regression equations which include a temperature coefficient cannot be populated with temperature data greater than or equal to 2°C. This is a limitation of the form of the equation.

### 5.6.2 Limitation #2: Non-Standard Fluid Dilutions

The data cannot be interpolated to determine holdover times for fluid dilutions other than the standard 100/0, 75/25 and 50/50 mixtures. This is due to the complex, non-linear, fluid-specific relationship between fluid dilution and holdover time.

### 5.6.3 Limitation #3: Precipitation Rates outside Rate Limit Boundaries

Caution must be used when using the regression equations to calculate holdover times with precipitation rates outside of the precipitation rate limits used in the development of HOT tables (see Subsection 2.1).

The regression coefficients are based on best-fit power-law curves and the shape of these curves can result in extreme values outside the precipitation rate limits at which endurance time tests are conducted. Caution must be exercised in applying the regression coefficients at precipitation rates outside of the precipitation rate limits, especially at precipitation rates below the lower limit where the power-law curves give much longer holdover times.



This limitation is illustrated in the sample regression shown in Figure 5.1. This example illustrates that at precipitation rates below the lower rate limit at which tests are conducted (5 g/dm<sup>2</sup>/h in this example), derived holdover times can increase substantially with a small decrease in precipitation rate. For example: at the lower rate limit of 5 g/dm<sup>2</sup>/h, the endurance time is approximately 82 minutes; at a slightly lower rate of 3 g/dm<sup>2</sup>/h, the endurance time jumps to 122 minutes.

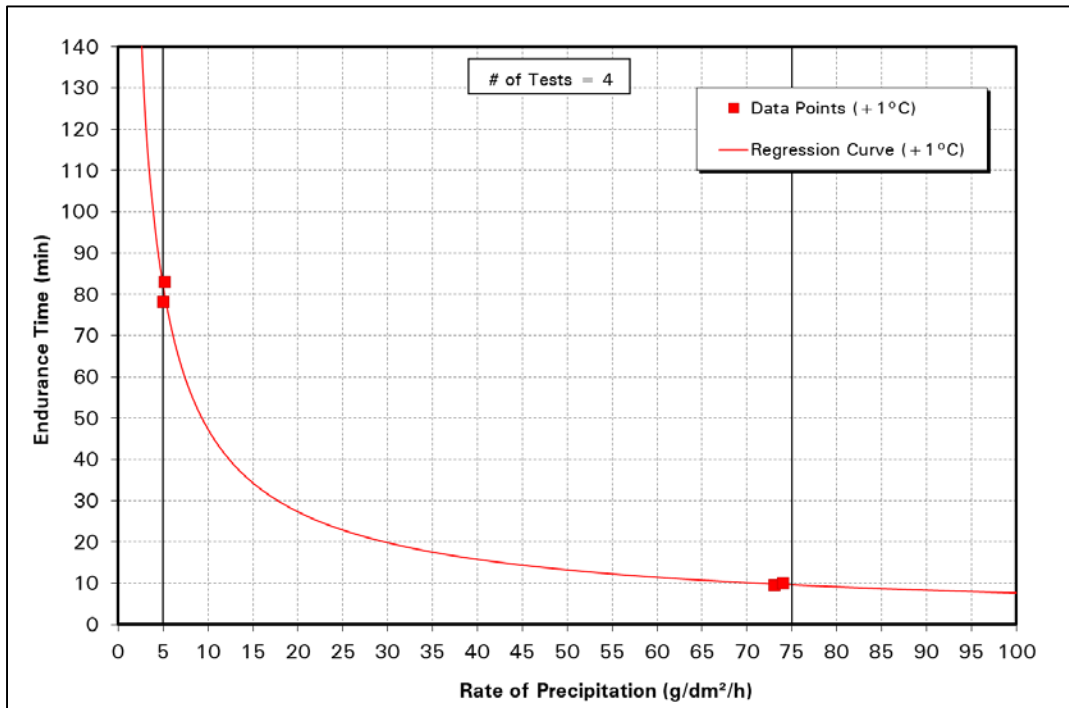


Figure 5.1: Sample Regression Curve – Cold-Soaked Wing

## 5.7 Document Publication

The regression information required for the 2013-14 HOT Guidelines was published online by Transport Canada and FAA in August 2013.

Transport Canada published the document *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2013-2014* on August 1, 2013. The document is available here: <http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm>.

FAA published regression information for the first time on August 2, 2013 in the document *Official FAA Holdover Time Regression Information Winter 2013-2014*. The document is available here: [http://www.faa.gov/other\\_visit/aviation\\_industry/airline\\_operators/airline\\_safety/deicing/](http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/).

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## 6. CONCLUSIONS

The regression information required for the 2013-14 HOT Guidelines was published online by Transport Canada and FAA in August 2013.

The data required, collected and removed for the 2013-14 online publication is documented in this report. The data was predominantly collected from the previous regression report, although additional data was collected from the results of endurance time testing conducted in 2012-13. The data is primarily sourced from the results of holdover time testing conducted from the winters of 1996-97 to 2012-13.

The regression coefficients and equations can be used as inputs in HOTDS for the winter of 2013-14. However, users are cautioned that care must be taken in the application of the regression information. There are a number of rules, exceptions and cautions detailed in this report, in the online publications and in the HOT Guidelines themselves that must be respected. It is also important to note that additional restrictions may be put on the usage of the data by regulators (for example by the Transport Canada exemption document).

Because the HOT Guidelines are updated on an annual basis and include changes such as the addition of newly qualified fluids, the removal of unavailable fluids and changes to the generic tables, the regression information must also be updated on an annual basis. That requires both the online publications and this report be updated.

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## 7. RECOMMENDATIONS

Due to the dynamic nature of the HOT tables, it is recommended that the regression information publications – the online documents and this report – be updated and published on an annual basis.

As HOTDS progress, further analysis may become necessary and/or desired. Several recommendations to this end are provided in the Transport Canada report, TP 14873E, *Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables* (1).

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## REFERENCES

1. Bendickson, S., *Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2008, TP 14873E, XX (to be published).
2. SAE International Aerospace Recommended Practice 5718A, *Process to Obtain Holdover Times for Aircraft Deicing/Anti-Icing Fluids, SAE AMS1428 Types II, III, and IV*, November 2012.
3. Alwaid, A., Dawson, P., Moc, N., *Generation of Holdover Times Using the New Type I Fluid Test Protocol*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2002, TP 13994E, 106.
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8. Bendickson, S., *Regression Coefficients and Equations Used to Develop the Winter 2011-12 Aircraft Ground Deicing Holdover Time Tables*, APS Aviation Inc., Transportation Development Centre, Montreal, January 2012, TP 15159E, XX (to be published).
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10. Bendickson, S., *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, March 2014, TP 15228E, XX (to be published).
11. Bendickson, S., D'Avirro, J., Gravito, P., Ruggi, M., Youssef, D, Zoitakis, V., *Aircraft Ground Icing General Research Activities During the 2011-12 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, March 2013, TP 15202E, XX (to be published).



**APPENDIX A**

**TRANSPORTATION DEVELOPMENT CENTRE  
WORK STATEMENT EXCERPT –  
AIRCRAFT & ANTI-ICING FLUID  
WINTER TESTING 2012-13**



**TRANSPORTATION DEVELOPMENT CENTRE  
WORK STATEMENT EXCERPT –  
AIRCRAFT & ANTI-ICING FLUID  
WINTER TESTING 2012-13**

**4.44 Update: Regression Coefficients Used to Compute Holdover Times**

- a) Update regression coefficients tables and verification tables to reflect changes made to the holdover time guidelines for the winter 2012-13 operating season;
- b) Add FAA coefficients to cells where FAA and TC differ;
- c) Prepare document suitable for online publication; and
- d) Prepare a final report to document the applicable regression coefficients and verification tables required for the winter of 2013-14.

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**APPENDIX B**

**TRANSPORT CANADA  
HOLDOVER TIME (HOT) GUIDELINES  
REGRESSION INFORMATION  
WINTER 2013-2014**



# Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2013-2014

**Original Issue, August 2013**

This document should be used in conjunction with the Transport Canada Holdover Time Guidelines, available at:  
<http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm>.

Questions or comments on the content of the holdover time guidelines should be addressed to Transport Canada Civil Aviation Communication Centre  
Telephone 1-800-305-2059 Facsimile 613-949-4204 TTY (613) 990-4500  
[services@tc.gc.ca](mailto:services@tc.gc.ca)

To receive notification of HOT Guideline updates, subscribe to or update your e-news subscription at the following Transport Canada Web site:  
<http://wwwapps.tc.gc.ca/Comm/5/ListServ/menu.aspx>. Subscribing to e-news will require an email address and selecting Holdover Time (HOT) Guidelines under Publications / Air Transportation / Aviation Safety - Safety Information.

**CHANGE CONTROL RECORDS**

This page indicates any changes made to individual pages within the document. Changed pages have the appropriate revision date in the footer.

It is the responsibility of the end user to periodically check the following website for updates on Regression Information: <http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm>.

<i>REVISION</i>	<i>DATE</i>	<i>DESCRIPTION OF CHANGES</i>	<i>AFFECTED PAGES</i>	<i>AUTHOR</i>



**TC HOT Guidelines Regression Information****Winter 2013-2014****SUMMARY OF CHANGES FROM PREVIOUS YEAR**

The principal changes from the previous year are briefly indicated herein.

**Type I Fluid**

- The Type I regression coefficients are unchanged.

**Type II Fluid**

- A regression coefficients table and verification table have been added for Cryotech Polar Guard II, a new Type II fluid added to the holdover time (HOT) guidelines for winter 2013-2014.
- The LNT Solutions P250 fluid-specific HOT table was removed from the HOT guidelines for winter 2013-2014. Correspondingly, the regression coefficients table and verification table for this fluid have been removed from this document.
- Supplemental snow testing with Clariant Safewing MP II FLIGHT PLUS resulted in changes to some of this fluid's snow regression coefficients. Decreases were also made to some of the fluid's lowest usable precipitation rates (LUPRs).
- Supplemental testing and analysis was completed with several Type II fluids in the winter of 2012-2013 in support of the development of light and very light snow holdover times. This testing resulted in the following changes to this document: addition of light and very light snow columns to some of the Type II regression coefficients tables, renaming of the existing snow column in these tables to moderate snow, and reductions to a number of Type II LUPRs.

**Type III Fluid**

- The Type III regression coefficients are unchanged.

**Type IV Fluid**

- A regression coefficients table and verification table have been added for Clariant Safewing MP IV LAUNCH PLUS, a new Type IV fluid added to the holdover time (HOT) guidelines for winter 2013-2014.
- The Kilfrost ABC-4<sup>sustain</sup> fluid-specific HOT table was removed from the HOT guidelines for winter 2013-2014. Correspondingly, the regression coefficients table and verification table for this fluid have been removed from this document.
- Several changes were made to the Type IV generic holdover times for winter 2013-2014. The Type IV generic verification table has been updated accordingly.
- Supplemental testing and analysis was completed with several Type IV fluids in the winter of 2012-2013 in support of the development of light and very light snow holdover times. This testing resulted in the following changes to this document: addition of light and very light snow columns to some of the Type IV regression coefficients tables, renaming of the existing snow column in these tables to moderate snow, and reductions to a number of Type IV LUPRs.

**Ice Crystals**

- Ice crystals were added to the HOT guidelines for the winter of 2013-14. Specifically, they were added to the freezing fog columns of all Type I, II, III and IV HOT tables. Ice crystals have correspondingly been added to the regression coefficients and verification tables.

**TC HOT Guidelines Regression Information****Winter 2013-2014****GUIDANCE FOR USING REGRESSION INFORMATION**

In recent years, several companies have been developing systems that measure temperature, precipitation type and precipitation rate in real-time. These systems, referred to as holdover time determination systems (HOTDS), use the weather data they collect and the regression information underlying the holdover time guidelines to calculate more precise holdover times than can be obtained from the holdover time guidelines.

As a result of the development of HOTDS, Transport Canada is required to make the regression coefficients and equations underlying the holdover time tables available to users. The purpose of this document is to provide the holdover time guidelines regression information for the 2013-14 holdover time guidelines and to provide guidance on its usage.

The sources of the regression data, along with a history of the publication of regression information, are documented in the Transport Canada report, TP 15229E, *Regression Coefficients and Equations Used to Develop the Winter 2013-14 Aircraft Ground Deicing Holdover Time Tables*. This document can be referenced for further information if required.

At this time, operational approval for use of these systems is only authorized through the Transport Canada exemption process. The information contained in this report can only be used in conjunction with the applicable Transport Canada exemption. The applicable exemption document must be referred to for further information and guidance.

**Interpreting Regression Coefficients Tables**

Regression information is provided in this document in a series of regression coefficients tables. Each regression coefficients table shows the regression coefficients and equations that are to be used to calculate holdover times at specific outside air temperatures, under specific precipitation types, with specific fluid dilutions (as applicable for Type II/III/IV fluids).

Each regression coefficients table is presented in the format of its corresponding holdover time table. A footnote is provided at the top of each column to indicate the form of the regression equation for the cells in that column. The regression coefficients required for the equation are given in the corresponding cells below.

The coefficients provided in each table cell are valid only for the conditions (temperature, precipitation type, fluid dilution) of that cell. In cells where no temperature coefficient (coefficient "B") is provided, temperature is not an input into the equation.

**Applicability of Regression Coefficients Tables**

The Type I generic regression coefficients tables are applicable for all Type I fluids. Fluid-specific regression coefficients tables are available and applicable for Type III fluids and Type IV fluids and for the majority of Type II fluids. If a fluid-specific table is not available for use in calculating fluid-specific holdover times for a Type II or Type IV fluid (currently the case for only two fluids – Clariant Safewing MP II 1951 and Kilfrost ABC-3) or if the specific fluid being used is not known, the methodology for calculating Type II or Type IV generic holdover times must be followed (see next page).

**TC HOT Guidelines Regression Information****Winter 2013-2014****Calculating Type II and Type IV Generic Holdover Times**

Generic Type II and Type IV holdover times are used when a flight crew is unaware of the specific fluid that has been used to de/anti-ice their aircraft. The generic values represent the shortest possible holdover time of either all Type II or all Type IV fluids available. The following methodologies must be applied to HOTDS programming to enable the systems to determine generic Type II and Type IV holdover times.

**Type II:** To calculate Type II generic holdover times, HOTDS must be programmed to return the shortest holdover time calculated from the regression information provided for each of the following:

- a) Each Type II fluid on the Transport Canada list of fluids tested for anti-icing performance and aerodynamic acceptance, excluding Kilfrost ABC-3;
- b) The Type II grandfathered fluid data set, and
- c) Each Type IV fluid on the Transport Canada list of fluids tested for anti-icing performance and aerodynamic acceptance (as Type IV fluids also qualify as Type II fluids).

This methodology must also be followed if either Kilfrost ABC-3 or Clariant Safewing MP II 1951 is being used, as neither of these fluids is qualified for use with fluid-specific holdover times.

**Type IV:** To calculate Type IV generic holdover times, HOTDS must be programmed to calculate the holdover time for each Type IV fluid on the Transport Canada list of fluids tested for anti-icing performance and aerodynamic acceptance and return the shortest holdover time calculated. This is the generic Type IV holdover time.

**Verification Tables**

Verification tables are provided for each of the regression coefficients tables and also for the generic Type II and generic Type IV holdover times. Each verification table provides verification values for select boundary conditions in the associated holdover time table. For Type II, III and IV fluids, the verification tables also include verification values for the lowest usable precipitation rate in snow.

**NOTE:** HOTDS manufacturers may find it useful to use these verification tables as an aid in verifying the implementation of their software algorithms. However, HOTDS manufacturers are cautioned that these tables are not all encompassing and that they must develop comprehensive verification and validation methods to ensure the adequacy of their software algorithms.

**NOTE:** The temperatures used in the verification tables do not respect limitations imposed by fluid lowest operational use temperatures.

**Lowest Usable Precipitation Rates in Snow (Table 5)**

Analysis conducted in the winter of 2011-12 determined that natural snow test data for some fluids is not sufficient to support extrapolation of the regression curves to very low rates of precipitation. The lowest usable precipitation rates (LUPRs) in snow have been identified and are included in Table 5 for Type II, III and IV fluids (Type I fluids are not affected). The lowest usable rates differ by fluid brand, fluid dilution and temperature. Supplemental testing conducted in the winter of 2012-13 resulted in reductions to the LUPRs of some Type II and IV fluids.

**TC HOT Guidelines Regression Information****Winter 2013-2014****Limitations of Regression Information**

Users are cautioned that care must be taken in the application of the regression information. There are a number of rules, exceptions and cautions detailed in both this document and in the holdover time guidelines that must be considered. It is also important to note that additional restrictions may be put on their usage by the applicable Transport Canada exemption document.

Several limitations on the usage of the regression information are listed below.

- The regression coefficients can only be used with liquid water equivalent information that is provided by an HOTDS in accordance with the exemption document.
- Regression equations which include a temperature coefficient can not be populated with temperature data greater than or equal to 2°C. This is a limitation of the form of the equation. At this time it is recommended that 0°C be input into HOTDS when temperature is above 0°C<sup>1</sup>.
- Regression data is developed for specific fluid dilutions. The data can not be interpolated to determine holdover times for use with dilutions other than the standard 100/0, 75/25 and 50/50 mixtures.
- The regression coefficients are based on best-fit power-law curves and the shape of these curves can result in extreme values outside the precipitation rate limits at which endurance time tests are conducted. Therefore, these values are not necessarily accurate. Caution must therefore be exercised when using the regression equations to calculate holdover times outside of the precipitation rate limits used in the development of holdover time tables, especially at precipitation rates below the lower precipitation rate limit, where the power-law curves give much longer holdover times.
- The lowest precipitation rate to be used as an input to the snow regression equations (this does not apply to other precipitation types) is constrained by the higher of the following:
  1. Minimum demonstrated precipitation measuring equipment rates in accordance with the Transport Canada exemption (in no case shall this be less than 2.0 g/dm<sup>2</sup>/h); and
  2. Lowest usable precipitation rate (LUPR) for each fluid/dilution/temperature as defined in Table 5 of this document. The LUPR is the lowest precipitation rate for which sufficient outdoor snow data exists to support use of the regression coefficients. Further data on the substantiation of the LUPR values is available in TP 15229E.
- As regression coefficients and equations are not currently used in the determination of frost holdover times, regression coefficient information is not provided for frost.
- As regression coefficients and equations are not used in the determination of the allowance times provided for ice pellets and ice pellets mixed with other types of precipitation, regression coefficient information is not provided for the ice pellet allowance times.

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<sup>1</sup> The issue of temperatures above 0°C will be addressed in future releases of the associated exemption document.

**TC HOT Guidelines Regression Information****Winter 2013-2014****REGRESSION INFORMATION FOR WINTER 2013-2014**

Table 1-1	Generic Type I (Aluminum Wing Surfaces) Regression Coefficients Table and Verification Table
Table 1-2	Generic Type I (Composite Wing Surfaces) Regression Coefficients Table and Verification Table
Table 2-1	ABAX Ecowing 26 Regression Coefficients Table and Verification Table
Table 2-2	Aviation Shaanxi Hi-Tech Clearwing II Regression Coefficients Table and Verification Table
Table 2-3	Clariant Safewing MP II 1951 Regression Coefficients Table and Verification Table
Table 2-4	Clariant Safewing MP II FLIGHT Regression Coefficients Table and Verification Table
Table 2-5	Clariant Safewing MP II FLIGHT PLUS Regression Coefficients Table and Verification Table
Table 2-6	Cryotech Polar Guard II Regression Coefficients Table and Verification Table
Table 2-7	Kilfroast ABC-2000 Regression Coefficients Table and Verification Table
Table 2-8	Kilfroast ABC-K Plus Regression Coefficients Table and Verification Table
Table 2-9	Newave Aerochemical FCY-2 Regression Coefficients Table and Verification Table
Table 2-10	Type II "Grandfathered" Fluid Data Regression Coefficients Table and Verification Table
Table 2-11	Type II Generic Verification Table
Table 3-1	Clariant Safewing MP III 2031 ECO Regression Coefficients Table and Verification Table
Table 4-1	ABAX AD-480 Regression Coefficients Table and Verification Table
Table 4-2	ABAX Ecowing AD-49 Regression Coefficients Table and Verification Table
Table 4-3	Clariant Max Flight 04 Regression Coefficients Table and Verification Table <i>(formerly Octagon Max Flight 04)</i>
Table 4-4	Clariant Safewing MP IV LAUNCH Regression Coefficients Table and Verification Table
Table 4-5	Clariant Safewing MP IV LAUNCH PLUS Regression Coefficients Table and Verification Table
Table 4-6	Cryotech Polar Guard Regression Coefficients Table and Verification Table
Table 4-7	Cryotech Polar Guard Advance Regression Coefficients Table and Verification Table
Table 4-8	Dow Chemical UCAR™ Endurance EG106 Regression Coefficients Table and Verification Table
Table 4-9	Dow Chemical UCAR™ FlightGuard AD-480 Regression Coefficients Table and Verification Table
Table 4-10	Dow Chemical UCAR™ FlightGuard AD-49 Regression Coefficients Table and Verification Table
Table 4-11	Kilfroast ABC-S Regression Coefficients Table and Verification Table
Table 4-12	Kilfroast ABC-S Plus Regression Coefficients Table and Verification Table
Table 4-13	Lyondell ARCTIC Shield™ Regression Coefficients Table and Verification Table
Table 4-14	Type IV Generic Verification Table
Table 5	Lowest Usable Precipitation Rates in Snow

TC HOT Guidelines Regression Information

Winter 2013-2014

**TABLE 1-1  
GENERIC TYPE I (ALUMINUM WING SURFACES)  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE**

Outside Air Temperature		Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit	Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	I = 1.3735 A = -0.4751	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.3829 A = -0.3848	I = 1.4688 A = -0.6200	I = 0.9355 A = -0.3384	CAUTION: No holdover time guidelines exist
below -3 to -6	below 27 to 21	I = 1.2734 A = -0.5299	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.3842 A = -0.6152	I = 1.4688 A = -0.6200		
below -6 to -10	below 21 to 14	I = 1.1678 A = -0.5575	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.2545 A = -0.5857	I = 2.2598 A = -1.4012		
below -10	below 14	I = 1.1473 A = -0.6415	I = 2.0072 A = -0.5752 B = -0.5585				

<sup>1</sup> Regression Equation:  $t = 10^I R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)

<sup>2</sup> Regression Equation:  $t = 10^I R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)

<sup>3</sup> Type I aluminum snow values are rounded down to the nearest one minute (i.e. 6.5 mins = 6 mins, 18.6 mins = 18 mins) to determine holdover time table values

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
	Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
	5	2	25	10	4	13	5	25	13	75	5
+1 / -3 *	11.0	17.0	6.5	11.0	18.6	9.0	13.0	4.0	6.0	2.0	5.0
-6	8.0	13.0	5.0	8.5	14.3	5.0	9.0	4.0	6.0		
-10	6.0	10.0	4.0	6.7	11.4	4.0	7.0	2.0	5.0		
-25	5.0	9.0	2.5	4.3	7.3						

\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TC HOT Guidelines Regression Information

Winter 2013-2014

TABLE 1-2  
**GENERIC TYPE I (COMPOSITE WING SURFACES)**  
**REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE**

Outside Air Temperature		Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit	Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	I = 1.3931 A = -0.6279	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.4691 A = -0.5081	I = 1.4688 A = -0.6200	I = 1.1144 A = -0.5943	CAUTION: No holdover time guidelines exist
below -3 to -6	below 27 to 21	I = 0.9976 A = -0.3140	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.3842 A = -0.6152	I = 1.4688 A = -0.6200		
below -6 to -10	below 21 to 14	I = 1.1308 A = -0.7565	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.2545 A = -0.5857	I = 2.2598 A = -1.4012		
below -10	below 14	I = 1.0289 A = -0.6107	I = 2.0072 A = -0.5752 B = -0.5585				

<sup>1</sup> Regression Equation:  $t = 10^4 R^2$ , where R = precipitation rate (g/dm<sup>2</sup>/h)

<sup>2</sup> Regression Equation:  $t = 10^4 R^2 (2-T)^2$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)

<sup>3</sup> Type I composite snow values below 10 mins are rounded down to the nearest one minute (i.e. 2.5 mins = 2 mins) to determine holdover time table values

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
	Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
	5	2	25	10	4	13	5	25	13	75	5
+1 / -3 *	9.0	16.0	3.0	6.0	11.8	8.0	13.0	4.0	6.0	1.0	5.0
-6	6.0	8.0	2.7	5.4	10.7	5.0	9.0	4.0	6.0		
-10	4.0	8.0	2.5	5.0	9.8	4.0	7.0	2.0	5.0		
-25	4.0	7.0	2.5	4.3	7.3						

\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TC HOT Guidelines Regression Information

Winter 2013-2014

TABLE 2-1  
**ABAX ECOWING 26**  
 REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1,4</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.3810 A = -0.6352	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4589 A = -0.6723	I = 2.0131 A = -0.2946	I = 2.3224 A = -0.5535	CAUTION: No holdover time guidelines exist
		75/25	I = 2.2439 A = -0.6073	I = 2.3334 A = -0.5288 B = -0.2160	I = 2.3334 A = -0.5288 B = -0.2160	I = 2.3485 A = -0.6016 B = -0.1043	I = 2.1009 A = -0.4085	I = 2.0488 A = -0.4806	I = 2.2032 A = -0.6072	
		50/50	I = 1.7955 A = -0.5090	I = 2.0178 A = -0.6943 B = 0.0298	I = 2.0178 A = -0.6943 B = 0.0298	I = 2.0178 A = -0.6943 B = 0.0298	I = 1.7327 A = -0.5413	I = 1.6166 A = -0.5058		
below -3 to -14	below 27 to 7	100/0	I = 2.5006 A = -1.2335	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4044 A = -0.8101	I = 2.7587 A = -1.1217		
		75/25	I = 2.1380 A = -0.8452	I = 2.3334 A = -0.5288 B = -0.2160	I = 2.3334 A = -0.5288 B = -0.2160	I = 2.3485 A = -0.6016 B = -0.1043	I = 2.2768 A = -0.8445	I = 2.3760 A = -0.8759		
below -14 to -25	below 7 to -13	100/0	I = 1.8682 A = -0.6972	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^4 R^0$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^4 R^0 (2-T)^0$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5  
<sup>4</sup> Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm<sup>2</sup>/h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm<sup>2</sup>/h, values in the holdover time table may differ slightly from those calculated using these coefficients.

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	86.5	154.8	37.9	60.5	137.4	51.3	97.5	39.9	48.4	19.3	86.2
	75/25	66.0	115.1	27.2	47.2	105.5	44.2	65.4	23.8	32.6	11.6	60.1
	50/50	27.5	43.9	11.7	22.1	51.0	13.5	22.6	8.1	11.3		
-10 / -14 ***	100/0	43.5	134.7	33.8	54.0	122.6	31.8	68.9	15.5	32.3		
	75/25	35.3	76.5	24.1	41.8	82.1	21.7	48.6	14.2	25.1		
	100/0	24.0	45.5	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C



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TABLE 2-2  
**AVIATION SHAANXI HI-TECH CLEANWING II**  
 REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.2573 A = -0.7407	I = 2.4007 A = -0.6714 B = 0.0000	I = 2.1979 A = -0.5728	I = 2.2567 A = -0.6317	I = 2.1512 A = -0.6064	CAUTION: No holdover time guidelines exist
		75/25	I = 2.0742 A = -0.5411	I = 2.3510 A = -0.6986 B = 0.0000	I = 2.1475 A = -0.5338	I = 2.2158 A = -0.6683	I = 2.1568 A = -0.6861	
		50/50	I = 1.9836 A = -0.6276	I = 2.3242 A = -0.6725 B = -0.2889	I = 2.0341 A = -0.6288	I = 2.1847 A = -0.7830		
below -3 to -14	below 27 to 7	100/0	I = 2.3283 A = -0.9431	I = 2.4007 A = -0.6714 B = 0.0000	I = 2.1441 A = -0.6033	I = 1.8282 A = -0.4021		
		75/25	I = 2.3328 A = -1.0611	I = 2.3510 A = -0.6986 B = 0.0000	I = 1.6685 A = -0.1061	I = 1.7474 A = -0.3274		
below -14 to -29	below 7 to -20.2	100/0	I = 1.9950 A = -0.9540	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^2$ , where R = precipitation rate (g/dm<sup>2</sup>h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^2 (2-T)^2$ , where R = precipitation rate (g/dm<sup>2</sup>h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> h)			Freezing Drizzle (g/dm <sup>2</sup> h)		Light Freezing Rain (g/dm <sup>2</sup> h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	54.9	108.2	29.0	53.6	99.2	36.3	62.7	23.6	35.7	10.3	53.4
	75/25	49.7	81.5	23.7	44.9	85.2	35.7	59.5	19.1	29.6	7.4	47.6
	50/50	35.1	62.3	15.2	28.2	35.8	21.6	39.3	12.3	20.5		
-10 / -14 ***	100/0	46.7	110.8	29.0	53.6	99.2	29.7	52.8	18.5	24.0		
	75/25	39.0	103.1	23.7	44.9	85.2	35.5	39.3	19.5	24.1		
	100/0	21.3	51.0	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-3  
CLARIANT SAFEWING MP II 1951  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions <sup>1</sup>					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>2</sup>	Snow, Snow Grains or Snow Pellets <sup>3,*</sup>	Freezing Drizzle <sup>2</sup>	Light Freezing Rain <sup>2</sup>	Rain on Cold Soaked Wing <sup>2</sup>	Other
-3 and above	27 and above	100/0	I = 2.1983 A = -0.6306	I = 2.4921 A = -0.7197 B = -0.1457	I = 2.1302 A = -0.5579	I = 2.0690 A = -0.5228	I = 2.1024 A = -0.5666	CAUTION: No holdover time guidelines exist
		75/25	I = 2.0535 A = -0.5710	I = 2.4196 A = -0.7591 B = -0.1914	I = 2.0792 A = -0.6250	I = 1.9155 A = -0.5042	I = 2.0174 A = -0.6000	
		50/50	I = 1.5607 A = -0.3896	I = 2.3542 A = -0.9691 B = -0.3207	I = 1.6283 A = -0.6320	I = 1.6164 A = -0.5744		
below -3 to -14	below 27 to 7	100/0	I = 2.1272 A = -0.6673	I = 2.4921 A = -0.7197 B = -0.1457	I = 2.1765 A = -0.6919	I = 2.3569 A = -0.8074		
		75/25	I = 1.9549 A = -0.6133	I = 2.4196 A = -0.7591 B = -0.1914	I = 1.9187 A = -0.5179	I = 1.9149 A = -0.5296		
below -14 to -28	below 7 to -18.4	100/0	I = 1.8859 A = -0.6776	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> The Clariant Safewing MP II 1951 regression information is only to be used in the calculation of Type II generic holdover times. The information cannot be used to deduce fluid-specific holdover times for Clariant Safewing MP II 1951.  
<sup>2</sup> Regression Equation:  $I = 10^4 R^2$ , where R = precipitation rate (g/dm<sup>2</sup>h)  
<sup>3</sup> Regression Equation:  $I = 10^4 R^2 (2-T)^2$ , where R = precipitation rate (g/dm<sup>2</sup>h) and T = temperature (in °C)  
<sup>4</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> h)			Freezing Drizzle (g/dm <sup>2</sup> h)		Light Freezing Rain (g/dm <sup>2</sup> h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> h)	
		5	2	25	10	LUPR <sup>*</sup>	13	5	25	13	75	5
+1 / -3 **	100/0	57.2	102.0	24.2	46.8	111.4	32.3	55.0	21.8	30.7	11.0	50.9
	75/25	45.1	76.1	16.8	33.6	114.1	24.2	43.9	16.2	22.6	7.8	39.6
	50/50	19.4	27.8	6.0	14.5	68.9	8.4	15.4	6.5	9.5		
-10 / -14 ***	100/0	45.8	84.4	20.4	39.5	94.0	25.5	49.3	16.9	28.7		
	75/25	33.6	58.9	13.4	26.9	91.3	22.0	36.0	14.9	21.1		
-25	100/0	18.7	41.9	15.0	30.0	30.0						

<sup>\*</sup> Refer to Table 5 for the lowest usable precipitation rates in snow  
<sup>\*\*</sup> Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
<sup>\*\*\*</sup> Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-4  
CLARIANT SAFEWING MP II FLIGHT  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions								
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>4</sup>	Light Freezing Rain <sup>4</sup>	Rain on Cold Soaked Wing <sup>4</sup>	Other	
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h					
-3 and above	27 and above	100/0	I = 2.4369 A = -0.1630	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6541 A = -0.6697	I = 2.9080 A = -0.8960	I = 2.4810 A = -0.7583		
		75/25	I = 2.3415 A = -0.4328	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.1306 A = -0.2689	I = 2.5596 A = -0.7512	I = 2.5884 A = -0.9638	I = 2.2277 A = -0.7375	
		50/50	I = 2.2250 A = -0.6732	I = 2.2879 A = -0.7080 B = -0.2971	I = 2.2879 A = -0.7080 B = -0.2971	I = 2.2879 A = -0.7080 B = -0.2971	I = 1.7413 A = -0.3693	I = 1.9070 A = -0.6463			
below -3 to -14	below 27 to 7	100/0	I = 2.2233 A = -0.6827	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6220 A = -0.9557	I = 2.5701 A = -0.8095		CAUTION: No holdover time guidelines exist	
		75/25	I = 2.1182 A = -1.0244	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.6085 A = -1.0800	I = 2.7141 A = -1.2023	I = 2.3076 A = -0.6932		
below -14 to -29	below 7 to -20.2	100/0	I = 1.8996 A = -0.6356	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000					

<sup>1</sup> Regression Equation:  $I = 10^6 R^2$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^6 R^2 (2-T)^2$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5  
<sup>4</sup> Calculate value using both sets of coefficients; take shortest holdover time calculated

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	210.4	244.2	58.2	95.7	184.1	80.9	153.5	46.7	83.4	11.5	89.3
	75/25	109.4	162.7	41.9	80.8	256.0	67.8	87.6	32.3	52.8	6.0	51.5
	50/50	56.8	105.3	12.3	23.6	55.3	21.4	30.4	10.1	15.4		
-10 / -14 ***	100/0	55.7	104.2	40.5	66.6	128.1	36.1	89.9	27.4	46.6		
	75/25	25.2	64.5	21.8	42.1	133.2	23.7	71.4	21.8	34.3		
-25	100/0	28.5	51.1	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-5  
CLARIANT SAFEWING MP II FLIGHT PLUS  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.5234 A = -0.4612	I = 3.1605 A = -0.8880 B = -0.3275	I = 2.4469 A = -0.4650	I = 2.2484 A = -0.4093	I = 2.6707 A = -0.8193	CAUTION: No holdover time guidelines exist
		75/25	I = 2.5521 A = -0.5255	I = 2.6834 A = -0.6171 B = -0.0598	I = 2.3720 A = -0.3524	I = 2.6120 A = -0.6593	I = 2.3026 A = -0.5932	
		50/50	I = 2.4106 A = -0.8778	I = 2.6120 A = -0.6769 B = -0.7146	I = 2.3447 A = -0.7750	I = 1.8799 A = -0.5318		
below -3 to -14	below 27 to 7	100/0	I = 2.5312 A = -1.2991	I = 3.1605 A = -0.8880 B = -0.3275	I = 2.6242 A = -0.9778	I = 2.5660 A = -0.7490		
		75/25	I = 2.4057 A = -1.2869	I = 2.6834 A = -0.6171 B = -0.0598	I = 2.5280 A = -0.9864	I = 2.1271 A = -0.4438		
below -14 to LOUT	below 7 to LOUT	100/0	I = 1.8877 A = -0.8771	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^2 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	158.9	242.4	49.0	110.6	204.6	84.9	132.4	47.4	62.0	13.6	125.3
	75/25	153.0	247.7	60.1	105.8	222.4	95.4	133.6	49.0	75.4	15.5	77.3
	50/50	62.7	140.1	14.7	27.3	50.7	30.3	63.5	13.7	19.4		
-10 / -14 ***	100/0	42.0	138.1	33.5	75.5	139.8	34.3	87.2	33.0	53.9		
	75/25	32.1	104.3	56.1	98.7	207.5	26.9	69.0	32.1	42.9		
	100/0	18.8	42.0	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-6  
CRYOTECH POLAR GUARD II  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.5794 A = -0.5025	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	CAUTION: No holdover time guidelines exist
		75/25	I = 2.5776 A = -0.5705	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.2204 A = -0.1898	I = 2.8328 A = -0.8896	I = 2.6248 A = -0.8807	
		50/50	I = 2.1254 A = -0.6271	I = 2.5102 A = -0.8406 B = -0.1391	I = 2.5102 A = -0.8406 B = -0.1391	I = 2.5102 A = -0.8406 B = -0.1391	I = 2.2943 A = -0.9086	I = 2.3695 A = -0.9996		
below -3 to -14	below 27 to 7	100/0	I = 2.5101 A = -1.1145	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886		
		75/25	I = 2.2594 A = -0.9785	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.4495 A = -0.9076	I = 2.0483 A = -0.3597		
below -14 to -30.5	below 7 to -22.9	100/0	I = 1.9253 A = -0.6979	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^4 R^0$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^4 R^0 (2-T)^0$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	169.1	268.0	79.2	110.1	169.7	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	44.9	80.3	223.2	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	17.3	37.4	144.5	19.2	45.6	9.4	18.0		
-10 / -14 ***	100/0	53.8	149.5	54.3	75.5	116.3	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	32.6	58.4	162.2	27.4	65.3	35.1	44.4		
	100/0	27.4	51.9	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-7  
KILFROST ABC-2000  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.5017 A = -0.7918	I = 2.6793 A = -0.7155 B = -0.2475	I = 2.3530 A = -0.5406	I = 2.1752 A = -0.4212	I = 2.2715 A = -0.6219	CAUTION: No holdover time guidelines exist
		75/25	I = 2.5693 A = -0.8090	I = 2.6945 A = -0.7473 B = -0.2060	I = 2.2641 A = -0.5653	I = 2.0107 A = -0.2793	I = 2.5276 A = -0.7483	
		50/50	I = 2.3546 A = -0.8144	I = 2.3633 A = -0.8758 B = 0.0000	I = 1.7696 A = -0.5811	I = 1.8264 A = -0.6348		
below -3 to -14	below 27 to 7	100/0	I = 2.1872 A = -0.8952	I = 2.6793 A = -0.7155 B = -0.2475	I = 2.2482 A = -0.7642	I = 2.8779 A = -1.2797		
		75/25	I = 2.1388 A = -0.8953	I = 2.6945 A = -0.7473 B = -0.2060	I = 2.2588 A = -0.7609	I = 2.5694 A = -0.9881		
below -14 to -27.5	below 7 to -17.5	100/0	I = 1.9361 A = -0.8977	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^3 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients											
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)		
		5	2	25	10	LUPR*	13	5	25	13	75	5	
+1 / -3 **	100/0	88.8	183.4	32.1	61.8	195.4	56.3	94.4	38.6	50.8	12.7	68.7	
	75/25	100.9	211.7	32.1	63.6	211.6	43.1	74.0	41.7	50.1	13.3	101.1	
	50/50	61.0	128.7	13.8	30.7	125.8	13.3	23.1	8.7	13.2			
-10 / -14 ***	100/0	36.4	82.7	24.0	46.3	146.5	24.9	51.8	12.3	28.3			
	75/25	32.6	74.0	25.2	50.0	166.5	25.8	53.3	15.4	29.4			
	100/0	20.4	46.3	15.0	30.0	30.0							

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-8  
KILFROST ABC-K PLUS  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.5148 A = -0.5532	I = 2.6804 A = -0.5771 B = -0.1414	I = 2.2527 A = -0.1978	I = 2.5473 A = -0.5588	I = 2.6523 A = -0.7393	CAUTION: No holdover time guidelines exist
		75/25	I = 2.3020 A = -0.4342	I = 2.5273 A = -0.6849 B = -0.0149	I = 2.3200 A = -0.3522	I = 2.4709 A = -0.5601	I = 2.5956 A = -0.7470	
		50/50	I = 1.9950 A = -0.6463	I = 2.3972 A = -0.8261 B = -0.5288	I = 1.7256 A = -0.3910	I = 2.0364 A = -0.7354		
below -3 to -14	below 27 to 7	100/0	I = 2.0780 A = -0.8928	I = 2.6804 A = -0.5771 B = -0.1414	I = 2.4865 A = -0.9979	I = 3.2510 A = -1.5260		
		75/25	I = 2.3405 A = -1.3357	I = 2.5273 A = -0.6849 B = -0.0149	I = 2.4921 A = -1.0863	I = 3.6906 A = -1.9574		
below -14 to -29	below 7 to -20.2	100/0	I = 1.9498 A = -0.6590	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^4 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	134.3	223.0	59.5	101.0	171.4	107.7	130.1	58.4	84.1	18.5	136.6
	75/25	99.7	148.4	36.3	67.9	127.2	84.7	118.5	48.7	70.3	15.7	118.4
	50/50	34.9	63.2	7.5	15.9	60.1	19.5	28.3	10.2	16.5		
-10 / -14 ***	100/0	28.4	64.5	50.5	85.7	145.4	23.7	61.5	13.1	35.6		
	75/25	25.5	86.8	35.6	66.8	125.0	19.1	54.1	9.0	32.4		
	100/0	30.8	56.4	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 2-9  
**NEWAVE AEROCHEMICAL FCY-2**  
 REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.3831 A = -0.7394	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.3424 A = -0.7349	I = 2.1756 A = -0.5685	I = 2.0886 A = -0.6241	CAUTION: No holdover time guidelines exist
		75/25	I = 2.1617 A = -0.6765	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.1241 A = -0.6856	I = 2.6154 A = -1.0787	I = 1.8312 A = -0.6039	
		50/50	I = 1.6808 A = -0.3883	I = 2.1561 A = -0.7445 B = 0.0000	I = 1.7656 A = -0.6698	I = 1.6020 A = -0.5128		
below -3 to -14	below 27 to 7	100/0	I = 2.1844 A = -0.7552	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.2637 A = -0.8968	I = 1.6935 A = -0.3738		
		75/25	I = 2.0300 A = -0.7545	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.0031 A = -0.7745	I = 2.0994 A = -0.8524		
below -14 to -28	below 7 to -18.4	100/0	I = 1.7388 A = -0.5485	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^3 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	73.5	144.7	30.4	55.8	162.9	33.4	67.4	24.0	34.9	8.3	44.9
	75/25	48.8	90.8	22.0	39.6	111.1	22.9	44.1	12.8	25.9	5.0	25.7
	50/50	25.7	36.6	13.0	25.8	85.5	10.5	19.8	7.7	10.7		
-10 / -14 ***	100/0	45.3	90.6	16.3	30.0	87.4	18.4	43.3	14.8	18.9		
	75/25	31.8	63.5	11.6	20.8	58.4	13.8	29.0	8.1	14.1		
	100/0	22.7	37.5	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C



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**TABLE 2-10**  
**TYPE II “GRANDFATHERED” FLUID DATA**  
**REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE**

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions <sup>1</sup>					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>2</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>2</sup>	Light Freezing Rain <sup>2</sup>	Rain on Cold Soaked Wing <sup>2</sup>	Other
-3 and above	27 and above	100/0	I = 2.2645 A = -1.0307	I = 2.5382 A = -0.8850	I = 2.2851 A = -0.7254	I = 2.6578 A = -1.0599	I = 1.9599 A = -0.5119	CAUTION: No holdover time guidelines exist
		75/25	I = 2.0657 A = -0.9554	I = 2.2336 A = -0.7565	I = 2.2464 A = -0.8486	I = 2.9588 A = -1.4012	I = 1.8133 A = -0.5943	
		50/50	I = 2.0141 A = -1.1989	I = 2.3751 A = -1.1990	I = 1.8080 A = -0.7254	I = 2.1807 A = -1.0599		
below -3 to -14	below 27 to 7	100/0	I = 2.2645 A = -1.0307	I = 2.6725 A = -1.0704	I = 2.2851 A = -0.7254	I = 3.3485 A = -1.6800		
		75/25	I = 2.0657 A = -0.9554	I = 2.2336 A = -0.7565	I = 2.2464 A = -0.8486	I = 2.9588 A = -1.4012		
below -14 to -25	below 7 to -13	100/0	I = 2.4483 A = -1.6414	I = 2.2336 A = -0.7565				

<sup>1</sup> The Grandfather fluid regression information is only to be used in the calculation of Type II generic holdover times. The information cannot be used to deduce fluid-specific holdover times for any fluid.

<sup>2</sup> Regression Equation:  $I = 10^R R^A$ , where R = precipitation rate (g/dm<sup>2</sup>h)

<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients											
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> h)			Freezing Drizzle (g/dm <sup>2</sup> h)		Light Freezing Rain (g/dm <sup>2</sup> h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> h)		
		5	2	25	10	LUPR*	13	5	25	13	75	5	
+1 / -3 **	100/0	35.0	90.0	20.0	45.0	45.0	30.0	60.0	15.0	30.0	10.0	40.0	
	75/25	25.0	60.0	15.0	30.0	30.0	20.0	45.0	10.0	25.0	5.0	25.0	
	50/50	15.0	45.0	5.0	15.0	15.0	10.0	20.0	5.0	10.0			
-10 / -14 ***	100/0	35.0	90.0	15.0	40.0	40.0	30.0	60.0	10.0	30.0			
	75/25	25.0	60.0	15.0	30.0	30.0	20.0	45.0	10.0	25.0			
-25	100/0	20.0	90.0	15.0	30.0	30.0							

\* Refer to Table 5 for the lowest usable precipitation rates in snow

\*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

\*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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**TABLE 2-11  
TYPE II GENERIC  
VERIFICATION TABLE**

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) <i>As Calculated from Regression Coefficients</i>									
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)		Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	13	5	25	13	75	5
+1 / -3 *	100/0	35.0	90.0	20.0	45.0	30.0	55.0	15.0	30.0	8.3	40.0
	75/25	25.0	60.0	15.0	30.0	20.0	43.9	10.0	22.6	5.0	25.0
	50/50	15.0	27.8	5.0	14.5	8.4	15.4	5.0	9.5		
-10 / -14 **	100/0	19.0	64.5	15.0	30.0	18.4	43.3	10.0	18.9		
	75/25	24.5	51.9	11.6	20.8	13.8	29.0	8.1	14.1		
-25	100/0	17.4	37.5	15.0	30.0						

\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 3-1  
CLARIANT SAFEWING MP III 2031 ECO  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 1.8574 A = -0.6489	I = 2.1115 A = -0.6963 B = -0.1456	I = 1.9299 A = -0.7118	I = 1.7185 A = -0.5394	I = 1.7197 A = -0.4605	CAUTION: No holdover time guidelines exist
		75/25	I = 1.7259 A = -0.6144	I = 1.9882 A = -0.6441 B = -0.1563	I = 1.7700 A = -0.6803	I = 1.8560 A = -0.7070	I = 1.5307 A = -0.5484	
		50/50	I = 1.5142 A = -0.6078	I = 1.7655 A = -0.6226 B = -0.2590	I = 1.3637 A = -0.5187	I = 1.4971 A = -0.5838		
below -3 to -10	below 27 to 14	100/0	I = 1.7495 A = -0.4928	I = 2.1115 A = -0.6963 B = -0.1456	I = 1.7755 A = -0.5900	I = 1.6118 A = -0.4205		
		75/25	I = 1.7409 A = -0.7580	I = 1.9882 A = -0.6441 B = -0.1563	I = 1.3372 A = -0.2919	I = 1.6085 A = -0.5431		
below -10	below 14	100/0	I = 1.8547 A = -0.6749	I = 2.1115 A = -0.6963 B = -0.1456				

<sup>1</sup> Regression Equation:  $t = 10^I R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^I R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients											
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)				Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	4	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	25.3	45.9	10.9	20.6	39.0	63.1	13.7	27.1	9.2	13.1	7.2	25.0
	75/25	19.8	34.7	9.5	17.2	31.0	48.4	10.3	19.7	7.4	11.7	3.2	14.0
	50/50	12.3	21.4	5.2	9.2	16.2	12.6	6.1	10.0	4.8	7.0		
-10	100/0	25.4	39.9	9.6	18.1	34.3	55.6	13.1	23.1	10.6	13.9		
	75/25	16.3	32.6	8.3	15.0	27.0	42.2	10.3	13.6	7.1	10.1		
-25	100/0	24.2	44.8	8.5	16.1	30.5	30.5						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

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TABLE 4-1  
ABAX AD-480  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.5155 A = -0.6296	I = 2.8771 A = -0.7459 B = -0.3169	I = 2.4133 A = -0.6465	I = 2.3229 A = -0.5386	I = 2.5009 A = -0.7370	CAUTION: No holdover time guidelines exist
		75/25	I = 2.4258 A = -0.6912	I = 2.8157 A = -0.8148 B = -0.2892	I = 2.2256 A = -0.4857	I = 2.2663 A = -0.5461	I = 2.3778 A = -0.7322	
		50/50	I = 1.7682 A = -0.3911	I = 2.4274 A = -0.8852 B = -0.2983	I = 1.8484 A = -0.6021	I = 1.7714 A = -0.5857		
below -3 to -14	below 27 to 7	100/0	I = 2.3324 A = -1.4027	I = 2.8771 A = -0.7459 B = -0.3169	I = 2.7690 A = -1.2527	I = 2.2782 A = -0.7465		
		75/25	I = 1.9626 A = -0.8214	I = 2.8157 A = -0.8148 B = -0.2892	I = 2.5153 A = -1.0108	I = 2.4335 A = -0.8683		
below -14 to -26	below 7 to -14.8	100/0	I = 1.8643 A = -0.8914	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)

<sup>2</sup> Regression Equation:  $I = 10^R R^3 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)

<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	119.0	211.8	41.0	81.2	269.8	49.3	91.5	37.2	52.8	13.2	96.8
	75/25	87.6	165.1	29.8	62.9	233.5	48.4	76.9	31.8	45.5	10.1	73.5
	50/50	31.2	44.7	9.6	21.6	33.9	15.1	26.8	9.0	13.2		
-10 / -14 ***	100/0	22.5	81.3	28.4	56.2	186.6	23.6	78.2	17.2	28.0		
	75/25	24.5	51.9	21.3	44.9	166.8	24.5	64.4	16.6	29.3		
	100/0	17.4	39.4	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow

\*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

\*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-2  
**ABAX ECOWING AD-49**  
 REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.4713 A = -0.2370	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	CAUTION: No holdover time guidelines exist
		75/25	I = 2.5800 A = -0.6022	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.1714 A = -0.1070	I = 2.9993 A = -0.9367	I = 2.5561 A = -0.8097	
		50/50	I = 1.9283 A = -0.7029	I = 2.0082 A = -0.5107 B = -0.1529	I = 2.0082 A = -0.5107 B = -0.1529	I = 2.0082 A = -0.5107 B = -0.1529	I = 2.0190 A = -0.7545	I = 1.5732 A = -0.3413		
below -3 to -14	below 27 to 7	100/0	I = 2.5177 A = -1.7715	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.8172 A = -1.2681	I = 1.9828 A = -0.5016		
		75/25	I = 2.1600 A = -1.0180	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.7575 A = -1.3630	I = 2.3495 A = -0.8598		
below -14 to -26	below 7 to -14.8	100/0	I = 1.7838 A = -0.5976	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^3 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	202.1	251.2	70.4	108.7	192.5	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	144.2	250.4	78.6	99.4	135.6	112.8	124.9	49.0	90.3	10.9	97.8
	50/50	27.4	52.1	15.4	24.6	45.5	15.1	31.0	12.5	15.6		
-10 / -14 ***	100/0	19.0	96.5	70.4	108.7	192.5	25.4	85.3	19.1	26.5		
	75/25	28.1	71.4	78.6	99.4	135.6	17.3	63.8	14.0	24.6		
	100/0	23.2	40.2	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-3  
**CLARIANT MAX FLIGHT 04 (formerly Octagon Max Flight 04)**  
 REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1,4</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.5102 A = -0.4343	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.0949 A = -0.0224	I = 2.4117 A = -0.4124	I = 2.6420 A = -0.6956	CAUTION: No holdover time guidelines exist
		75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
below -3 to -14	below 27 to 7	100/0	I = 2.5385 A = -1.1945	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.8956 A = -1.3456	I = 2.8529 A = -1.1429		
		75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -26.5	below 7 to -15.7	100/0	I = 1.8804 A = -0.7843	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^4 R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)

<sup>2</sup> Regression Equation:  $t = 10^4 R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)

<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

<sup>4</sup> Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm<sup>2</sup>/h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm<sup>2</sup>/h, values in the holdover time table may differ slightly from those calculated using these coefficients.

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes)										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	160.9	239.6	83.1	163.8	539.4	117.5	120.0	68.4	89.6	21.8	143.2
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
-10 / -14 ***	100/0	50.5	151.0	35.6	70.3	231.4	24.9	90.2	18.0	38.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
	100/0	21.5	44.1	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow

\*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

\*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-4  
CLARIANT SAFEWING MP IV LAUNCH  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.3942 A = 0.0152	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7789 A = -0.7426	I = 2.9492 A = -0.8489	I = 2.5170 A = -0.7291	CAUTION: No holdover time guidelines exist
		75/25	I = 2.4388 A = -0.1431	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7945 A = -0.7101	I = 2.7548 A = -0.7917	I = 2.6192 A = -0.8499	
		50/50	I = 2.4323 A = -0.7333	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.0818 A = -0.5727	I = 1.7686 A = -0.3607		
below -3 to -14	below 27 to 7	100/0	I = 2.2823 A = -0.7333	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7424 A = -1.0767	I = 2.6379 A = -0.8846		
		75/25	I = 2.1203 A = -0.7220	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.6204 A = -1.0940	I = 2.4901 A = -0.7708		
below -14 to -28.5	below 7 to -19.3	100/0	I = 1.8894 A = -0.6349	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^R R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^R R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	254.0	250.5	64.3	104.8	199.2	89.5	181.9	57.9	100.8	14.1	101.7
	75/25	218.2	248.7	59.9	105.5	222.0	100.8	198.7	44.5	74.6	10.6	106.0
	50/50	83.1	162.8	24.5	45.3	133.2	27.8	48.0	18.4	23.3		
-10 / -14 ***	100/0	58.8	115.2	48.6	79.2	150.5	34.9	97.7	25.2	44.9		
	75/25	41.3	80.0	47.2	83.2	175.0	25.2	71.7	25.9	42.8		
	100/0	27.9	49.9	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-5  
CLARIANT SAFEWING MP IV LAUNCH PLUS  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.3920 A = -0.0283	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 2.1074 A = -0.0294	I = 3.1822 A = -0.9927	I = 2.5435 A = -0.6674	CAUTION: No holdover time guidelines exist
		75/25	I = 2.3948 A = -0.0330	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 2.0839 A = -0.0124	I = 2.0297 A = -0.0872	I = 2.4962 A = -0.6485	
		50/50	I = 2.1682 A = -0.4153	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.4651 A = -0.9953	I = 1.8233 A = -0.4948		
below -3 to -14	below 27 to 7	100/0	I = 2.4166 A = -0.9721	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 2.8810 A = -1.3058	I = 2.2126 A = -0.5630		
		75/25	I = 2.4251 A = -1.1486	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 2.5583 A = -1.0902	I = 2.1385 A = -0.5738		
below -14 to -29	below 7 to -20.2	100/0	I = 1.9339 A = -0.8158	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^2 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	235.6	241.8	55.2	124.8	364.6	118.8	122.1	62.3	119.2	19.6	119.4
	75/25	235.4	242.6	47.9	114.3	358.7	117.5	118.9	80.9	85.6	19.1	110.4
	50/50	75.5	110.5	20.1	43.7	171.5	22.7	58.8	13.5	18.7		
-10 / -14 ***	100/0	54.6	133.0	37.7	85.2	248.8	26.7	93.0	26.6	38.5		
	75/25	41.9	120.0	30.6	73.0	229.1	22.1	62.6	21.7	31.6		
	100/0	23.1	48.8	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C



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TABLE 4-6  
CRYOTECH POLAR GUARD  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.4745 A = -0.4951	I = 2.9490 A = -0.6572 B = -0.4714	I = 2.4635 A = -0.5345	I = 2.5395 A = -0.6046	I = 2.4044 A = -0.6799	CAUTION: No holdover time guidelines exist
		75/25	I = 2.3528 A = -0.4927	I = 2.8812 A = -0.6909 B = -0.5035	I = 2.1051 A = -0.2583	I = 2.7647 A = -0.8848	I = 2.3810 A = -0.7348	
		50/50	I = 1.7729 A = -0.5202	I = 2.5348 A = -0.5623 B = -1.0578	I = 1.8582 A = -0.6374	I = 1.9646 A = -0.6911		
below -3 to -14	below 27 to 7	100/0	I = 2.3284 A = -0.9987	I = 2.9490 A = -0.6572 B = -0.4714	I = 2.5957 A = -1.0521	I = 2.8526 A = -1.1562		
		75/25	I = 2.2518 A = -1.0158	I = 2.8812 A = -0.6909 B = -0.5035	I = 2.5165 A = -0.9865	I = 2.1692 A = -0.6193		
below -14 to -23.5	below 7 to -10.3	100/0	I = 1.8174 A = -0.7192	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	134.4	211.6	50.2	91.7	144.6	73.8	123.0	49.5	73.5	13.5	85.0
	75/25	102.0	160.1	36.6	68.9	209.5	65.7	84.1	33.7	60.1	10.1	73.7
	50/50	25.7	41.3	10.2	17.1	42.3	14.1	25.9	10.0	15.7		
-10 / -14 ***	100/0	42.7	106.6	29.0	53.0	83.6	26.5	72.5	17.2	36.7		
	75/25	34.8	88.3	20.4	38.4	116.7	26.2	67.1	20.1	30.2		
-25	100/0	20.6	39.9	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-7  
CRYOTECH POLAR GUARD ADVANCE  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.5794 A = -0.5025	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	CAUTION: No holdover time guidelines exist
		75/25	I = 2.5776 A = -0.5705	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.2204 A = -0.1898	I = 2.8328 A = -0.8896	I = 2.6248 A = -0.8807	
		50/50	I = 2.1254 A = -0.6271	I = 2.5102 A = -0.8406 B = -0.1391	I = 2.5102 A = -0.8406 B = -0.1391	I = 2.5102 A = -0.8406 B = -0.1391	I = 2.2943 A = -0.9086	I = 2.3695 A = -0.9996		
below -3 to -14	below 27 to 7	100/0	I = 2.5101 A = -1.1145	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886		
		75/25	I = 2.2594 A = -0.9785	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.7318 A = -0.6352 B = -0.2744	I = 2.4495 A = -0.9076	I = 2.0483 A = -0.3597		
below -14 to -30.5	below 7 to -22.9	100/0	I = 1.9253 A = -0.6979	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^4 R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^4 R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	169.1	268.0	79.2	110.1	169.7	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	44.9	80.3	223.2	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	17.3	37.4	144.5	19.2	45.6	9.4	18.0		
-10 / -14 ***	100/0	53.8	149.5	54.3	75.5	116.3	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	32.6	58.4	162.2	27.4	65.3	35.1	44.4		
-25	100/0	27.4	51.9	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-8  
DOW CHEMICAL UCAR™ ENDURANCE EG106  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.4198 A = -0.4664	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.4460 A = -0.5295	I = 2.5011 A = -0.5672	I = 2.5903 A = -0.7102	CAUTION: No holdover time guidelines exist
		75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
below -3 to -14	below 27 to 7	100/0	I = 2.4942 A = -0.6588	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.5065 A = -0.6779	I = 2.6525 A = -0.7145		
		75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
below -14 to -27	below 7 to -16.6	100/0	I = 2.0589 A = -0.7941	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^4 R^A$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^4 R^A (2-T)^B$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	124.1	190.3	38.4	79.6	207.5	71.8	119.1	51.1	74.0	18.1	124.1
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
-10 / -14 ***	100/0	108.1	197.6	30.5	63.1	164.5	56.4	107.8	45.0	71.9		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
	100/0	31.9	66.0	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-9  
DOW CHEMICAL UCAR™ FLIGHTGUARD AD-480  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.5155 A = -0.6296	I = 2.8771 A = -0.7459 B = -0.3169	I = 2.4133 A = -0.6465	I = 2.3229 A = -0.5386	I = 2.5009 A = -0.7370	CAUTION: No holdover time guidelines exist
		75/25	I = 2.4258 A = -0.6912	I = 2.8157 A = -0.8148 B = -0.2892	I = 2.2256 A = -0.4857	I = 2.2663 A = -0.5461	I = 2.3778 A = -0.7322	
		50/50	I = 1.7682 A = -0.3911	I = 2.4274 A = -0.8852 B = -0.2983	I = 1.8484 A = -0.6021	I = 1.7714 A = -0.5857		
below -3 to -14	below 27 to 7	100/0	I = 2.3324 A = -1.4027	I = 2.8771 A = -0.7459 B = -0.3169	I = 2.7690 A = -1.2527	I = 2.2782 A = -0.7465		
		75/25	I = 1.9626 A = -0.8214	I = 2.8157 A = -0.8148 B = -0.2892	I = 2.5153 A = -1.0108	I = 2.4335 A = -0.8683		
below -14 to -26	below 7 to -14.8	100/0	I = 1.8643 A = -0.8914	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)

<sup>2</sup> Regression Equation:  $I = 10^R R^3 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)

<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	119.0	211.8	41.0	81.2	269.8	49.3	91.5	37.2	52.8	13.2	96.8
	75/25	87.6	165.1	29.8	62.9	233.5	48.4	76.9	31.8	45.5	10.1	73.5
	50/50	31.2	44.7	9.6	21.6	33.9	15.1	26.8	9.0	13.2		
-10 / -14 ***	100/0	22.5	81.3	28.4	56.2	186.6	23.6	78.2	17.2	28.0		
	75/25	24.5	51.9	21.3	44.9	166.8	24.5	64.4	16.6	29.3		
	100/0	17.4	39.4	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow

\*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

\*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-10  
DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.4713 A = -0.2370	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	CAUTION: No holdover time guidelines exist
		75/25	I = 2.5800 A = -0.6022	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.1714 A = -0.1070	I = 2.9993 A = -0.9367	I = 2.5561 A = -0.8097	
		50/50	I = 1.9283 A = -0.7029	I = 2.0082 A = -0.5107 B = -0.1529	I = 2.0082 A = -0.5107 B = -0.1529	I = 2.0082 A = -0.5107 B = -0.1529	I = 2.0190 A = -0.7545	I = 1.5732 A = -0.3413		
below -3 to -14	below 27 to 7	100/0	I = 2.5177 A = -1.7715	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.8172 A = -1.2681	I = 1.9828 A = -0.5016		
		75/25	I = 2.1600 A = -1.0180	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.2550 A = -0.2574 B = 0.0000	I = 2.7575 A = -1.3630	I = 2.3495 A = -0.8598		
below -14 to -26	below 7 to -14.8	100/0	I = 1.7838 A = -0.5976	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^0$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^0 (2-T)^0$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	202.1	251.2	70.4	108.7	192.5	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	144.2	250.4	78.6	99.4	135.6	112.8	124.9	49.0	90.3	10.9	97.8
	50/50	27.4	52.1	15.4	24.6	45.5	15.1	31.0	12.5	15.6		
-10 / -14 ***	100/0	19.0	96.5	70.4	108.7	192.5	25.4	85.3	19.1	26.5		
	75/25	28.1	71.4	78.6	99.4	135.6	17.3	63.8	14.0	24.6		
	100/0	23.2	40.2	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-11  
KILFROST ABC-S  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					Other
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	
-3 and above	27 and above	100/0	I = 2.7032 A = -0.7245	I = 2.7666 A = -0.6013 B = -0.2217	I = 2.2743 A = -0.3333	I = 2.5227 A = -0.5326	I = 2.2207 A = -0.4813	CAUTION: No holdover time guidelines exist
		75/25	I = 2.1889 A = -0.5545	I = 2.5569 A = -0.7273 B = -0.1092	I = 2.1721 A = -0.4710	I = 2.3286 A = -0.5836	I = 2.0484 A = -0.5136	
		50/50	I = 1.6863 A = -0.5068	I = 2.3232 A = -0.8869 B = -0.2936	I = 1.7499 A = -0.5783	I = 1.6395 A = -0.4931		
below -3 to -14	below 27 to 7	100/0	I = 2.4307 A = -1.1131	I = 2.7666 A = -0.6013 B = -0.2217	I = 2.1724 or I = 3.0193 A = -0.5641 or A = -1.5395	I = 3.1764 A = -1.5258		
		75/25	I = 2.0461 A = -0.9024	I = 2.5569 A = -0.7273 B = -0.1092	I = 2.4843 or I = 3.0881 A = -0.9047 or A = -1.6196	I = 3.5272 A = -1.7987		
below -14 to -28	below 7 to -18.4	100/0	I = 1.8469 A = -0.7299	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^4 R^4$ , where R = precipitation rate (g/dm<sup>2</sup>h)  
<sup>2</sup> Regression Equation:  $t = 10^4 R^4 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5  
<sup>4</sup> Calculate value using both sets of coefficients; take shortest holdover time calculated

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	157.3	305.6	59.0	102.4	211.2	80.0	110.0	60.0	85.0	20.8	76.6
	75/25	63.3	105.2	29.1	56.7	110.3	44.4	69.6	32.6	47.7	12.2	48.9
	50/50	21.5	34.2	7.6	17.0	49.5	12.8	22.2	8.9	12.3		
-10 / -14 ***	100/0	44.9	124.6	45.6	79.1	163.2	20.2	60.0	11.1	30.0		
	75/25	26.0	59.5	25.6	49.9	97.2	19.2	71.1	10.3	33.4		
-25	100/0	21.7	42.4	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-12  
KILFROST ABC-S PLUS  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>			Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
				< 4 g/dm <sup>2</sup> /h	4 to <10 g/dm <sup>2</sup> /h	≥ 10 g/dm <sup>2</sup> /h				
-3 and above	27 and above	100/0	I = 2.5882 A = -0.6773	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.1349 A = -0.0810	I = 3.2080 A = -1.0102	I = 2.5437 A = -0.6337	CAUTION: No holdover time guidelines exist
		75/25	I = 2.4204 A = -0.6975	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.1108 A = -0.2951	I = 2.5019 A = -0.7097	I = 2.4230 A = -0.7288	
		50/50	I = 1.8988 A = -0.5888	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.2203 A = -0.8993	I = 1.7490 A = -0.4516		
below -3 to -14	below 27 to 7	100/0	I = 2.7468 A = -1.4224	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.9992 A = -1.4676	I = 2.3542 A = -0.7931		
		75/25	I = 2.3554 A = -1.0359	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.8273 A = -1.3891	I = 2.1553 A = -0.6538		
below -14 to -28	below 7 to -18.4	100/0	I = 1.9370 A = -0.5185	I = 2.0691 A = -0.7757 B = 0.0000	I = 1.7911 A = -0.3140 B = 0.0000	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $t = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $t = 10^R R^2 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	130.3	242.3	72.8	124.9	253.7	110.8	119.8	62.5	121.0	22.7	126.1
	75/25	85.7	162.3	42.8	72.9	146.8	60.5	80.3	32.3	51.4	11.4	82.0
	50/50	30.7	52.7	17.5	32.2	94.1	16.5	39.1	13.1	17.6		
-10 / -14 ***	100/0	56.6	208.3	60.2	103.2	209.7	23.1	94.1	17.6	29.6		
	75/25	42.8	110.6	35.4	60.2	121.3	19.1	71.8	17.4	26.7		
	100/0	37.5	60.4	15.0	30.0	50.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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TABLE 4-13  
LYONDELL ARCTIC SHIELD™  
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals <sup>1</sup>	Snow, Snow Grains or Snow Pellets <sup>2,3</sup>	Freezing Drizzle <sup>1</sup>	Light Freezing Rain <sup>1</sup>	Rain on Cold Soaked Wing <sup>1</sup>	Other
-3 and above	27 and above	100/0	I = 2.4454 A = -0.5452	I = 2.6137 A = -0.5939 B = -0.1143	I = 2.4067 A = -0.5864	I = 2.5402 A = -0.6454	I = 2.3859 A = -0.6640	CAUTION: No holdover time guidelines exist
		75/25	I = 2.3152 A = -0.5992	I = 2.4438 A = -0.5642 B = -0.1089	I = 2.2230 A = -0.4318	I = 2.4152 A = -0.6779	I = 2.4635 A = -0.7899	
		50/50	I = 1.7122 A = -0.2153	I = 2.1743 A = -0.6196 B = 0.0000	I = 1.8862 A = -0.5423	I = 1.9811 A = -0.6862		
below -3 to -14	below 27 to 7	100/0	I = 2.4503 A = -0.9456	I = 2.6137 A = -0.5939 B = -0.1143	I = 2.8685 A = -1.2952	I = 1.9544 A = -0.4082		
		75/25	I = 2.2491 A = -0.7644	I = 2.4438 A = -0.5642 B = -0.1089	I = 2.5673 A = -0.9868	I = 2.0026 A = -0.4621		
below -14 to -24.5	below 7 to -12.1	100/0	I = 1.8254 A = -0.6370	I = 2.2336 A = -0.7565 B = 0.0000				

<sup>1</sup> Regression Equation:  $I = 10^R R^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h)  
<sup>2</sup> Regression Equation:  $I = 10^R R^3 (2-T)^3$ , where R = precipitation rate (g/dm<sup>2</sup>/h) and T = temperature (in °C)  
<sup>3</sup> CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) As Calculated from Regression Coefficients										
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)			Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	116.0	191.1	50.5	87.1	99.4	56.7	99.3	43.4	66.3	13.8	83.5
	75/25	78.8	136.4	37.9	63.6	72.1	55.2	83.4	29.3	45.7	9.6	81.5
	50/50	36.5	44.4	20.3	35.9	44.7	19.1	32.1	11.2	17.3		
-10 / -14 ***	100/0	61.6	146.4	44.2	76.2	87.0	26.7	91.9	24.2	31.6		
	75/25	51.9	104.5	33.4	56.0	63.6	29.4	75.4	22.7	30.8		
	100/0	24.0	43.0	15.0	30.0	30.0						

\* Refer to Table 5 for the lowest usable precipitation rates in snow  
 \*\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C  
 \*\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C



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**TABLE 4-14  
TYPE IV GENERIC  
VERIFICATION TABLE**

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) <i>As Calculated from Regression Coefficients</i>									
		Freezing Fog or Ice Crystals (g/dm <sup>2</sup> /h)		Snow, Snow Grains or Snow Pellets (g/dm <sup>2</sup> /h)		Freezing Drizzle (g/dm <sup>2</sup> /h)		Light Freezing Rain (g/dm <sup>2</sup> /h)		Rain on Cold Soaked Wing (g/dm <sup>2</sup> /h)	
		5	2	25	10	13	5	25	13	75	5
+1 / -3 *	100/0	116.0	190.3	38.4	79.6	49.3	91.5	37.2	52.8	11.2	76.6
	75/25	63.3	105.2	29.1	56.7	44.4	69.6	29.3	45.5	9.4	48.9
	50/50	21.5	34.2	7.6	17.0	12.8	22.2	8.9	12.3		
-10 / -14 **	100/0	19.0	81.3	28.4	53.0	20.2	60.0	11.1	26.5		
	75/25	24.5	51.9	20.4	38.4	17.3	62.6	10.3	24.6		
-25	100/0	17.4	39.4	15.0	30.0						

\* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

\*\* Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

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**TABLE 5**  
**LOWEST USABLE PRECIPITATION RATES IN SNOW<sup>1</sup>**  
**TYPE II, TYPE III AND TYPE IV FLUIDS<sup>2</sup>**

TYPE II FLUIDS			
Fluid Name	Fluid Dilution	-14°C and Above	Below -14°C
ABAX Ecowing 26	100/0	2 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	3 g/dm <sup>2</sup> /h	not applicable
Aviation Shaanxi Hi-Tech Cleanwing II	100/0	4 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	4 g/dm <sup>2</sup> /h	not applicable
	50/50	7 g/dm <sup>2</sup> /h	not applicable
Clariant Safewing MP II 1951	100/0	3 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Clariant Safewing MP II FLIGHT	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	3 g/dm <sup>2</sup> /h	not applicable
Clariant Safewing MP II FLIGHT PLUS	100/0	5 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	3 g/dm <sup>2</sup> /h	not applicable
	50/50	4 g/dm <sup>2</sup> /h	not applicable
Cryotech Polar Guard II	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Kilfrost ABC 2000	100/0	2 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Kilfrost ABC-K Plus	100/0	4 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	4 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Newave Aerochemical FCY-2	100/0	2 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Type II Grandfathered Fluid Data	100/0	10 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	10 g/dm <sup>2</sup> /h	not applicable
	50/50	10 g/dm <sup>2</sup> /h	not applicable

TYPE III FLUIDS			
Fluid Name	Fluid Dilution	-10°C and Above	Below -10°C
Clariant Safewing MP III 2031 ECO	100/0	2 g/dm <sup>2</sup> /h	4 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	6 g/dm <sup>2</sup> /h	not applicable

TYPE IV FLUIDS			
Fluid Name	Fluid Dilution	-14°C and Above	Below -14°C
ABAX AD-480	100/0	2 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	6 g/dm <sup>2</sup> /h	not applicable
ABAX Ecowing AD-49	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	3 g/dm <sup>2</sup> /h	not applicable
	50/50	3 g/dm <sup>2</sup> /h	not applicable
Clariant Max Flight 04	100/0	2 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	not applicable	not applicable
	50/50	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	3 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Clariant Safewing MP IV LAUNCH PLUS	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	3 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Cryotech Polar Guard	100/0	5 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Cryotech Polar Guard Advance	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Dow UCAR Endurance EG106	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	not applicable	not applicable
	50/50	not applicable	not applicable
Dow UCAR FlightGuard AD-480	100/0	2 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	2 g/dm <sup>2</sup> /h	not applicable
	50/50	6 g/dm <sup>2</sup> /h	not applicable
Dow UCAR FlightGuard AD-49	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	3 g/dm <sup>2</sup> /h	not applicable
	50/50	3 g/dm <sup>2</sup> /h	not applicable
Kilfrost ABC-S	100/0	3 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	4 g/dm <sup>2</sup> /h	not applicable
	50/50	3 g/dm <sup>2</sup> /h	not applicable
Kilfrost ABC-S Plus	100/0	3 g/dm <sup>2</sup> /h	3 g/dm <sup>2</sup> /h
	75/25	3 g/dm <sup>2</sup> /h	not applicable
	50/50	2 g/dm <sup>2</sup> /h	not applicable
Lyondell Arctic Shield	100/0	8 g/dm <sup>2</sup> /h	10 g/dm <sup>2</sup> /h
	75/25	8 g/dm <sup>2</sup> /h	not applicable
	50/50	7 g/dm <sup>2</sup> /h	not applicable

<sup>1</sup> The lowest precipitation rate to be used as an input to the snow regression equations is constrained by the higher of: (1) the minimum demonstrated precipitation measuring equipment rates in accordance with the Transport Canada exemption (in no case less than 2.0 g/dm<sup>2</sup>/h) and (2) the lowest usable precipitation rate (LUPR) for the fluid/dilution/temperature as defined in this table.

<sup>2</sup> Type I fluids are limited only by the general precipitation rate limitations set out in the exemption document.