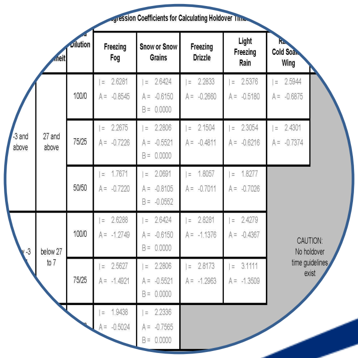
TP 15198E

Regression Coefficients and Equations Used to Develop the Winter 2012-13 Aircraft Ground Deicing Holdover Time Tables



gression Coefficients for Calculating Holdover Tim

		Dilution	Freezing Fog	Snow or Snow Grains	Freezing Drizzle	Light Freezing Rain	Cold Soa Wing
-3 and above	27 and above	100/0	I = 2.6281 A = -0.8545	I = 2.6424 A = -0.6150 B = 0.0000	I = 2.2833 A = -0.2660	I = 2.5376 A = -0.5180	I = 2.5944 A = -0.6875
		75/25	I = 2.2675 A = -0.7226	I = 2.2806 A = -0.5521 B = 0.0000	I = 2.1504 A = -0.4811	I = 2.3054 A = -0.6216	I = 2.4301 A = -0.7374
		50/50	I = 1.7671 A = -0.7220	I = 2.0691 A = -0.8105 B = -0.0552	I = 1.8057 A = -0.7011	I = 1.8277 A = -0.7026	CAUTION: No holdover time guidelines exist
w -3	below 27 to 7	100/0	I = 2.6288 A = -1.2749	I = 2.6424 A = -0.6150 B = 0.0000	I = 2.8281 A = -1.1376	I = 2.4279 A = -0.4367	
		75/25	I = 2.5627 A = -1.4921	I = 2.2806 A = -0.5521 B = 0.0000	I = 2.8173 A = -1.2963	I = 3.1111 A = -1.3509	
			I = 1.9438 A = -0.5024	I = 2.2336 A = -0.7565 B = 0.0000			

Prepared for
Transportation Development Centre

In cooperation with

Civil Aviation
Transport Canada

and

The Federal Aviation Administration
William J. Hughes Technical Center

Prepared by:

APS Aviation Inc.

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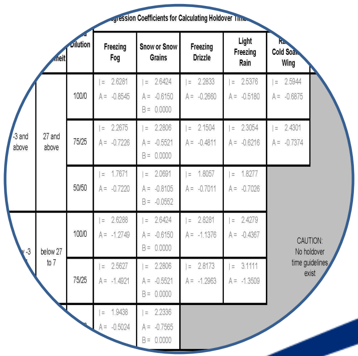
TP 15198E

Regression Coefficients and Equations Used to Develop the Winter 2012-13 Aircraft Ground Deicing Holdover Time Tables



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By:

Stephanie Bendickson

Prepared by:

APS Aviation Inc.

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September 13, 2018
Date

Reviewed by:

Notarius

John D'Avirro
Director, Aviation Services

September 13, 2018
Date

Approved by: **

John Detombe
Chief Engineer
ADGA Group Consultants Inc.

Date

Un sommaire français se trouve avant la table des matières.

This report was first provided to Transport Canada as Final Draft 1.0 in November 2012.
It has been published as Final Version 1.0 in September 2018.

***Final Draft 1.0 of this report was signed and provided to Transport Canada in November 2012. A Transport Canada technical and editorial review was subsequently completed and the report was finalized in September 2018; John Detombe was not available to participate in the final review or to sign the current version of the report.*

PREFACE

Under contract to the Transportation Development Centre of Transport Canada with support from the Federal Aviation Administration (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 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 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 evaluate the use of sensors in determining active frost conditions;
- To continue research for development of ice detection capabilities for pre-deicing, engine deicing and departing aircraft at the runway threshold;
- To update the regression coefficient report with the newly-qualified de/anti-icing fluids; and
- To evaluate if Type II/IV holdover times can be developed for light and very light snow categories.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2011-12 are documented in six reports. The titles of the reports are as follows:

- TP 15198E Regression Coefficients and Equations Used to Develop the Winter 2012-13 Aircraft Ground Deicing Holdover Time Tables;
- TP 15199E Research to Assess the Need for Remote On-Ground Ice Detection Systems (ROGIDS) at End-of-Runway;
- TP 15200E Cold Climate Technologies – Investigation of Sensor Technologies as an Alternative Means of Detecting Aircraft Icing;
- TP 15201E Winter Weather Impact on Holdover Time Table Format (1995-2012);
- TP 15202E Aircraft Ground Icing General Research Activities During the 2011-12 Winter; and
- TP 15203E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2011-12 Winter.

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

- *Evaluation of Endurance Times on Extended Flaps and Slats;*
- *Further Development of Ice Pellet Allowance Times: Characterization and Calibration of Wind Tunnel for Examining Anti-Icing Fluid Flow-Off Characteristics; and*
- *Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates.*

This report, TP15198E, has the following objective:

- To document the regression information required for the winter 2012-13 aircraft ground deicing holdover time tables and to document how and from where the information was obtained.

This objective was met by analyzing data from holdover time testing conducted over the winters of 1996-97 through 2011-12.

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: Steven Baker, Stephanie Bendickson, Jeffrey Bourgerois, John D'Avirro, Jesse Dybka, Daniel Fata, Benjamin Guthrie, Dany Posteraro, Marco Ruggi, James Smyth, David Youssef and Victoria Zoitakis.

Special thanks are extended to Howard Posluns, Yvan Chabot, Doug Ingold and Warren Underwood, who on behalf of the Transportation Development Centre and the Federal Aviation Administration, have participated, contributed and provided guidance in the preparation of these documents.

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Antoine Lacroix for
Yvan Chabot

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

Several research reports for testing of de/anti-icing technologies were produced for previous winters on behalf of Transport Canada. These are available from the Transportation Development Centre (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.

16. Abstract

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:

- an online document published on the Transport Canada Holdover Time (HOT) Guidelines website (http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm), which provides users with the regression information for the current winter's HOT Guidelines in a timely manner in a user friendly format; and
- this TP report, which documents the source of the regression information and how it was obtained.

For the 2012-13 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 2011-12. 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 2011-12.

A table of lowest usable precipitation rates for snow was added to the regression publication for 2012-13. These are the lowest precipitation rates for which sufficient outdoor snow data exists to support use of the regression coefficients. Values were determined through examination of the robustness of existing snow data sets.

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 2013-14.

17. Key Words

Anti-icing, deicing, deicing fluid, holdover times, precipitation, endurance times, Type I, Type II, Type III, Type IV, aircraft, ground, test, winter, regression, holdover time determination system

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Yvan Chabot

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

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

16. Résumé

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 :

- Un document en ligne publié sur le site Web de Transports Canada sur les lignes directrices des durées d'efficacité : (http://www.tc.gc.ca/fra/aviationcivile/normes/commerce-delaisdefficacite-menu-1877.htm), 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
- Le présent rapport TP, qui documente les sources de l'information de régression et la façon de l'obtenir.

Pour les lignes directrices sur les durées d'efficacité de 2012-2013, 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 2011-2012. 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 2011-2012.

Un tableau des plus bas taux de précipitations de neige utilisables a été ajouté à la publication de régression de 2012-2013. 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. Les valeurs ont été établies en examinant la solidité des ensembles de données actuelles sur la neige.

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 2013-2014.

17. Mots clés

Antigivrage, dégivrage, liquide de dégivrage, durées d'efficacité, précipitation, temps d'endurance, Type I, Type II, Type III, Type IV, aéronef, sol, essai, hiver, régression, systèmes de détermination de durées d'efficacité

18. Diffusion

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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 Canadian operators, Transport Canada must make the regression information underlying the HOT Guidelines available to users. Transport Canada publishes two documents on HOT regression information annually:

- an online document, which provides users with the regression information for the current winter's HOT Guidelines in a timely manner in a user-friendly format; and
- this TP report, which documents the sources of the regression information and how it was obtained.

For the 2012-13 HOT Guidelines, regression data was required 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 2011-12. 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 2011-12 with newly certified fluids Clariant Safewing MP II Flight Plus and LNT P250.

The 2012-13 regression information was published online on the Transport Canada HOT Guidelines website on July 18, 2012. The information can be used by HOTDS to calculate holdover times during the winter of 2012-13.

It is recommended that both regression publications – the online document and this report – be updated in one year to reflect any changes made to the HOT Guidelines for the winter of 2013-14.

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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.

Pour que les exploitants canadiens puissent utiliser les HOTDS, Transports Canada doit mettre à la disposition des utilisateurs l'information de régression sous-jacente aux lignes directrices sur les durées d'efficacité. Transports Canada publie annuellement deux documents d'information de régression sur les durées d'efficacité :

- Un document en ligne, qui fournit aux utilisateurs l'information sur la régression, applicable aux lignes directrices de l'hiver en cours sur les durées d'efficacité, en temps opportun et dans un format convivial; et
- Le présent rapport TP, qui documente les sources de l'information de régression et la façon de l'obtenir.

Pour les lignes directrices de 2011-2012 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 2011-2012. Plusieurs des données avaient été documentées dans un rapport précédent de Transports Canada et provenaient en conséquence de 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 2011-2012, sur des liquides nouvellement certifiés, les liquides Clariant Safewing MP II Flight Plus et LNT P250.

L'information de régression de 2012-2013 a été publiée en ligne sur le site Web de Transports Canada sur les lignes directrices sur les durées d'efficacité le 18 juillet 2012 (http://www.tc.gc.ca/CivilAviation/commerce/HoldoverTime/menu.htm). L'information peut servir aux HOTDS pour le calcul des durées d'efficacité pour l'hiver 2012-2013.

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 2013-2014.

CONTENTS

LIST OF APPENDICES

LIST OF TABLES Page

LIST OF FIGURES Page

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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 Ground Icing Research Program since its inception. The Transport Canada Holdover Time (HOT) Guidelines 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 Transport Canada's Role

In order for HOTDS to be used by Canadian operators, Transport Canada must:

1. Provide regulations that allow the use of HOTDS by Canadian operators; and
2. Publish the regression equations and related coefficients that are used in the development of the Transport Canada 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.

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. As indicated in the following excerpt from the performance standard, the regression information must be provided by Transport Canada or an equally valid source.

> *5.1.12 The HOTDS shall incorporate the most current regression curves and associated coefficients. These regression curves and associated coefficients are:*
>
> > *5.1.12.1 Those obtained from or published by Transport Canada, or*
> >
> > *5.1.12.2 Those where traceability and validity [have been] demonstrated to be equivalent to those in 5.1.12.1.*
>
> *5.1.13 Holdover Time Determinations from the system for all de/anti-icing fluids shall be computed using the regression curves and associated coefficients referenced in 5.1.12.*

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), Transport Canada 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. The information 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 on the Transport Canada HOT Guidelines website, which allows the information to be made available in a timely manner, typically in the summer preceding the winter operating season. The document is entitled "*Transport Canada Holdover Time (HOT) Guidelines Regression Information [current winter]*".

2. **Document #2 – TP Report:** The second document is a reference document for regulators. Its purpose is to document the source of the regression information published in the online document. 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 each year, when new regression documents are created, previous publications become obsolete.

The documents that will be published for the winter of 2012-13 are shown in the last row of the table. These documents are currently the only valid regression publications.

Table 1.1: Transport Canada Regression Information Publications

	Document 1 (Online Publication)	**Document 2 (TP Report)**
Publication Name	Transport Canada Holdover Time (HOT) Guidelines Regression Information [Current Winter]	Regression Coefficients and Equations Used to Develop the [Current Winter] Aircraft Ground Deicing Holdover Time Tables
Publication Type	Online publication	Transport Canada TP report
Publication Location	Holdover Time Guidelines website (http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm)	Available from Transport Canada
Purpose	To provide regression information and guidance on its use to users in a timely manner in a user-friendly document	To document the source of the regression information provided in the online publication
Contents	• Regression equations and coefficients required for the current winter's HOT Guidelines • Guidance for application and use of regression information, including procedures for calculating generic holdover times	• Methodology to derive holdover times using regression analysis • Methodology used to determine HOT table values (fluid-specific and generic) • History of regression information collection • Source locations for current winter's regression information • Regression information required for the current winter's HOT Guidelines (incorporated by including the online publication as an appendix to the report)

Table 1.2: History of Regression Publications

Winter	Document 1 (Online Publication)	Document 2 (TP Report)
2008-09	• No online publication	• **Title:** Regression Coefficients and Equations Used to Develop the Winter 2008-09 Aircraft Ground Deicing Holdover Time Tables (TP 14873E) • **Publication Status:** Not yet published by Transport Canada • **Validity:** Obsolete
2009-10	• **Title:** Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2009-2010 • **Publication Status:** Published online January 2010 • **Validity:** Obsolete	• **Title:** Regression Coefficients and Equations Used to Develop the Winter 2009-10 Aircraft Ground Deicing Holdover Time Tables (TP 14937E) • **Publication Status:** Not yet published by Transport Canada • **Validity:** Obsolete
2010-11	• **Title:** Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2010-2011 • **Publication Status:** Published online July 2010 • **Validity:** Obsolete	• **Title:** Regression Coefficients and Equations Used to Develop the Winter 2010-11 Aircraft Ground Deicing Holdover Time Tables (TP 15054E) • **Publication Status:** Not yet published by Transport Canada • **Validity:** Obsolete
2011-12	• **Title:** Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2011-2012 • **Publication Status:** Published online July 2011 • **Validity:** Obsolete	• Title: Regression Coefficients and Equations Used to Develop the Winter 2011-12 Aircraft Ground Deicing Holdover Time Tables (TP 15159E) • **Publication Status:** Not yet published by Transport Canada • **Validity:** Obsolete
2012-13	• **Title:** Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2012-2013 • **Publication Status:** Published online July 2012 • **Validity:** Current	• Title: Regression Coefficients and Equations Used to Develop the Winter 2012-13 Aircraft Ground Deicing Holdover Time Tables (TP 15198E) • **Publication Status:** Not yet published by Transport Canada • **Validity:** Current

1.3 Objectives

The primary objective of this report is to document how and from where the regression information for the 2012-13 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 2012-13 and a short history of data collected in previous winters;
- Section 5 describes the Winter 2012-13 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 Validity of Regression Coefficient Data for FAA Guidelines

The regression information documented in this report was prepared for Transport Canada to be used in conjunction with the Transport Canada HOT Guidelines. The FAA publishes a separate set of guidelines for operators in the United States. For the most part the Transport Canada and FAA guidelines contain the same holdover time values; however, several minor differences exist between the Transport Canada and FAA Type I and Type III generic HOT tables. These differences are detailed in Subsections 3.3 and 3.4. They are also detailed in footnotes to the affected regression coefficients tables in the online document (included as Appendix B). It remains the responsibility of the user to ensure the appropriate application of the data provided in this report.

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[1]:

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[1] 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^2/h;
- Freezing drizzle: 5 and 13 g/dm^2/h;
- Light freezing rain: 13 and 25 g/dm^2/h; and
- Rain on cold-soaked wing: 5 and 75 g/dm^2/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 Type I and Type III HOT tables. The precipitation rate limits used for the Type I/Type III snowfall intensity categories are[2]:

- Very Light Snow[3]: 4 g/dm^2/h;
- Light Snow: 4 and 10 g/dm^2/h; and
- Moderate Snow: 10 and 25 g/dm^2/h.

One snowfall intensity category is provided in the Type II and Type IV HOT tables. The precipitation rate limits used for the Type II/Type IV snowfall intensity category are[2]:

- Snow: 10 and 25 g/dm^2/h.

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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[2] These definitions are not directly correlated to meteorological observations.

[3] While the Transport Canada holdover time guidelines define very light snow with a single precipitation rate limit (4 g/dm^2/h), the FAA guidelines include both a lower limit (3 g/dm^2/h) and upper limit (4 g/dm^2/h) for very light snow.

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 $\mathbf{t = 10^{I} R^{A}}$, where:
    - t = time (minutes)
    - R = rate of precipitation ($g/dm^2/h$)
    - 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. For example, Type II/IV raw values are subject to rounding when they are used to develop the Type II and Type IV fluid-specific HOT tables.

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 $\mathbf{t = 10^{I} R^{A} (2\text{-}T)^{B}}$, where:
    - t = time (minutes)
    - R = rate of precipitation ($g/dm^2/h$)
    - 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. For example, Type II/IV raw values are subject to rounding when they are used to develop the Type II and Type IV fluid-specific HOT tables.

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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;
3. Snow, freezing drizzle, freezing rain, and rain on cold-soaked wing values are capped at 2 hours; and
4. Freezing fog values are capped at 4 hours.

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 and 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 HOT Guidelines is used to determine which fluids are included in the Type II and Type IV generic analyses. Table 5-2 in the HOT Guidelines provides the list of Type II fluids; Table 5-4 provides the list of Type IV fluids. These lists are updated on an annual basis as new fluids are added and old fluids are removed. (Refer to note on qualified fluids in Subsection 3.2.1.)

It should be noted that SAE International (SAE) standards stipulate that all fluids that qualify as Type IV fluids also automatically qualify as Type II fluids. Therefore, the Type IV fluids from Table 5-4 of the HOT Guidelines are also included in the Type II generic analysis.

3.2.1 Note on Qualified Fluids

When the water spray endurance test (WSET) and aerodynamic 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 actually 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) 5718, Section 5.12.3 (2). The protocol stipulates that fluids will be removed from the HOT Guidelines four years after WSET/aerodynamic fluid qualification has expired.

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^2/h; the FAA table provides two values in each cell based on rates of 3 and 4 g/dm^2/h.

2. **Light Freezing Rain *"-3°C and above"* and *"below -3 to -6°C"* Cells**: The Transport Canada table gives a holdover time range of 4 to 6 minutes; the FAA table gives a holdover time range of 2 to 5 minutes.

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^2/h; the FAA table provides two values in each cell based on rates of 3 and 4 g/dm^2/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 2012-13 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 2012-13 publication and includes the source locations of the data contained in the 2012-13 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^{sustain} (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.

4.2 Data for the 2012-13 Holdover Time Guidelines

The data required for the 2012-13 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 2012-13 publication; and
4. Data Removal: a description of any data removed from the regression publication for winter 2012-13.

Table 4.1, at the end of this chapter, summarizes the data included in the winter 2012-13 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 15159E (8).

4.2.1.4 Data Removed

No Type I data was removed from the HOT Guidelines in 2012-13; 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 2012-13 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. Kilfrost ABC-2000;
6. Kilfrost ABC-K Plus;
7. LNT P250; 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[4]. 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.

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.

2. **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.

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[4] See comment on qualified fluids in Subsection 3.2.1.

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

Regression information for all but two of the Type II fluids was collected previously (see Table 4.1) and was obtained from the previous regression publication, TP 15159E (8).

The remaining two fluids, Clariant Safewing MP II Flight Plus and LNT P250, are new fluids which underwent endurance time testing in 2011-12. Regression information for these fluids was collected from the Transport Canada Report, TP 15203E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2011-12 Winter* (9). It should be noted that both of these fluids were assigned generic Type II holdover times in the “below -3 to -14°C” snow cells and therefore were given the regression coefficients of the fluids responsible for the related generic holdover times in winter 2012-13.

4.2.2.4 Data Removed

Two Type II fluids, Clariant Safewing MP II 2025 ECO and Octagon E Max II, were removed from the HOT Guidelines for 2012-13. The regression information for the fluids 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 15159E (8).

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 2012-13 HOT Guidelines:

1. ABAX AD-480;
2. ABAX Ecowing AD-49;
3. Clariant Max-Flight 04;
4. Clariant Safewing MP IV Launch;
5. Cryotech Polar Guard;
6. Cryotech Polar Guard Advance;
7. Dow Chemical UCAR FlightGuard AD-480;
8. Dow Chemical UCAR AD-49;
9. Dow Chemical UCAR™ Endurance EG106;
10. Kilfrost ABC-4^{sustain};
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[5]. As all Type IV fluids have fluid-specific HOT tables, and regression information is collected for the fluid-specific tables, no additional regression information is required to calculate the generic Type IV holdover times.

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 of the Type IV fluids was collected previously (see Table 4.1) and was obtained from the previous regression publication, TP 15159E (8).

4.2.4.4 Data Removed

Two Type IV fluids, Clariant Safewing MP IV 2001 and Dow Chemical UCAR™ ADF/AAF ULTRA+, were removed from the HOT Guidelines for 2012-13. The regression information for the fluids was correspondingly removed from the regression publication.

4.2.5 Summary

Table 4.1 lists the regression data sets that are required for the 2012-13 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

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[5] See comment on qualified fluids in Subsection 3.2.1.

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.

4.2.6 Formatting Changes

Due to the acquisition of the fluid manufacturing company Octagon Process by Clariant GmbH, the fluid previously listed as Octagon Max-Flight 04 is listed as Clariant Max-Flight 04 in the winter 2012-13 HOT guidelines and regression publications.

4.2.7 New Content – Lowest Usable Precipitation Rates for Snow

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. This led to the recommendation of identifying the lowest usable precipitation rate (LUPR) in snow for each Type II, III and Type IV fluid brand, fluid dilution and air temperature. The work completed to determine the lowest usable precipitation rates is documented in the TC report, TP 15202E, *Aircraft Ground Icing Research General Activities During the 2011-12 Winter* (10).

The lowest usable precipitation rates were added to the regression publication for winter 2012-13 as Table 5. Footnotes pointing to Table 5 were also added to the Type II, III and IV regression coefficients tables.

4.2.8 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 2012-13

Fluid Type: Data Set Name	Source of Regression Data	Year Added to Regression Publication
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	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
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: LNT P250	HOT Testing: 2011-12	2012-13
Type II: Newave 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 2012-13 (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: 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-4^{sustain}	HOT Testing: 2008-09	2009-10
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: 2012-13

The regression information underlying the 2012-13 Transport Canada HOT Guidelines is provided on the Transport Canada HOT Guidelines website (http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm) in a document entitled, *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2012-2013*. A copy of this document is included as Appendix B.

The online publication is a 36-page document which includes: a summary of changes page, guidance material, regression coefficients tables and verification tables.

The contents of the document are described in this chapter.

5.1 Summary of Changes

The summary of changes, included at the front of the document, provides a detailed account of the changes that were made to the document contents for 2012-13. This includes the addition/removal/changes to any fluids (presented by fluid type) and a description of any formatting changes.

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 2012-13 regression information publication. A list of the tables is provided in Table 5.1.

Fluids are listed in alphabetical order by fluid type. There are two Type I tables, ten Type II tables, one Type III table and thirteen Type IV tables.

Table 5.1: Regression Coefficients Tables for Winter 2012-13

Fluid Type	**Regression Coefficients Tables**
Type I	• Generic Type I (Aluminum Wing Surfaces) • Generic Type I (Composite Wing Surfaces)
Type II	• ABAX Ecowing 26 • Aviation Shaanxi Hi-tech Cleanwing II • Clariant Safewing MP II 1951* • Clariant Safewing MP II Flight • Clariant Safewing MP II Flight Plus • Kilfrost ABC-2000 • Kilfrost ABC-K Plus • LNT P250 • Newave Aerochemical FCY-2 • Type II “Grandfathered” Fluid Data*
Type III	• Clariant Safewing MP III 2031
Type IV	• ABAX AD-480 • ABAX Ecowing AD-49 • Clariant Max-Flight 04 • Clariant Safewing MP IV Launch • Cryotech Polar Guard • Cryotech Polar Guard Advance • Dow Chemical UCAR Endurance EG106 • Dow Chemical UCAR FlightGuard AD-480 • Dow Chemical UCAR FlightGuard AD-49 • Kilfrost ABC-4^{sustain} • Kilfrost ABC-S • Kilfrost ABC-S Plus • Lyondell ARCTIC Shield

* 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.

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.

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 4.2.5). 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 LOUT" snow cell for all Type II and Type IV fluids.

5.4 Data Verification Tables

Verification tables are included in the online regression coefficients publication (Appendix B). 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 the 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 of the regression coefficients and equations data 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 therefore be exercised in applying the regression coefficients at precipitation rates outside of the precipitation rate limits, especially at precipitation rates below the lower precipitation rate 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^2/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^2/h, the endurance time is approximately 82 minutes; at a slightly lower rate of 3 g/dm^2/h, the endurance time jumps to 122 minutes.

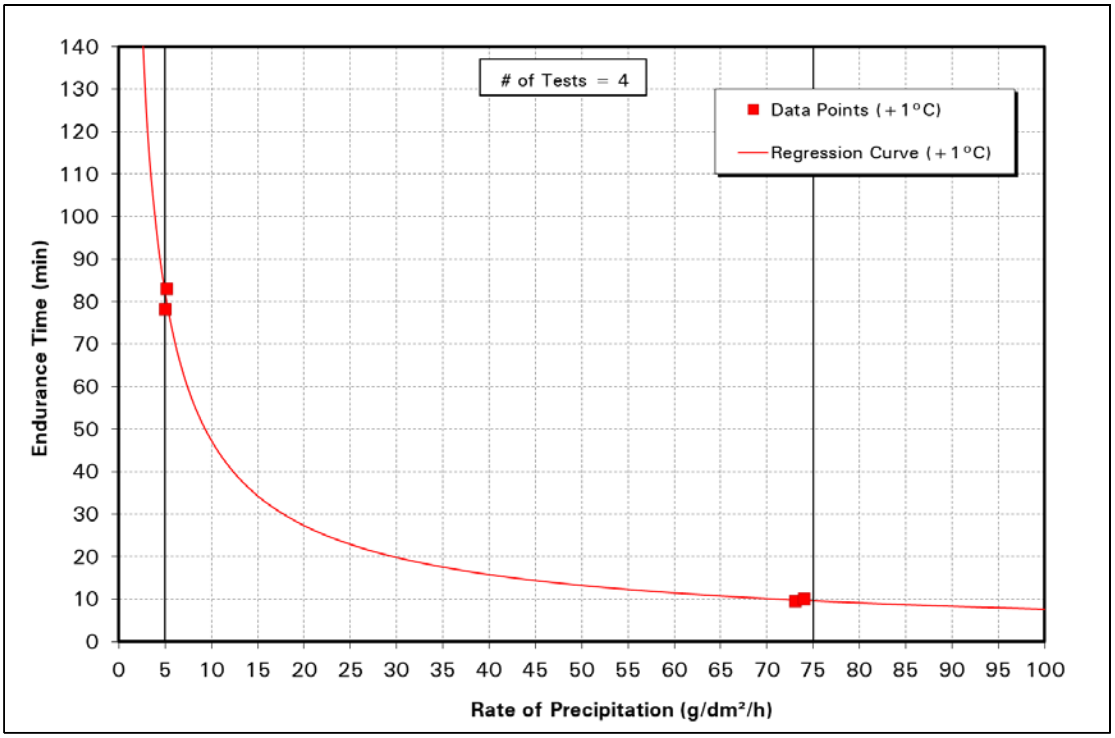

Figure 5.1: Sample Regression Curve – Cold-Soaked Wing

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6. CONCLUSIONS

The regression information required for the 2012-13 HOT Guidelines was published online in July 2012 in the document entitled, *Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2012-2013*. The document is available on the Transport Canada HOT Guidelines website: http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm.

The data required, collected and removed for the 2012-13 online publication is documented in this report. The data was predominantly collected from the 2011-12 regression publication, although additional data was collected from the results of endurance time testing conducted in 2011-12. The data is primarily sourced from the results of holdover time testing conducted from the winters of 1996-97 to 2011-12.

The regression coefficients and equations can be used as inputs in HOTDS, as required by the Transport Canada exemption to CAR 622.11, for the winter of 2012-13. 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 publication 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 that both the online publication 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 two regression information publications – the online document 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 5718, *Qualification Process for SAE AMS1428 Type II, III, and IV Fluids*, March 2008.

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.

4. Bendickson, S., Ruggi, M., *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces*, APS Aviation Inc., Transportation Development Centre, Montreal, May 2011, TP 15052E, XX (to be published).

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

6. Bendickson, S., *Regression Coefficients and Equations Used to Develop the Winter 2009-10 Aircraft Ground Deicing Holdover Time Tables,* APS Aviation Inc., Transportation Development Centre, Montreal, December 2009, TP 14937E, XX (to be published).

7. Bendickson, S., *Regression Coefficients and Equations Used to Develop the Winter 2010-11 Aircraft Ground Deicing Holdover Time Tables*, APS Aviation Inc., Transportation Development Centre, Montreal, October 2010, TP 15054E, XX (to be published).

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).

9. Bendickson, S., *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2011-12 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, October 2012, TP 15203E, XX (to be published).

10. 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 2011-12

TRANSPORTATION DEVELOPMENT CENTRE
WORK STATEMENT EXCERPT –
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2011-12

3.16 INVESTIGATION OF SENSOR TECHNOLOGIES AS AN ALTERNATIVE MEANS OF DETECTING AIRCRAFT ICING

3.16.4 Update: Regression Coefficients Used to Compute Holdover Times

a) Add FAA coefficients to cells where FAA and TC differ;

b) Prepare document suitable for online publication; and

c) Prepare a final report to document the applicable regression coefficients and verification tables required for the winter of 2012-13.

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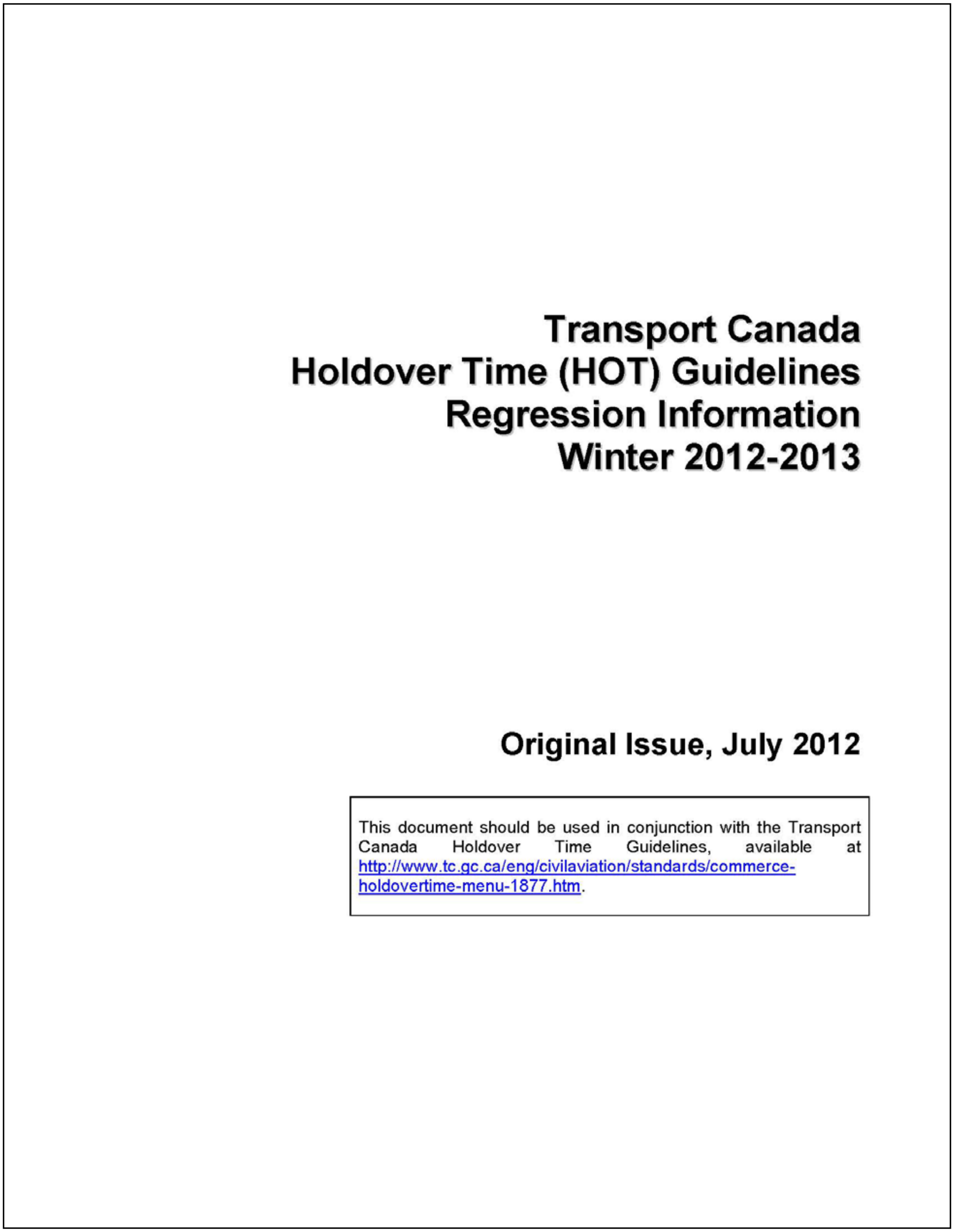
APPENDIX B

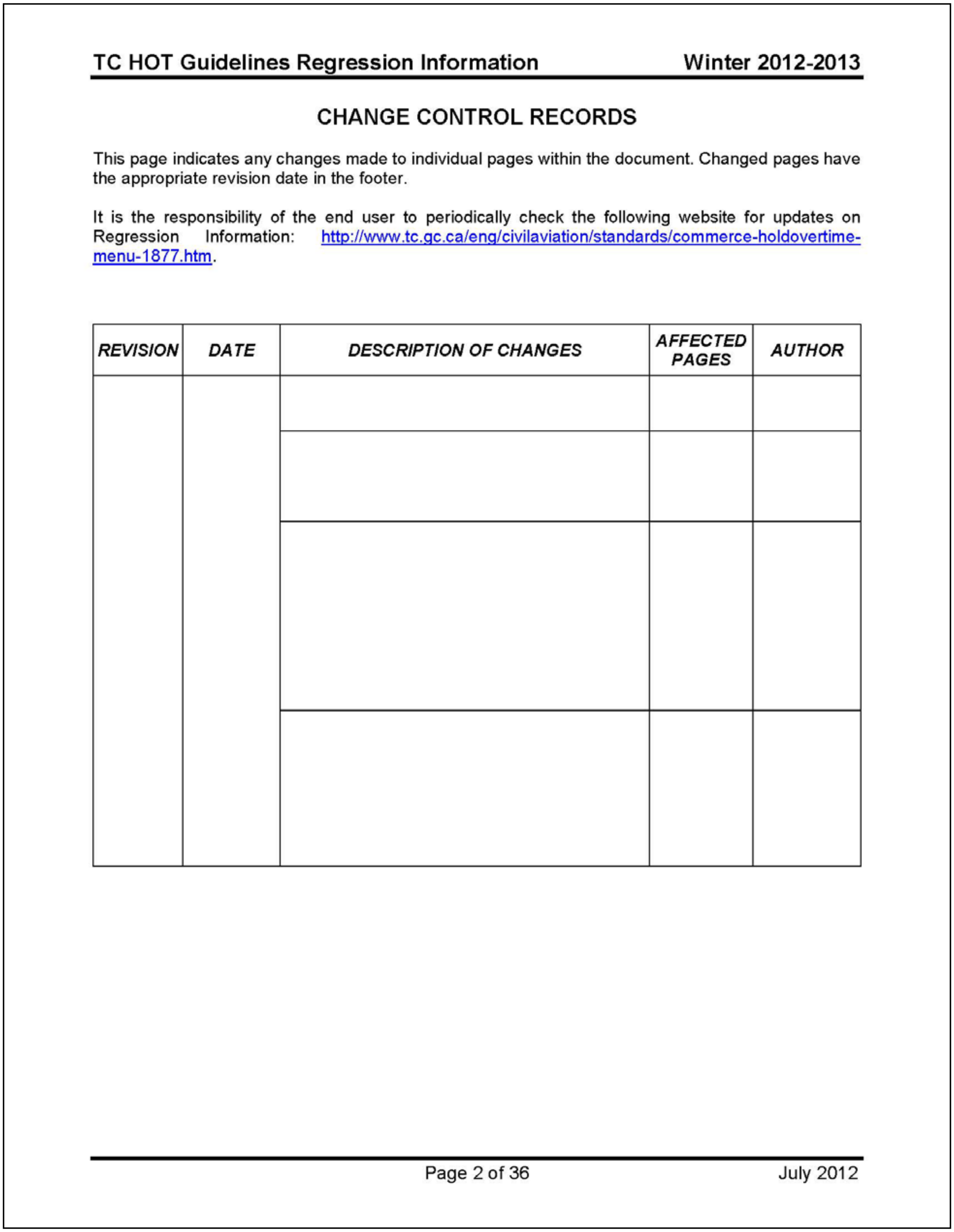
TRANSPORT CANADA
HOLDOVER TIME (HOT) GUIDELINES
REGRESSION INFORMATION
WINTER 2012-2013



Transport Canada
Holdover Time (HOT) Guidelines
Regression Information
Winter 2012-2013

Original Issue, July 2012

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.

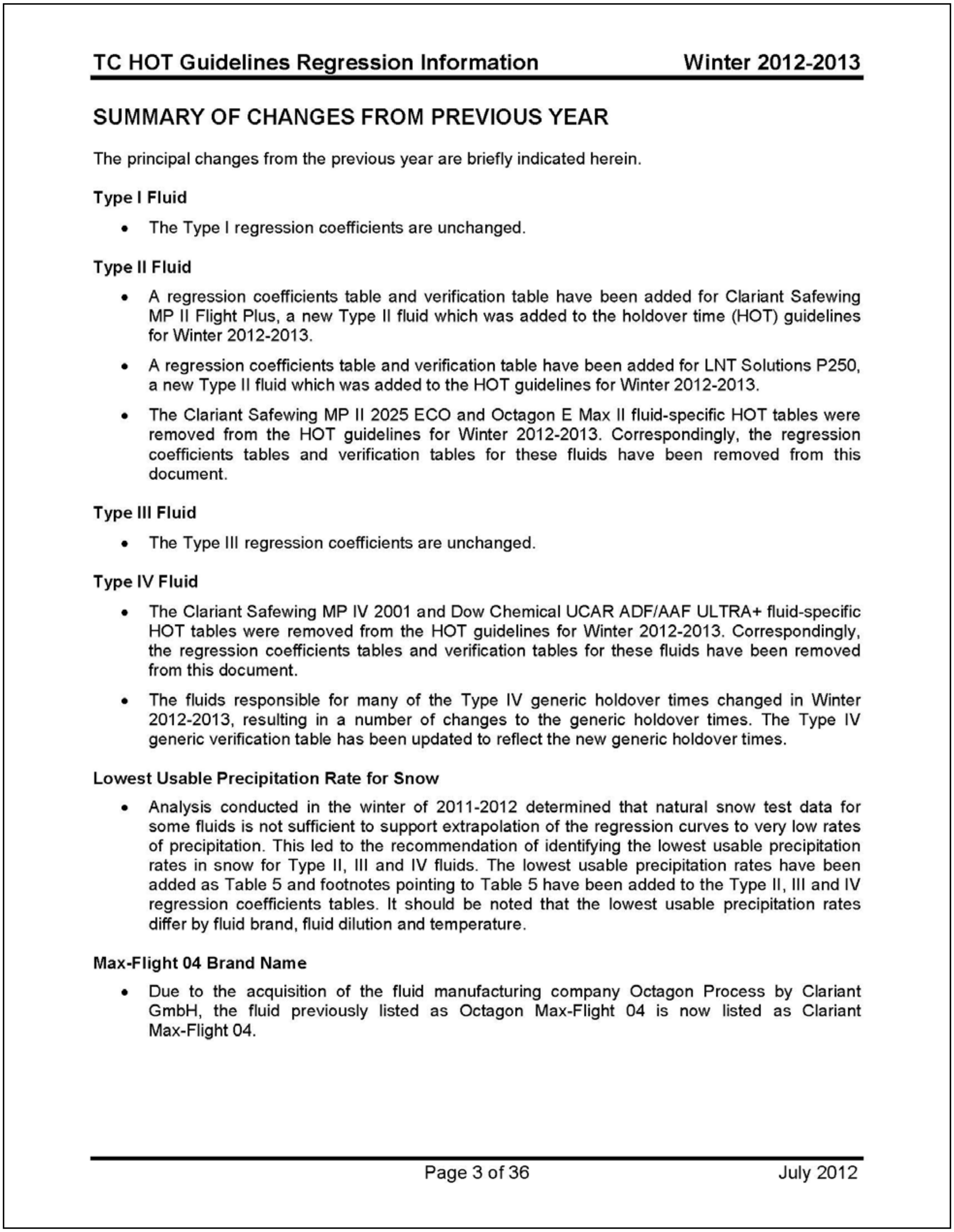


CHANGE CONTROL RECORDS

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.

REVISION	*DATE*	*DESCRIPTION OF CHANGES*	*AFFECTED PAGES*	*AUTHOR*



SUMMARY OF CHANGES FROM PREVIOUS YEAR

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

Type I Fluid

- The Type I regression coefficients are unchanged.

Type II Fluid

- A regression coefficients table and verification table have been added for Clariant Safewing MP II Flight Plus, a new Type II fluid which was added to the holdover time (HOT) guidelines for Winter 2012-2013.
- A regression coefficients table and verification table have been added for LNT Solutions P250, a new Type II fluid which was added to the HOT guidelines for Winter 2012-2013.
- The Clariant Safewing MP II 2025 ECO and Octagon E Max II fluid-specific HOT tables were removed from the HOT guidelines for Winter 2012-2013. Correspondingly, the regression coefficients tables and verification tables for these fluids have been removed from this document.

Type III Fluid

- The Type III regression coefficients are unchanged.

Type IV Fluid

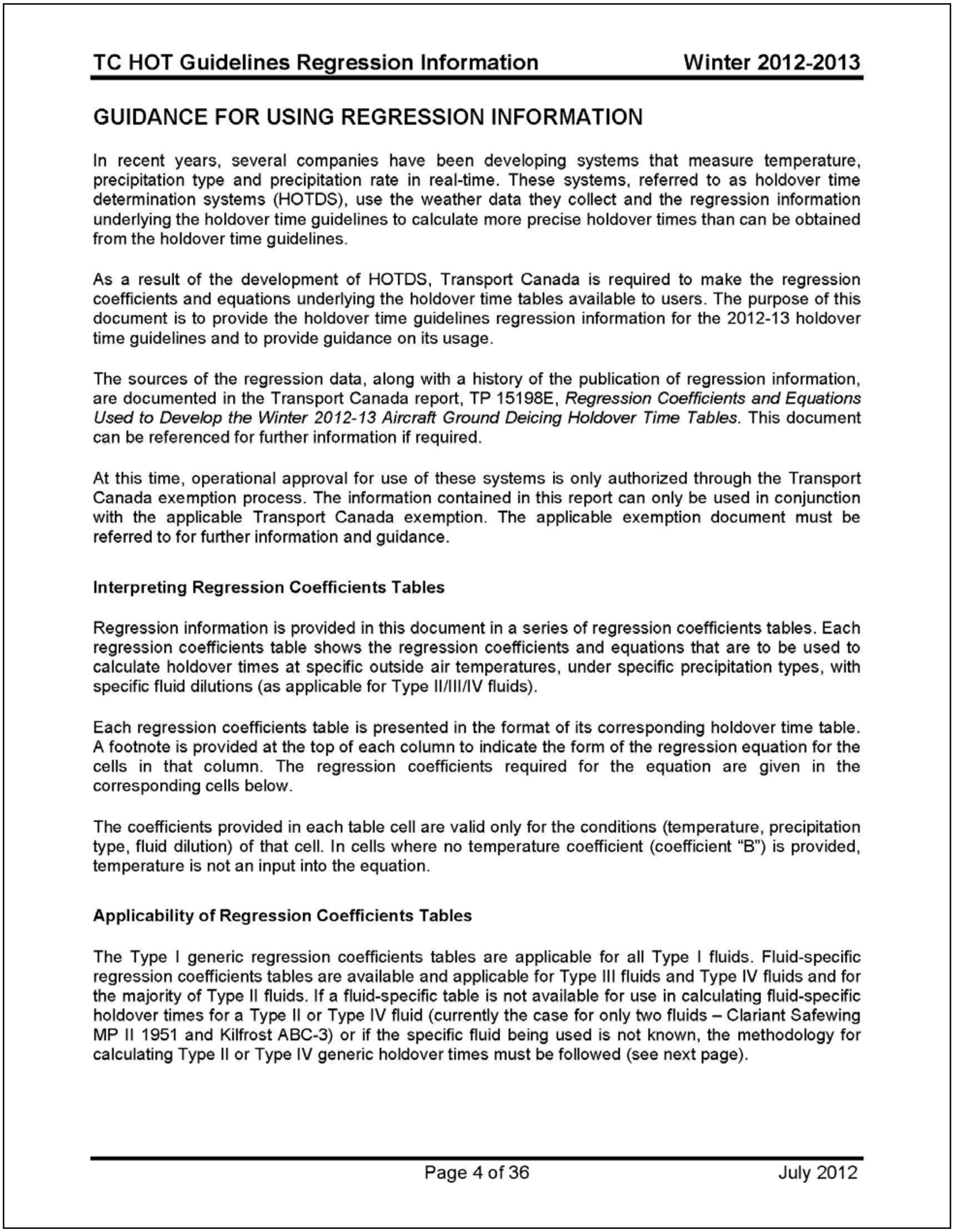
- The Clariant Safewing MP IV 2001 and Dow Chemical UCAR ADF/AAF ULTRA+ fluid-specific HOT tables were removed from the HOT guidelines for Winter 2012-2013. Correspondingly, the regression coefficients tables and verification tables for these fluids have been removed from this document.
- The fluids responsible for many of the Type IV generic holdover times changed in Winter 2012-2013, resulting in a number of changes to the generic holdover times. The Type IV generic verification table has been updated to reflect the new generic holdover times.

Lowest Usable Precipitation Rate for Snow

- Analysis conducted in the winter of 2011-2012 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. This led to the recommendation of identifying the lowest usable precipitation rates in snow for Type II, III and IV fluids. The lowest usable precipitation rates have been added as Table 5 and footnotes pointing to Table 5 have been added to the Type II, III and IV regression coefficients tables. It should be noted that the lowest usable precipitation rates differ by fluid brand, fluid dilution and temperature.

Max-Flight 04 Brand Name

- Due to the acquisition of the fluid manufacturing company Octagon Process by Clariant GmbH, the fluid previously listed as Octagon Max-Flight 04 is now listed as Clariant Max-Flight 04.



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 2012-13 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 15198E, *Regression Coefficients and Equations Used to Develop the Winter 2012-13 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).

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 the 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 (LUPR) 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 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.

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[1].
- 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/dm²/h); and
    2. Lowest usable precipitation rate (LUPR) for each fluid/dilution/temperature as defined in Table 5 of this document. The LUPR is the lowest precipitation rate for which sufficient outdoor snow data exists to support use of the regression coefficients. Further data on the substantiation of the LUPR values is available in TP 15198E.
- 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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[1] The issue of temperatures above 0°C will be addressed in future releases of the associated exemption document.

REGRESSION INFORMATION TABLES FOR WINTER 2012-2013

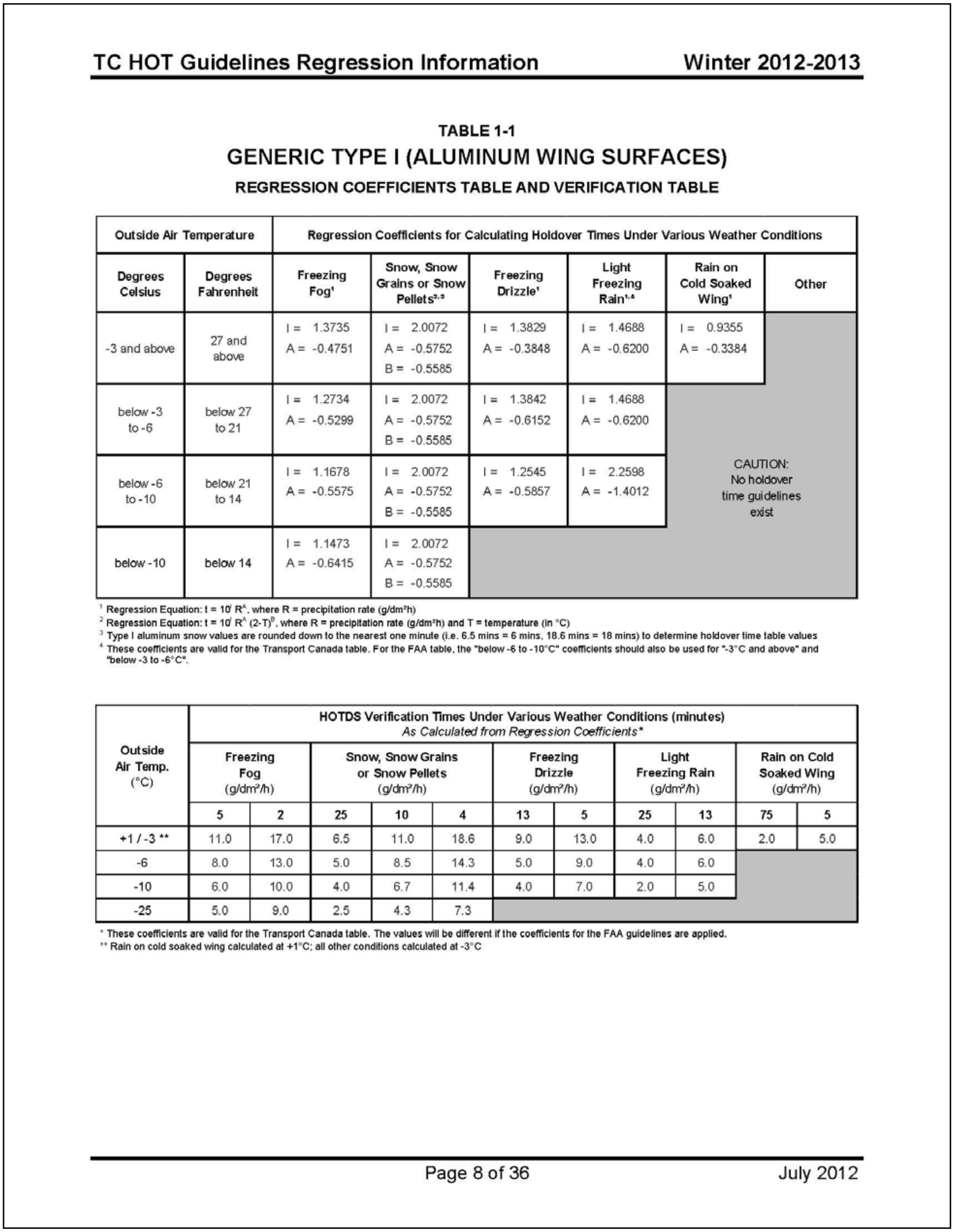


TABLE 1-1

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**[1]	**Snow, Snow Grains or Snow Pellets**[2,3]	**Freezing Drizzle**[1]	**Light Freezing Rain**[1,4]	**Rain on Cold Soaked Wing**[1]	**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	
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	CAUTION: No holdover time guidelines exist	
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				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

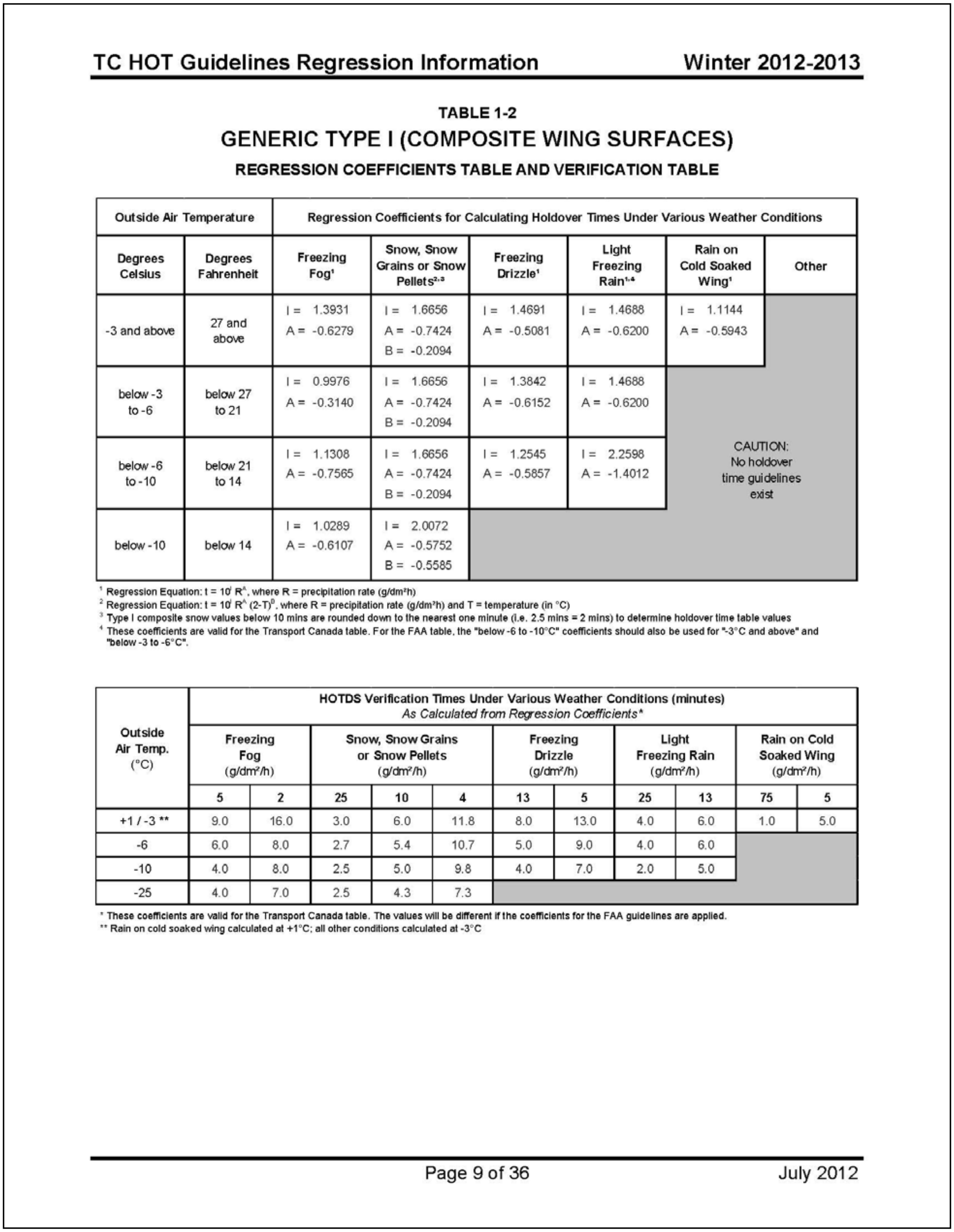
[3] Type I aluminum snow values are rounded down to the nearest one minute (i.e. 6.5 mins = 6 mins, 18.6 mins = 18 mins) to determine holdover time table values

[4] These coefficients are valid for the Transport Canada table. For the FAA table, the "below -6 to -10°C" coefficients should also be used for "-3°C and above" and "below -3 to -6°C".

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients**										
	Freezing Fog (g/dm²/h)		**Snow, Snow Grains or Snow Pellets** (g/dm²/h)			**Freezing Drizzle** (g/dm²/h)		**Light Freezing Rain** (g/dm²/h)		**Rain on Cold Soaked Wing** (g/dm²/h)	
	5	**2**	**25**	**10**	**4**	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	11.0	17.0	6.5	11.0	18.6	9.0	13.0	4.0	6.0	2.0	5.0
-6	8.0	13.0	5.0	8.5	14.3	5.0	9.0	4.0	6.0		
-10	6.0	10.0	4.0	6.7	11.4	4.0	7.0	2.0	5.0		
-25	5.0	9.0	2.5	4.3	7.3						

* These coefficients are valid for the Transport Canada table. The values will be different if the coefficients for the FAA guidelines are applied.

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



TC HOT Guidelines Regression Information Winter 2012-2013

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1,4]	Rain on Cold Soaked Wing[1]	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	
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	CAUTION: No holdover time guidelines exist	
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				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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

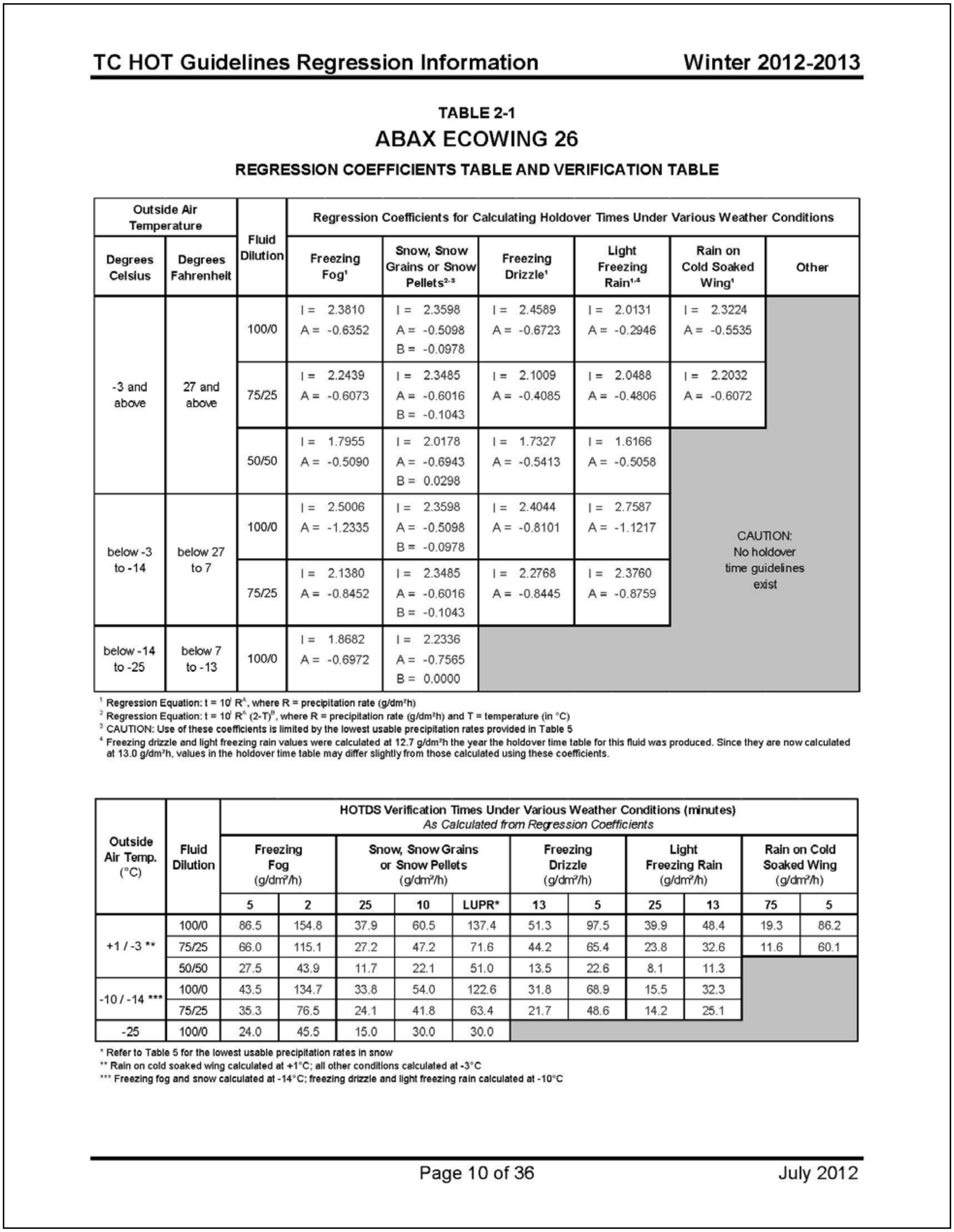
[4] These coefficients are valid for the Transport Canada table. For the FAA table, the "below -6 to -10°C" coefficients should also be used for "-3°C and above" and "below -3 to -6°C".

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients**										
	Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
	5	2	25	10	4	13	5	25	13	75	5
+1 / -3 **	9.0	16.0	3.0	6.0	11.8	8.0	13.0	4.0	6.0	1.0	5.0
-6	6.0	8.0	2.7	5.4	10.7	5.0	9.0	4.0	6.0		
-10	4.0	8.0	2.5	5.0	9.8	4.0	7.0	2.0	5.0		
-25	4.0	7.0	2.5	4.3	7.3						

* These coefficients are valid for the Transport Canada table. The values will be different if the coefficients for the FAA guidelines are applied.

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

Page 9 of 36 July 2012



TC HOT Guidelines Regression Information **Winter 2012-2013**

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[1]	Snow, Snow Grains or Snow Pellets[2-3]	Freezing Drizzle[1]	Light Freezing Rain[1-4]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.3810 A = -0.6352	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4589 A = -0.6723	I = 2.0131 A = -0.2946	I = 2.3224 A = -0.5535	
		75/25	I = 2.2439 A = -0.6073	I = 2.3485 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 = 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 = 2.4044 A = -0.8101	I = 2.7587 A = -1.1217	CAUTION: No holdover time guidelines exist	
		75/25	I = 2.1380 A = -0.8452	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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

[4] Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm²h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm²h, values in the holdover time table may differ slightly from those calculated using these coefficients.

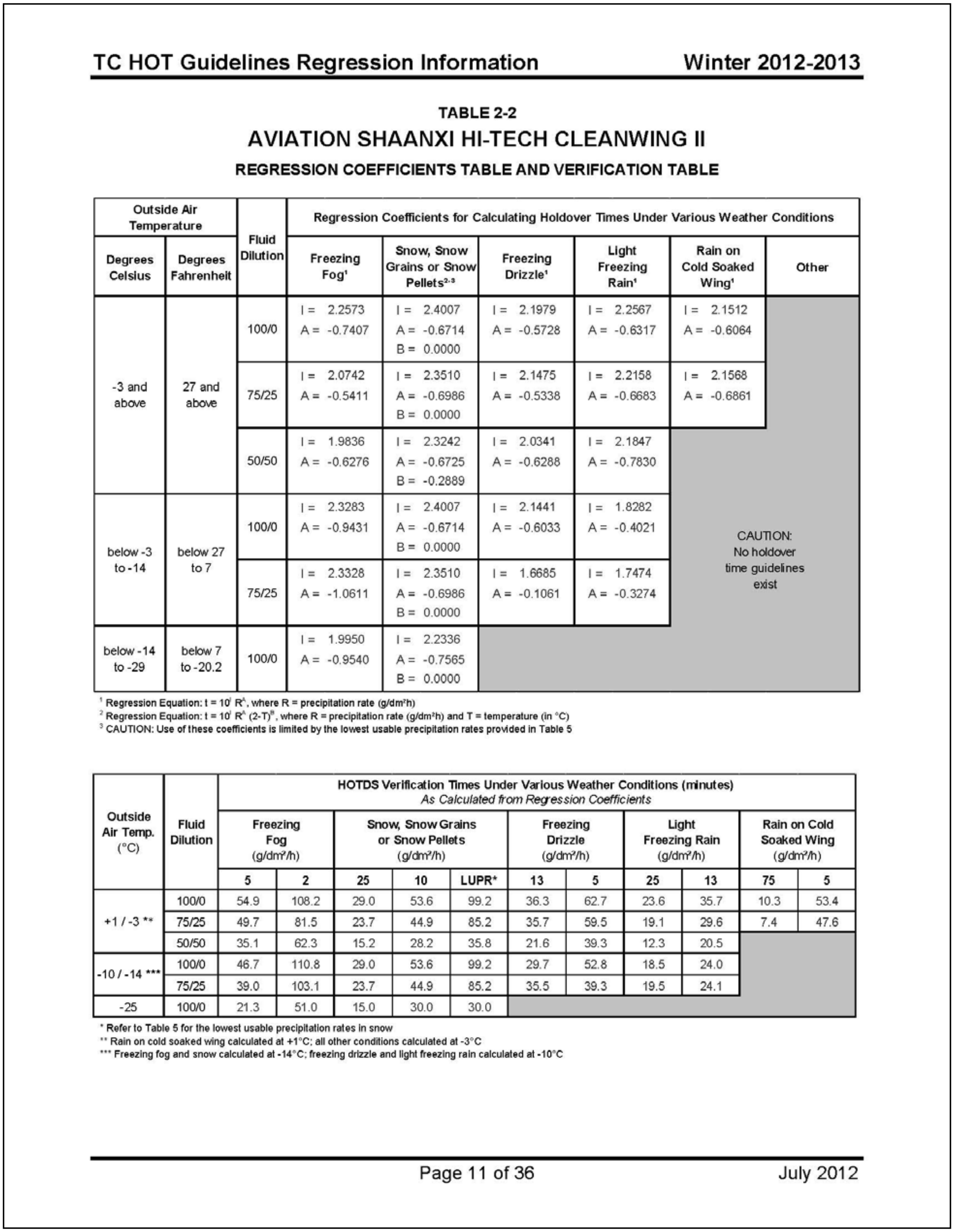
Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	86.5	154.8	37.9	60.5	137.4	51.3	97.5	39.9	48.4	19.3	86.2
	75/25	66.0	115.1	27.2	47.2	71.6	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	63.4	21.7	48.6	14.2	25.1		
-25	100/0	24.0	45.5	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

Page 10 of 36 July 2012



TC HOT Guidelines Regression Information Winter 2012-2013

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[1]**	**Snow, Snow Grains or Snow Pellets[2,3]**	**Freezing Drizzle[1]**	**Light Freezing Rain[1]**	**Rain on Cold Soaked Wing[1]**	**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				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

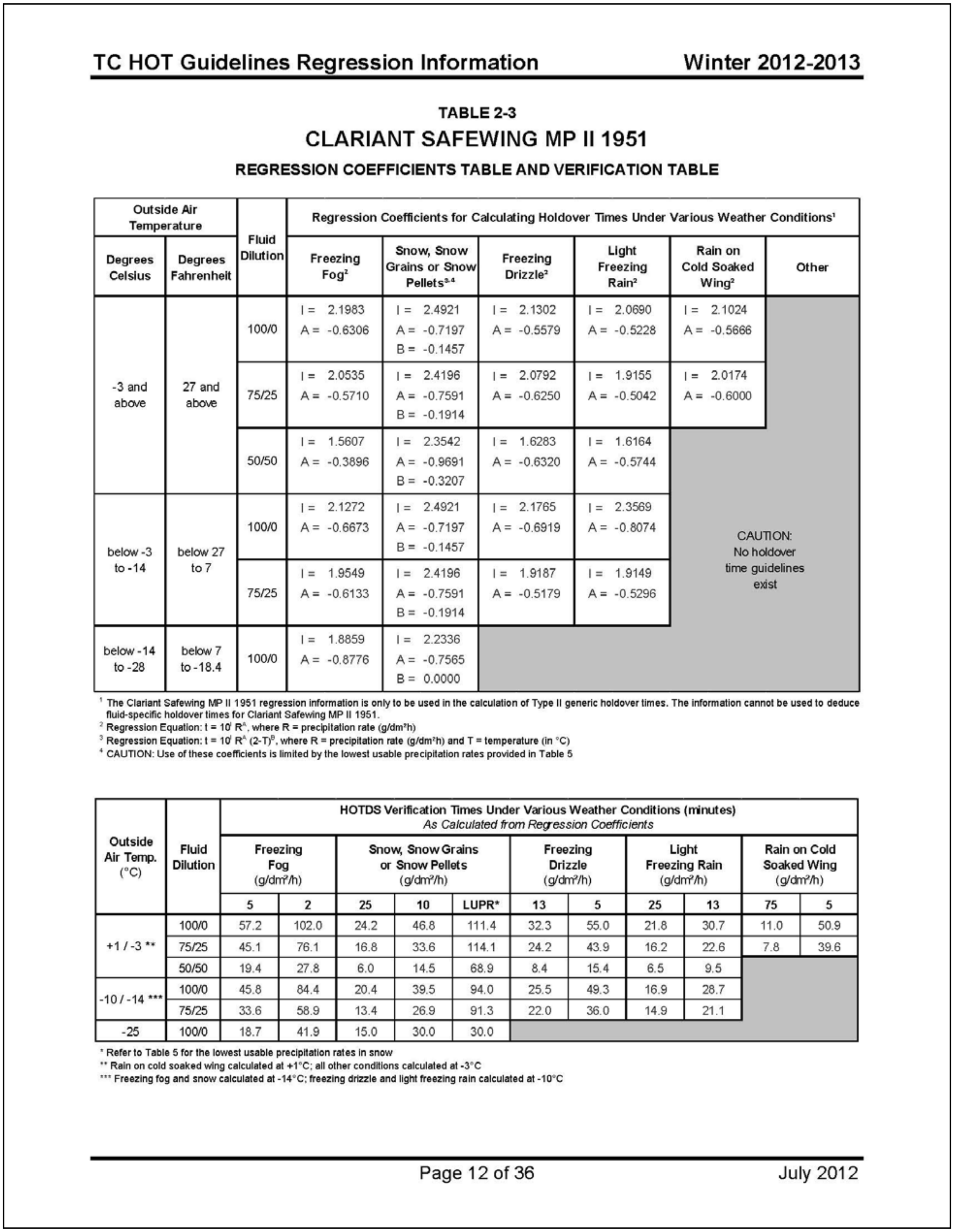
Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		**Snow, Snow Grains or Snow Pellets (g/dm²/h)**			**Freezing Drizzle (g/dm²/h)**		**Light Freezing Rain (g/dm²/h)**		**Rain on Cold Soaked Wing (g/dm²/h)**	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	54.9	108.2	29.0	53.6	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		
-25	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

Page 11 of 36 July 2012



TC HOT Guidelines Regression Information **Winter 2012-2013**

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[1]					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog[2]	Snow, Snow Grains or Snow Pellets[3,4]	Freezing Drizzle[2]	Light Freezing Rain[2]	Rain on Cold Soaked Wing[2]	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 = -0.8776	I = 2.2336 A = -0.7565 B = 0.0000				

[1] 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.

[2] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[3] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[4] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

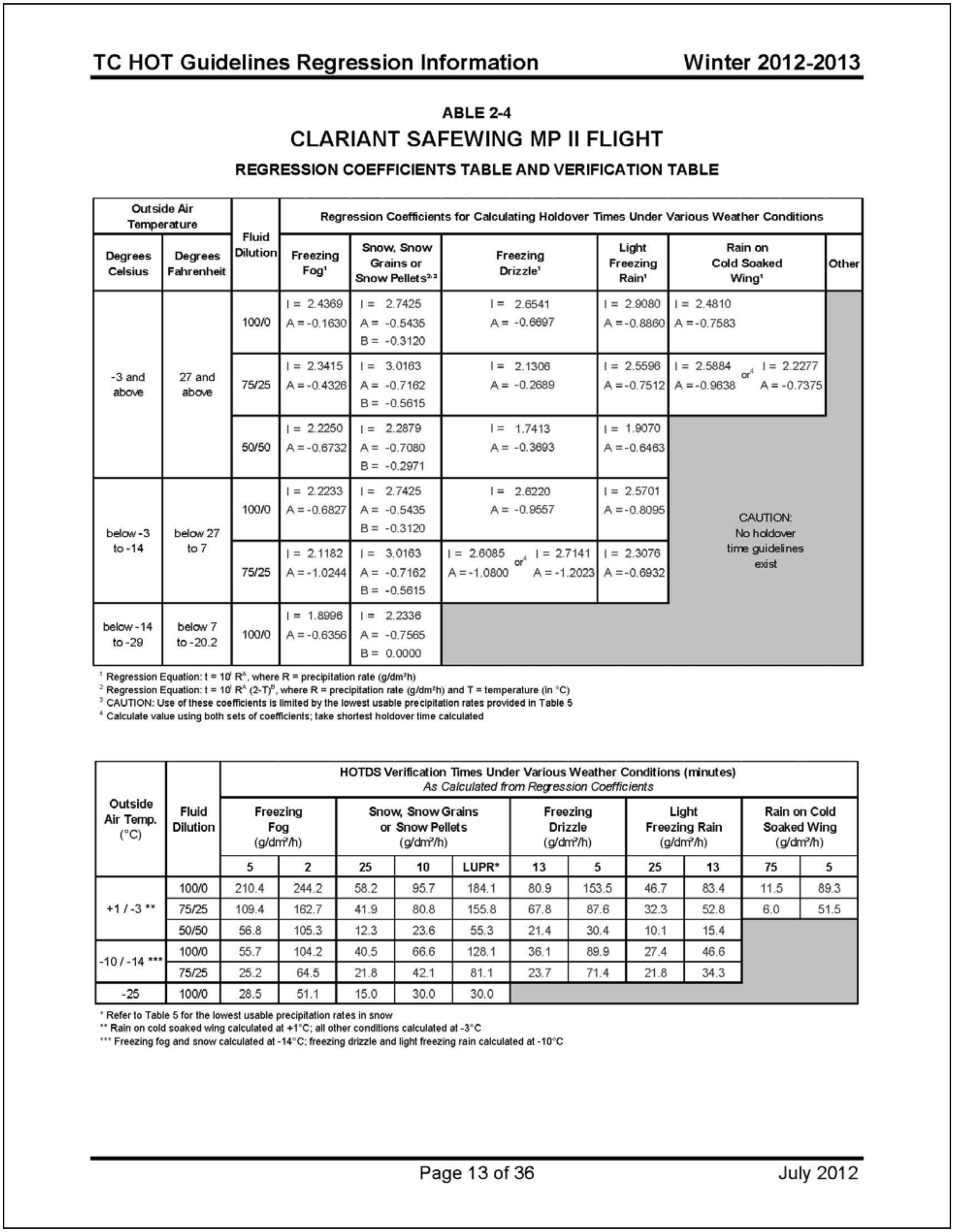
Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	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						

* 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

Page 12 of 36 July 2012



TC HOT Guidelines Regression Information Winter 2012-2013

ABLE 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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.4369 A = -0.1630	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6541 A = -0.6697	I = 2.9080 A = -0.8860	I = 2.4810 A = -0.7583	
		75/25	I = 2.3415 A = -0.4326	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.1306 A = -0.2689	I = 2.5596 A = -0.7512	I = 2.5884 A = -0.9638 or[4] I = 2.2277 A = -0.7375	
		50/50	I = 2.2250 A = -0.6732	I = 2.2879 A = -0.7080 B = -0.2971	I = 1.7413 A = -0.3693	I = 1.9070 A = -0.6463	CAUTION: No holdover time guidelines exist	
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 = 2.6220 A = -0.9557	I = 2.5701 A = -0.8095		
		75/25	I = 2.1182 A = -1.0244	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.6085 A = -1.0800 or[4] 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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

[4] Calculate value using both sets of coefficients; take shortest holdover time calculated

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	210.4	244.2	58.2	95.7	184.1	80.9	153.5	46.7	83.4	11.5	89.3
	75/25	109.4	162.7	41.9	80.8	155.8	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	81.1	23.7	71.4	21.8	34.3		
-25	100/0	28.5	51.1	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

Page 13 of 36 July 2012

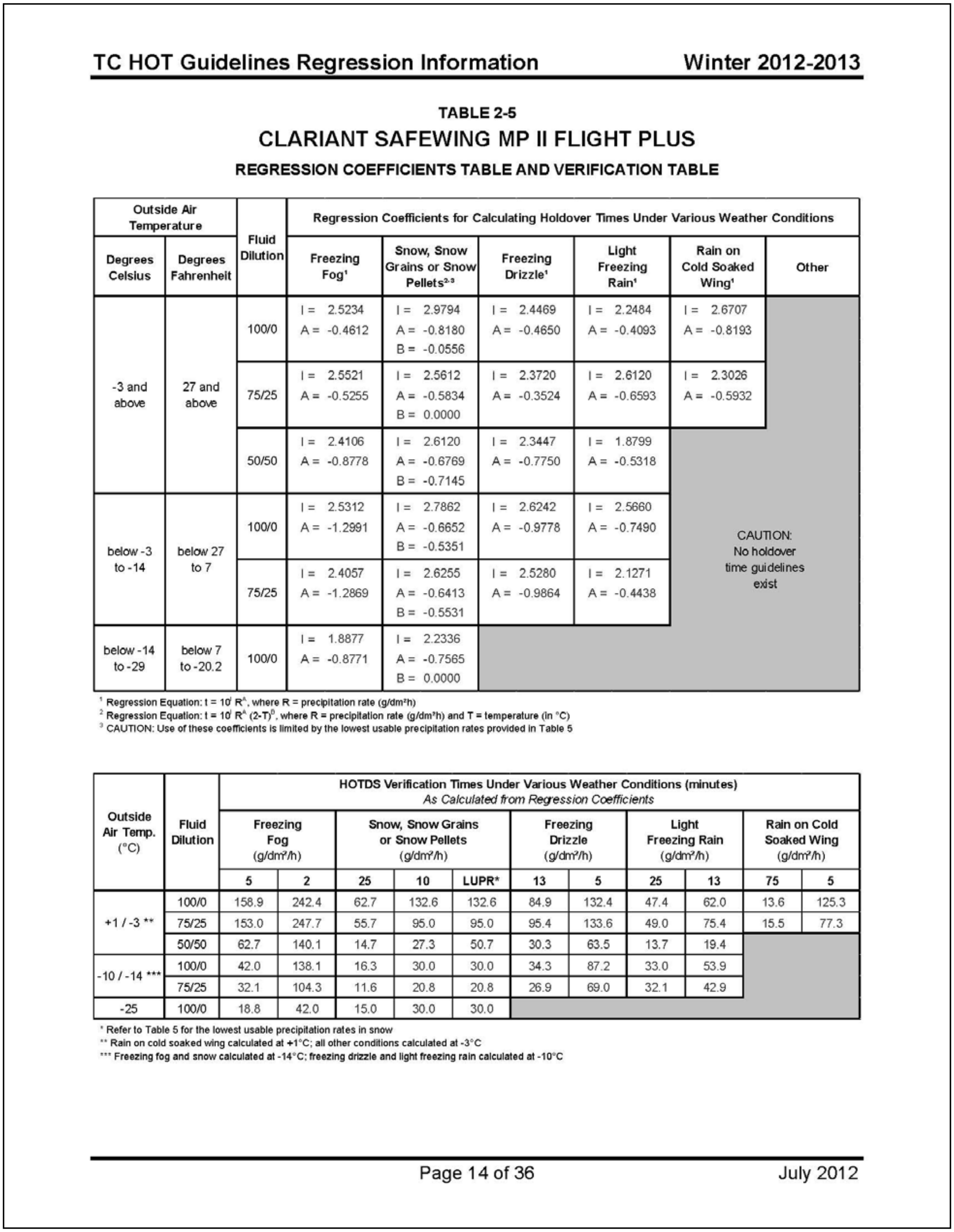


TABLE 2-5

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.5234 A = -0.4612	I = 2.9794 A = -0.8180 B = -0.0556	I = 2.4469 A = -0.4650	I = 2.2484 A = -0.4093	I = 2.6707 A = -0.8193	
		75/25	I = 2.5521 A = -0.5255	I = 2.5612 A = -0.5834 B = 0.0000	I = 2.3720 A = -0.3524	I = 2.6120 A = -0.6593	I = 2.3026 A = -0.5932	
		50/50	I = 2.4106 A = -0.8778	I = 2.6120 A = -0.6769 B = -0.7145	I = 2.3447 A = -0.7750	I = 1.8799 A = -0.5318	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	I = 2.5312 A = -1.2991	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.6242 A = -0.9778	I = 2.5660 A = -0.7490		
		75/25	I = 2.4057 A = -1.2869	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.5280 A = -0.9864	I = 2.1271 A = -0.4438		
below -14 to -29	below 7 to -20.2	100/0	I = 1.8877 A = -0.8771	I = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

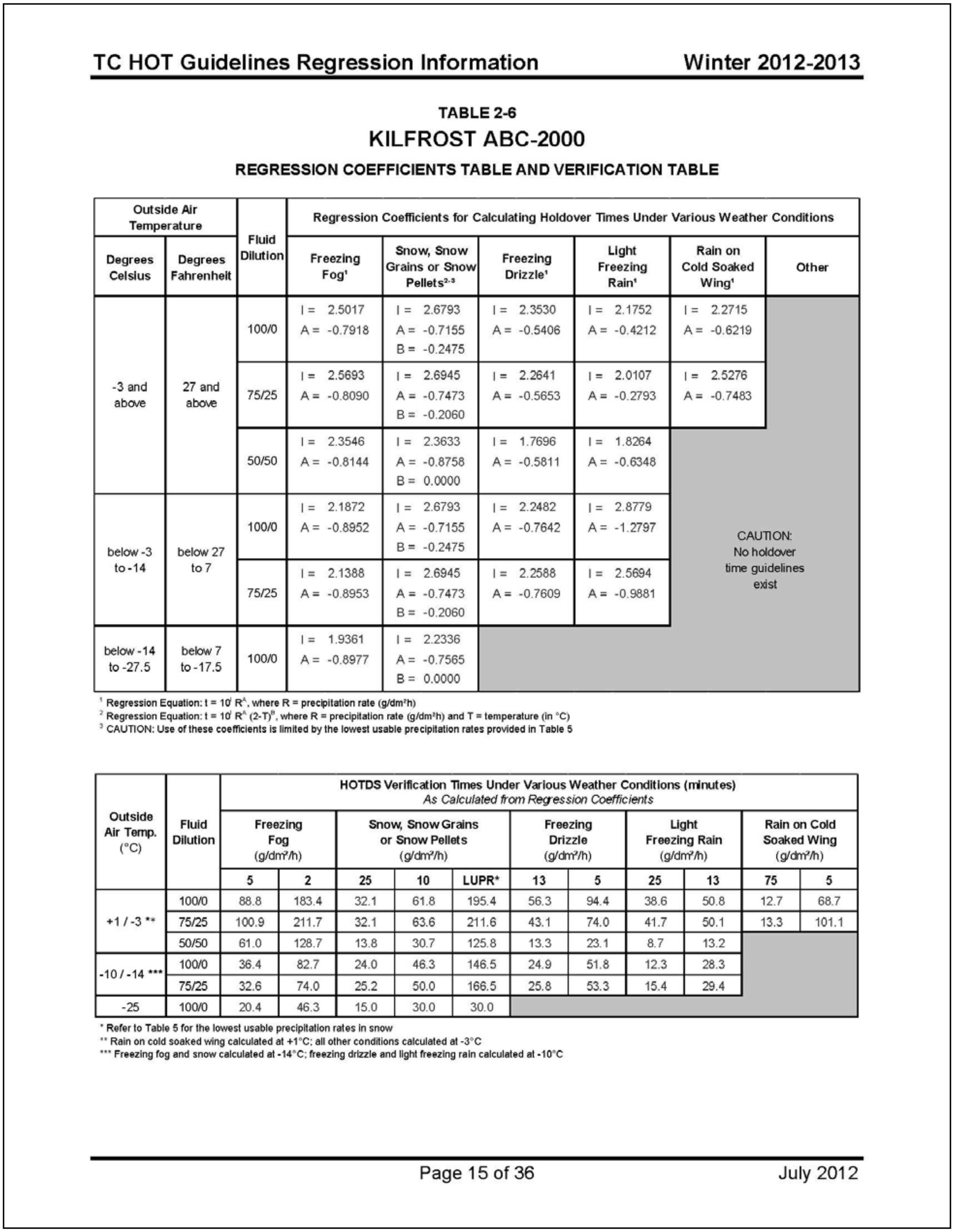
[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	158.9	242.4	62.7	132.6	132.6	84.9	132.4	47.4	62.0	13.6	125.3
	75/25	153.0	247.7	55.7	95.0	95.0	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	16.3	30.0	30.0	34.3	87.2	33.0	53.9		
	75/25	32.1	104.3	11.6	20.8	20.8	26.9	69.0	32.1	42.9		
-25	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



TC HOT Guidelines Regression Information Winter 2012-2013

TABLE 2-6

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	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	
		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	CAUTION: No holdover time guidelines exist	
		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				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	88.8	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		
-25	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

Page 15 of 36 July 2012

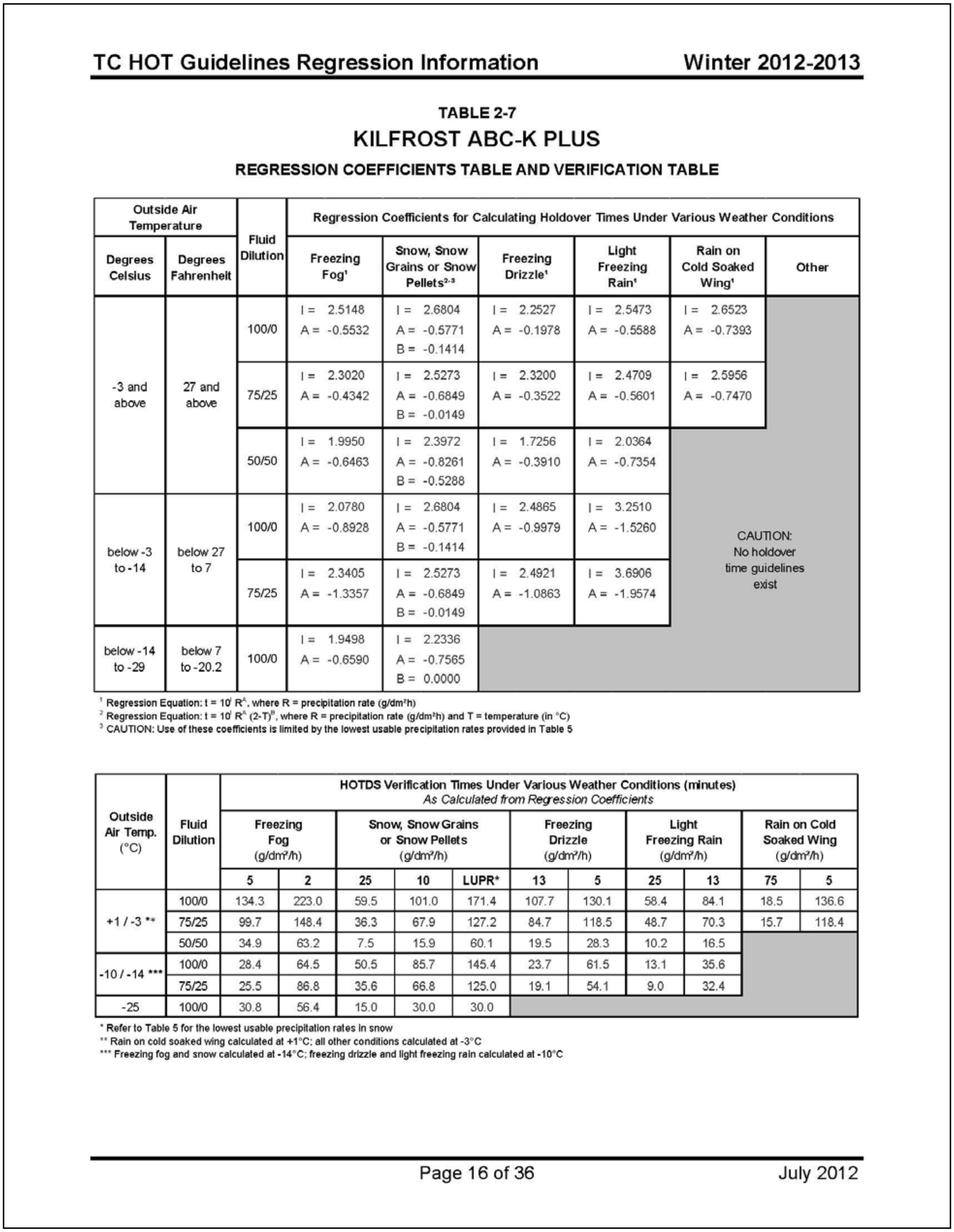


TABLE 2-7

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	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				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm^2h)

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

[3] 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 ($g/dm^2/h$)		Snow, Snow Grains or Snow Pellets ($g/dm^2/h$)			Freezing Drizzle ($g/dm^2/h$)		Light Freezing Rain ($g/dm^2/h$)		Rain on Cold Soaked Wing ($g/dm^2/h$)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	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		
-25	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

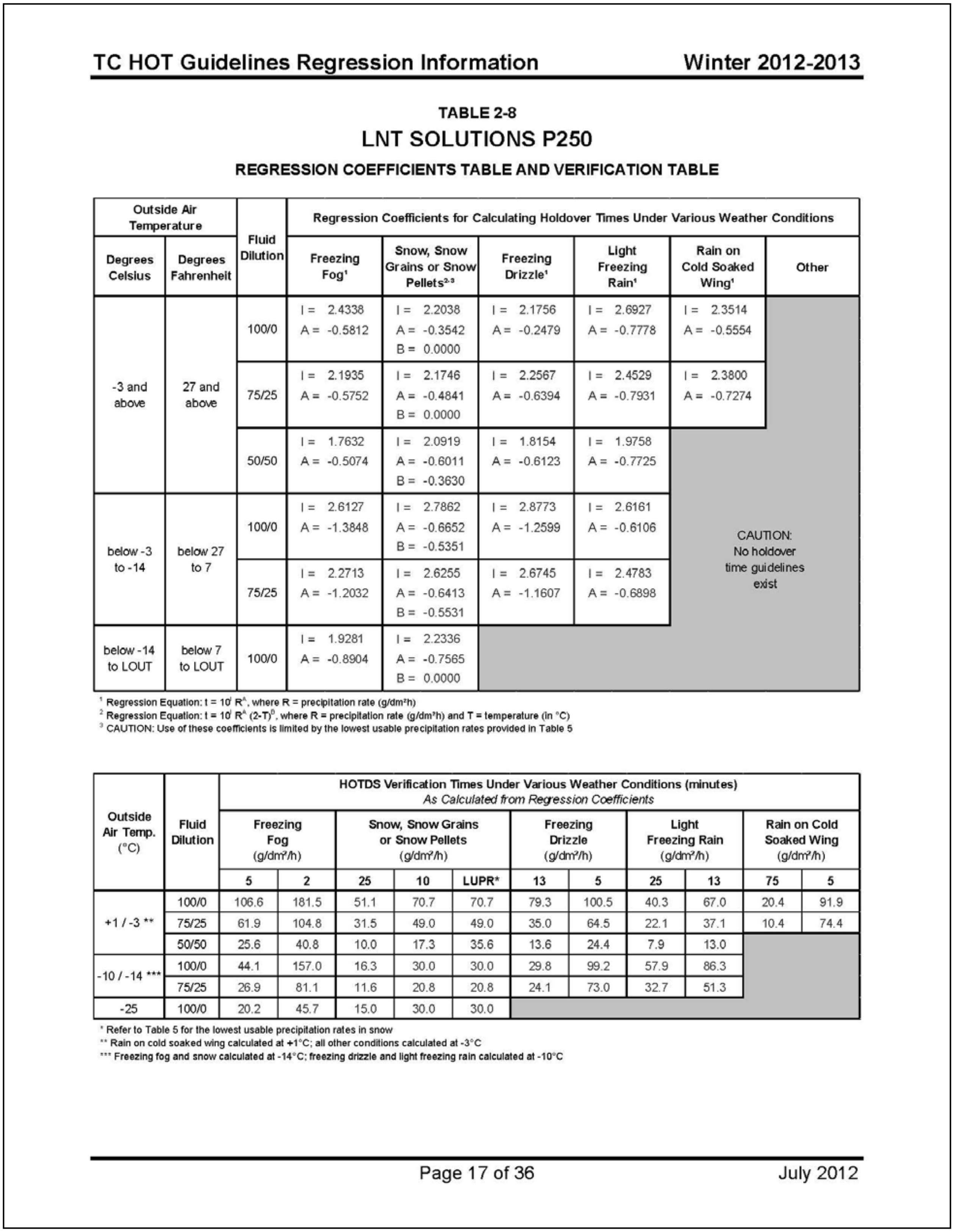


TABLE 2-8

LNT SOLUTIONS P250

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.4338 A = -0.5812	I = 2.2038 A = -0.3542 B = 0.0000	I = 2.1756 A = -0.2479	I = 2.6927 A = -0.7778	I = 2.3514 A = -0.5554	
		75/25	I = 2.1935 A = -0.5752	I = 2.1746 A = -0.4841 B = 0.0000	I = 2.2567 A = -0.6394	I = 2.4529 A = -0.7931	I = 2.3800 A = -0.7274	
		50/50	I = 1.7632 A = -0.5074	I = 2.0919 A = -0.6011 B = -0.3630	I = 1.8154 A = -0.6123	I = 1.9758 A = -0.7725		
below -3 to -14	below 27 to 7	100/0	I = 2.6127 A = -1.3848	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.8773 A = -1.2599	I = 2.6161 A = -0.6106	CAUTION: No holdover time guidelines exist	
		75/25	I = 2.2713 A = -1.2032	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.6745 A = -1.1607	I = 2.4783 A = -0.6898		
below -14 to LOUT	below 7 to LOUT	100/0	I = 1.9281 A = -0.8904	I = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	106.6	181.5	51.1	70.7	70.7	79.3	100.5	40.3	67.0	20.4	91.9
	75/25	61.9	104.8	31.5	49.0	49.0	35.0	64.5	22.1	37.1	10.4	74.4
	50/50	25.6	40.8	10.0	17.3	35.6	13.6	24.4	7.9	13.0		
-10 / -14 ***	100/0	44.1	157.0	16.3	30.0	30.0	29.8	99.2	57.9	86.3		
	75/25	26.9	81.1	11.6	20.8	20.8	24.1	73.0	32.7	51.3		
-25	100/0	20.2	45.7	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

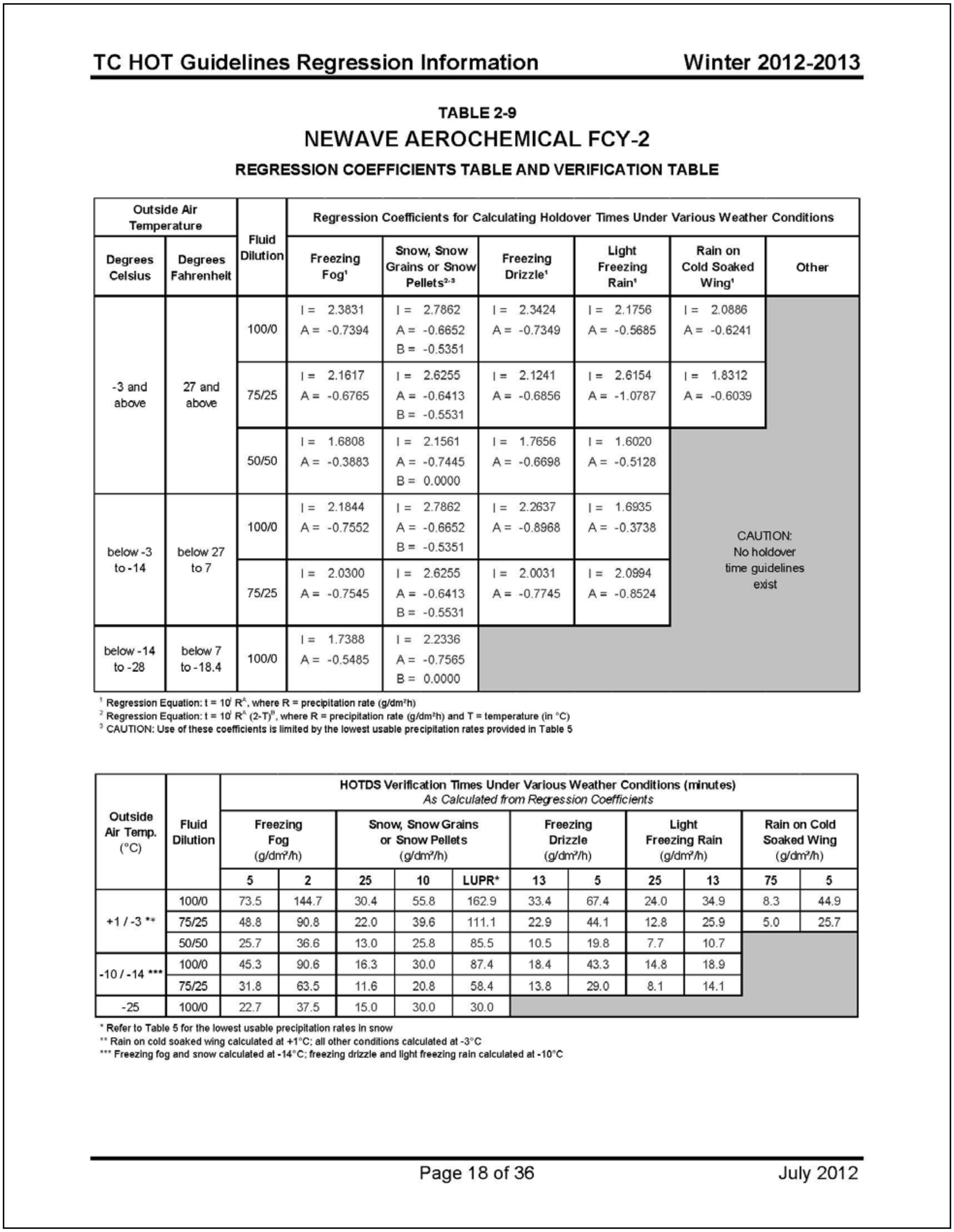


TABLE 2-9

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	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				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	73.5	144.7	30.4	55.8	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		
-25	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

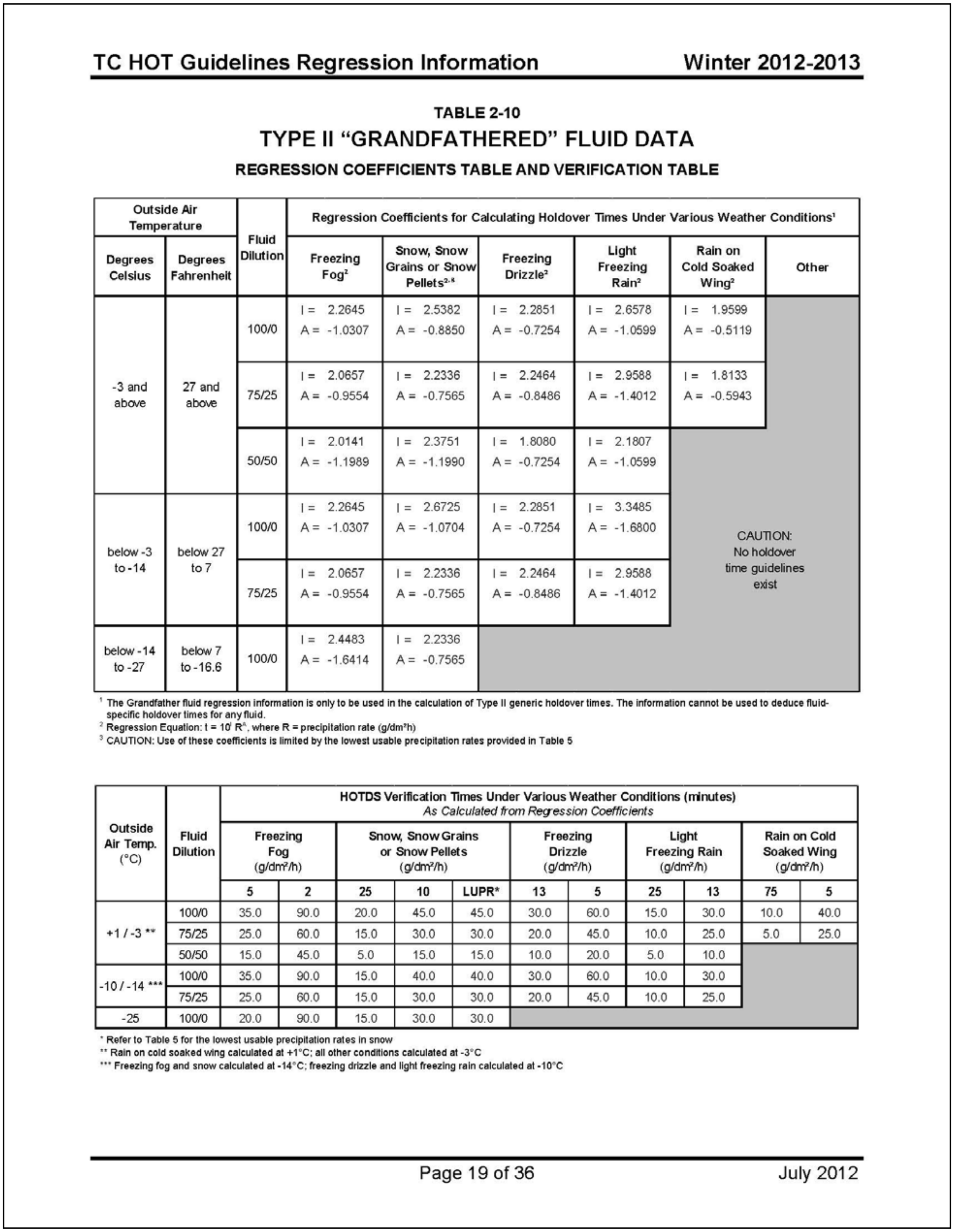


TABLE 2-10

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[1]					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog[2]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[2]	Light Freezing Rain[2]	Rain on Cold Soaked Wing[2]	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 -27	below 7 to -16.6	100/0	I = 2.4483 A = -1.6414	I = 2.2336 A = -0.7565				

[1] 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.

[2] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	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

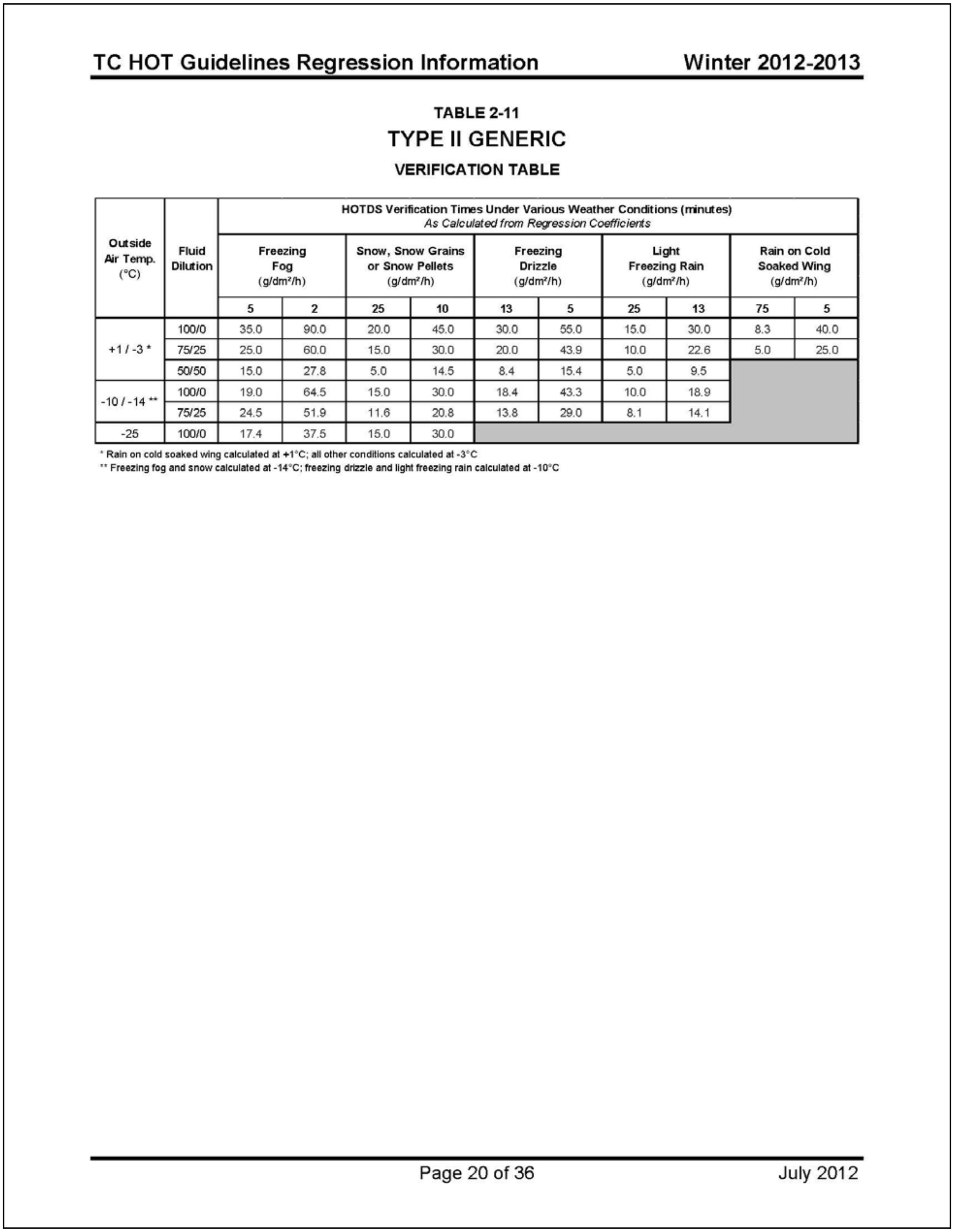


TABLE 2-11

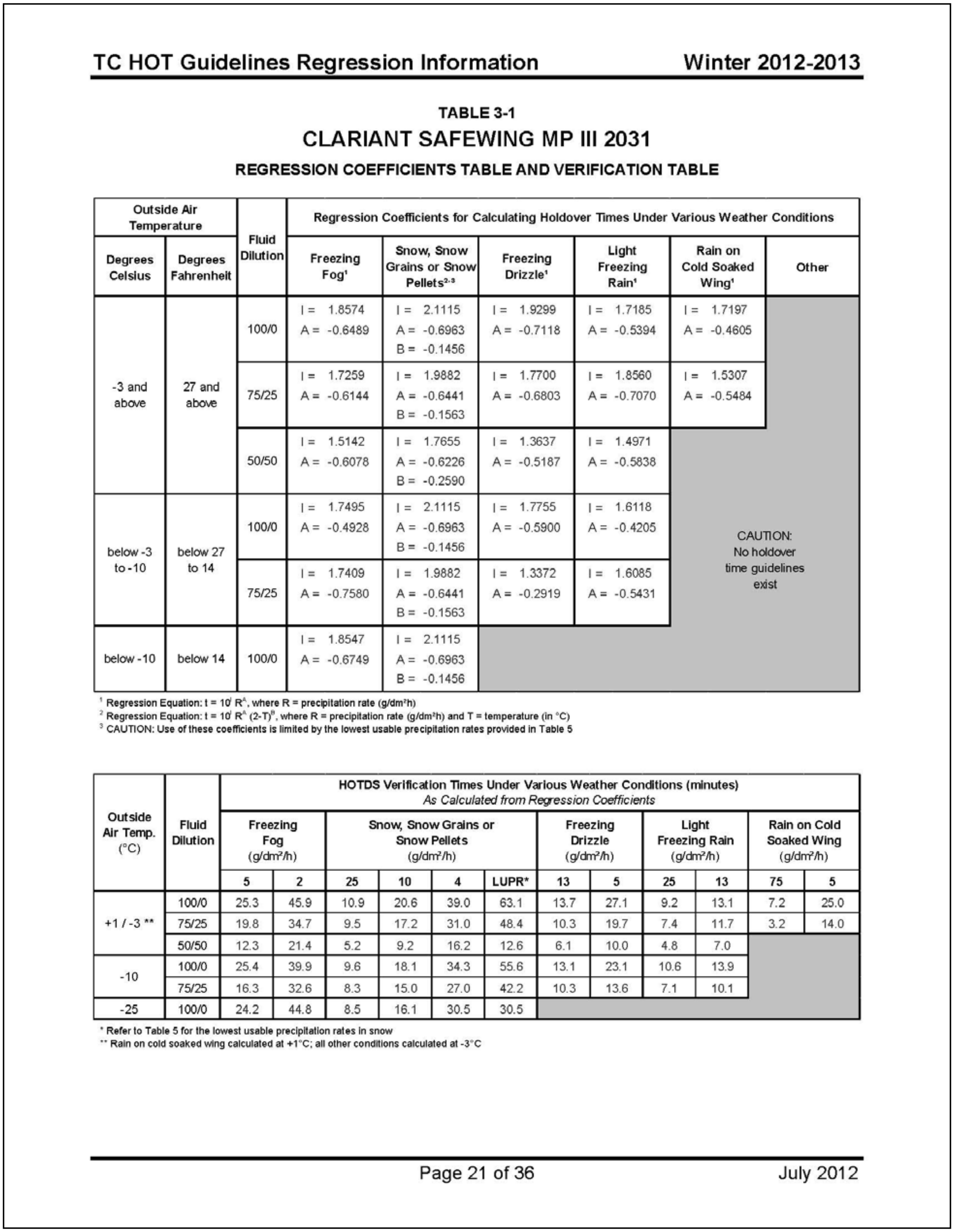
TYPE II GENERIC

VERIFICATION TABLE

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)		Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 *	100/0	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



TC HOT Guidelines Regression Information **Winter 2012-2013**

TABLE 3-1

CLARIANT SAFEWING MP III 2031

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**[1]	**Snow, Snow Grains or Snow Pellets**[2,3]	**Freezing Drizzle**[1]	**Light Freezing Rain**[1]	**Rain on Cold Soaked Wing**[1]	**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	
		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		CAUTION: No holdover time guidelines exist
		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				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

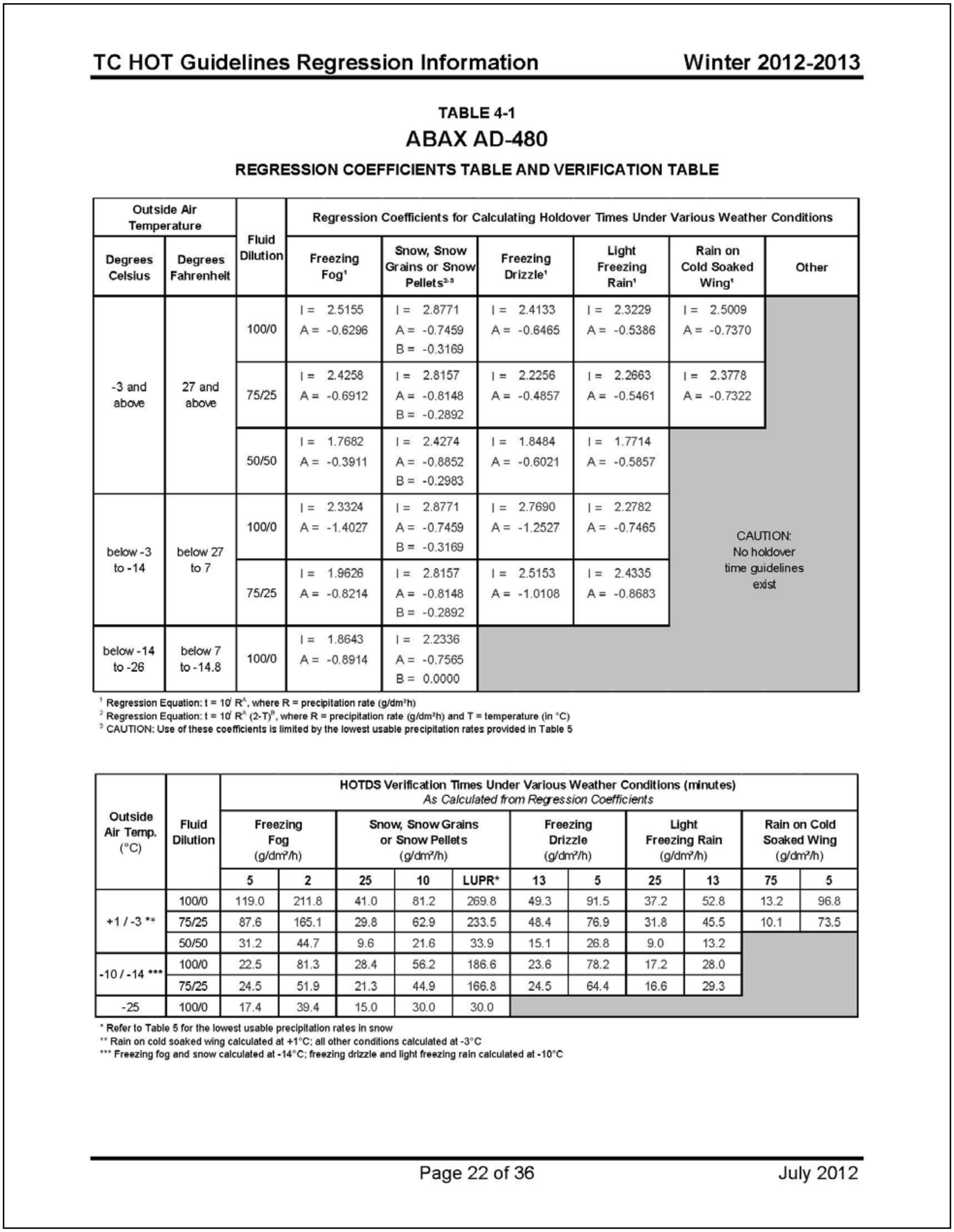
[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	**Fluid Dilution**	**HOTDS Verification Times Under Various Weather Conditions (minutes)** *As Calculated from Regression Coefficients*											
		Freezing Fog (g/dm²/h)		**Snow, Snow Grains or Snow Pellets (g/dm²/h)**				**Freezing Drizzle (g/dm²/h)**		**Light Freezing Rain (g/dm²/h)**		**Rain on Cold Soaked Wing (g/dm²/h)**	
		5	**2**	**25**	**10**	**4**	**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

Page 21 of 36 July 2012



TC HOT Guidelines Regression Information Winter 2012-2013

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	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				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	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		
-25	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

Page 22 of 36 July 2012

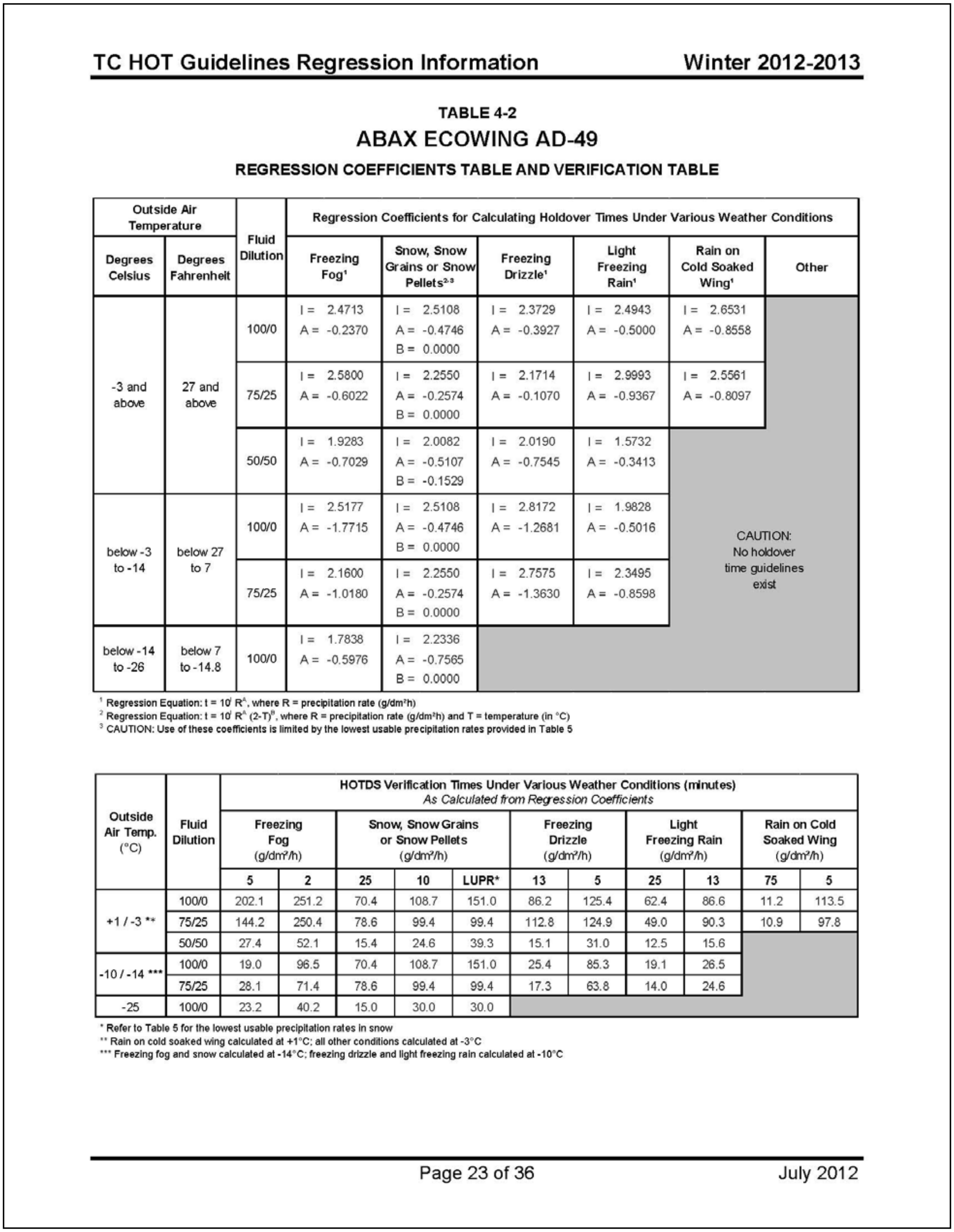


TABLE 4-2

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.4713 A = -0.2370	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.3729 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 = 2.1714 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 = 2.0190 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 = 2.8172 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 = 2.7575 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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	202.1	251.2	70.4	108.7	151.0	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	144.2	250.4	78.6	99.4	99.4	112.8	124.9	49.0	90.3	10.9	97.8
	50/50	27.4	52.1	15.4	24.6	39.3	15.1	31.0	12.5	15.6		
-10 / -14 ***	100/0	19.0	96.5	70.4	108.7	151.0	25.4	85.3	19.1	26.5		
	75/25	28.1	71.4	78.6	99.4	99.4	17.3	63.8	14.0	24.6		
-25	100/0	23.2	40.2	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

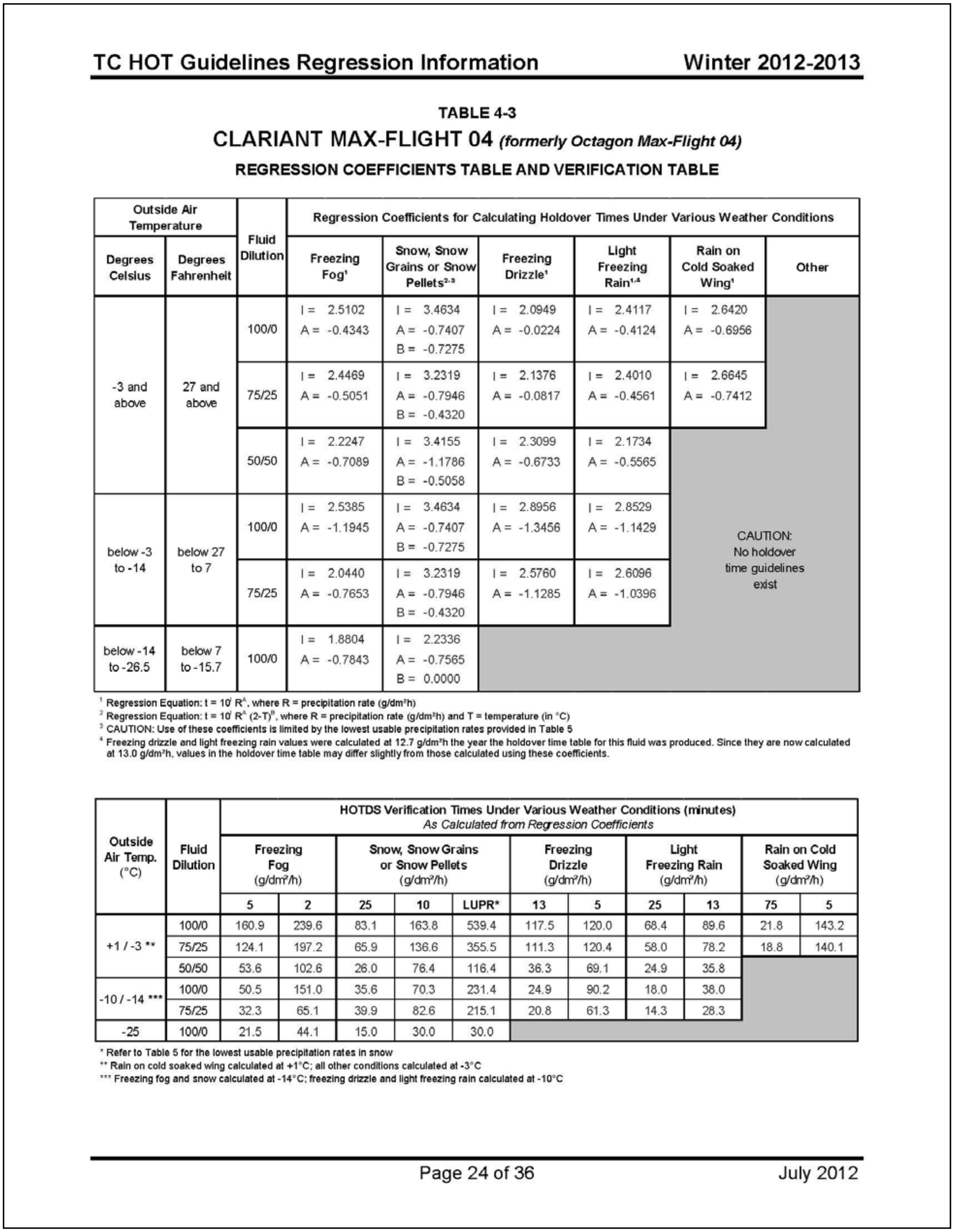


TABLE 4-3

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[1]**	**Snow, Snow Grains or Snow Pellets[2-3]**	**Freezing Drizzle[1]**	**Light Freezing Rain[1-4]**	**Rain on Cold Soaked Wing[1]**	**Other**
-3 and above	27 and above	100/0	I = 2.5102 A = -0.4343	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.0949 A = -0.0224	I = 2.4117 A = -0.4124	I = 2.6420 A = -0.6956	
		75/25	I = 2.4469 A = -0.5051	I = 3.2319 A = -0.7946 B = -0.4320	I = 2.1376 A = -0.0817	I = 2.4010 A = -0.4561	I = 2.6645 A = -0.7412	
		50/50	I = 2.2247 A = -0.7089	I = 3.4155 A = -1.1786 B = -0.5058	I = 2.3099 A = -0.6733	I = 2.1734 A = -0.5565		
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 = 2.8956 A = -1.3456	I = 2.8529 A = -1.1429		CAUTION: No holdover time guidelines exist
		75/25	I = 2.0440 A = -0.7653	I = 3.2319 A = -0.7946 B = -0.4320	I = 2.5760 A = -1.1285	I = 2.6096 A = -1.0396		
below -14 to -26.5	below 7 to -15.7	100/0	I = 1.8804 A = -0.7843	I = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

[4] Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm²h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm²h, 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 (g/dm²/h)		**Snow, Snow Grains or Snow Pellets** (g/dm²/h)			**Freezing Drizzle** (g/dm²/h)		**Light Freezing Rain** (g/dm²/h)		**Rain on Cold Soaked Wing** (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	160.9	239.6	83.1	163.8	539.4	117.5	120.0	68.4	89.6	21.8	143.2
	75/25	124.1	197.2	65.9	136.6	355.5	111.3	120.4	58.0	78.2	18.8	140.1
	50/50	53.6	102.6	26.0	76.4	116.4	36.3	69.1	24.9	35.8		
-10 / -14 ***	100/0	50.5	151.0	35.6	70.3	231.4	24.9	90.2	18.0	38.0		
	75/25	32.3	65.1	39.9	82.6	215.1	20.8	61.3	14.3	28.3		
-25	100/0	21.5	44.1	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

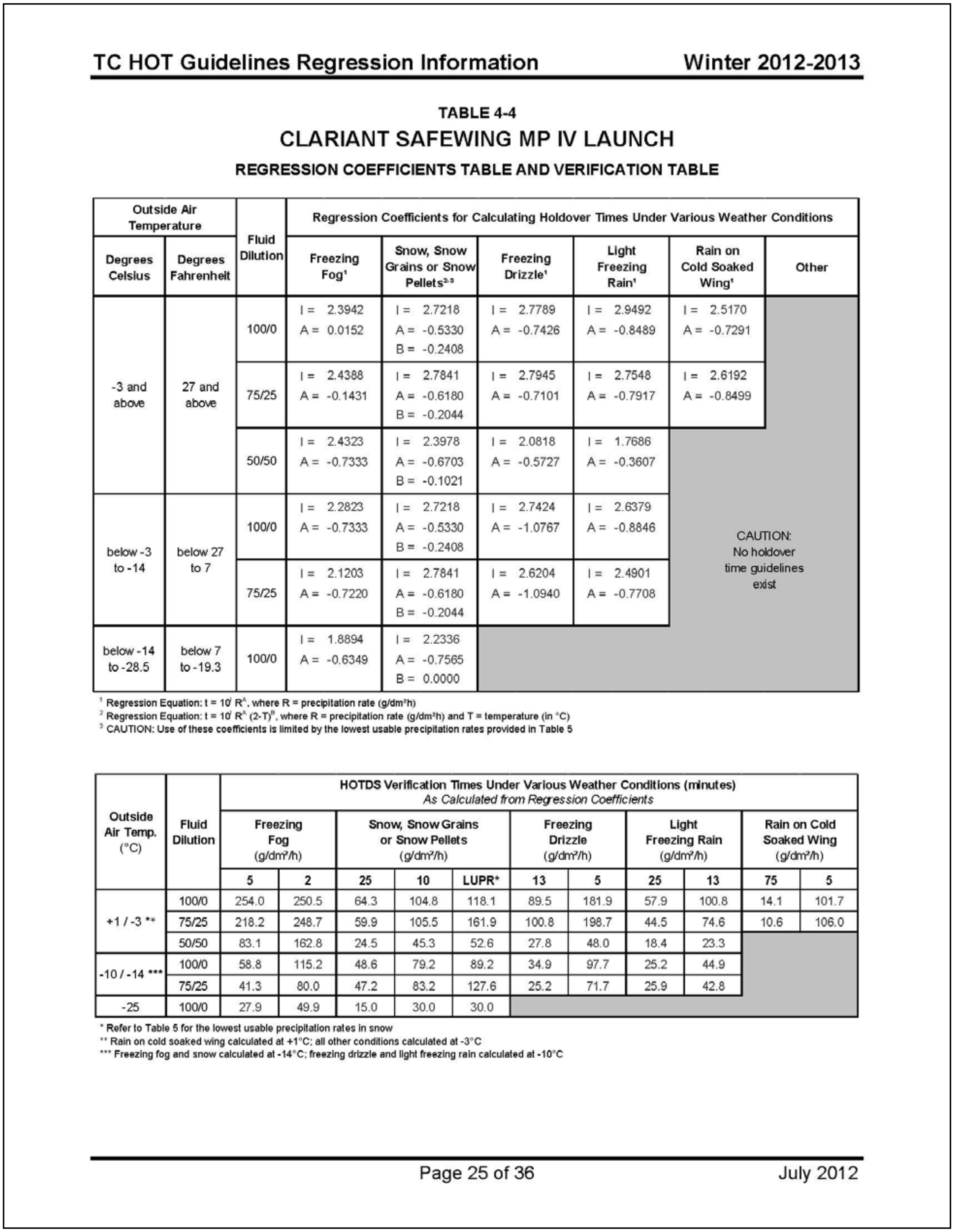


TABLE 4-4

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[1]**	**Snow, Snow Grains or Snow Pellets[2,3]**	**Freezing Drizzle[1]**	**Light Freezing Rain[1]**	**Rain on Cold Soaked Wing[1]**	**Other**
-3 and above	27 and above	100/0	I = 2.3942 A = 0.0152	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7789 A = -0.7426	I = 2.9492 A = -0.8489	I = 2.5170 A = -0.7291	
		75/25	I = 2.4388 A = -0.1431	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7945 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 = 2.0818 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 = 2.7424 A = -1.0767	I = 2.6379 A = -0.8846	CAUTION: No holdover time guidelines exist	
		75/25	I = 2.1203 A = -0.7220	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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		**Snow, Snow Grains or Snow Pellets (g/dm²/h)**			**Freezing Drizzle (g/dm²/h)**		**Light Freezing Rain (g/dm²/h)**		**Rain on Cold Soaked Wing (g/dm²/h)**	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	254.0	250.5	64.3	104.8	118.1	89.5	181.9	57.9	100.8	14.1	101.7
	75/25	218.2	248.7	59.9	105.5	161.9	100.8	198.7	44.5	74.6	10.6	106.0
	50/50	83.1	162.8	24.5	45.3	52.6	27.8	48.0	18.4	23.3		
-10 / -14 ***	100/0	58.8	115.2	48.6	79.2	89.2	34.9	97.7	25.2	44.9		
	75/25	41.3	80.0	47.2	83.2	127.6	25.2	71.7	25.9	42.8		
-25	100/0	27.9	49.9	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

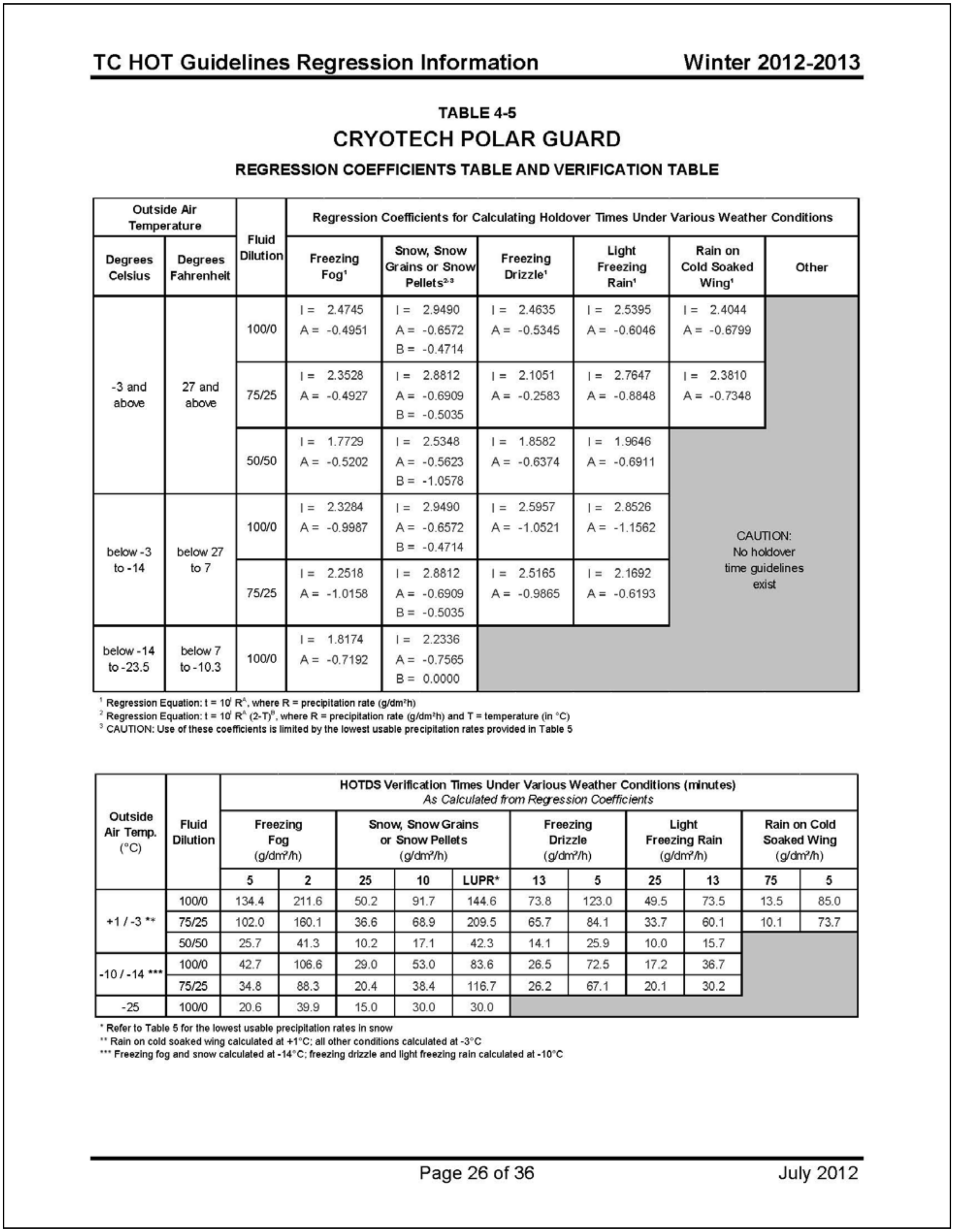


TABLE 4-5

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	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	
		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	CAUTION: No holdover time guidelines exist	
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				

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

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

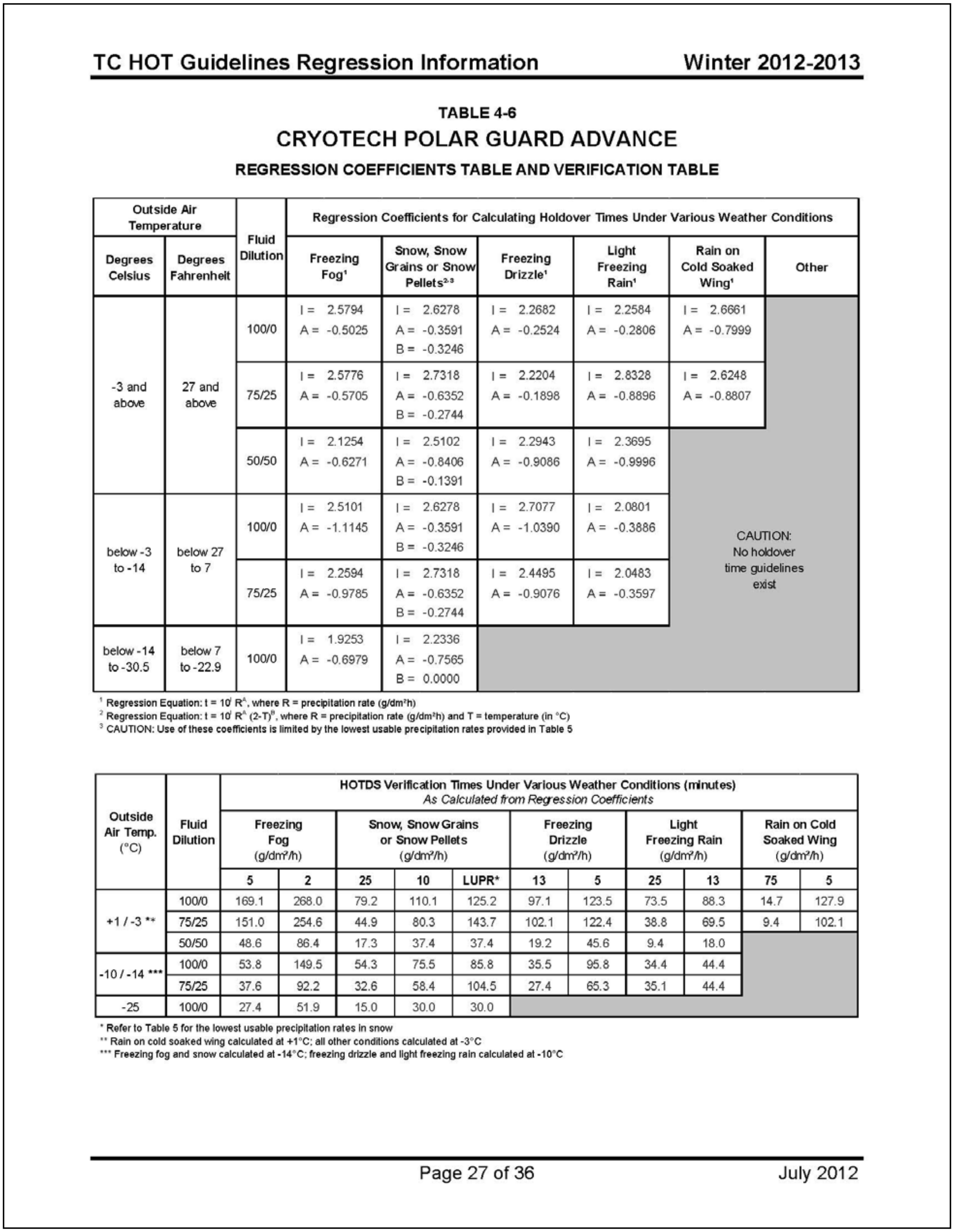
[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog $(g/dm^2/h)$		Snow, Snow Grains or Snow Pellets $(g/dm^2/h)$			Freezing Drizzle $(g/dm^2/h)$		Light Freezing Rain $(g/dm^2/h)$		Rain on Cold Soaked Wing $(g/dm^2/h)$	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	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



TC HOT Guidelines Regression Information Winter 2012-2013

TABLE 4-6

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.5794 A = -0.5025	I = 2.6278 A = -0.3591 B = -0.3246	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	
		75/25	I = 2.5776 A = -0.5705	I = 2.7318 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 = 2.2943 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 = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886	CAUTION: No holdover time guidelines exist	
		75/25	I = 2.2594 A = -0.9785	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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

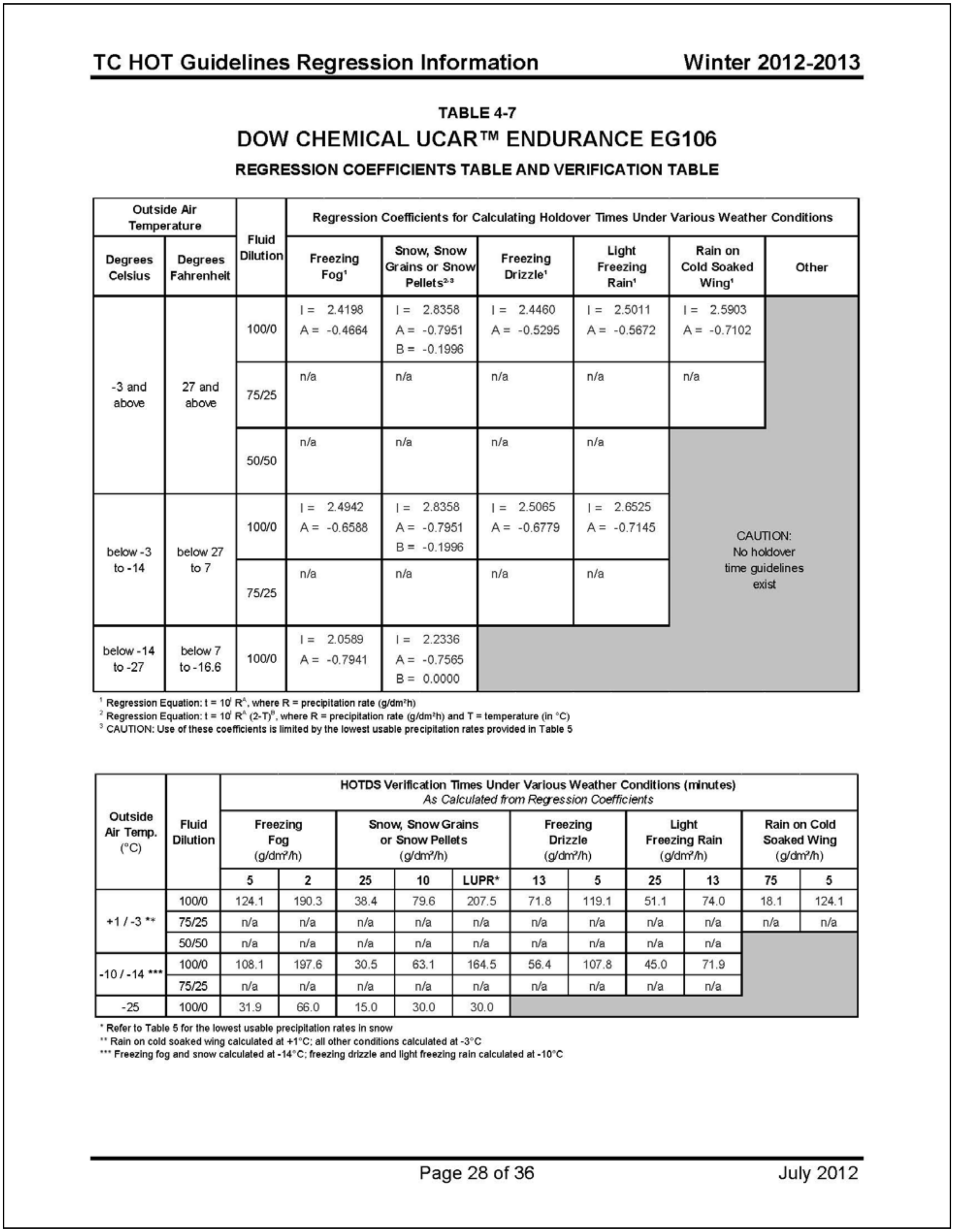
Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	169.1	268.0	79.2	110.1	125.2	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	44.9	80.3	143.7	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	17.3	37.4	37.4	19.2	45.6	9.4	18.0		
-10 / -14 ***	100/0	53.8	149.5	54.3	75.5	85.8	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	32.6	58.4	104.5	27.4	65.3	35.1	44.4		
-25	100/0	27.4	51.9	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

Page 27 of 36 July 2012



TC HOT Guidelines Regression Information Winter 2012-2013

TABLE 4-7

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.4198 A = -0.4664	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.4460 A = -0.5295	I = 2.5011 A = -0.5672	I = 2.5903 A = -0.7102	
		75/25	n/a	n/a	n/a	n/a	n/a	
		50/50	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 = 2.5065 A = -0.6779	I = 2.6525 A = -0.7145	CAUTION: No holdover time guidelines exist	
		75/25	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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

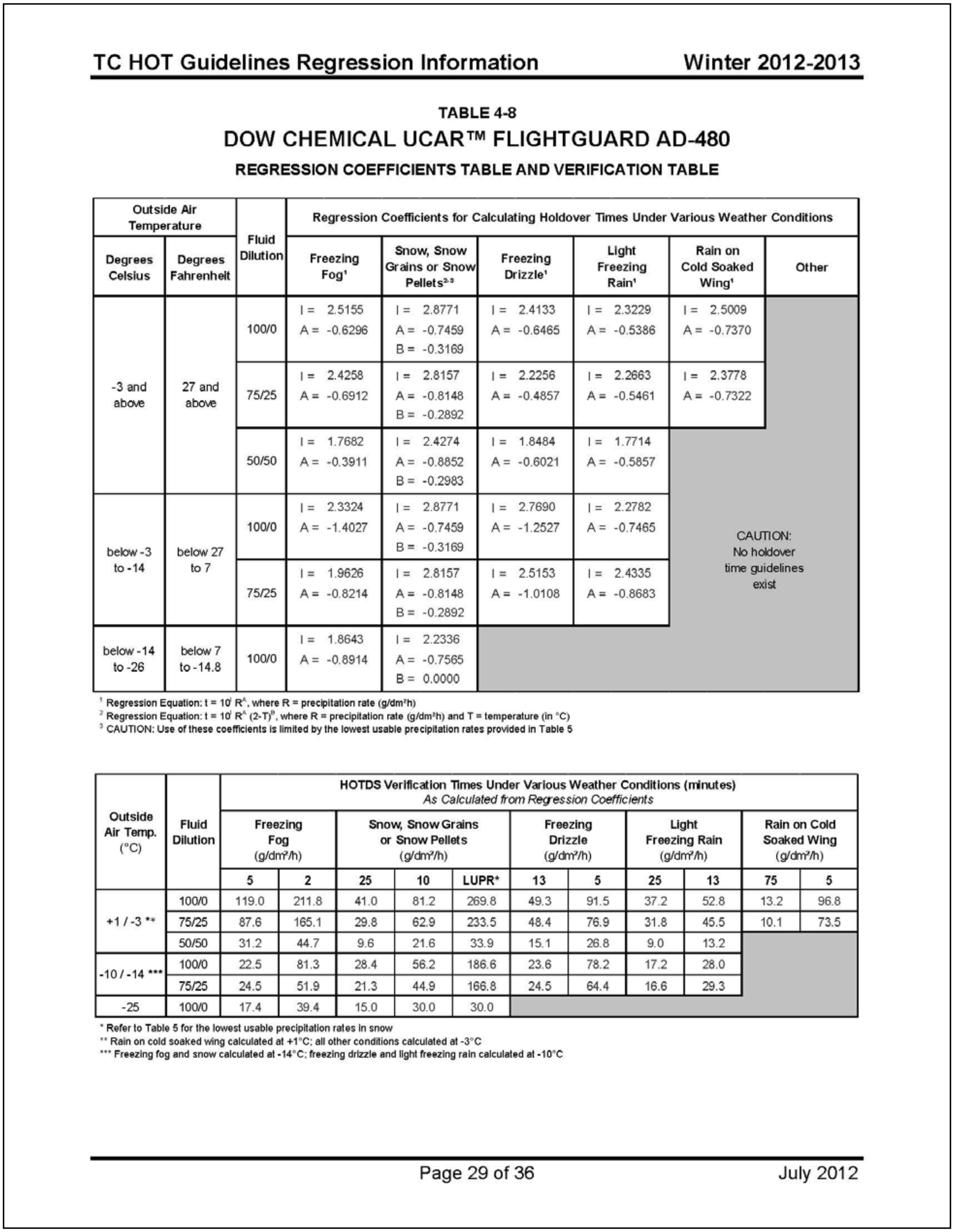
Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	124.1	190.3	38.4	79.6	207.5	71.8	119.1	51.1	74.0	18.1	124.1
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-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		
-25	100/0	31.9	66.0	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

Page 28 of 36 July 2012



TC HOT Guidelines Regression Information Winter 2012-2013

TABLE 4-8

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	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	
		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	CAUTION: No holdover time guidelines exist	
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				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)
[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)
[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	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		
-25	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

Page 29 of 36 July 2012

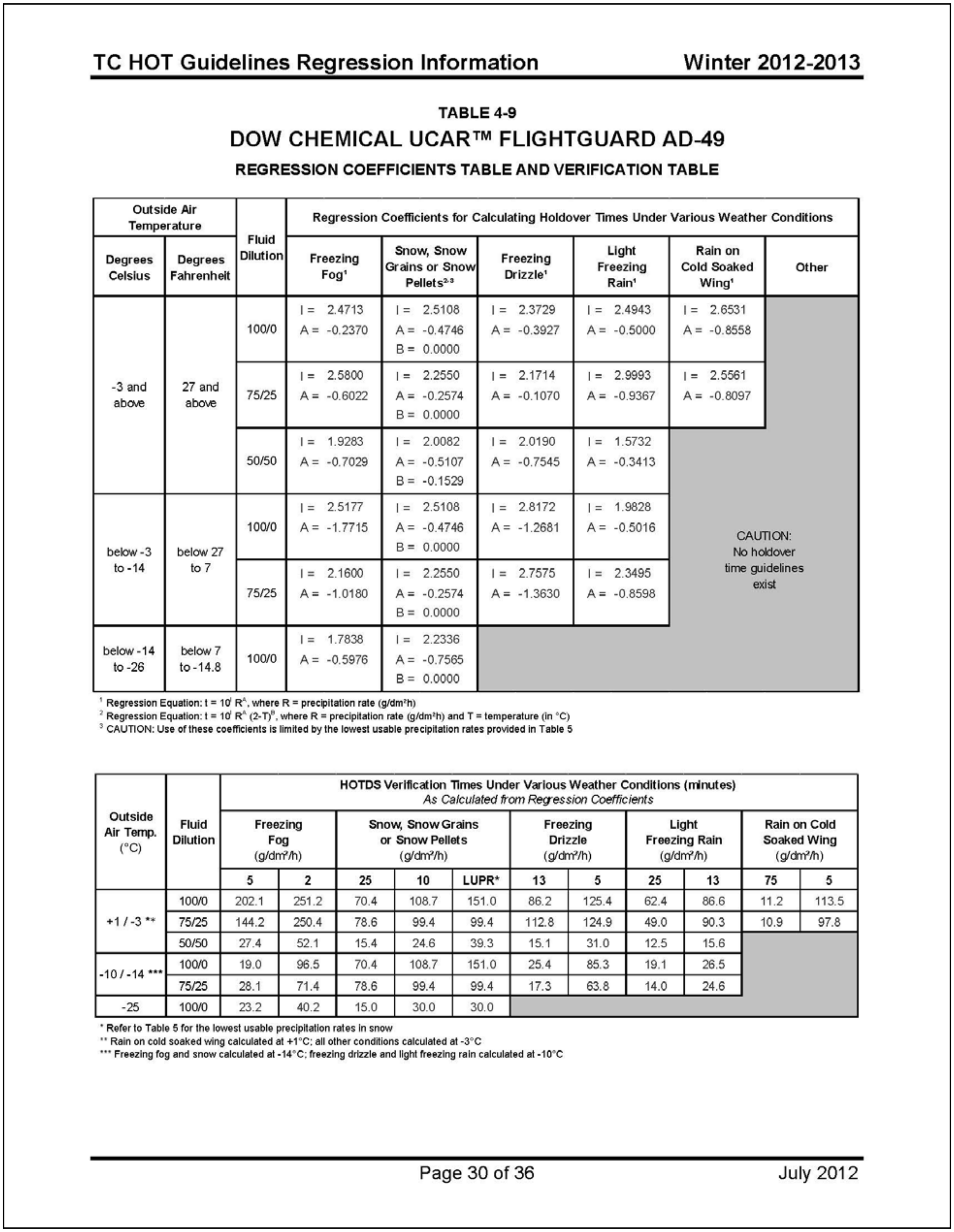


TABLE 4-9

DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

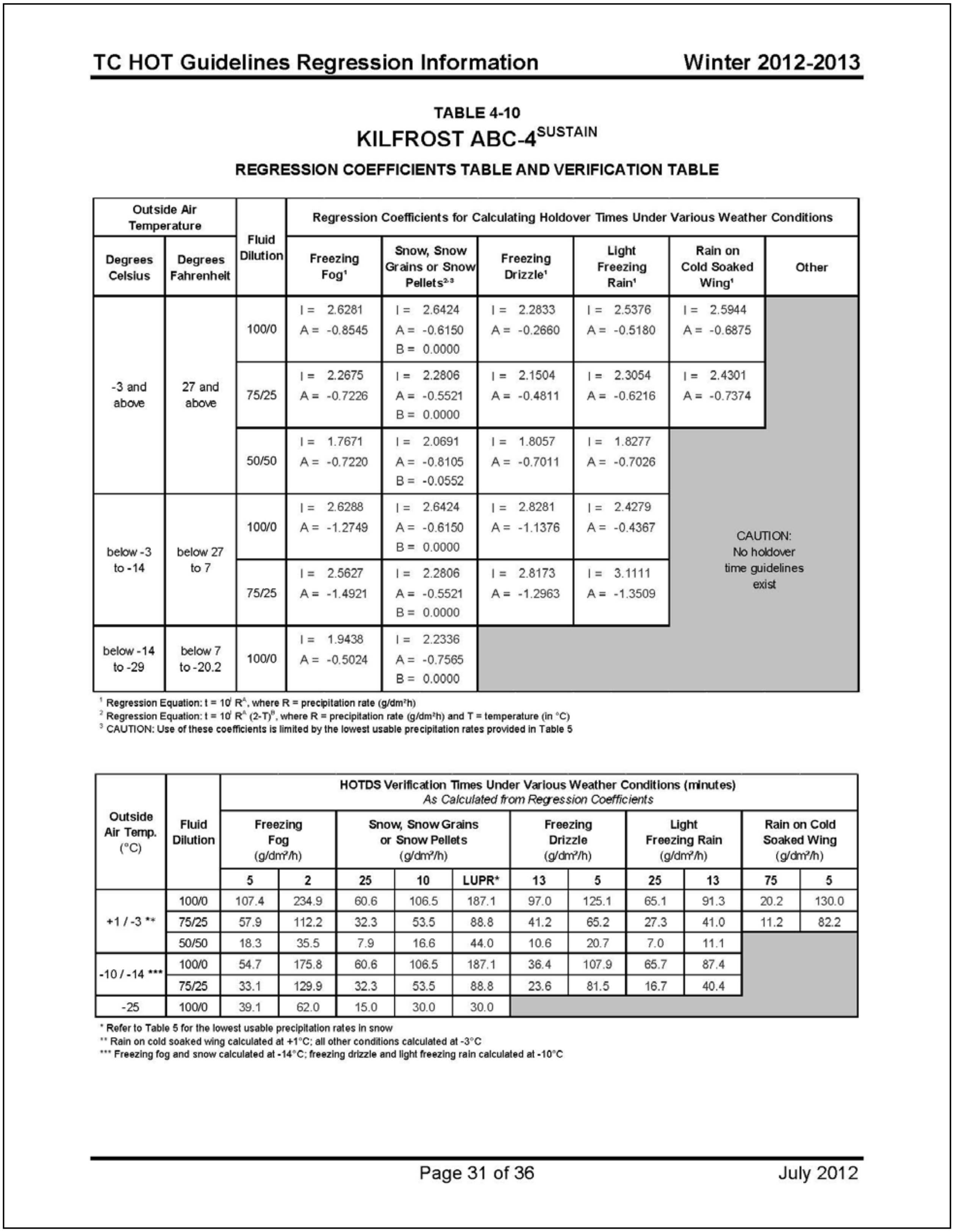
REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature		Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.4713 A = -0.2370	I = 2.5108 A = -0.4746 B = 0.0000	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	
		75/25	I = 2.5800 A = -0.6022	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 = 2.0190 A = -0.7545	I = 1.5732 A = -0.3413	CAUTION: No holdover time guidelines exist	
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 = 2.8172 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 = 2.7575 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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^{I} R^{A}$, where R = precipitation rate (g/dm²h)
[2] Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)
[3] 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 (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	202.1	251.2	70.4	108.7	151.0	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	144.2	250.4	78.6	99.4	99.4	112.8	124.9	49.0	90.3	10.9	97.8
	50/50	27.4	52.1	15.4	24.6	39.3	15.1	31.0	12.5	15.6		
-10 / -14 ***	100/0	19.0	96.5	70.4	108.7	151.0	25.4	85.3	19.1	26.5		
	75/25	28.1	71.4	78.6	99.4	99.4	17.3	63.8	14.0	24.6		
-25	100/0	23.2	40.2	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



TC HOT Guidelines Regression Information **Winter 2012-2013**

TABLE 4-10

KILFROST ABC-4^{SUSTAIN}

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.6281 A = -0.8545	I = 2.6424 A = -0.6150 B = 0.0000	I = 2.2833 A = -0.2660	I = 2.5376 A = -0.5180	I = 2.5944 A = -0.6875	
		75/25	I = 2.2675 A = -0.7226	I = 2.2806 A = -0.5521 B = 0.0000	I = 2.1504 A = -0.4811	I = 2.3054 A = -0.6216	I = 2.4301 A = -0.7374	
		50/50	I = 1.7671 A = -0.7220	I = 2.0691 A = -0.8105 B = -0.0552	I = 1.8057 A = -0.7011	I = 1.8277 A = -0.7026	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	I = 2.6288 A = -1.2749	I = 2.6424 A = -0.6150 B = 0.0000	I = 2.8281 A = -1.1376	I = 2.4279 A = -0.4367		
		75/25	I = 2.5627 A = -1.4921	I = 2.2806 A = -0.5521 B = 0.0000	I = 2.8173 A = -1.2963	I = 3.1111 A = -1.3509		
below -14 to -29	below 7 to -20.2	100/0	I = 1.9438 A = -0.5024	I = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

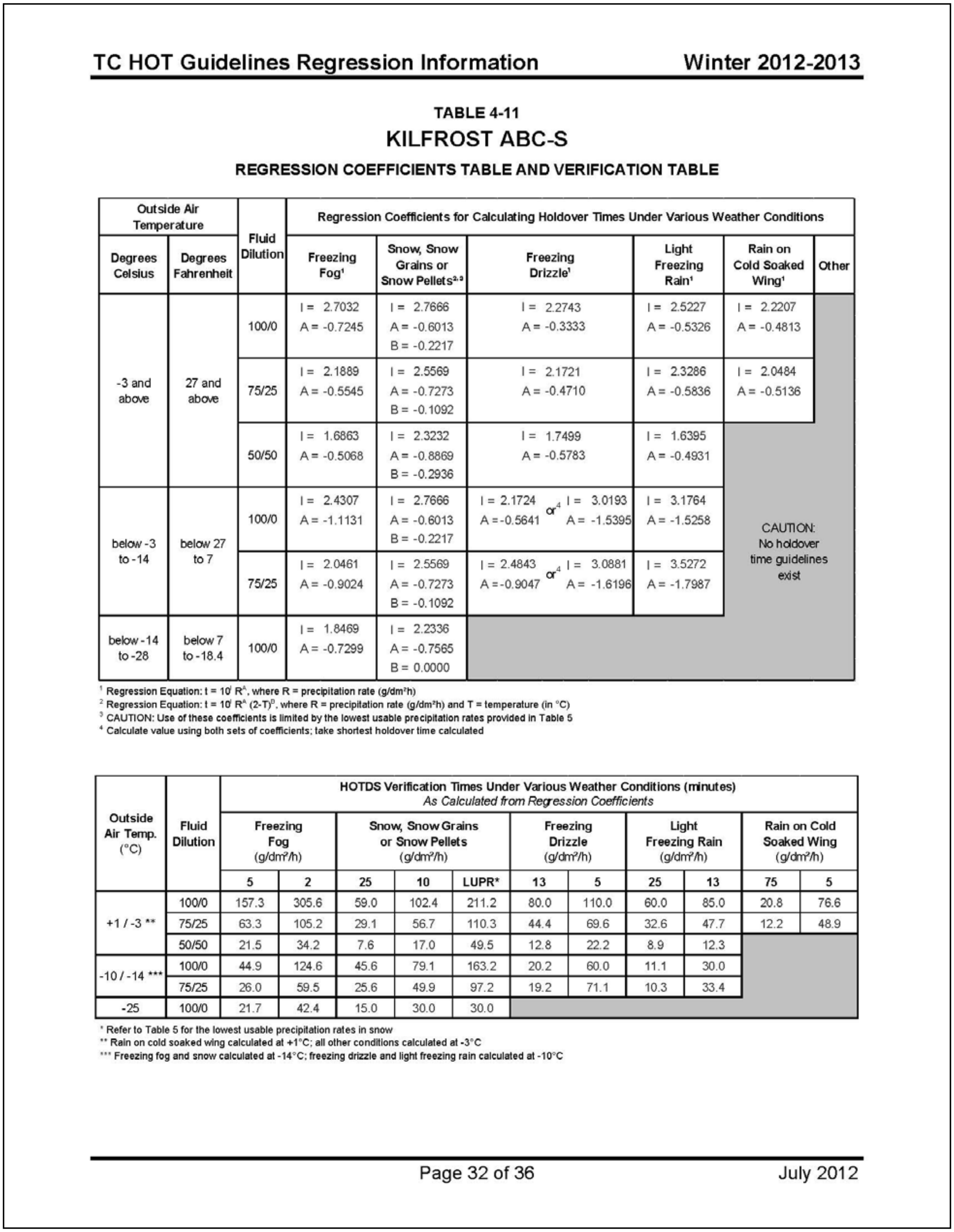
Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	107.4	234.9	60.6	106.5	187.1	97.0	125.1	65.1	91.3	20.2	130.0
	75/25	57.9	112.2	32.3	53.5	88.8	41.2	65.2	27.3	41.0	11.2	82.2
	50/50	18.3	35.5	7.9	16.6	44.0	10.6	20.7	7.0	11.1		
-10 / -14 ***	100/0	54.7	175.8	60.6	106.5	187.1	36.4	107.9	65.7	87.4		
	75/25	33.1	129.9	32.3	53.5	88.8	23.6	81.5	16.7	40.4		
-25	100/0	39.1	62.0	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

Page 31 of 36 July 2012



TC HOT Guidelines Regression Information — Winter 2012-2013

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					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog[1]	Snow, Snow Grains or Snow Pellets[2, 3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-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	
		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	CAUTION: No holdover time guidelines exist	
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 A = -0.5641 or[4] I = 3.0193 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 A = -0.9047 or[4] I = 3.0881 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				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2\text{-}T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

[4] Calculate value using both sets of coefficients; take shortest holdover time calculated

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*											
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	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

Page 32 of 36 — July 2012

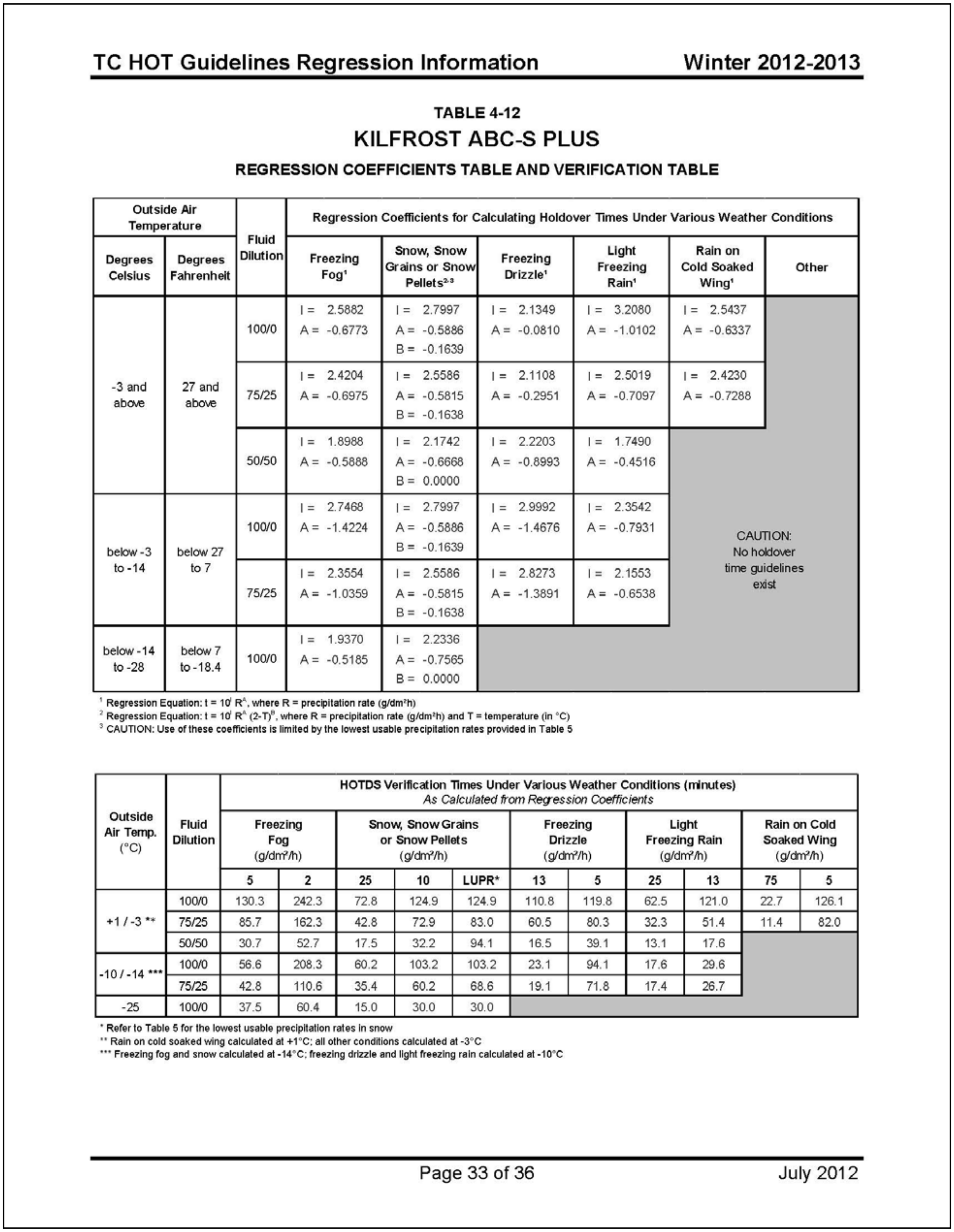


TABLE 4-12

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[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 and above	27 and above	100/0	I = 2.5882 A = -0.6773	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.1349 A = -0.0810	I = 3.2080 A = -1.0102	I = 2.5437 A = -0.6337	
		75/25	I = 2.4204 A = -0.6975	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.1108 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 = 2.2203 A = -0.8993	I = 1.7490 A = -0.4516	CAUTION: No holdover time guidelines exist	
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 = 2.9992 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 = 2.8273 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 = 2.2336 A = -0.7565 B = 0.0000				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

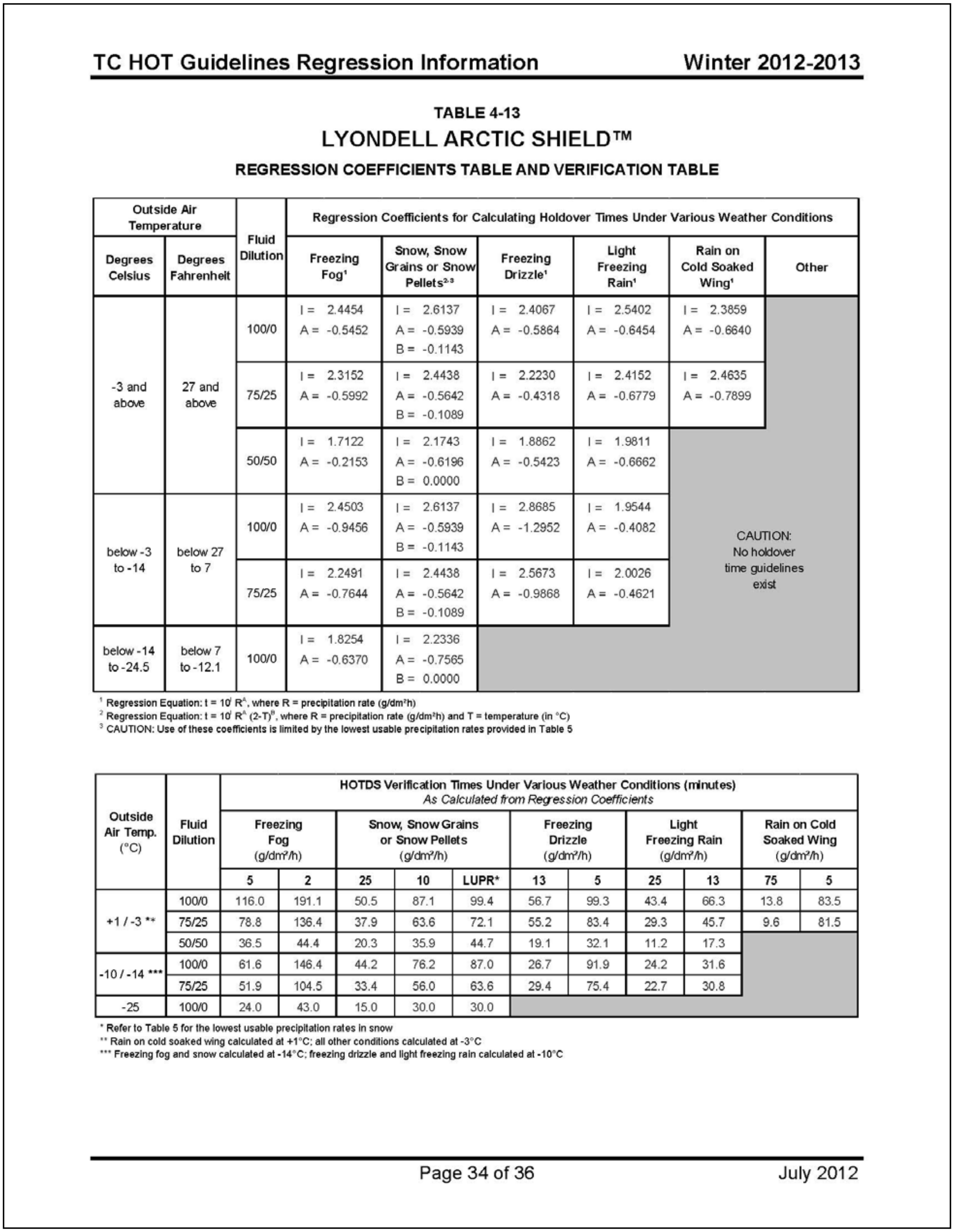
[3] CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	130.3	242.3	72.8	124.9	124.9	110.8	119.8	62.5	121.0	22.7	126.1
	75/25	85.7	162.3	42.8	72.9	83.0	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	103.2	23.1	94.1	17.6	29.6		
	75/25	42.8	110.6	35.4	60.2	68.6	19.1	71.8	17.4	26.7		
-25	100/0	37.5	60.4	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



TC HOT Guidelines Regression Information Winter 2012-2013

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**[1]	**Snow, Snow Grains or Snow Pellets**[2,3]	**Freezing Drizzle**[1]	**Light Freezing Rain**[1]	**Rain on Cold Soaked Wing**[1]	**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	
		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 = -0.6662	CAUTION: No holdover time guidelines exist	
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				

[1] Regression Equation: $t = 10^I R^A$, where R = precipitation rate (g/dm²h)

[2] Regression Equation: $t = 10^I R^A (2-T)^B$, where R = precipitation rate (g/dm²h) and T = temperature (in °C)

[3] 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 (g/dm²/h)		**Snow, Snow Grains or Snow Pellets (g/dm²/h)**			**Freezing Drizzle (g/dm²/h)**		**Light Freezing Rain (g/dm²/h)**		**Rain on Cold Soaked Wing (g/dm²/h)**	
		5	**2**	**25**	**10**	**LUPR***	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 **	100/0	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		
-25	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

Page 34 of 36 July 2012

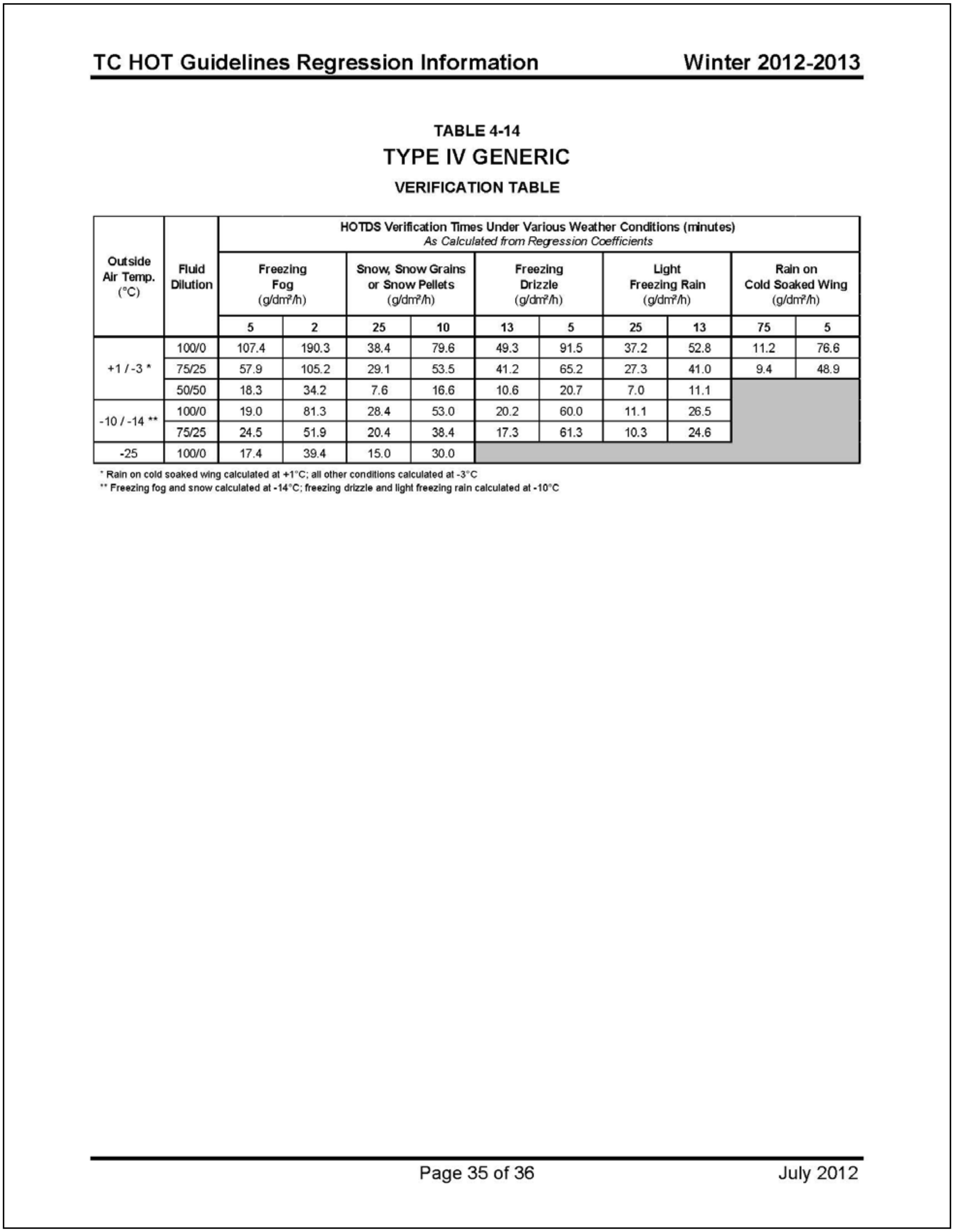


TABLE 4-14

TYPE IV GENERIC

VERIFICATION TABLE

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)		Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	**2**	**25**	**10**	**13**	**5**	**25**	**13**	**75**	**5**
+1 / -3 *	100/0	107.4	190.3	38.4	79.6	49.3	91.5	37.2	52.8	11.2	76.6
	75/25	57.9	105.2	29.1	53.5	41.2	65.2	27.3	41.0	9.4	48.9
	50/50	18.3	34.2	7.6	16.6	10.6	20.7	7.0	11.1		
-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	61.3	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

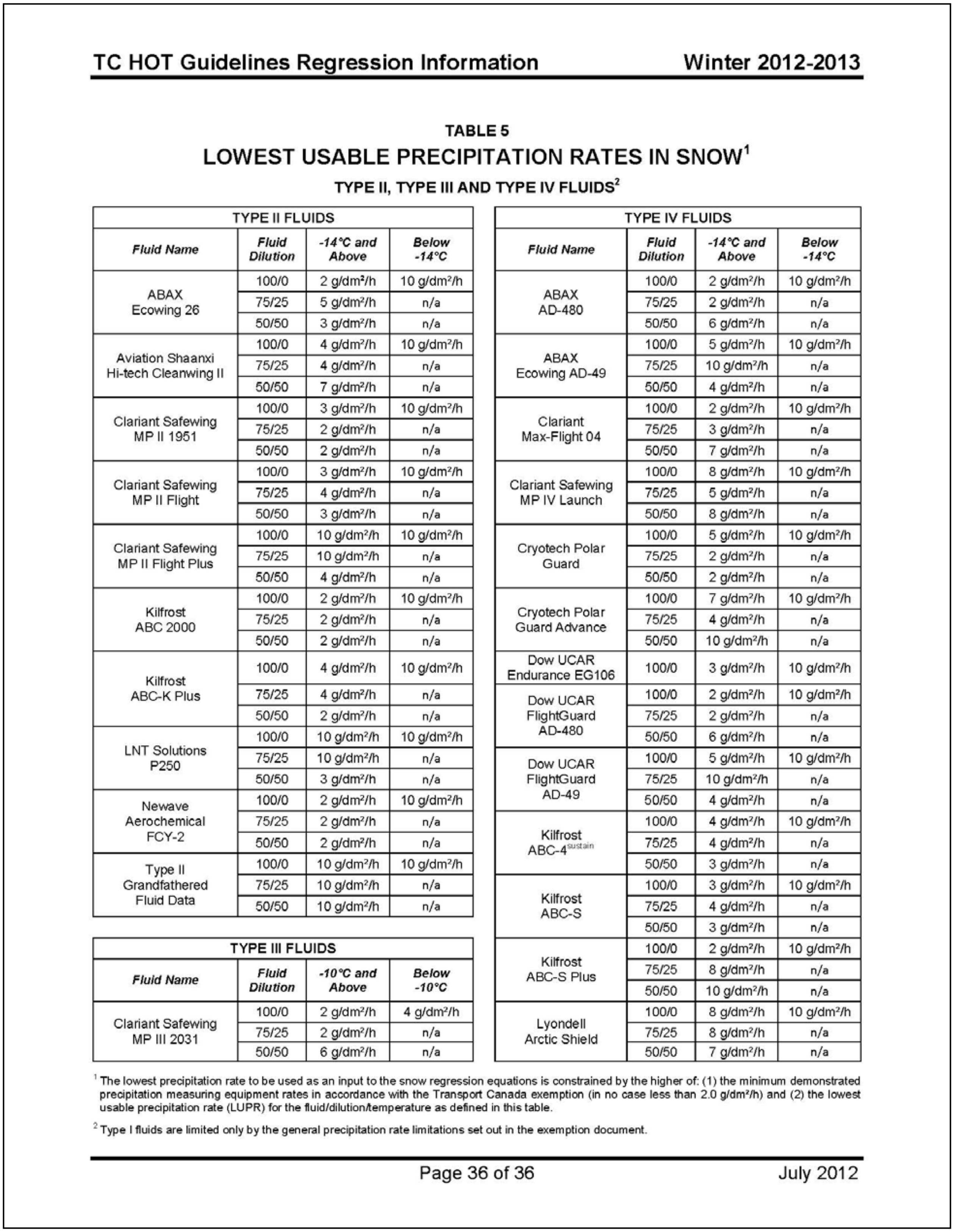


TABLE 5
LOWEST USABLE PRECIPITATION RATES IN SNOW[1]
TYPE II, TYPE III AND TYPE IV FLUIDS[2]

TYPE II FLUIDS			
Fluid Name	***Fluid Dilution***	***-14°C and Above***	***Below -14°C***
ABAX Ecowing 26	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	5 g/dm^2/h	n/a
	50/50	3 g/dm^2/h	n/a
Aviation Shaanxi Hi-tech Cleanwing II	100/0	4 g/dm^2/h	10 g/dm^2/h
	75/25	4 g/dm^2/h	n/a
	50/50	7 g/dm^2/h	n/a
Clariant Safewing MP II 1951	100/0	3 g/dm^2/h	10 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	2 g/dm^2/h	n/a
Clariant Safewing MP II Flight	100/0	3 g/dm^2/h	10 g/dm^2/h
	75/25	4 g/dm^2/h	n/a
	50/50	3 g/dm^2/h	n/a
Clariant Safewing MP II Flight Plus	100/0	10 g/dm^2/h	10 g/dm^2/h
	75/25	10 g/dm^2/h	n/a
	50/50	4 g/dm^2/h	n/a
Kilfrost ABC 2000	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	2 g/dm^2/h	n/a
Kilfrost ABC-K Plus	100/0	4 g/dm^2/h	10 g/dm^2/h
	75/25	4 g/dm^2/h	n/a
	50/50	2 g/dm^2/h	n/a
LNT Solutions P250	100/0	10 g/dm^2/h	10 g/dm^2/h
	75/25	10 g/dm^2/h	n/a
	50/50	3 g/dm^2/h	n/a
Newave Aerochemical FCY-2	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	2 g/dm^2/h	n/a
Type II Grandfathered Fluid Data	100/0	10 g/dm^2/h	10 g/dm^2/h
	75/25	10 g/dm^2/h	n/a
	50/50	10 g/dm^2/h	n/a

TYPE III FLUIDS			
Fluid Name	***Fluid Dilution***	***-10°C and Above***	***Below -10°C***
Clariant Safewing MP III 2031	100/0	2 g/dm^2/h	4 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	6 g/dm^2/h	n/a

TYPE IV FLUIDS			
Fluid Name	***Fluid Dilution***	***-14°C and Above***	***Below -14°C***
ABAX AD-480	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	6 g/dm^2/h	n/a
ABAX Ecowing AD-49	100/0	5 g/dm^2/h	10 g/dm^2/h
	75/25	10 g/dm^2/h	n/a
	50/50	4 g/dm^2/h	n/a
Clariant Max-Flight 04	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	3 g/dm^2/h	n/a
	50/50	7 g/dm^2/h	n/a
Clariant Safewing MP IV Launch	100/0	8 g/dm^2/h	10 g/dm^2/h
	75/25	5 g/dm^2/h	n/a
	50/50	8 g/dm^2/h	n/a
Cryotech Polar Guard	100/0	5 g/dm^2/h	10 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	2 g/dm^2/h	n/a
Cryotech Polar Guard Advance	100/0	7 g/dm^2/h	10 g/dm^2/h
	75/25	4 g/dm^2/h	n/a
	50/50	10 g/dm^2/h	n/a
Dow UCAR Endurance EG106	100/0	3 g/dm^2/h	10 g/dm^2/h
Dow UCAR FlightGuard AD-480	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	2 g/dm^2/h	n/a
	50/50	6 g/dm^2/h	n/a
Dow UCAR FlightGuard AD-49	100/0	5 g/dm^2/h	10 g/dm^2/h
	75/25	10 g/dm^2/h	n/a
	50/50	4 g/dm^2/h	n/a
Kilfrost ABC-4^{sustain}	100/0	4 g/dm^2/h	10 g/dm^2/h
	75/25	4 g/dm^2/h	n/a
	50/50	3 g/dm^2/h	n/a
Kilfrost ABC-S	100/0	3 g/dm^2/h	10 g/dm^2/h
	75/25	4 g/dm^2/h	n/a
	50/50	3 g/dm^2/h	n/a
Kilfrost ABC-S Plus	100/0	2 g/dm^2/h	10 g/dm^2/h
	75/25	8 g/dm^2/h	n/a
	50/50	10 g/dm^2/h	n/a
Lyondell Arctic Shield	100/0	8 g/dm^2/h	10 g/dm^2/h
	75/25	8 g/dm^2/h	n/a
	50/50	7 g/dm^2/h	n/a

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

[2] Type I fluids are limited only by the general precipitation rate limitations set out in the exemption document.