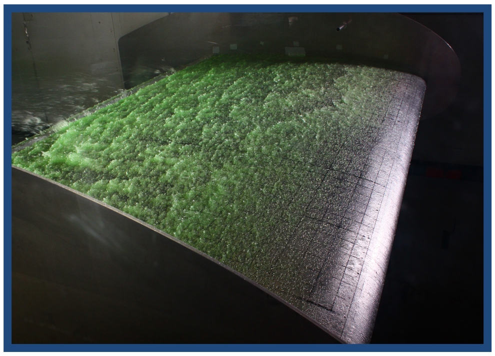
TP 15273E

WIND TUNNEL TRIALS TO SUPPORT FURTHER DEVELOPMENT OF ICE PELLET ALLOWANCE TIMES: WINTER 2013-14



Prepared for
Transportation Development Centre

In cooperation with

Civil Aviation
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and

The Federal Aviation Administration
William J. Hughes Technical Center

Prepared by:

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February 2015
Final Version 1.0

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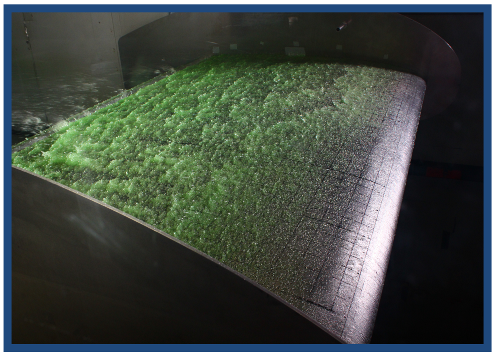

by

Marco Ruggi

Prepared by:

APS Aviation Inc.

February 2015

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

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

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PREFACE

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

- To develop holdover time data for all newly-qualified de/anti-icing fluids and update and maintain the website for the holdover time guidelines;
- To evaluate weather data from previous winters that can have an impact on the format of the holdover time guidelines;
- To conduct general and exploratory de/anti-icing research;
- To conduct tests to evaluate the effect of deployed flaps and slats prior to anti-icing;
- To conduct tests and research on surfaces treated with ice phobic products;
- To conduct tests with the snow machine to support ARP5485 changes;
- To conduct tests to evaluate holdover times in heavy snow conditions;
- To develop an SAE AIR for the evaluation of aircraft coatings;
- To support the evaluation of the National Research Council Canada propulsion icing wind tunnel to determine its flow characteristics;
- To develop holdover time guidance for operation in ice crystal conditions;
- To continue research for development of ice detection capabilities for pre-deicing, engine deicing and departing aircraft at the runway threshold;
- To develop a performance specification for electronic holdover time applications;
- To investigate pre-takeoff contamination check 5-minute allowance;
- To conduct full-scale general aviation aircraft windshield washer fluid deicing testing to substantiate and support flat plate testing results;
- To develop training and fluid failure photos/videos for global archive;
- To update the regression coefficient report with the newly-qualified de/anti-icing fluids; and
- To develop guidelines on radiation cooling during taxi.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2013-14 are documented in eight reports. The titles of the reports are as follows:

- TP 15268E Winter Weather Impact on Holdover Time Table Format (1995-2014);
- TP 15269E Aircraft Ground Icing General Research Activities During the 2013-14 Winter;
- TP 15270E Regression Coefficients and Equations Used to Develop the Winter 2014-15 Aircraft Ground Deicing Holdover Time Tables;

- TP 15271E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2013-14 Winter;
- TP 15272E Cold Climate Technologies – Investigation of Sensor Technologies as an Alternative Means of Detecting Aircraft Icing (Year 3 of 3);
- TP 15273E Wind Tunnel Trials to Support Further Development of Ice Pellet Allowance Times: Winter 2013-14;
- TP 15274E Exploratory Wind Tunnel Aerodynamic Research Examination of Contaminated Anti-Icing Fluid Flow-Off Characteristics Winter 2013-14; and
- TP 15275E Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates.

In addition, the following interim report is being prepared:

This report, TP 15273E has the following objective:

- To conduct research in the Circuit Propulsion Icing Wind Tunnel with a thin-high performance wing section to further support and develop the anti-icing fluid ice pellet allowance times.

This objective was met by conducting a series of full-scale tests using a thin high-performance wing model in the National Research Council Canada Propulsion Icing Wind Tunnel with the cooperation of Transport Canada and the Federal Aviation Administration.

PROGRAM ACKNOWLEDGEMENTS

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

APS Aviation Inc. would also like to acknowledge the dedication of the research team, whose performance was crucial to the acquisition of hard data. This includes the following people: Yelyzaveta Asnytska, Brandon Auclair; Steven Baker, Stephanie Bendickson, John D'Avirro, Jesse Dybka, Ben Falvo, Benjamin Guthrie, Michael Hawdur, Eric Perocchio, Dany Posteraro, Marco Ruggi, Gordon Smith, James Smyth, David Youssef, Nondas Zoitakis and Victoria Zoitakis.

Special thanks are extended to Howard Posluns, Yvan Chabot, Doug Ingold, Warren Underwood and Charles J. Enders, 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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Several research reports for testing of de/anti-icing technologies were produced for previous winters on behalf of Transport Canada. These are available from the Transportation Development Centre. Several reports were produced as part of this winter's research program. Their subject matter is outlined in the preface. The work described in this report was, in part, co-sponsored by the Federal Aviation Administration.

16\. Abstract

As part of a larger research program examining de/anti-icing fluid flow-off during simulated aircraft takeoff, APS Aviation Inc. conducted a series of full-scale tests in the National Research Council Canada 3 m x 6 m Open-Circuit Propulsion and Icing Wind Tunnel using a super critical wing model to determine the flow-off characteristics of anti-icing fluid with and without mixed precipitation conditions with ice pellets.

A wind tunnel testing program was developed for the winter of 2013-14 with the primary objectives of conducting aerodynamic testing with a thin high performance airfoil ensure the repeatability of the dry wing performance, expand the ice pellet allowance times for light ice pellets mixed with light or moderate snow conditions, substantiate the current ice pellet allowance times with new fluids, fluids previously tested but with limited data, and temperatures close to the lowest operational use temperature (LOUT), and support the development of a Type III ice pellet allowance time table.

The data collected in 2013-14 supported the development of a comprehensive Type III un-heated fluid allowance time table for use with high speed aircraft. Preliminary data was also collected with heated Type III fluid applications, however the tests showed risks of adhered contamination during take-off and therefore guidance could not be issued without further investigating the possible risks associated.

Testing was conducted during the winter of 2013-14 to validate and expand the existing Type IV allowance times. The data collected in 2013-14 supported the following changes to the guidance material: 10-minute allowance time for moderate ice pellets at 115 knots rotation speed should be limited to -16ºC due to the higher lift losses observed and 7-minute allowance time for Light Ice Pellets mixed with Moderate Snow below -5º to -10ºC

Possible future areas of research for the winter of 2014-15 may include allowance time testing to expand the guidance for mixed conditions including light ice pellets with light or moderate snow conditions, investigation of the higher lift losses observed at lower temperatures close to the fluid LOUT to determine the aerodynamic effects of ice pellet contamination at these colder temperatures, further substantiation of the ice pellet allowance times with new fluids, or fluids previously tested but with limited data, and lift loss scaling with NASA LS-0417 and NACA 23012 wing sections.

17\. Key Words
Ice Pellet, Allowance Time, High Speed Rotation, Low Speed Rotation, Type II, Type III, Type IV, Fluid Adherence, Fluid Flow-Off, Wind Tunnel, Propulsion Icing Wind Tunnel, Wing Aerodynamics

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Antoine Lacroix pour Howard Posluns

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

Plusieurs rapports de recherche sur des essais de technologies de dégivrage et d'antigivrage ont été produits au cours des hivers précédents pour le compte de Transports Canada. Ils sont disponibles auprès du Centre de développement des transports. Plusieurs rapports ont été rédigés dans le cadre du programme de recherche de cet hiver. Leur objet apparaît à l'avant-propos. Les travaux décrits dans ce rapport ont été en partie coparrainés par la Federal Aviation Administration.

16. Résumé

Le présent rapport documente la série d'essais pleine grandeur réalisés dans la soufflerie de givrage à propulsion et à circuit ouvert de 3 m sur 6 m du Conseil national de recherches Canada, au moyen d'un modèle d'aile supercritique, afin de déterminer les caractéristiques de ruissellement du liquide d'antigivrage avec et sans conditions de précipitations mixtes comprenant des granules de glace.

Un programme d'essais en soufflerie a été élaboré pour l'hiver 2013-2014 avec comme principaux objectifs de réaliser des tests aérodynamiques au moyen d'une surface portante haute performance à profil mince afin d'assurer la répétabilité de la performance de l'aile sèche, d'élargir les marges de tolérance pour les granules de glace de façon à inclure les conditions mixtes de granules de glace légers avec de la neige légère ou modérée, de corroborer les marges de tolérance actuelles dans des conditions de granules de glace avec de nouveaux liquides et des liquides déjà testés, mais pour lesquels les données sont limitées, de même qu'à des températures se rapprochant de la température minimale d'utilisation opérationnelle (LOUT), et d'appuyer l'élaboration d'un tableau des marges de tolérance pour les liquides de type III dans des conditions de granules de glace.

Les données recueillies en 2013-2014 ont appuyé l'élaboration d'un tableau complet des marges de tolérance pour les liquides de type III non chauffés à utiliser avec les aéronefs à haute vitesse. Des données préliminaires ont aussi été recueillies pour l'application de liquides de type III chauffés, mais les essais ont démontré un risque que la contamination adhère aux surfaces durant le décollage ; il est donc impossible de formuler des lignes directrices à ce sujet avant d'avoir analysé les possibles risques associés.

Des essais ont été réalisés au cours de l'hiver 2013-2014 afin de valider et d'élargir les marges de tolérance existantes pour les liquides de type IV. Les données recueillies en 2013-2014 ont corroboré les changements suivants apportés aux lignes directrices : la marge de tolérance de 10 minutes dans des conditions de granules de glace modérés à une vitesse de rotation de 115 nœuds devrait être limitée à une température de -16 °C en raison des pertes de portance accrues observées, et la marge de tolérance de 7 minutes pour les granules de glace légers avec neige modérée à des températures inférieures à -10 °C.

Certains éléments qui pourraient être étudiés à l'hiver 2014-2015 peuvent inclure des essais sur les marges de tolérance visant à élargir les lignes directrices dans des conditions mixtes de façon à inclure les conditions de granules de glace légers avec de la neige légère ou modérée, l'analyse des pertes de portance supérieures observées à basse température se rapprochant de la température minimale d'utilisation opérationnelle du liquide (LOUT) afin de déterminer les effets aérodynamiques de la contamination par des granules de glace à ces températures plus froides, la corroboration supplémentaire des marges de tolérance dans des conditions de granules de glace avec les nouveaux liquides, ou avec les liquides déjà testés, mais pour lesquels les données sont limitées, et l'échelle des pertes de portance sur les profils d'aile NASA LS-0417 et NACA 23012.

17. Mots clés

Granule de glace, marge de tolérance, rotation à haute vitesse, rotation à basse vitesse, Type II, Type III, Type IV, adhérence de liquide, écoulement de liquide, soufflerie, soufflerie de givrage à propulsion, aérodynamisme des ailes

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EXECUTIVE SUMMARY

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

As part of a larger research program examining de/anti-icing fluid flow-off during simulated aircraft takeoff, APS conducted a series of full-scale tests in the National Research Council Canada (NRC) 3 m x 6 m Open-Circuit Propulsion Icing Wind Tunnel (PIWT) using a supercritical wing model to determine the flow-off characteristics of anti-icing fluid with and without mixed precipitation conditions with ice pellets.

Background and Objective

A wind tunnel testing program was developed for the winter of 2013-14 with the primary objectives of conducting aerodynamic testing with a thin high-performance airfoil to:

- Ensure the repeatability of the dry wing performance;
- Expand the ice pellet allowance times for light ice pellets mixed with light or moderate snow conditions;
- Substantiate the current ice pellet allowance times with new fluids, fluids previously tested but with limited data, and temperatures close to the lowest operational use temperature (LOUT); and
- Support the development of a Type III ice pellet allowance time table.

Additional research objectives were also attempted and are described in a separate report.

Conclusions

The data collected in 2013-14 supported the development of a comprehensive Type III unheated fluid allowance time table for use with high speed aircraft. Preliminary data was also collected with heated Type III fluid applications; however, the tests showed risk of adhered contamination during takeoff and therefore guidance could not be issued without further investigating the possible risks associated.

Testing was conducted during the winter of 2013-14 to validate and expand the existing Type IV allowance times. The data collected in 2013-14 supported the following changes to the guidance material:

- 10-minute allowance time for moderate ice pellets at 115 knots rotation speed should be limited to -16°C for propylene glycol (PG) fluids due to the higher lift losses observed; and
- 7-minute allowance time for Light Ice Pellets mixed with Moderate Snow below -5° to -10°C.

Future Research

Possible future areas of research for the winter of 2014-15 may include:

- Allowance time testing to expand the guidance for mixed conditions, including light ice pellets with light or moderate snow conditions;
- Investigation of the higher lift losses observed at lower temperatures close to the fluid LOUT to determine the aerodynamic effects of ice pellet contamination at these colder temperatures;
- Further substantiation of the ice pellet allowance times with new fluids, or fluids previously tested but with limited data; and
- Lift loss scaling with National Aeronautics and Space Administration (NASA) LS-0417 and NACA 23012 wing sections.

SOMMAIRE

Dans le cadre d'un contrat avec le Centre de développement des transports (CDT) et avec l'appui financier de la Federal Aviation Administration (FAA), APS Aviation Inc. (APS) a entrepris des activités de recherche visant à faire progresser les technologies associées au dégivrage et à l'antigivrage d'aéronefs au sol.

Le présent rapport documente la série d'essais pleine grandeur réalisés dans la soufflerie de givrage à propulsion et à circuit ouvert de 3 m sur 6 m du Conseil national de recherches Canada (CNRC), au moyen d'un modèle d'aile supercritique, afin de déterminer les caractéristiques de ruissellement du liquide d'antigivrage avec et sans conditions de précipitations mixtes comprenant des granules de glace.

Contexte et objectif

Un programme d'essais en soufflerie a été élaboré pour l'hiver 2013-2014 avec comme principaux objectifs de réaliser des tests aérodynamiques au moyen d'une surface portante haute performance à profil mince afin :

- D'assurer la répétabilité de la performance de l'aile sèche ;
- D'élargir les marges de tolérance pour les granules de glace de façon à inclure les conditions mixtes de granules de glace légers avec de la neige légère ou modérée ;
- De corroborer les marges de tolérance actuelles dans des conditions de granules de glace avec de nouveaux liquides et des liquides déjà testés, mais pour lesquels les données sont limitées, de même qu'à des températures se rapprochant de la température minimale d'utilisation opérationnelle (LOUT) ; et
- D'appuyer l'élaboration d'un tableau des marges de tolérance pour les liquides de type III dans des conditions de granules de glace.

D'autres objectifs de recherche ont aussi été ciblés et sont décrits dans un rapport distinct.

Conclusions

Les données recueillies en 2013-2014 ont appuyé l'élaboration d'un tableau complet des marges de tolérance pour les liquides de type III non chauffés à utiliser avec les aéronefs à haute vitesse. Des données préliminaires ont aussi été recueillies pour l'application de liquides de type III chauffés, mais les essais ont démontré un risque

que la contamination adhère aux surfaces durant le décollage ; il est donc impossible de formuler des lignes directrices à ce sujet avant d'avoir analysé les possibles risques associés.

Des essais ont été réalisés au cours de l'hiver 2013-2014 afin de valider et d'élargir les marges de tolérance existantes pour les liquides de type IV. Les données recueillies en 2013-2014 ont corroboré les changements suivants apportés aux lignes directrices :

- La marge de tolérance de 10 minutes dans des conditions de granules de glace modérés à une vitesse de rotation de 115 nœuds devrait être limitée à une température de -16 °C pour les liquides à base de propylène glycol en raison des pertes de portance accrues observées ; et
- La marge de tolérance de 7 minutes pour les granules de glace légers avec neige modérée à des températures inférieures à -5° à -10 °C.

Recherches à venir

Voici certains éléments qui pourraient être étudiés à l'hiver 2014-2015 :

- Essais sur les marges de tolérance visant à élargir les lignes directrices dans des conditions mixtes de façon à inclure les conditions de granules de glace légers avec de la neige légère ou modérée ;
- Analyse des pertes de portance supérieures observées à basse température se rapprochant de LOUT du liquide afin de déterminer les effets aérodynamiques de la contamination par des granules de glace à ces températures plus froides ;
- Corroboration supplémentaire des marges de tolérance dans des conditions de granules de glace avec les nouveaux liquides, ou avec les liquides déjà testés, mais pour lesquels les données sont limitées ; et
- Mise à l'échelle des pertes de portance sur les profils d'aile National Aeronautics and Space Administration (NASA) LS-0417 et NACA 23012.

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GLOSSARY

APS	APS Aviation Inc.
AWG	G-12 Aerodynamics Working Group
FAA	Federal Aviation Administration
HOT	Holdover Time
LOUT	Lowest Operational Use Temperature
MSC	Meteorological Service of Canada
NASA	National Aeronautics and Space Administration
NRC	National Research Council Canada
OAT	Outside Air Temperature
PG	Propylene Glycol
PIWT	3 m x 6 m Open-Circuit Propulsion Icing Wind Tunnel
RTD	Resistance Temperature Detector
TC	Transport Canada
TDC	Transportation Development Centre

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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. Aircraft ground deicing had, until recently, never been researched and there is still an incomplete understanding of the hazard and of what can be done to reduce the risks posed by the operation of aircraft in winter precipitation conditions. This "winter operations contaminated aircraft – ground" program of research is aimed at overcoming this lack of knowledge.

Since the early 1990s, the Transportation Development Centre (TDC) of Transport Canada (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), the Meteorological Service of Canada (MSC), several major airlines, and deicing fluid manufacturers. The TDC is continuing its research, development, testing and evaluation program.

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

As part of a larger research program examining de/anti-icing fluid flow-off during simulated aircraft takeoff, APS conducted a series of full-scale tests in the NRC 3 m x 6 m Open-Circuit Propulsion Icing Wind Tunnel (PIWT) using a supercritical wing model to determine the flow-off characteristics of anti-icing fluid with and without mixed precipitation conditions with ice pellets.

1.1 Background

In 2005-06, the inability for operators to release aircraft in ice pellet conditions led TC and the FAA to begin a research campaign to develop allowance times. Developing holdover times (HOTs) was not feasible due to the properties of the ice pellets, as they remain embedded in the fluid and take longer to dissolve compared to snow, which is immediately absorbed and dissolved. Research was initiated through live aircraft testing with the NRC Falcon 20 in Ottawa, Canada, and later evolved to a more controlled environment with the NRC Propulsion Icing Wind Tunnel, also in Ottawa.

The early testing in 2005-06 with the Falcon 20 primarily used visual observations to evaluate fluid flow-off. During the Falcon 20 work, the wing was anti-iced and exposed to contamination, and aborted takeoff runs allowed researchers onboard to observe and evaluate the fluid flow-off. Testing in 2006-07 began in the Propulsion Icing Wind Tunnel (PIWT), allowing aerodynamic data to be used for evaluating fluid flow-off performance. The PIWT also allowed for a more controlled environment less susceptible to the elements.

The work continued each year, and the test methods and equipment improved, allowing for real-time data analysis, better repeatability, and an overall greater confidence in the results. The work conducted by the FAA and TC was presented by APS to the G-12 Aerodynamics Working Group (AWG) and the HOT Committee yearly since 2006. Additional presentations were also given to the AWG in May 2012 and May 2013 by National Aeronautics and Space Administration (NASA) and the NRC, which focused on the extensive calibration and characterization work performed with a generic thin high-performance airfoil. This work also helped increase confidence in how the data was used to help support and develop TC/FAA guidance material. A detailed account of the more recent work conducted is included in the report, TC report, TP 15232E, *Wind Tunnel Trials to Examine Anti-Icing Fluid Flow-Off Characteristics and to Support the Development of Ice Pellet Allowance Times, Winters 2009-10 to 2012-13* (1).

The Ice Pellet Allowance Time research has helped further develop and improve the PIWT facility. As a result, a new medium is now available for aerodynamic testing of aircraft ground icing fluids with or without contamination in a full-scale format. Several other ground deicing projects have been ongoing as a result of industry requests and are expected to continue. The PIWT has evolved into a multidisciplinary facility; however, it continues to be the primary source for the development and further refinement of the ground deicing ice pellet allowance time guidance material.

1.2 Program Objectives

A wind tunnel testing program was developed for the winter of 2013-14 with the primary objectives of conducting aerodynamic testing with a thin high-performance airfoil to:

- Ensure the repeatability of the dry wing performance;
- Expand the ice pellet allowance times for light ice pellets mixed with light or moderate snow conditions;
- Substantiate the current ice pellet allowance times with new fluids, fluids previously tested but with limited data, and temperatures close to the lowest operational use temperature (LOUT);

- Support the development of a Type III ice pellet allowance time table;
- Evaluate the effect of coatings on aerodynamics with and without fluids;
- Evaluate the equivalency of the new ice pellet/snow dispenser systems; and
- Evaluate Type I fluid flow-off performance for low-speed rotation less than 80 knots.

As secondary objectives, preliminary testing was also conducted to:

- Evaluate an airfoil performance monitor (APM) system;
- Investigate aerodynamic effects of heavy contamination; and
- Evaluate the effect of a cooling system on testing repeatability.

The work statement for these tests is provided in Appendix A.

Table 1.1 demonstrates the groupings for the global set of tests conducted at the wind tunnel during the winter of 2013-14. Only tests pertaining to the baseline and ice pellet allowance time testing (Objectives #1, #2, #3, and #4) are described in this report.

Table 1.1: Summary of 2013-14 Wind Tunnel Tests by Objective

Objective #	**Objective**	**# of Runs**
1	Baseline	26
2	Type III Allowance Times	28
3	Ice Pellet Expansion	11
4	Ice Pellet Validation with New Temperatures & Fluids	10
5	Ice Phobic Coatings	257
6	Type I Very Low Speed	31
7	New Ice Pellet Dispenser System Validation	11
8	R&D (APM, Heavy Contamination, Cooling System)	9
	Total	**383**

1.3 Previous Ice Pellet Allowance Time Tables

The Type IV allowance time tables have been available since the winter of 2007-08. Each year, the Type IV testing has built upon the latest version of the allowance time table published in the TC and FAA HOT Guidelines.

In the case of Type III fluid, early research was conducted during the winter of 2008-09 with the LS-0417 wing section, and a preliminary allowance time table was developed (see Table 1.2). However, this table was never published due to the limitations of the data. The data collected was for low-speed 80-knot tests conducted with fluid applied at air temperature. Concerns were raised by the regulators; more testing was proposed at higher speeds (100 knots) as well as with heated fluid application to investigate any risks of adherence.

Table 1.2: Prototype Type III Allowance Time Table Developed in 2008-09

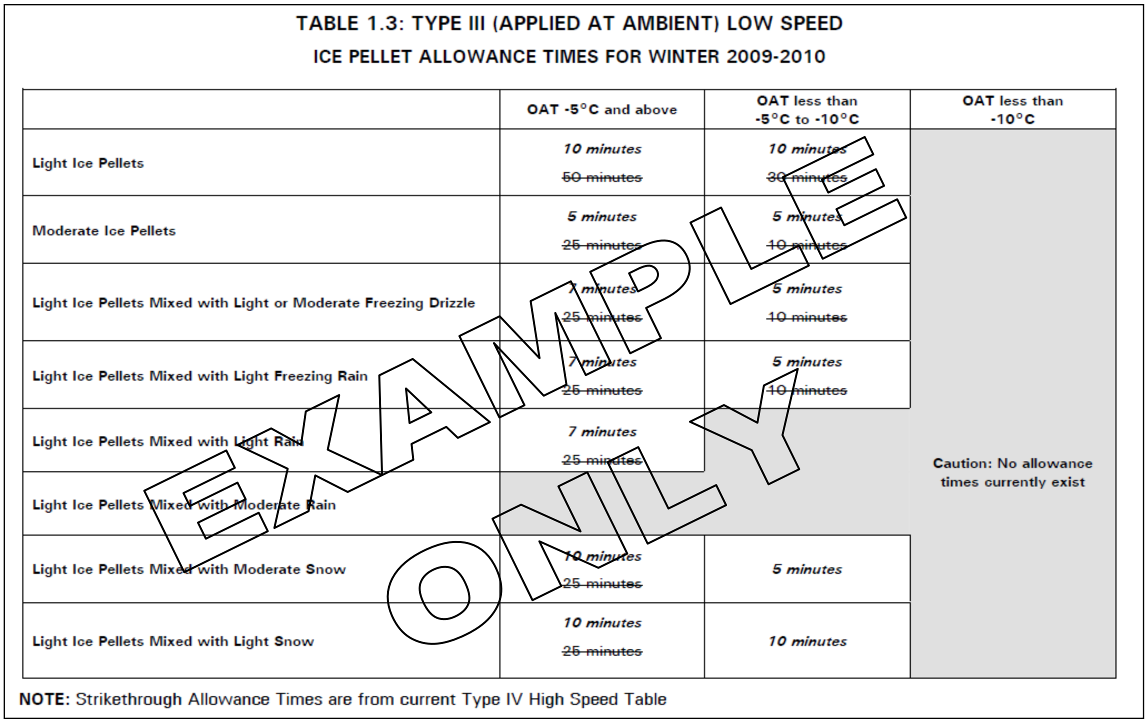

TABLE 1.3: TYPE III (APPLIED AT AMBIENT) LOW SPEED

ICE PELLET ALLOWANCE TIMES FOR WINTER 2009-2010

	OAT -5°C and above	OAT less than -5°C to -10°C	OAT less than -10°C
Light Ice Pellets	*10 minutes* ~~50 minutes~~	*10 minutes* ~~30 minutes~~	Caution: No allowance times currently exist
Moderate Ice Pellets	*5 minutes* ~~25 minutes~~	*5 minutes* ~~10 minutes~~	
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	*7 minutes* ~~25 minutes~~	*5 minutes* ~~10 minutes~~	
Light Ice Pellets Mixed with Light Freezing Rain	*7 minutes* ~~25 minutes~~	*5 minutes* ~~10 minutes~~	
Light Ice Pellets Mixed with Light Rain	*7 minutes* ~~25 minutes~~		
Light Ice Pellets Mixed with Moderate Rain			
Light Ice Pellets Mixed with Moderate Snow	*10 minutes* ~~25 minutes~~	*5 minutes*	
Light Ice Pellets Mixed with Light Snow	*10 minutes* ~~25 minutes~~	*10 minutes*	

NOTE: Strikethrough Allowance Times are from current Type IV High Speed Table

EXAMPLE ONLY

1.4 Report Format

The wind tunnel work has been conducted since the winter of 2006-07 and has been documented in yearly reports. A detailed account of the more recent work conducted is included in the report, TP 15232E (1). It contains more thorough details regarding the testing methodologies as well as links to previous historical reports. The current report has been prepared in a more abbreviated format. The following list provides short descriptions of subsequent sections of this report:

a) Section 2 describes the methodology used in testing, as well as equipment and personnel requirements necessary to carry out testing;

b) Section 3 describes data collected during the full-scale testing conducted;

c) Sections 4 to 9 describe the testing conducted to further develop the allowance time tables in each respective condition;

d) Section 10 presents a summary of the conclusions and observations; and

e) Section 11 lists the recommendations for future testing.

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2. METHODOLOGY

This section provides a brief description of the test methodology and equipment specific to the full-scale aerodynamic tests conducted at the NRC PIWT.

For more details, see TP 15232E (1), which contains more thorough details regarding the testing methodologies.

2.1 Test Schedule

Fifteen days of testing were conducted over a period of four weeks starting January 8, 2014, and ending January 29, 2014. Setup and teardown time was minimal and was done on the first and last day of testing. Testing days were selected based on weather. Table 2.1 presents the calendar of wind tunnel tests performed. It should be noted that the tests listed comprise all the tests conducted, which also include the tests pertaining to other objectives not discussed in this report. At the beginning of each test day, a plan was developed that included the list of tests (taken from the global test plan) to be completed based on the weather conditions and testing priorities. This daily plan was discussed, approved, and modified (if necessary) by TC, the FAA, and APS.

Table 2.1: Calendar of Tests

Date (Start date in case of overnight)	**# of Tests Run**
8 January 2014	6
9 January 2014	10
10 January 2014	9
13 January 2014	41
14 January 2014	68
15 January 2014	58
16 January 2014	52
17 January 2014	15
20 January 2014	36
21 January 2014	18
22 January 2014	21
23 January 2014	6
27 January 2014	13
28 January 2014	14
29 January 2014	16
Total	383

2.2 Wind Tunnel Procedure

To satisfy the fluid testing objective, simulated takeoff and climb-out tests were performed with the supercritical wing section. Different parameters including fluid thickness, wing temperature, and fluid freezing point were recorded at designated times during the tests. The supercritical wing section was constructed by the NRC specifically to conduct these tests following extensive consultations with an airframe manufacturer to ensure a representative supercritical design.

The procedure for each fluid test was as follows:

a) The wing section was treated with anti-icing fluid, poured in a one-step operation (no Type I fluid was used during the tests);

b) When applicable, contamination, in the form of simulated ice pellets, freezing rain, and/or snow, was applied to the wing section. Test parameters were measured at the beginning and end of the exposure to contamination;

c) At the end of the contamination period, the tunnel was cleared of all equipment and scaffolding;

d) The wind tunnel was subsequently operated through a simulated takeoff and climb-out test; and

e) The behaviour of the fluid during takeoff and climb-out was recorded with digital high-speed still cameras. In addition, windows overlooking the wing section allowed observers to document the fluid elimination performance in real-time.

The procedure for the wind tunnel trials is included in Appendix B. The procedure includes details regarding the test objectives, test plan, procedure and methodology, and pertinent information and documentation.

2.2.1 Test Sequence

The length of each test (from start of setup to end of last measurement) varied largely due to the length of exposure to precipitation (if applicable). Time required for setup and teardown as well as preparing and configuring the wing section was relatively the same from test to test. Figure 2.1 demonstrates a sample timeline for a typical wind tunnel test. It should be noted that a precipitation exposure time of 30 minutes was used for illustration purposes; this time varied for each test depending on the objective.

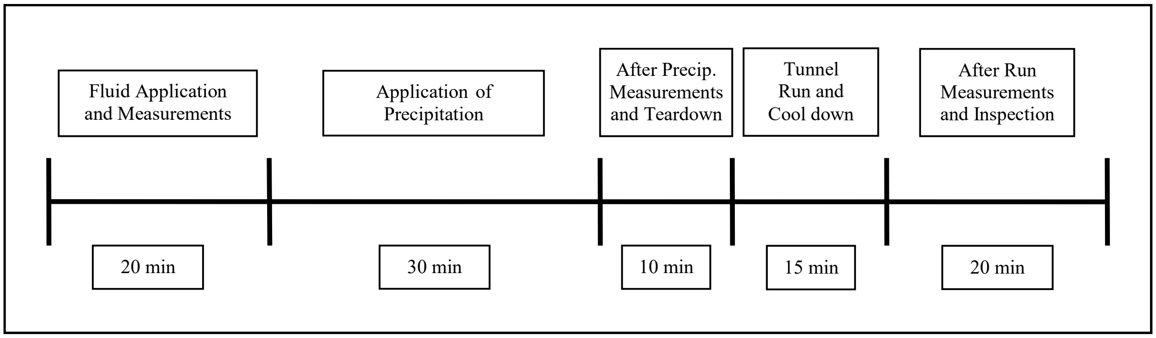


Figure 2.1: Typical Wind Tunnel Test Timeline

2.3 Wind Tunnel and Airfoil Model Technical Overview

The following sections describe the wind tunnel and major components.

2.3.1 Wind Tunnel Test Site

PIWT tests are performed at the NRC Aerospace Facilities, Building M-46, at the NRC Montreal Road campus, located in Ottawa, Canada. Figure 2.2 provides a schematic of the NRC Montreal Road campus showing the location of the NRC PIWT. Photo 2.1 shows an outside view of the wind tunnel test facility. Photo 2.2 shows an inside view of the wind tunnel test section. The open-circuit layout, with a fan at entry, permits contaminants associated with the test articles (such as heat or de/anti-icing fluid) to discharge directly, without recirculating or contacting the fan. The test section is 3 m (10 ft.) wide by 6 m (20 ft.) high by 12 m (40 ft.) long, with a maximum wind speed of 78 knots when using the electrical turbine drive and with a maximum wind speed of just over 115 knots when using the gas turbine drive. The fan is normally driven electrically, but high-speed operation can be accommodated by a gas turbine drive system. Due to the requirements of both high-speed and low-speed operations during the testing, the gas turbine was selected to allow for greater flexibility. The gas turbine drive can perform both low- and high-speed operations, whereas the electric drive is limited to low-speed operations. Scaffolding was constructed to allow access to the wing section, which facilitated the application of fluids and the subsequent inspection and cleaning of the airfoil.

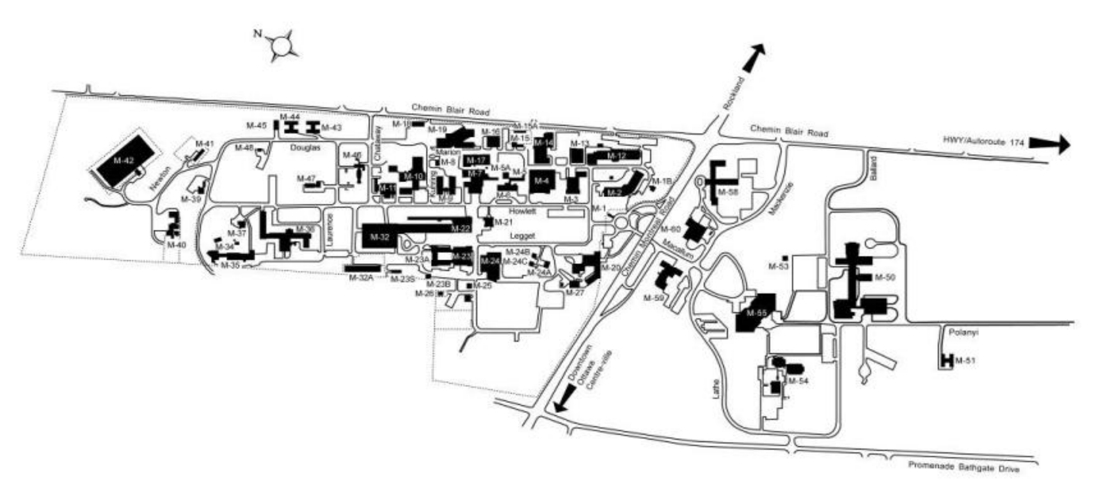


Figure 2.2: Schematic of NRC Montreal Road Campus

2.3.2 Generic High-Performance “Supercritical” Commuter Airfoil

The wing section used for testing was a generic high-performance commuter airfoil, also referred to as “supercritical.” This wing section was constructed by the NRC in 2009 specifically to conduct these tests following extensive consultations with an airframe manufacturer to ensure a representative supercritical design. The original wing design was representative of an outboard section and did not include a flap; the flap was later added at the request of TC, the FAA, and APS. A computational fluid dynamics analysis of the modified wing section was conducted by the airframe manufacturer, and it was confirmed that the wing section provided a good representation of a flapped section of an operational thin high-performance wing. Photo 2.3 shows the wing section used for testing.

A cross sectional view of the supercritical wing section used for testing has been included in Figure 2.3; the dimensions indicated are in meters. Some of the pertinent dimensions of the wing section are:

a) Chord length not including flap: 1.4 m (4.6 ft.); and

b) Width: 2.4 m (8 ft.).

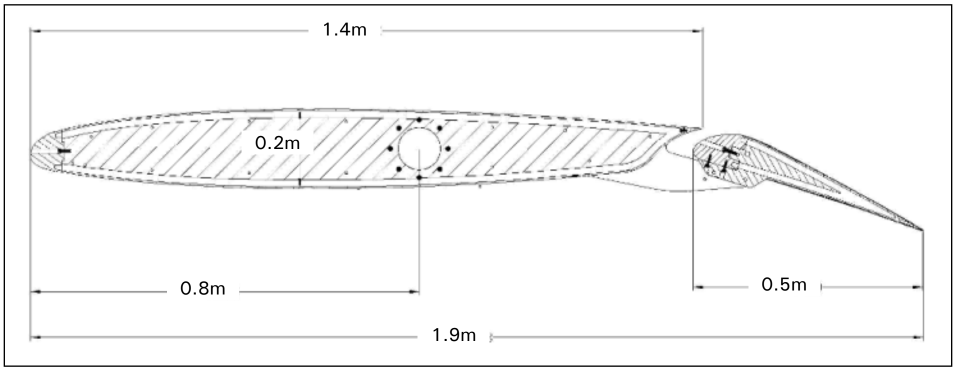


Figure 2.3: Generic "Supercritical " Wing Section

An analysis of the wing section model was conducted by the airframe manufacturer to determine the typical rest position of this type of wing section. It was determined that on a typical commuter aircraft, this section of wing would typically be pitched forward by 2° when sitting on the ground. As a result, the NRC ensured the rest position of the wing model was set to -2° for each test.

The wing section was fitted with a hinged flap. The flap position was fixed at 20° and was not intended to be changed during testing. The top surface of the flap wing section had a steeper angle; a flap setting of 20° created close to a 26° slope on the top surface of the flap (with the wing pitched forward by 2°). As testing progressed, the ability to change the flap setting from 0° to 20° was necessary; contrary to a nested flap, which is typically protected during precipitation, a hinged flap is always exposed, and results indicated earlier failures were due to the shallower angle of the hinged flap. Modifications were made by the NRC to allow the flap setting to alternate between 0° and 20° for the fluid application and contamination periods; however, all takeoff simulations were conducted with the flap set to 20°. No moveable devices were available on the wing section. Detailed coordinates for this airfoil are available.

End plates were installed on the wing section to eliminate the "wall effects" from the wind tunnel walls and to provide a better aerodynamic flow-off above the test area. Figure 2.4 demonstrates the end plates installed on the thin high-performance wing section (note: the wing section is depicted without the top wing skin).

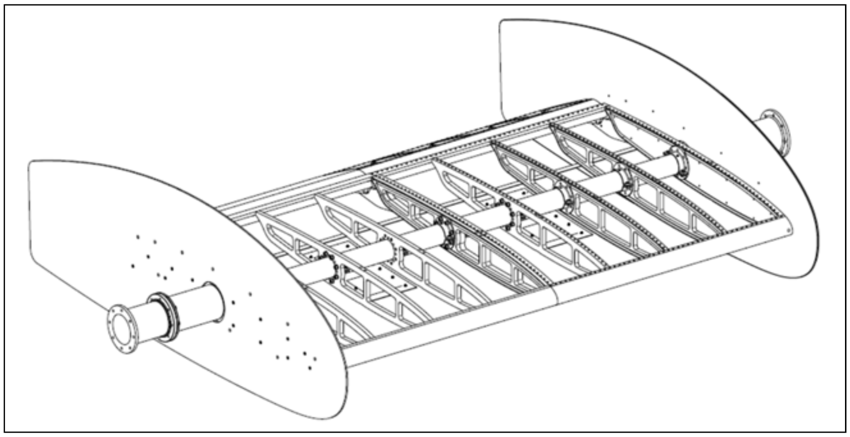


Figure 2.4: End Plates Installed on Supercritical Wing Section

2.3.3 Test Area Grid

APS personnel used markers to draw a grid on the wing's upper surface (excluding the flap). Each grid cell measured 5.1 cm x 5.1 cm (2 in. x 2 in.) with the cell axis positioned perpendicular and parallel to the leading edge (see Photo 2.4). The grid section was 2.4 m (8 ft.), which covered the entire wing section. The grid markings began approximately 10.1 cm (4 in.) aft of the leading edge stagnation point and continued along the length of the main chord; grid markings were not drawn on the flap section. The grid was used to facilitate observations of the fluid shearing off the wing and the movement of ice pellets during takeoff.

It should be noted that the grid was not re-drawn on the ice phobic skins installed over top of the wing section as the previous grid markings were still visible; however, this should be considered for future tests.

2.3.4 Wind Tunnel Measurement Capabilities

The supercritical wing section was supported on either side by 2-axis weigh scales capable of measuring drag and lift forces generated on the wing section. The wing section was attached to servo-systems capable of pitching the wing section to a static angle or generating dynamic movements. The servo-system was programmed to simulate pitch angles during takeoff and climb-out based on operational aircraft flight profiles.

The wing section was also equipped with eight Resistance Temperature Detectors (RTDs); these were installed by NRC personnel recording the skin temperature on the leading edge (LE), mid chord (MID), trailing edge (TE), and under-wing (UND). RTDs were placed along a chord 0.5 m (1.5 ft.)in pairs to the left and to the right of the wing centreline. The following are the locations of the RTDs:

- RTD LE located approximately 25 cm from the leading edge (as measured along wing skin curvature);
- RTD MID located approximately 70 cm from the leading edge (as measured along wing skin curvature);
- RTD TE located approximately 30 cm from the trailing edge (as measured along wing skin curvature); and
- RTD UND located approximately 45 cm from the leading edge.

Figure 2.5 demonstrates the general location of the RTDs. These RTDs were primarily used to monitor the skin temperature in real-time through the NRC data display system and were recorded by APS personnel as described in Subsection 2.15.3.

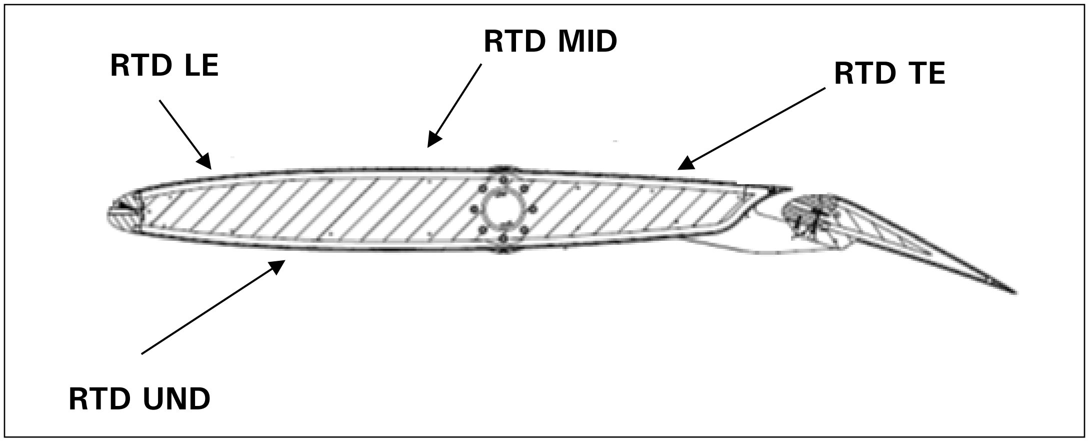


Figure 2.5: Location of RTDs Installed Inside Supercritical Wing

The wind tunnel was also equipped with sensors recording the following parameters:

- Air temperature inside the tunnel;
- Outside air temperature;
- Air pressure;
- Wind speed; and
- Relative humidity.

2.4 Simulated Precipitation

The following types of precipitation have been simulated for aerodynamic research in the PIWT:

- Ice Pellets;
- Snow;
- Freezing Rain/Rain; and
- Other conditions related to HOTs.

2.4.1 Ice Pellets

Simulated ice pellets were produced with diameters ranging from 1.4 mm to 4.0 mm to represent the most common ice pellet sizes observed during natural events. The ice pellets were manufactured inside a refrigerated truck (see Photo 2.5). Cubes of ice were crushed and passed through calibrated sieves (see Photo 2.6) to obtain the required ice pellet size range. Hand-held motorized dispensers were used to dispense the ice pellets. The ice pellets were applied to the leading and trailing edges of the wing at the same time.

2.4.2 Snow

Snow was produced using the same method for producing ice pellets. The snow used consisted of small ice crystals measuring less than 1.4 mm in diameter. Previous testing conducted by APS investigated the dissolving properties of the simulated snow versus natural snow. The simulated snow was selected as an appropriate substitute for natural snow.

The snow was manufactured inside a refrigerated truck. Cubes of ice were crushed and passed through calibrated sieves to obtain the required snow size range. Hand-held motorized dispensers were used to dispense the snow. The snow was applied to the leading and trailing edges of the wing at the same time.

2.4.3 Freezing Rain/Rain

The same sprayer head and scanner used for HOT testing at the NRC Climatic Engineering Facility was employed for testing. The sprayer system uses compressed air and distilled water to produce freezing rain. The temperature of the water is controlled and is kept just above freezing temperature in order to produce freezing rain. To produce rain, the temperature of the water is raised until the precipitation no longer freezes on the test surfaces.

2.4.4 Definition of Precipitation Rates

When simulating precipitation rates for full-scale and plate testing, the rate limits defined for standard HOT testing were referenced. Figure 2.6 demonstrates the HOT testing rate precipitation breakdown.

HOT testing protocol for ice pellets does not currently exist. As a result, ice pellet precipitation rate limits were based on the freezing rain rate breakdown. The following precipitation rates were used for the full-scale and flat plate testing conducted during the winter of 2008-09:

Light Ice Pellets:	13-25 g/dm²/h;
Moderate Ice Pellets:	25-75 g/dm²/h;
Light Freezing Rain:	13-25 g/dm²/h;
Moderate Freezing Drizzle:	5-13 g/dm²/h;
Light Rain:	13-25 g/dm²/h;
Moderate Rain:	25-75 g/dm²/h;
Light Snow:	4-10 g/dm²/h; and
Moderate Snow	10-25 g/dm²/h.

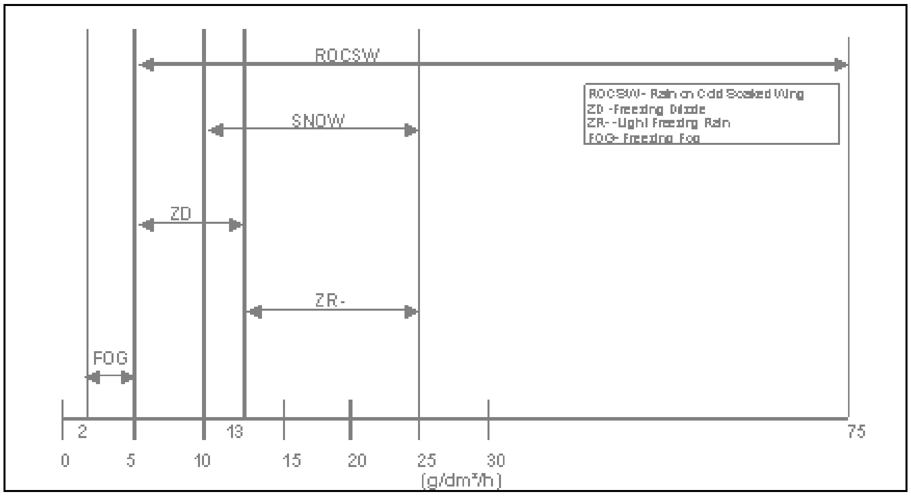


Figure 2.6: Precipitation Rate Breakdown

2.5 Test Equipment

A considerable amount of test equipment was used to perform these tests. Key items are described in the following subsections; a full list of equipment is provided in the test procedure, which is included in Appendix B.

2.5.1 Video and Photo Equipment

APS used the observation windows on the sides of the test section to install Canon EOS XTi DSLR cameras and Profoto Compact 600 flashes capable of second-by-second photography with an intervalometer. In addition, GoPro cameras were used for wide-angle filming of fluid flow-off during the test runs. Photos 2.9 and 2.10 demonstrate the camera setup used for the testing period.

2.5.2 Refractometer/Brixometer

Fluid freezing points were measured using a hand-held Misco 10431VP refractometer with a Brix scale (shown in Figure 2.7). The freezing points of the various fluid samples were determined using the conversion curve or table provided to APS by the fluid manufacturer.

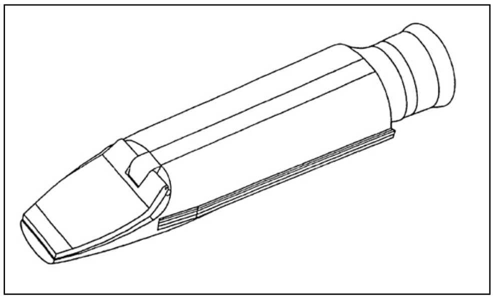


Figure 2.7: Hand-Held Refractometer/Brixometer

2.5.3 Wet Film Thickness Gauges

Wet film thickness gauges, shown in Figure 2.8, were used to measure fluid film thickness. These gauges were selected because they provide an adequate range of thicknesses (0.1 mm to 10.2 mm) for Type I/II/III/IV fluids. The rectangular gauge has a finer scale and was used in some cases when the fluid film was thinner (toward the end of a test). The observer recorded a thickness value (in mils), as read directly from the thickness gauge. The recorded value was the last wetted tooth of the thickness gauge; however, the true thickness lies between the last wetted tooth and the next un-wetted tooth. A thickness conversion table was used to convert the recorded thickness values into the corrected thickness values.

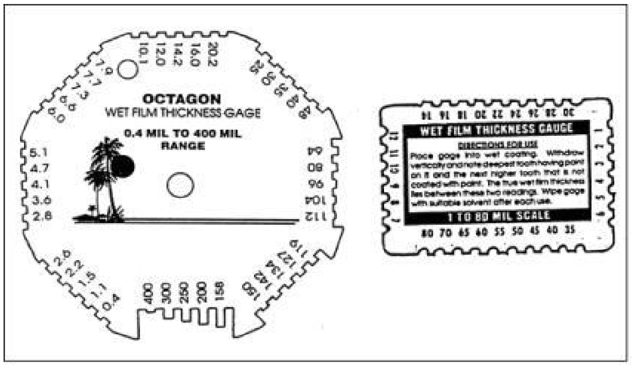


Figure 2.8: Wet Film Thickness Gauges

2.5.4 Temperature Sensor

When required, wing skin temperature and fluid temperature were measured using a Wahl digital heat-probe thermometer Model 392Vxc. A surface temperature probe was used for wing skin temperature measurements (generally, wing-mounted RTDs were used), and an immersion probe was used for measuring and monitoring fluid temperatures.

2.6 Personnel

During the fluid testing and exploratory research testing, four APS staff members were required to conduct the tests, and four additional persons from Ottawa were tasked to manufacture and dispense ice pellets as well as to help with general setup tasks. A professional photographer was retained to record digital images of the test setup and test runs. Representatives from NASA, the TDC, and the FAA provided direction in testing and participated as observers. Photo 2.12 shows a portion of the research team (due to scheduling, not all participants were available for the photo).

2.7 Data Forms

Several different forms were used to facilitate the documentation of the various data collected in the wind tunnel tests. These forms include:

a) General Form;

b) Wing Temperature, Fluid Thickness and Fluid Brix Form;

c) Ice Pellet and Snow Dispensing Forms;

d) Sprayer Calibration Form;

e) Visual Evaluation Rating Form;

f) Condition of Wing and Plate Form;

g) Fluid Receipt Form; and

h) Log of Fluid Sample Bottles.

Copies of these forms are provided in the test procedure, which is included in Appendix B. Completed wing temperature, fluid thickness, and fluid Brix data forms have been included in Appendix C.

2.8 Data Collection

Fluid thickness, fluid Brix, and skin temperature measurements were collected by APS personnel. The measurements were collected before and after fluid application, after the application of contamination, and at the end of the test. The completed data forms have been scanned and included in Appendix C for referencing purposes.

High-speed digital photographs of each test were taken. In addition, videos were also taken during a greater portion of the tests. Due to the large amount of data available, photos of the individual tests have not been included in this report; rather, the high-resolution photos are in electronic format and have been made available to the TDC and can be seen upon request.

2.9 De/Anti-Icing Fluids

Seven fluids were used during the wind tunnel tests conducted during the winter of 2013-14. The seven fluids were leftover inventory acquired during the 2012-13 winter season that were verified for viscosity and overall integrity prior to the 2013-14 testing. The viscosity of the fluids received was measured using the Stony Brook PDVdi-120 Falling Ball Viscometer and the Brookfield Digital Viscometer Model DV-1+ to ensure the fluid was within the fluid manufacturer production specifications and comparable to previous samples received. The pertinent characteristics of these fluids are given in Table 2.2.

2.9.1 Viscometer

Historically, viscosity measurements were carried out using a Brookfield viscometer (Model DV-1+, shown in Photo 2.13) fitted with a recirculating fluid bath and small sample adapter.

In recent years, on-site measurements are done with the Stony Brook PDVdi-120 Falling Ball Viscometer (Photo 2.14) to obtain a verification of the fluid integrity; falling ball tests are much faster and more convenient to perform as compared to tests with the Brookfield viscometer.

2.9.2 Type II/III/IV Fluid Application Equipment

The Type II/III/IV fluids were stored outside the wind tunnel and were kept at air temperature. The fluids were poured rather than sprayed so that application would not change the fluid viscosity. This methodology was appropriate given the relatively small test area of the wing section and the goal of minimizing the amount of fluid flowing off the wing.

Type II/III/IV fluids are generally received in 20 L containers; however, some fluids are received in large 200 L barrels and larger 1000 L totes. The fluid is applied to the wing section by using smaller 2 L containers (Photo 2.11). Approximately 16 L to 20 L of fluid were applied to the wing section for each test; less fluid was required for the less viscous Type III fluid. Due to the flat top surface of the supercritical wing, the thickened fluid did not easily settle and flow on the top surface. The wing was therefore tilted forward (by approximately 10 degrees) for 1 minute following the end of fluid application to allow for the fluid to spread out evenly over the top surface of the wing.

2.9.3 Waste Fluid Collection

Using a relatively small test area and applying the fluids by pouring minimized the amount of fluid falling off the wing. APS personnel used a vacuum to collect the fluid that would drip onto the tunnel floor prior to each test. The NRC also fitted the wind tunnel with appropriate drainage tubes to collect spent fluid during the takeoff test runs. At the end of the testing period, the services of Lacombe Waste Services were employed to safely dispose of the waste glycol fluid.

2.10 Analysis Methodology

The following provides a brief description of the analysis methodology. More details on the analysis methodology can be found in TP 15232E (1).

Each ice pellet test was analysed in detail using the following objectives:

a) Test parameters;
b) Visual ratings at the start of the test;
c) Visual ratings at rotation;
d) 8° lift loss; and
e) Overall test status.

The evaluation grades for each criterion were “good,” “review,” or “bad.” These grades were determined based on whether the criteria satisfied each test objective requirement. Figure 2.9 shows a summary of each test objective and criteria.

Several test parameters were evaluated, such as tunnel temperature before the start of the test, rate of precipitation, and exposure time of precipitation. These parameters were compared against the target parameters described in the test plan. The ramp-up time was also evaluated and compared to the target ramp-up time determined; this became less of an issue after 2011-12 with the use of the automated ramp-up system instead of the previous manual system.

2.10.1 Visual Ratings at the Start of the Test

During each of the tests conducted, visual contamination ratings were determined by three observers: one observer from the FAA and two observers from APS. The level of contamination present on the leading edge and trailing edge of the wing, as well as on the flap, was quantified using a scale of one-to-five with five being the worst case scenario. Partial numbers were sometimes assigned when cases were also marginally above or below a specific rating.

The visual contamination rating criteria at the start of the test on both the leading and trailing edge must be equal to 3 or less in order to pass. The flap must have a rating of 4 or less. For a review grade to be given, the leading and trailing edge must have a rating between 3 and 3.5, and the flap must have a rating between 4 and 4.5. Any rating greater than 3.5 on the leading and trailing edge is considered a fail, while anything greater than 4.5 on the flap is a fail.

2.10.2 Visual Ratings at Rotation

The visual contamination rating criteria at the time of rotation on the leading edge must be equal to 1 or less in order to pass. For a review grade to be given, the leading edge must have a rating between 1 and 1.5. Any rating on the leading edge greater than 1.5 is considered a fail.

2.10.3 Eight Degree Lift Loss

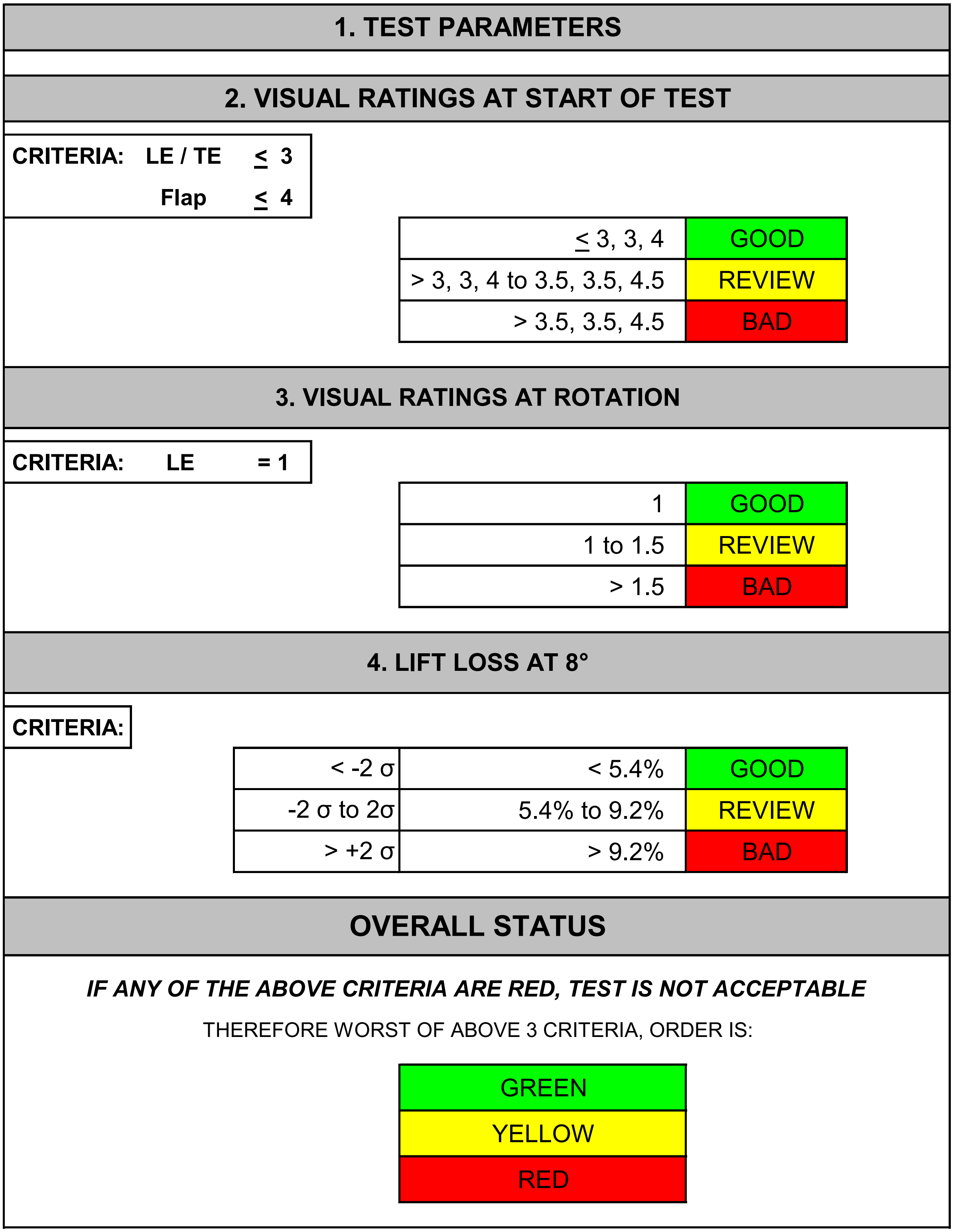
For a pass, the 8° lift loss must be less than 5.4 percent. A review grade was given should the lift loss be between 5.4 percent and 9.2 percent. Any lift loss greater than 9.2 is considered a fail.

2.10.4 Overall Test Status

After all objectives were analysed, an overall status was given a “good,” “review,” or “bad.” This provided an overall summary for each test. The overall status was determined by the worst case scenario from any of the test objectives; if any of the criteria were given a “bad” grade, the overall status would be “bad” and the test is considered a fail.

2.10.5 Dry Wing Calibration

To ensure the accuracy of the testing results, a dry wing calibration test was conducted at the start of each day. The dry wing test allowed the research team to ensure that the model aerodynamics did not change due to mechanical, communication, or analytical errors. Dry wing tests were also conducted following any mechanical modification to the airfoil (i.e., after applying the ice phobic wing skins). During the winter of 2013-14, the dry wing results demonstrated that the changes in dry wing performance were within the range of experimental error and did not indicate any repeatability issues with the model.



1. TEST PARAMETERS

2. VISUAL RATINGS AT START OF TEST

CRITERIA: LE / TE ≤ 3
Flap ≤ 4

≤ 3, 3, 4	GOOD
> 3, 3, 4 to 3.5, 3.5, 4.5	REVIEW
> 3.5, 3.5, 4.5	BAD

3. VISUAL RATINGS AT ROTATION

CRITERIA: LE = 1

1	GOOD
1 to 1.5	REVIEW
> 1.5	BAD

4. LIFT LOSS AT 8°

CRITERIA:

< -2 σ	< 5.4%	GOOD
-2 σ to 2σ	5.4% to 9.2%	REVIEW
> +2 σ	> 9.2%	BAD

OVERALL STATUS

IF ANY OF THE ABOVE CRITERIA ARE RED, TEST IS NOT ACCEPTABLE

THEREFORE WORST OF ABOVE 3 CRITERIA, ORDER IS:

GREEN
YELLOW
RED

Figure 2.9: Ice Pellet Test Analysis Criteria

Table 2.2: 2013-14 Re-Testing of Existing 2012-13 Leftover Fluid Inventory

Test #	Sample Name	Dilution	MID OR LOW VISCOSITY	Receiving Quantity	Method Type	Method	Spindle	Fluid Volume	Fluid Temp	Speed	Time (mins)	Can-Am Result (cP) 2012-13	Can-Am Result (cP) 2013-14	TAKE SAMPLE FROM	Without Guardleg
1	Kilfrost ABC-S Plus	100/0	MID	500	AIR/MAN	c	LV2	150	20	0.3	10	19,996	25,200	From unopened containers	19,800
2	Dow FlightGuard AD-49	100/0	MID	700	MAN.	k	31	10	20	0.3	10	14,397	14,100	From unopened containers	-
3	DOW EG 106	100/0	MID	800	AIR	g	LV1	500 mL	20	0.3	10	3,979	3,420	From unopened drum	-
4	CLARIANT 2031	100/0	MID	200	MAN.	h	LV0	16	20	0.3	10	554	322	From opened drum	-
5	Clariant MPIV Launch	100/0	MID	400	AIR/MAN	g	LV1	500	20	0.3	10	13,997	13,320	From unopened drum	-
6	Clariant MaxFlight 04	100/0	MID	700	MAN.	d	LV1	500	20	0.3	33.33	11,658	11,780	From unopened containers	-
7	Cryotech Polar Guard Advance	100/0	MID	600	MAN.	n	34	10	20	0.3	10	15,200	15,400	From unopened containers	-

NOTES:
- Test #1: the fluid was completely de-bubbled in an ultrasonic bath
- Tests #1, #3, #5, #6 were performed with the Guard Leg
- Test #1 was repeated without Guard Leg (19800 cP)

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Photo 2.1: Outside View of NRC Wind Tunnel Facility

Photo 2.2: Inside View of NRC Wind Tunnel Test Section

Photo 2.3: Thin High-Performance Wing Section Used for Testing

Photo 2.4: Grid Markings on Thin High-Performance Wing Section

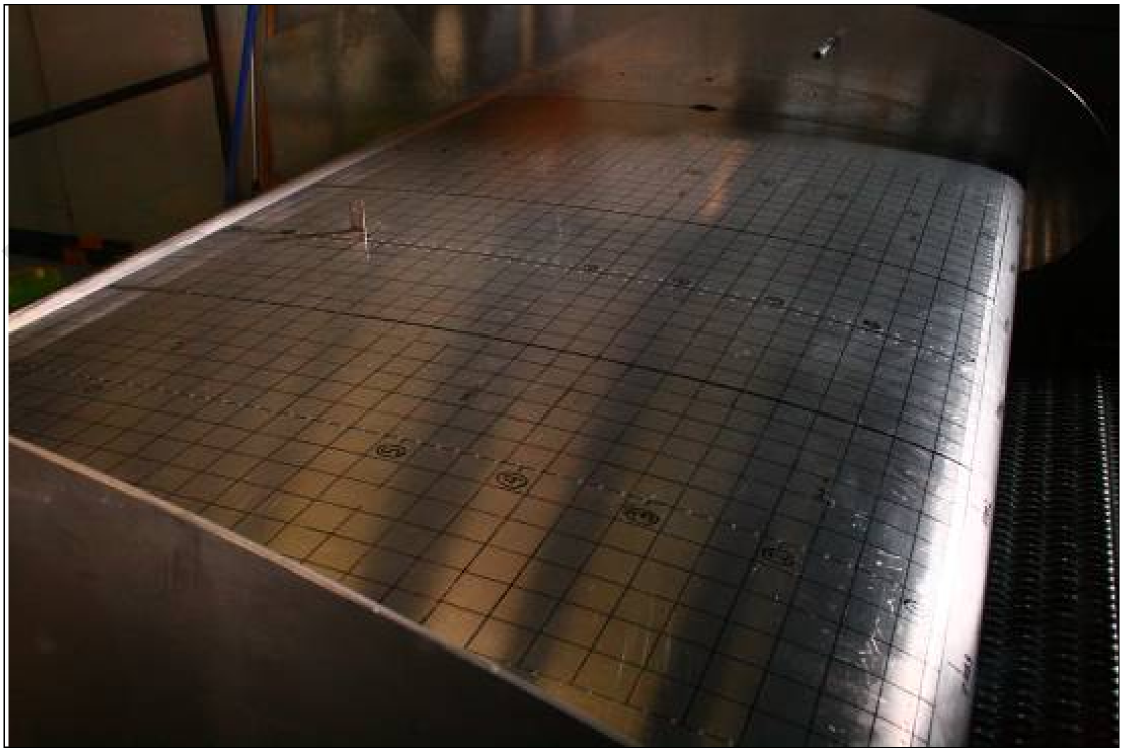

Photo 2.5: Refrigerated Truck Used for Manufacturing Ice Pellets

Photo 2.6: Calibrated Sieves Used to Obtain Desired Size Distribution

Photo 2.7: Ice Pellet Dispensers Operated by APS Personnel

Photo 2.8: Ceiling-Mounted Freezing Rain Sprayer

Photo 2.9: Wind Tunnel Setup for Flashes

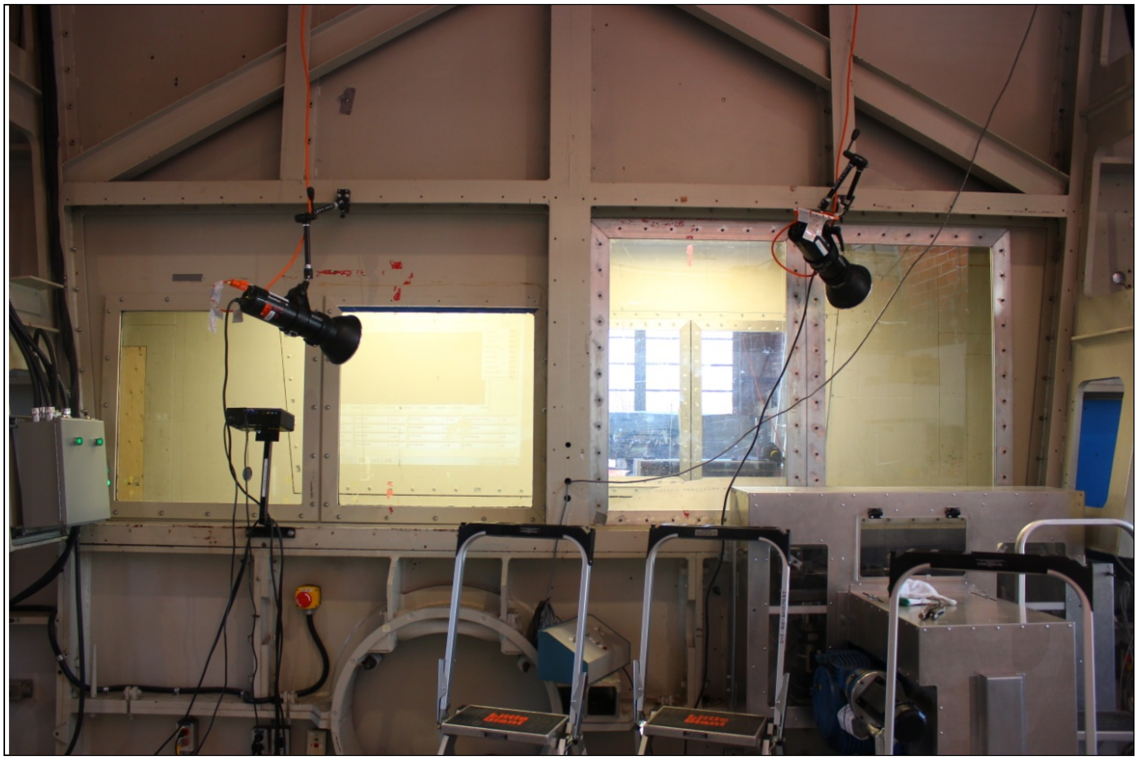

Photo 2.10: Wind Tunnel Setup for Digital Cameras

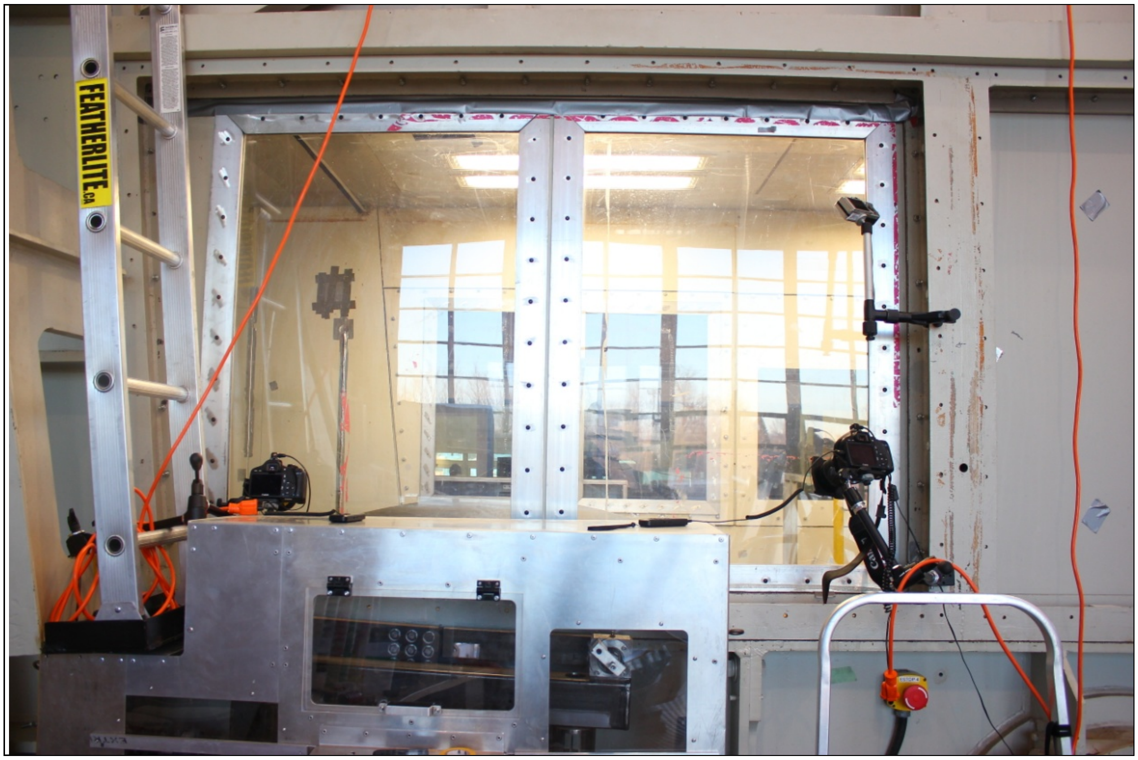

Photo 2.11: Fluid Pour Containers

Photo 2.12: 2012-13 Research Team

Absent at time of photo: Warren Underwood and John D'Avirro

Photo 2.13: Brookfield Digital Viscometer Model DV-1+

Photo 2.14: Stony Brook PDVdi-120 Falling Ball Viscometer

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3. FULL-SCALE DATA COLLECTED

3.1 Test Log

A calendar of the tests conducted during the winter of 2013-14 can be found in Table 2.1. A detailed log of the tests conducted in the NRC PIWT is shown in Table 3.1. Data pertaining to all test objectives (exploratory research objectives as well) is included in the log. Table 3.1 provides relevant information for each of the tests, as well as final values used for the data analysis. Each column contains data specific to one test. The following is a brief description of the column headings for Table 3.1:

Run #:	Exclusive number identifying each test run.
Test Plan #:	Exclusive number used for planning purposes and identified in the test procedure.
Year:	The year in which the test was conducted.
Objective:	Main objective of the test.
Test Condition:	Description of the simulated conditions for the test.
Fluid:	Aircraft anti-icing fluid used during the test.
Rotation Angle:	Maximum angle of rotation obtained during simulated takeoff run; began testing with a max 8° rotation angle and increased to 20° as testing progressed.
Flap Angle:	Positioning of the flap during the precipitation period; either 0° (retracted) or 20° (extended). *Note: Flap was always extended at 20° during the takeoff run.*
Date:	Date when the test was conducted.
Precipitation End Time:	End time of the application of precipitation, recorded in local time.
Tunnel Start Time:	Start of the simulated takeoff run, recorded in local time.
OAT Before Test (°C):	Outside air temperature recorded just before the start of the simulated takeoff test, measured in degrees Celsius.

	Note: Not an important parameter as "Tunnel Temp. Before Test" was used as actual test temperature for analysis.
Tunnel Temp. Before Test (ºC):	Static tunnel air temperature recorded just before the start of the simulated takeoff test, measured in degrees Celsius. *Note: This parameter was used as the actual test temperature for analysis.*
Avg. Wing Temp. Before Test (ºC):	Average of the wing skin temperature measurements just before the start of the simulated takeoff test, recorded in degrees Celsius.
Precipitation Rate (Type: [g/dm²/h]):	Simulated freezing precipitation rate (or combination of different precipitation rates). "N/A" indicates that no precipitation was applied.
Exposure Time:	Simulated precipitation period, recorded in minutes.

The visual contamination ratings are described below. Visual contamination ratings were typically reported as the average of the three observer ratings and rounded to the nearest decimal. The visual contamination ratings system is further described in Subsection 4.1.

Visual Contamination Rating Before Takeoff (LE, TE, Flap):	Visual contamination rating determined before the start of the simulated takeoff: 1 - Contamination not very visible, fluid still clean. 2 - Contamination is visible, but lots of fluid still present. 3 - Contamination visible, spots of bridging contamination. 4 - Contamination visible, lots of dry bridging present. 5 - Contamination visible, adherence of contamination.
Visual Contamination Rating at Rotation (LE, TE, Flap):	Visual contamination rating determined at the time of rotation:

1 - Contamination not very visible, fluid still clean.
2 - Contamination is visible, but lots of fluid still present.
3 - Contamination visible, spots of bridging contamination.
4 - Contamination visible, lots of dry bridging present.
5 - Contamination visible, adherence of contamination.

Visual Contamination Rating After Takeoff (LE, TE, Flap): Visual contamination rating determined at the end of the test:

1 - Contamination not very visible, fluid still clean.
2 - Contamination is visible, but lots of fluid still present.
3 - Contamination visible, spots of bridging contamination.
4 - Contamination visible, lots of dry bridging present.
5 - Contamination visible, adherence of contamination.

CL at 0° Before Rotation: Calculated lift coefficient at the 0° wing angle position just prior to the start of the rotation; data provided by NRC.

CL at 8° During Rotation: Calculated lift coefficient at the 8° wing rotation angle position; data provided by the NRC.

CL at 4° Following End of Rotation: Calculated lift coefficient at the 4° wing rotation angle position attained at the end of the rotation cycle; data provided by the NRC.

% Lift Loss: Percentage lift loss calculated based on the comparison of the 8° lift coefficient during the test run versus the dry wing average lift coefficient.

Speed (kts): Maximum speed obtained during simulated takeoff run, recorded in knots.

Table 3.1: Wind Tunnel Test Log 2013-14

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm^2/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° Cl vs Dry Cl	Speed Kts
1	2013-14	Baseline	Dry Wing	none	22	20	8-Jan-14	-9.9	-9.3	-	-	-	-	-	1.460	0.38%	80
2	2013-14	Baseline	Dry Wing	none	8	20	8-Jan-14	-9.9	-9.3	-	-	-	-	-	1.473	-0.56%	100
3	2013-14	Baseline	Dry Wing	none	22	20	8-Jan-14	-10.1	-10.1	-	-	-	-	-	1.460	0.34%	80
4	2013-14	Baseline	Dry Wing	none	8	20	8-Jan-14	-10.1	-10.1	-	-	-	-	-	1.474	-0.60%	100
5	2013-14	R&D	EFFECT OF COOLING SYSTEM		8	20	8-Jan-14	-9.2	-5.2	-	-	-	-	-	1.439	1.78%	100
6	2013-14	R&D	EFFECT OF COOLING SYSTEM	EG106	8	20	8-Jan-14	n/a	n/a	-	-	-	-	-	n/a	-	100
7	2013-14	Baseline	Dry Wing	none	22	20	9-Jan-14	-11.5	-9.9	-	-	-	-	-	1.462	0.24%	80
8	2013-14	Baseline	Dry Wing	none	8	20	9-Jan-14	-10.1	-7.3	-	-	-	-	-	1.471	-0.41%	100
9	2013-14	IP Expansion	IP- / SN-	ABC-S Plus	8	20	9-Jan-14	-10.1	-7.3	IP=25 SN=10	10	2, 2, 2.5	1, 1.5, 1.75	1, 1, 1.1	1.370	6.47%	100
10	2013-14	IP Expansion	IP- / SN	ABC-S Plus	8	20	9-Jan-14	-9.6	-6.7	IP=25 SN=25	10	2, 2, 3	1, 1.5, 2.25	1, 1, 1.2	1.372	6.38%	100
11	2013-14	IP Expansion	IP- / SN	Launch	8	20	9-Jan-14	-9	-5.2	IP=25 SN=25	10	2, 1.75, 3.25	1, 1.35, 2.25	1, 1, 1.2	1.367	6.70%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
12	2013-14	IP Expansion	IP- / SN	AD-49	8	20	9-Jan-14	-7.4	-3.3	IP=25 SN=25	10	2, 2, 3.5	1, 1.6, 2.25	1, 1.2, 1.4	1.381	5.75%	100
13	2013-14	Type III Allowance Times	IP- / SN	2031 - Cold	8	20	9-Jan-14	-7.4	-3.1	IP=25 SN=25	10	2.25, 1.9, 3.5	1, 1.5, 1.95	1, 1.15, 1.2	1.431	2.32%	100
14	2013-14	Type III Allowance Times	IP- / SN-	2031 - Cold	8	20	9-Jan-14	-7.2	-4.2	IP=25 SN=10	10	2, 2, 2.1	1, 1.05, 1.25	1, 1, 1	1.441	1.64%	100
15	2013-14	Type III Allowance Times	IP-	2031 - Cold	8	20	9-Jan-14	-7.1	-4.7	IP=25	10	2, 2, 2	1, 1, 1.15	1, 1, 1	1.434	2.14%	100
16	2013-14	Type III Allowance Times	IP Mod	2031 - Cold	8	20	9-Jan-14	-7.3	-4.8	IP=75	5	2, 2, 2.15	1, 1.1, 1.4	1, 1, 1	1.441	1.63%	100
17	2013-14	Baseline	Dry Wing	none	22	20	10-Jan-14	-11.2	-4.8	-	-	-	-	-	1.465	0.00%	80
18	2013-14	Baseline	Dry Wing	none	8	20	10-Jan-14	-11.2	-4.8	-	-	-	-	-	1.462	0.22%	100
19	2013-14	Type III Allowance Times	IP- / ZR-	2031 - Cold	8	20	10-Jan-14	-9.2	-3.8	IP=25 ZR=25	7	2, 2, 2.15	1, 1, 1.5	1, 1, 1.35	1.442	1.57%	100
20	2013-14	Type III Allowance Times	IP- / ZR-	2031 - Hot	8	20	10-Jan-14	-8.5	-3.3	IP=25 ZR=25	7	1.25, 1.5, 1.45	1, 1, 1	1, 1, 1	1.439	1.77%	100
21	2013-14	Type III Allowance Times	IP-	2031 - Hot	8	20	10-Jan-14	-7.7	-5.2	IP=25	10	2, 2, 2.1	1, 5, 1	1, 5, 1	1.437	1.90%	100
22	2013-14	Type III Allowance Times	IP-	2031 - Hot	8	20	10-Jan-14	-7.2	-2.8	IP=25	7	1.9, 1.75, 1.25	1, 3, 1	1, 3, 1	1.441	1.64%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
23	2013-14	Type III Allowance Times	IP-	2031 - Hot	8	20	10-Jan-14	-6.9	-2.9	IP=25	5	1.5, 1.25, 1.15	1, 1, 1	1, 1, 1	1.436	2.00%	100
24	2013-14	Type III Allowance Times	IP Mod	2031 - Hot	8	20	10-Jan-14	-6.7	-3	IP=75	5	2.25, 2, 2.25	1, 5, 1	1, 5, 1	1.444	1.46%	100
25	2013-14	Type III Allowance Times	IP- / SN	2031 - Hot	8	20	10-Jan-14	-6.1	-2.3	IP=25 SN=25	10	2.5, 2, 3.75	1, 3.25, 3.75	1, 5, 3.75	1.439	1.76%	100
26	2013-14	Baseline	Dry Wing	none	22	20	13-Jan-14	4.8	8.1	-	-	-	-	-	1.460	0.35%	80
27	2013-14	Baseline	Dry Wing	none	8	20	13-Jan-14	4.8	8.1	-	-	-	-	-	1.477	-0.81%	100
28	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.470	-0.29%	100
29	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.471	-0.37%	100
30	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.473	-0.56%	100
31	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.481	-1.10%	100
32	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.482	-1.14%	100
33	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.482	-1.11%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
34	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	80
35	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	80
36	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	80
37	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	100
38	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	100
39	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	100
40	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	115
41	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	115
42	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	5.5	5.7	-	-	-	-	-	n/a	-	115
43	2013-14	Ice Phobic R&D	Dry Wing	none	22	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.461	0.26%	80
44	2013-14	Ice Phobic R&D	Dry Wing	none	22	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.466	-0.03%	80

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
45	2013-14	Ice Phobic R&D	Dry Wing	none	22	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.466	-0.03%	80
46	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.474	-0.63%	100
47	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.469	-0.27%	100
48	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	13-Jan-14	5.5	5.7	-	-	-	-	-	1.469	-0.26%	100
49	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	40
50	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	40
51	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	40
52	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	60
53	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	60
54	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	60
55	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	80

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
56	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	80
57	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	80
58	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	100
59	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	100
60	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	100
61	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	max (120)
62	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	max (120)
63	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	13-Jan-14	6.1	6.4	-	-	-	-	-	n/a	-	max (120)
64	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	13-Jan-14	6.1	6.4	-	-	-	-	-	1.448	1.21%	80
65	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	13-Jan-14	6.1	6.4	-	-	-	-	-	1.464	0.09%	80
66	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	13-Jan-14	6.1	6.4	-	-	-	-	-	1.464	0.09%	80

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
67	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.466	-0.08%	100
68	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.459	0.44%	100
69	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.460	0.33%	100
70	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.471	-0.38%	100
71	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.470	-0.32%	100
72	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.470	-0.32%	100
73	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	80
74	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	80
75	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	80
76	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	100
77	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
78	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	100
79	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	115
80	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	115
81	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	115
82	2013-14	Ice Phobic R&D	Dry Wing	none	20	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.449	1.11%	80
83	2013-14	Ice Phobic R&D	Dry Wing	none	20	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.449	1.14%	80
84	2013-14	Ice Phobic R&D	Dry Wing	none	20	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.447	1.24%	80
85	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.458	0.46%	100
86	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.461	0.27%	100
87	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.462	0.20%	100
88	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.464	0.11%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
89	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.465	0.04%	100
90	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.461	0.30%	100
91	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.470	-0.31%	100
92	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.472	-0.44%	100
93	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.470	-0.33%	100
94	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	80
95	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	80
96	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	80
97	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	100
98	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	100
99	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
100	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	115
101	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	115
102	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.4	4.3	-	-	-	-	-	n/a	-	115
103	2013-14	Ice Phobic R&D	Dry Wing	none	20	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.445	1.37%	80
104	2013-14	Ice Phobic R&D	Dry Wing	none	20	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.444	1.44%	80
105	2013-14	Ice Phobic R&D	Dry Wing	none	20	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.451	0.97%	80
106	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.463	0.17%	100
107	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.460	0.36%	100
108	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.4	4.3	-	-	-	-	-	1.461	0.31%	100
109	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.460	0.33%	100
110	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.458	0.50%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm^2/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
111	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.462	0.25%	100
112	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.466	-0.02%	100
113	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.464	0.06%	100
114	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.466	-0.07%	100
115	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	80
116	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	80
117	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	80
118	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	100
119	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	100
120	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	100
121	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	115

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
122	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	115
123	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	14-Jan-14	4.3	4.4	-	-	-	-	-	n/a	-	115
124	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.444	1.43%	80
125	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.443	1.53%	80
126	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.446	1.30%	80
127	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.458	0.50%	100
128	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.454	0.76%	100
129	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	4.3	4.4	-	-	-	-	-	1.453	0.85%	100
130	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	14-Jan-14	-0.4	1.2	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.65%	100
131	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	14-Jan-14	-0.5	1.2	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.427	2.62%	100
132	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	14-Jan-14	-1.3	1.1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.424	2.83%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm^2/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
133	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	-1.2	-0.3	-	-	-	-	-	1.444	1.45%	100
134	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	14-Jan-14	-1.2	-0.3	-	-	-	-	-	1.445	1.36%	100
135	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-1.1	1.4	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.71%	100
136	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-1.5	-0.5	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.425	2.74%	100
137	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-1.7	0.9	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.430	2.42%	100
138	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.5	0.4	-	-	-	-	-	1.456	0.65%	100
139	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.5	0.4	-	-	-	-	-	1.457	0.55%	100
140	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.454	0.76%	100
141	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.452	0.93%	100
142	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.462	0.20%	100
143	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.462	0.25%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
144	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.461	0.29%	100
145	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	100
146	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	80
147	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	80
148	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	80
149	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	100
150	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	100
151	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	100
152	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	115
153	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	115
154	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	n/a	-	115

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
155	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.442	1.59%	80
156	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.443	1.49%	80
157	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.435	2.05%	80
158	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.453	0.82%	100
159	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.455	0.69%	100
160	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-2.3	-1.5	-	-	-	-	-	1.454	0.80%	100
161	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-2.9	-1.2	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.70%	100
162	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-3	-1.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.68%	100
163	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-3.3	-1.8	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.66%	100
164	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-4.3	0.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.436	1.99%	100
165	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-4.1	-2.9	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.437	1.95%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
166	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-4.3	0.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.436	2.00%	100
167	2013-14	Baseline	Dry Wing	none	8	20	15-Jan-14	-0.3	0.3	-	-	-	-	-	1.479	-0.96%	100
168	2013-14	Baseline	Dry Wing	none	22	20	15-Jan-14	-0.3	0.3	-	-	-	-	-	1.456	0.64%	80
169	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.459	0.45%	100
170	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.459	0.44%	100
171	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.457	0.56%	100
172	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.468	-0.20%	100
173	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.466	-0.07%	100
174	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.468	-0.20%	100
175	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	80
176	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	80

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate ($g/dm^2/h$)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
177	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	80
178	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	100
179	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	100
180	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	100
181	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	115
182	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	115
183	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	15-Jan-14	-1.1	-1	-	-	-	-	-	n/a	-	115
184	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.435	2.04%	80
185	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.445	1.35%	80
186	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.435	2.09%	80
187	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.453	0.81%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
188	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.455	0.68%	100
189	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	15-Jan-14	-1.1	-1	-	-	-	-	-	1.457	0.54%	100
190	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-0.9	-0.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.429	2.46%	100
191	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-0.8	-0.5	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.424	2.80%	100
192	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	15-Jan-14	-0.9	-0.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.430	2.40%	100
193	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.1	-0.3	-	-	-	-	-	1.462	0.25%	100
194	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.1	-0.3	-	-	-	-	-	1.456	0.62%	100
195	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.460	0.39%	100
196	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.456	0.66%	100
197	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.453	0.86%	100
198	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.461	0.32%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
199	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.462	0.25%	100
200	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.463	0.13%	100
201	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	100
202	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	100
203	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	100
204	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	80
205	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	80
206	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	80
207	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	115
208	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	115
209	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	n/a	-	115

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
210	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.439	1.78%	80
211	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.439	1.81%	80
212	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.442	1.60%	80
213	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.458	0.49%	100
214	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.455	0.70%	100
215	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-1.9	-2.3	-	-	-	-	-	1.456	0.66%	100
216	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	16-Jan-14	-2	-0.8	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.68%	100
217	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	16-Jan-14	-2.2	-1.1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.424	2.84%	100
218	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	16-Jan-14	-2.5	-2.2	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.426	2.65%	100
219	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-2.6	-1.8	-	-	-	-	-	1.448	1.21%	100
220	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-2.6	-1.8	-	-	-	-	-	1.450	1.01%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
221	2013-14	Ice Phobic R&D	ZR	none	8	20	16-Jan-14	-2.8	-1.8	ZR = 100	2	-	-	-	1.427	2.59%	100
222	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.458	0.50%	100
223	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.455	0.71%	100
224	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.449	1.14%	100
225	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.461	0.29%	100
226	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.458	0.50%	100
227	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	100
228	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
229	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
230	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
231	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
232	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
233	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
234	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
235	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
236	2013-14	Ice Phobic R&D	Dry Wing	none	n/a*	20	16-Jan-14	-3	-3.4	-	-	-	-	-	n/a	-	n/a*
237	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.435	2.09%	100
238	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.439	1.80%	100
239	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.434	2.10%	100
240	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.450	1.03%	100
241	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.443	1.50%	100
242	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	16-Jan-14	-3	-3.4	-	-	-	-	-	1.449	1.12%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
243	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	16-Jan-14	-3.5	-1.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.422	2.96%	100
244	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	16-Jan-14	-3.7	-3.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.422	2.94%	100
245	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	17-Jan-14	-3.8	-1.8	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.414	3.47%	100
246	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	17-Jan-14	-4.1	-1.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.420	3.07%	100
247	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	17-Jan-14	-4.2	-2.6	-	-	-	-	-	1.449	1.13%	100
248	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	17-Jan-14	-4.2	-2.6	-	-	-	-	-	n/a	-	100
249	2013-14	Ice Phobic R&D	ZR	none	8	20	17-Jan-14	-4.1	-1.5	-	5	-	-	-	1.446	1.34%	100
250	2013-14	Baseline	Dry Wing	none	22	20	17-Jan-14	-4.3	0	-	-	-	-	-	1.447	1.26%	80
251	2013-14	Baseline	Dry Wing	none	8	20	17-Jan-14	-4.3	0	-	-	-	-	-	1.463	0.17%	100
252	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	17-Jan-14	-4.3	-0.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.463	0.16%	100
253	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	17-Jan-14	-4.4	-1.4	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.434	2.11%	60

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
254	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	17-Jan-14	-4.5	-1.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.437	1.91%	55
255	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	17-Jan-14	-4.5	-0.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.440	1.71%	45
256	2013-14	Type I Low Speed	Baseline	none	8	20	17-Jan-14	-4.4	-0.2	-	-	-	-	-	1.466	-0.04%	45
257	2013-14	Type I Low Speed	Baseline	none	8	20	17-Jan-14	-4.4	-0.2	-	-	-	-	-	1.459	0.41%	55
258	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	17-Jan-14	-4.4	-0.7	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.422	2.95%	45
259	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	17-Jan-14	-4.5	-1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.430	2.44%	55
260	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.463	0.18%	100
261	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.455	0.68%	100
262	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.461	0.27%	100
263	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.468	-0.16%	100
264	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.468	-0.17%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
265	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.469	-0.27%	100
266	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	80
267	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	80
268	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	80
269	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	100
270	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	100
271	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	100
272	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	115
273	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	115
274	2013-14	Ice Phobic R&D	Dry Wing	none	-2,0,+2	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	n/a	-	115
275	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.438	1.83%	80

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
276	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.442	1.59%	80
277	2013-14	Ice Phobic R&D	Dry Wing	none	23	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.439	1.77%	80
278	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.456	0.63%	100
279	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.456	0.62%	100
280	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-8.1	-8.3	-	-	-	-	-	1.456	0.66%	100
281	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	20-Jan-14	-9	-8.7	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.425	2.75%	100
282	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	20-Jan-14	-9.4	-8.7	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.423	2.91%	100
283	2013-14	Ice Phobic R&D	Fluid Only	EG106	8	20	20-Jan-14	-10	-9.8	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.423	2.88%	100
284	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-10.4	-10.1	-	-	-	-	-	1.461	0.26%	100
285	2013-14	Ice Phobic R&D	Dry Wing	none	8	20	20-Jan-14	-10.4	-10.1	-	-	-	-	-	1.458	0.52%	100
286	2013-14	Ice Phobic R&D	ZR	none	8	20	20-Jan-14	-10.7	-10.3	-	6	-	-	-	1.429	2.47%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm^2/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
287	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-11.8	-11.6	-	-	-	-	-	1.466	-0.08%	100
288	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-11.8	-11.6	-	-	-	-	-	1.463	0.13%	100
289	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-11.8	-11.6	-	-	-	-	-	1.464	0.10%	100
290	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-13	-13	-	-	-	-	-	1.467	-0.10%	100
291	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-13	-13	-	-	-	-	-	1.465	0.03%	100
292	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	20-Jan-14	-13	-13	-	-	-	-	-	1.465	-0.01%	100
293	2013-14	Baseline	Dry Wing	none	22	20	20-Jan-14	-20	-17.9	-	-	-	-	-	1.458	0.52%	80
294	2013-14	Baseline	Dry Wing	none	8	20	20-Jan-14	-20	-17.9	-	-	-	-	-	1.465	0.03%	100
295	2013-14	Type III Allowance Times	IP-	2031 - Cold	8	20	20-Jan-14	-20.4	-18.7	IP=25	10	2.2, 2.2, 2.7	1, 1.8, 2.1	1, 1, 1.2	1.384	5.55%	100
296	2013-14	Type III Allowance Times	IP Mod	2031 - Cold	8	20	21-Jan-14	-20.6	-17.7	IP=75	5	2.3, 2.3, 2.8	1, 1.8, 2.1	1, 1.1, 1.3	1.393	4.90%	100
297	2013-14	Type III Allowance Times	IP-	2031 - Hot	8	20	21-Jan-14	-21.1	-18.1	IP=25	10	2.2, 2.1, 2.7	2.3, 3.8, 1.6	2.3, 5, 1.2	1.395	4.79%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate ($g/dm^2/h$)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
298	2013-14	Type III Allowance Times	IP Mod	2031 - Hot	8	20	21-Jan-14	-21.3	-19	IP=75	5	2.2, 2.5, 3.2	2.4, 5, 2	2.3, 5, 1.2	1.396	4.73%	100
299	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	21-Jan-14	-21.7	-18.5	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.436	2.01%	100
300	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	21-Jan-14	-22	-20.5	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.398	4.57%	60
301	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	21-Jan-14	-22.4	-20.2	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.401	4.41%	60
302	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	21-Jan-14	-22.4	-20.2	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.409	3.83%	55
303	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	21-Jan-14	-22.5	-17.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.404	4.21%	45
304	2013-14	IP Expansion	IP- / SN-	Polar Guard Advance	8	20	21-Jan-14	-23.5	-14.6	IP=25 SN=10	15	2.5, 2.7, 3.83	1.2, 1.9, 3.2	1.1, 1.1, 2.8	1.348	8.01%	115
305	2013-14	New Ice Pellet Dispenser Validation	IP- / SN-	Polar Guard Advance	8	20	21-Jan-14	-23.8	-11.4	IP=25 SN=10	15	2.5, 2.6, 3.8	1.2, 2, 3	1, 1.4, 2.9	1.351	7.80%	115
306	2013-14	New Ice Pellet DispensrValidation	IP- / SN-	Polar Guard Advance	8	20	21-Jan-14	-24	-14.4	IP=25 SN=10	15	2.3, 2.3, 3.6	1.2, 1.8, 3	1, 1.5, 2.7	1.348	7.97%	115
307	2013-14	Baseline	Dry Wing	none	22	20	21-Jan-14	-22.6	-14	-	-	-	-	-	1.456	0.62%	80
308	2013-14	Baseline	Dry Wing	none	8	20	21-Jan-14	-22.6	-14	-	-	-	-	-	1.465	0.00%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
309	2013-14	New Ice Pellet Dispenser Validation	IP- / SN-	Polar Guard Advance	8	20	21-Jan-14	-22.6	-9.6	IP=25 SN=10	15	2.8, 2.8, 4	1.1, 2, 3.3	1.1, 1.5, 3.2	1.349	7.94%	115
310	2013-14	IP Expansion	IP- / SN-	EG106	8	20	21-Jan-14	-23.1	-17.4	IP=25 SN=10	15	1.7, 1.7, 2.3	1, 1.3, 1.5	1, 1.1, 1.3	1.436	2.00%	115
311	2013-14	IP Expansion	IP- / SN-	EG106	8	20	21-Jan-14	-23.9	-18.1	IP=25 SN=10	15	1.9, 1.9, 2.3	1.1, 1.5, 1.7	1, 1.1, 1.2	1.406	4.06%	100
312	2013-14	IP Expansion	IP- / SN-	Launch	8	20	21-Jan-14	-24.3	-17.4	IP=25 SN=10	15	2.8, 2.7, 3.7	1.1, 1.9, 2.4	1, 1.6, 2.1	1.332	9.11%	115
313	2013-14	IP Expansion	IP- / SN-	Max-Flight	8	20	21-Jan-14	-24.5	-15.3	IP=25 SN=10	15	2.6, 2.5, 3.5	1.1, 1.8, 2.4	1, 1.1, 1.4	1.340	8.54%	115
314	2013-14	IP Expansion	IP- / SN-	AD-49	8	20	22-Jan-14	-24.8	-19.8	IP=25 SN=10	15	3, 2.4, 4	1.3, 2, 3.7	1.1, 1.8, 3.7	1.342	8.39%	115
315	2013-14	IP Expansion	IP- / SN-	AD-49	8	20	22-Jan-14	-25.1	-19.4	IP=25 SN=10	10	2.9, 2.8, 3.8	1.2, 1.9, 3	1.1, 1.9, 3	1.361	7.14%	115
316	2013-14	Type I Low Speed	Fluid Only	Dow ADF	8	20	22-Jan-14	-25.5	-23.4	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.449	1.11%	100
317	2013-14	Type I Low Speed	Fluid Only	Dow ADF	8	20	22-Jan-14	-25.6	-23.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.438	1.83%	60
318	2013-14	Type I Low Speed	Fluid Only	Dow ADF	8	20	22-Jan-14	-25.6	-24.1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.434	2.11%	55
319	2013-14	Type I Low Speed	Fluid Only	Dow ADF	8	20	22-Jan-14	-25.7	-24.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.421	3.05%	45

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
320	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-25.8	-24.3	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.409	3.84%	100
321	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-25.9	-25	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.375	6.15%	60
322	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-26	-25.4	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.353	7.65%	55
323	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-26	-25.1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.342	8.40%	45
324	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-26.2	-24.8	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.406	4.06%	100
325	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-26.3	-25.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.370	6.50%	60
326	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-26.4	-25.1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.346	8.14%	55
327	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	22-Jan-14	-26.5	-25.5	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.340	8.55%	45
328	2013-14	Baseline	Dry Wing	none	22	20	22-Jan-14	-19.8	-16.1	-	-	-	-	-	1.465	0.00%	80
329	2013-14	Baseline	Dry Wing	none	8	20	22-Jan-14	-19.8	-16.1	-	-	-	-	-	1.472	-0.43%	100
330	2013-14	New Ice Pellet Dispenser Validation	IP Mod	Launch	8	20	22-Jan-14	-20	-18.1	IP=75	10	2.5, 3, 3.6	1, 1.9, 2.4	1, 1, 1.6	1.353	7.67%	115

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
331	2013-14	New Ice Pellet Dispenser Validation	IP Mod	Launch	8	20	22-Jan-14	-20.2	-16.3	IP=75	10	2.7, 2.8, 3.6	1.1, 2.1, 2.5	1, 1.4, 2	1.334	8.95%	115
332	2013-14	New Ice Pellet Dispenser Validation	IP Mod	Launch	8	20	22-Jan-14	-20.6	-17	IP=75	10	2.9, 2.8, 3.8	1.1, 1.7, 2.5	1, 1.2, 1.5	1.330	9.25%	115
333	2013-14	New Ice Pellet Dispenser Validation	IP Mod	Launch	8	20	22-Jan-14	-20.6	-16.4	IP=75	10	3, 2.8, 3.8	1.1, 1.9, 2.4	1, 1.2, 1.5	1.327	9.42%	115
334	2013-14	New Ice Pellet Dispenser Validation	IP Mod	Launch	8	20	23-Jan-14	-20.9	-18.8	IP=75	10	2.9, 2.8, 3.8	1.1, 1.9, 2.3	1, 1.1, 1.4	1.307	10.82%	115
335	2013-14	New Ice Pellet Dispenser Validation	IP Mod	Launch	8	20	22-Jan-14	-21	-20	IP=75	10	2.8, 2.8, 3.8	1.1, 1.9, 2.2	1, 1.3, 1.5	1.325	9.55%	115
336	2013-14	New Ice Pellet Dispensr Validation	IP Mod	Launch	8	20	23-Jan-14	-21.4	-19.6	IP=75	10	3, 2.8, 3.8	1.1, 1.6, 2.2	1, 1.3, 1.5	1.328	9.35%	115
337	2013-14	New Ice Pellet Dispensr Validation	IP Mod	Launch	8	20	23-Jan-14	-21.9	-20.6	IP=75	5	2.6, 2.5, 3.7	1.1, 1.8, 2.2	1, 1.1, 1.4	1.338	8.66%	115
338	2013-14	IP Validation with New Temps & Fluids	IP Mod	ABC-S Plus	8	20	23-Jan-14	-22.3	-20.6	IP=75	7	2.8, 2.7, 3.8	1, 1.7, 2.1	1, 1.1, 1.3	1.368	6.61%	115
339	2013-14	IP Validation with New Temps & Fluids	IP Mod	Max-Flight	8	20	23-Jan-14	-22.6	-21.5	IP=75	7	2.6, 2.6, 3.9	1, 1.7, 2.2	1, 1, 1.2	1.358	7.35%	115
340	2013-14	IP Validation with New Temps & Fluids	IP Mod	Polar Guard Advance	8	20	23-Jan-14	-22.8	-21.4	IP=75	10	2.7, 2.4, 3.8	1, 1.6, 2.2	1, 1, 1.2	1.372	6.37%	115
341	2013-14	Baseline	Dry Wing	none	22	20	27-Jan-14	-13.3	-9.3	-	-	-	-	-	1.468	-0.16%	80

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm^2/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
342	2013-14	Baseline	Dry Wing	none	8	20	27-Jan-14	-13.3	-9.3	-	-	-	-	-	1.459	0.45%	100
343	2013-14	Type III Allowance Times	IP-	2031 - Cold	8	20	27-Jan-14	-11.6	-11.4	IP=25	10	2.5, 2.7, 2.8	1, 1, 1.3	1, 1, 1.1	1.439	1.76%	100
344	2013-14	Type III Allowance Times	IP-	2031 - Hot	8	20	27-Jan-14	-9.2	-9.1	IP=25	10	2.3, 2.4, 2.2	3, 5, 5	3, 5, 5	1.432	2.30%	100
345	2013-14	Type III Allowance Times	IP Mod	2031 - Cold	8	20	27-Jan-14	-7.8	-6.9	IP=75	5	2.5, 2.7, 2.8	1, 1.1, 1.2	1, 1, 1	1.435	2.04%	100
346	2013-14	Type III Allowance Times	IP Mod	2031 - Hot	8	20	27-Jan-14	-7.9	-6.4	IP=75	5	2.8, 2.4, 2.2	2.3, 4.7, 2.5	2.3, 4.8, 4.5	1.439	1.77%	100
347	2013-14	Type III Allowance Times	IP Mod	ABC-S Plus - Hot	8	20	27-Jan-14	-11.3	-9.4	IP=75	10	2.1, 2.4, 2.8	3, 5, 5	3, 5, 5	1.390	5.13%	100
348	2013-14	Type III Allowance Times	IP Mod	EG106 - Hot	8	20	27-Jan-14	-11.7	-10.6	IP=75	10	2.5, 2.3, 3	3, 5, 5	3, 5, 5	1.445	1.40%	100
349	2013-14	Type III Allowance Times	IP Mod	2031 - Hot	8	20	27-Jan-14	-12.4	-9.5	IP=75	5	2.7, 2.7, 2.5	3, 5, 5	3, 5, 5	1.412	3.61%	100
350	2013-14	Type III Allowance Times	IP- / ZR-	2031 - Cold	8	20	27-Jan-14	-12.2	-11.1	IP=25 ZR=25	5	2.5, 2.7, 2.9	1, 1.1, 1.5	1, 1, 1.1	1.426	2.68%	100
351	2013-14	Type III Allowance Times	IP- / ZR-	2031 - Hot	8	20	27-Jan-14	-12.9	-9.6	IP=25 ZR=25	5	2, 2, 2.3	5, 5, 5	5, 5, 5	1.434	2.15%	100
352	2013-14	Type III Allowance Times	IP- / SN-	2031 - Cold	8	20	27-Jan-14	-12.8	-11	IP=25 SN=10	10	2.5, 2.8, 3.3	1.1, 1.4, 1.8	1, 1.1, 1.3	1.410	3.75%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate ($g/dm^2/h$)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
353	2013-14	Type III Allowance Times	IP- / SN	2031 - Cold	8	20	27-Jan-14	-13	-10.2	IP=25 SN=25	5	2.5, 2.7, 3.5	1.1, 1.4, 2	1, 1.1, 1.3	1.409	3.83%	100
354	2013-14	Baseline	Dry Wing	none	22	20	28-Jan-14	-19	-11.4	-	-	-	-	-	1.459	0.46%	80
355	2013-14	Baseline	Dry Wing	none	8	20	28-Jan-14	-19	-11.4	-	-	-	-	-	1.469	-0.26%	100
356	2013-14	IP Validation with New Temps & Fluids	IP Mod	AD-49	8	20	28-Jan-14	-18.7	-11.6	IP=75	7	2.7, 2.4, 3.5	1.2, 1.6, 2	1, 1.3, 1.5	1.368	6.66%	115
357	2013-14	IP Validation with New Temps & Fluids	IP Mod	AD-49	8	20	28-Jan-14	-17.9	-14	IP=75	10	3, 2.8, 3.8	1.2, 1.6, 2.2	1, 1.2, 1.6	1.360	7.16%	115
358	2013-14	IP Validation with New Temps & Fluids	IP Mod	ABC-S Plus	8	20	28-Jan-14	-16.9	-12.2	IP=75	10	2.5, 2.3, 3.8	1, 1.5, -	-, -, -	n/a	-	115
359	2013-14	IP Validation with New Temps & Fluids	IP Mod	ABC-S Plus	8	20	28-Jan-14	-14.1	-10.9	IP=75	10	2.4, 2.4, 3.8	1.1, 1.5, 1.9	1, 1.1, 1.2	1.358	7.31%	115
360	2013-14	IP Validation with New Temps & Fluids	IP Mod	Launch	8	20	28-Jan-14	-12.3	-12.1	IP=75	10	2.3, 2.3, 3.7	1.1, 1.3, 1.9	1, 1, 1.2	1.363	6.95%	115
361	2013-14	IP Validation with New Temps & Fluids	IP Mod	Max-Flight	8	20	28-Jan-14	-11	-10.9	IP=75	10	2.2, 2.3, 3.3	1, 1.2, 1.7	1, 1, 1.2	1.391	5.08%	115
362	2013-14	IP Validation with New Temps & Fluids	IP Mod	Polar Guard Advance	8	20	28-Jan-14	-10.9	-11	IP=75	10	2.3, 2.3, 3.3	1, 1.3, 1.7	1, 1, 1.2	1.377	6.01%	115

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate ($g/dm^2/h$)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
363	2013-14	Type III Allowance Times	IP Mod	ABC-S Plus	8	20	28-Jan-14	-10.6	-7.4	IP=75	10	2, 2, 2.8	1, 1.3, 1.7	1, 1, 1.2	1.337	8.72%	100
364	2013-14	Type III Allowance Times	IP Mod	EG106	8	20	28-Jan-14	-10.2	-7.1	IP=75	10	2.3, 2.3, 2.8	3, 5, 5	3, 5, 5	1.442	1.56%	100
365	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	28-Jan-14	-10.7	-10.4	-	-	-	-	-	1.463	0.13%	100
366	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	28-Jan-14	-10.7	-10.4	-	-	-	-	-	1.455	0.67%	100
358	2013-14	IP Validation with New Temps & Fluids	IP Mod	ABC-S Plus	8	20	28-Jan-14	-16.9	-12.2	IP=75	10	2.5, 2.3, 3.8	1, 1.5, -	-, -, -	n/a	-	115
359	2013-14	IP Validation with New Temps & Fluids	IP Mod	ABC-S Plus	8	20	28-Jan-14	-14.1	-10.9	IP=75	10	2.4, 2.4, 3.8	1.1, 1.5, 1.9	1, 1.1, 1.2	1.358	7.31%	115
360	2013-14	IP Validation with New Temps & Fluids	IP Mod	Launch	8	20	28-Jan-14	-12.3	-12.1	IP=75	10	2.3, 2.3, 3.7	1.1, 1.3, 1.9	1, 1, 1.2	1.363	6.95%	115
361	2013-14	IP Validation with New Temps & Fluids	IP Mod	Max-Flight	8	20	28-Jan-14	-11	-10.9	IP=75	10	2.2, 2.3, 3.3	1, 1.2, 1.7	1, 1, 1.2	1.391	5.08%	115
362	2013-14	IP Validation with New Temps & Fluids	IP Mod	Polar Guard Advance	8	20	28-Jan-14	-10.9	-11	IP=75	10	2.3, 2.3, 3.3	1, 1.3, 1.7	1, 1, 1.2	1.377	6.01%	115
363	2013-14	Type III Allowance Times	IP Mod	ABC-S Plus	8	20	28-Jan-14	-10.6	-7.4	IP=75	10	2, 2, 2.8	1, 1.3, 1.7	1, 1, 1.2	1.337	8.72%	100

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
364	2013-14	Type III Allowance Times	IP Mod	EG106	8	20	28-Jan-14	-10.2	-7.1	IP=75	10	2.3, 2.3, 2.8	3, 5, 5	3, 5, 5	1.442	1.56%	100
365	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	28-Jan-14	-10.7	-10.4	-	-	-	-	-	1.463	0.13%	100
366	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	28-Jan-14	-10.7	-10.4	-	-	-	-	-	1.455	0.67%	100
367	2013-14	Ice Phobic R&D	Dry Wing	none	8 pitch pause	20	28-Jan-14	-10.7	-10.4	-	-	-	-	-	1.458	0.52%	100
368	2013-14	Baseline	Dry Wing	none	22	20	29-Jan-14	-14.1	-8.2	-	-	-	-	-	1.471	-0.41%	80
369	2013-14	Baseline	Dry Wing	none	8	20	29-Jan-14	-14.1	-8.2	-	-	-	-	-	1.465	-0.01%	100
370	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	29-Jan-14	-13.6	-13.8	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.442	1.57%	100
371	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	29-Jan-14	-13.3	-13.4	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.414	3.52%	60
372	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	29-Jan-14	-12.6	-13.1	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.400	4.47%	55
373	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	29-Jan-14	-12.5	-13	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.386	5.41%	45
374	2013-14	Type I Low Speed	Fluid Only	Polar Plus	8	20	29-Jan-14	-12.3	-12.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.366	6.79%	30

Table 3.1: Wind Tunnel Test Log 2013-14 (cont'd)

Test #	Test Year	Objective	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	Date	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Visual Contamination Rating After Takeoff (LE,TE,Flap)	Corrected for 3D Effects CL at 8°	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
375	2013-14	Type I Low Speed	Fluid Only w/ Squeegee Lines	Polar Plus	8	20	29-Jan-14	-12.2	-12.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	1.420	3.06%	45
376	2013-14	Ice Phobic R&D	Fluid Only	2031	fixed angle 4deg	20	29-Jan-14	-12.3	-12.6	-	-	1, 1, 1	1, 1, 1	1, 1, 1	n/a	-	100
377	2013-14	R&D	HEAVY CONTAMI NATION	ABC-S+	22	20	29-Jan-14	-11.2	-4.1	IP=375 ZR=50	26	-	-	-	1.279	12.73%	80
378	2013-14	R&D	APM Unit	None	23	20	29-Jan-14	-11.2	-1.8	-	-	-	-	-	1.442	1.57%	80
379	2013-14	R&D	APM Unit	None	23 PITCH PAUSE	20	29-Jan-14	-11.2	-11.3	-	-	-	-	-	1.459	0.41%	80
380	2013-14	R&D	APM Unit	ABC-S Plus	23	20	29-Jan-14	-11.1	-11.3	-	-	-	-	-	1.355	7.56%	80
381	2013-14	R&D	APM Unit	ABC-S Plus	23 PITCH PAUSE	20	29-Jan-14	-11.1	-11.6	-	-	-	-	-	1.431	2.33%	80
382	2013-14	R&D	APM Unit	ABC-S Plus (unit covered)	23	20	29-Jan-14	-11	-11.3	-	-	-	-	-	1.422	2.96%	80
383	2013-14	R&D	APM Unit	ABC-S Plus (unit covered)	23 PITCH PAUSE	20	29-Jan-14	-11	-11.3	-	-	-	-	-	1.436	2.02%	80

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4. LIGHT ICE PELLET ALLOWANCE TIMES

A summary of the Light Ice Pellet tests conducted with Type III fluids in the wind tunnel is shown in Table 4.1. The table provides relevant information for each of the tests, as well as final values used for the data analysis. Each row contains data specific to one test. A more detailed test log of all conditions tested using the wind tunnel is provided in Subsection 3.1.

It should be noted that Type IV testing was not conducted in Light Ice Pellet conditions, as this was not an area of high priority for the 2013-14 research program.

4.1 Analysis of Data Collected

The data collected has been sorted according to test parameters and included in the respective cells of the ice pellet allowance time table format for ease of reference; this is shown in Table 4.2. A more detailed analysis separating the data according to the allowance time cell and rotation speed has been conducted and is shown in Table 4.3. In addition, a conclusion regarding the test results has also been included for each condition in Table 4.3.

4.2 Overall Summary of Results

The testing results indicated that an allowance time of 10 minutes was acceptable for Type III fluid down to below -10ºC when applied cold (air temperature). The data collected with heated fluid applications indicated risks of adhered contamination, especially at colder temperatures; therefore, providing allowance times was not feasible without more extensive testing to understand the potential effects.

Table 4.1: Summary of 2013-14 Type III Light Ice Pellet Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
15	IP-	2031 - Cold	8	20	-7.1	-4.7	IP=25	10	2, 2, 2	1, 1, 1.15	2.14%	100
21	IP-	2031 - Hot	8	20	-7.7	-5.2	IP=25	10	2, 2, 2.1	1, 5, 1	1.90%	100
22	IP-	2031 - Hot	8	20	-7.2	-2.8	IP=25	7	1.9, 1.75, 1.25	1, 3, 1	1.64%	100
23	IP-	2031 - Hot	8	20	-6.9	-2.9	IP=25	5	1.5, 1.25, 1.15	1, 1, 1	2.00%	100
295	IP-	2031 - Cold	8	20	-20.4	-18.7	IP=25	10	2.2, 2.2, 2.7	1, 1.8, 2.1	5.55%	100
297	IP-	2031 - Hot	8	20	-21.1	-18.1	IP=25	10	2.2, 2.1, 2.7	2.3, 3.8, 1.6	4.79%	100
343	IP-	2031 - Cold	8	20	-11.6	-11.4	IP=25	10	2.5, 2.7, 2.8	1, 1, 1.3	1.76%	100
344	IP-	2031 - Hot	8	20	-9.2	-9.1	IP=25	10	2.3, 2.4, 2.2	3, 5, 5	2.30%	100

Table 4.2: Type III Light Ice Pellets Allowance Time Tests Winter 2013-14

Light Ice Pellets	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 kts Runs	10 Minutes Test # 15	10 Minutes Test # 21 (h), 344 (h)	10 Minutes Test # 295, 297 (h), 343
	7 Minutes Test # 22 (h)		
	5 Minutes Test # 23 (h)		

Note: (h) = Hot Application of Fluid

Table 4.3: Summary of Type III Light Ice Pellets Allowance Time Test Results

OAT -5°C AND ABOVE 100 Kts (10 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
15	2031 - Cold	-4.7	IP=25	10	2, 2, 2	Good	1, 1, 1.15	Good	2.14%	Good	Good

Table 4.3: Summary of Type III Light Ice Pellets Allowance Time Test Results (cont'd)

OAT -5°C AND ABOVE 100 Kts (7 MINUTES)											
22	2031 - Hot	-2.8	IP=25	7	1.9, 1.75, 1.25	Good	1, 3, 1	Good	1.64%	Good	Good
OAT -5°C AND ABOVE 100 Kts (5 MINUTES)											
23	2031 - Hot	-2.9	IP=25	5	1.5, 1.25, 1.15	Good	1, 1, 1	Good	2.00%	Good	Good
CONCLUSION: 10 MINUTES IS GOOD FOR COLD FLUID. 5 MINUTES IS GOOD FOR HOT FLUID, 7 MINUTES MAY ALSO BE ACCEPTABLE.											
OAT LESS THAN -5°C TO -10°C 100 Kts (10 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
21	2031 - Hot	-5.2	IP=25	10	2, 2, 2.1	Good	1, 5, 1	Good	1.90%	Good	Good
344	2031 - Hot	-9.1	IP=25	10	2.3, 2.4, 2.2	Good	3, 5, 5	Bad	2.30%	Good	Bad
CONCLUSION: ALLOWANCE TIMES MAY NOT BE POSSIBLE FOR HOT FLUID DUE TO RISK OF ADHESION											

Table 4.3: Summary of Type III Light Ice Pellets Allowance Time Test Results (cont'd)

OAT LESS THAN -10°C 100 Kts (10 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
295	2031 - Cold	-18.7	IP=25	10	2.2, 2.2, 2.7	Good	1, 1.8, 2.1	Good	5.55%	Review	Review
297	2031 - Hot	-18.1	IP=25	10	2.2, 2.1, 2.7	Good	2.3, 3.8, 1.6	Bad	4.79%	Good	Bad
343	2031 - Cold	-11.4	IP=25	10	2.5, 2.7, 2.8	Good	1, 1, 1.3	Good	1.76%	Good	Good
CONCLUSION: 10 MINUTES IS GOOD FOR COLD FLUID. **ALLOWANCE TIMES MAY NOT BE POSSIBLE FOR HOT FLUID DUE TO RISK OF ADHESION**											

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5. MODERATE ICE PELLET ALLOWANCE TIMES

A summary of the Moderate Ice Pellet tests conducted with Type III and Type IV fluids in the wind tunnel is shown in Table 5.1 and Table 5.2. The tables provide relevant information for each of the tests, as well as final values used for the data analysis. Each row contains data specific to one test. A more detailed test log of all conditions tested using the wind tunnel is provided in Subsection 3.1.

5.1 Analysis of Data Collected

The data collected has been sorted according to test parameters and included in the respective cells of the ice pellet allowance time table format for ease of reference; this is shown in Table 5.3 and Table 5.4. A more detailed analysis separating the data according to the allowance time cell and rotation speed has been conducted and is shown in Table 5.5 and Table 5.6. In addition, a conclusion regarding the test results has also been included for each condition in Table 5.5 and Table 5.6.

5.2 Overall Summary of Results

5.2.1 Type III Testing

The testing results indicated that an allowance time of 5 minutes was acceptable for Type III fluid down to below -10ºC when applied cold (air temperature). The data collected with heated fluid applications indicated risks of adhered contamination, especially at colder temperatures; therefore, providing allowance times was not feasible without more extensive testing to understand the potential effects.

Additional tests with heated Type IV fluids were conducted to confirm the results seen with Type III fluid. The results indicated that less adherence occurred with Type IV fluids (likely due to the thicker fluid); however, adherence did still occur, further supporting why allowance times have only existed for unheated fluid applications.

5.2.2 Type IV Testing

The testing results showed that, for Type IV propylene glycol (PG) fluids, the existing 10-minute allowance time at 115 knots rotation speed should be limited to -16ºC due to the higher lift losses observed. The data collected this year, as well as in previous years with the same wing model, supports this change to the current guidance.

Preliminary testing has also indicated that a shorter allowance time could be explored as an alternative; however, shorter allowance times may not be as useful operationally.

Table 5.1: Summary of 2013-14 Type III Moderate Ice Pellet Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
16	IP Mod	2031 - Cold	8	20	-7.3	-4.8	IP=75	5	2, 2, 2.15	1, 1.1, 1.4	1.63%	100
24	IP Mod	2031 - Hot	8	20	-6.7	-3	IP=75	5	2.25, 2, 2.25	1, 5, 1	1.46%	100
296	IP Mod	2031 - Cold	8	20	-20.6	-17.7	IP=75	5	2.3, 2.3, 2.8	1, 1.8, 2.1	4.90%	100
298	IP Mod	2031 - Hot	8	20	-21.3	-19	IP=75	5	2.2, 2.5, 3.2	2.4, 5, 2	4.73%	100
345	IP Mod	2031 - Cold	8	20	-7.8	-6.9	IP=75	5	2.5, 2.7, 2.8	1, 1.1, 1.2	2.04%	100
346	IP Mod	2031 - Hot	8	20	-7.9	-6.4	IP=75	5	2.8, 2.4, 2.2	2.3, 4.7, 2.5	1.77%	100
349	IP Mod	2031 - Hot	8	20	-12.4	-9.5	IP=75	5	2.7, 2.7, 2.5	3, 5, 5	3.61%	100

Table 5.2: Summary of 2013-14 Type IV Moderate Ice Pellet Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
330	IP Mod	Launch	8	20	-20	-18.1	IP=75	10	2.5, 3, 3.6	1, 1.9, 2.4	7.67%	115
331	IP Mod	Launch	8	20	-20.2	-16.3	IP=75	10	2.7, 2.8, 3.6	1.1, 2.1, 2.5	8.95%	115
332	IP Mod	Launch	8	20	-20.6	-17	IP=75	10	2.9, 2.8, 3.8	1.1, 1.7, 2.5	9.25%	115
333	IP Mod	Launch	8	20	-20.6	-16.4	IP=75	10	3, 2.8, 3.8	1.1, 1.9, 2.4	9.42%	115
334	IP Mod	Launch	8	20	-20.9	-18.8	IP=75	10	2.9, 2.8, 3.8	1.1, 1.9, 2.3	10.82%	115
335	IP Mod	Launch	8	20	-21	-20	IP=75	10	2.8, 2.8, 3.8	1.1, 1.9, 2.2	9.55%	115
336	IP Mod	Launch	8	20	-21.4	-19.6	IP=75	10	3, 2.8, 3.8	1.1, 1.6, 2.2	9.35%	115
337	IP Mod	Launch	8	20	-21.9	-20.6	IP=75	5	2.6, 2.5, 3.7	1.1, 1.8, 2.2	8.66%	115
338	IP Mod	ABC-S Plus	8	20	-22.3	-20.6	IP=75	7	2.8, 2.7, 3.8	1, 1.7, 2.1	6.61%	115
339	IP Mod	Max-Flight	8	20	-22.6	-21.5	IP=75	7	2.6, 2.6, 3.9	1, 1.7, 2.2	7.35%	115
340	IP Mod	Polar Guard Advance	8	20	-22.8	-21.4	IP=75	10	2.7, 2.4, 3.8	1, 1.6, 2.2	6.37%	115

Table 5.2: Summary of 2013-14 Type IV Moderate Ice Pellet Testing (cont'd)

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
347	IP Mod	ABC-S Plus - Hot	8	20	-11.3	-9.4	IP=75	10	2.1, 2.4, 2.8	3, 5, 5	5.13%	100
348	IP Mod	EG106 - Hot	8	20	-11.7	-10.6	IP=75	10	2.5, 2.3, 3	3, 5, 5	1.40%	100
356	IP Mod	AD-49	8	20	-18.7	-11.6	IP=75	7	2.7, 2.4, 3.5	1.2, 1.6, 2	6.66%	115
357	IP Mod	AD-49	8	20	-17.9	-14	IP=75	10	3, 2.8, 3.8	1.2, 1.6, 2.2	7.16%	115
358	IP Mod	ABC-S Plus	8	20	-16.9	-12.2	IP=75	10	2.5, 2.3, 3.8	1, 1.5, -	#VALUE!	115
359	IP Mod	ABC-S Plus	8	20	-14.1	-10.9	IP=75	10	2.4, 2.4, 3.8	1.1, 1.5, 1.9	7.31%	115
360	IP Mod	Launch	8	20	-12.3	-12.1	IP=75	10	2.3, 2.3, 3.7	1.1, 1.3, 1.9	6.95%	115
361	IP Mod	Max-Flight	8	20	-11	-10.9	IP=75	10	2.2, 2.3, 3.3	1, 1.2, 1.7	5.08%	115
362	IP Mod	Polar Guard Advance	8	20	-10.9	-11	IP=75	10	2.3, 2.3, 3.3	1, 1.3, 1.7	6.01%	115
363	IP Mod	ABC-S Plus	8	20	-10.6	-7.4	IP=75	10	2, 2, 2.8	1, 1.3, 1.7	8.72%	100
364	IP Mod	EG106	8	20	-10.2	-7.1	IP=75	10	2.3, 2.3, 2.8	3, 5, 5	1.56%	100

Table 5.3: Type III Moderate Ice Pellets Allowance Time Tests Winter 2013-14

Moderate Ice Pellets	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 kts	5 Minutes Tests # 16, 24 (h)	5 Minutes Tests # 345, 346 (h), 349 (h)	10 Minutes Tests # 347, 348, 363, 364
			5 Minutes Tests # 296, 298 (h)

Note: (h) = Hot Application of Fluid

Table 5.4: Type IV Moderate Ice Pellets Allowance Time Tests Winter 2013-14

Moderate Ice Pellets	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 kts	25 Minutes N/A	10 Minutes N/A	5 Minutes Tests # 337
115 kts			10 Minutes Tests # 330, 331, 332, 333, 334, 335, 336, 340, 357, 358, 359, 360, 361, 362
			7 Minutes Tests # 338, 339, 356

Table 5.5: Summary of Type III Moderate Ice Pellets Allowance Time Test Results

OAT -5°C AND ABOVE 100 Kts (5 MINUTES)											
Run #	Fluid	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE, TE, Flap)	Before Takeoff Status	Visual Contamination Rating at Rotation (LE, TE, Flap)	At Rotation Status	% Lift Loss	Lift Loss Status	Overall Status
16	2031 - Cold	-4.8	IP=75	5	2, 2, 2.15	**Good**	1, 1.1, 1.4	**Good**	1.63%	**Good**	**Good**
24	2031 - Hot	-3	IP=75	5	2.25, 2, 2.25	**Good**	1, 5, 1	**Good**	1.46%	**Good**	**Good**
CONCLUSION: 5 MINUTES IS GOOD FOR COLD FLUID. 5 MINUTES MAY BE OK FOR HOT FLUID.											

OAT LESS THAN -5°C TO -10°C 100 Kts (5 MINUTES)											
Run #	Fluid	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE, TE, Flap)	Before Takeoff Status	Visual Contamination Rating at Rotation (LE, TE, Flap)	At Rotation Status	% Lift Loss	Lift Loss Status	Overall Status
345	2031 - Cold	-6.9	IP=75	5	2.5, 2.7, 2.8	**Good**	1, 1.1, 1.2	**Good**	2.04%	**Good**	**Good**
346	2031 - Hot	-6.4	IP=75	5	2.8, 2.4, 2.2	**Good**	2.3, 4.7, 2.5	**Bad**	1.77%	**Good**	**Bad**
349	2031 - Hot	-9.5	IP=75	5	2.7, 2.7, 2.5	**Good**	3, 5, 5	**Bad**	3.61%	**Good**	**Bad**
CONCLUSION: 5 MINUTES IS GOOD FOR COLD FLUID. ALLOWANCE TIMES MAY NOT BE POSSIBLE FOR HOT FLUID DUE TO RISK OF ADHERED ICE PELLETS.											

Table 5.5: Summary of Type III Moderate Ice Pellets Allowance Time Test Results (cont'd)

<table>
<tr><th colspan="12">OAT LESS THAN -10°C 100 Kts (5 MINUTES)</th></tr>
<tr><th>Run #</th><th>Fluid</th><th>Tunnel Temp. Before Test (°C)</th><th>Precipitation Rate (g/dm²/h)</th><th>Exposure Time (min)</th><th>Visual Contamination Rating Before Takeoff (LE, TE, Flap)</th><th>Before Takeoff Status</th><th>Visual Contamination Rating at Rotation (LE, TE, Flap)</th><th>At Rotation Status</th><th>% Lift Loss</th><th>Lift Loss Status</th><th>Overall Status</th></tr>
<tr><td>296</td><td>2031 - Cold</td><td>-17.7</td><td>IP=75</td><td>5</td><td>2.3, 2.3, 2.8</td><td>Good</td><td>1, 1.8, 2.1</td><td>Good</td><td>4.90%</td><td>Good</td><td>Good</td></tr>
<tr><td>298</td><td>2031 - Hot</td><td>-19</td><td>IP=75</td><td>5</td><td>2.2, 2.5, 3.2</td><td>Good</td><td>2.4, 5, 2</td><td>Bad</td><td>4.73%</td><td>Good</td><td>Bad</td></tr>
<tr><td colspan="12">CONCLUSION: 5 MINUTES IS GOOD FOR COLD FLUID.
ALLOWANCE TIMES MAY NOT BE POSSIBLE FOR HOT FLUID DUE TO RISK OF ADHERED ICE PELLETS.</td></tr>
</table>

<table>
<tr><th colspan="12">ADDITIONAL TYPE IV TESTING TO CONFIRM
ADHERENCE ISSUES OBSERVED WITH TYPE III
OAT Less than -10°C (10 MINUTES)</th></tr>
<tr><td>347</td><td>ABC-S Plus - Hot</td><td>-9.4</td><td>IP=75</td><td>10</td><td>2.1, 2.4, 2.8</td><td>Good</td><td>3, 5, 5</td><td>Bad</td><td>5.13%</td><td>Good</td><td>Bad</td></tr>
<tr><td>348</td><td>EG106 - Hot</td><td>-10.6</td><td>IP=75</td><td>10</td><td>2.5, 2.3, 3</td><td>Good</td><td>3, 5, 5</td><td>Bad</td><td>1.40%</td><td>Good</td><td>Bad</td></tr>
<tr><td>363</td><td>ABC-S Plus</td><td>-7.4</td><td>IP=75</td><td>10</td><td>2, 2, 2.8</td><td>Good</td><td>1, 1.3, 1.7</td><td>Good</td><td>8.72%</td><td>Review</td><td>Review</td></tr>
<tr><td>364</td><td>EG106</td><td>-7.1</td><td>IP=75</td><td>10</td><td>2.3, 2.3, 2.8</td><td>Good</td><td>3, 5, 5</td><td>Bad</td><td>1.56%</td><td>Good</td><td>Bad</td></tr>
<tr><td colspan="12">CONCLUSION: SIMILAR TO TYPE III FLUID, ALLOWANCE TIMES MAY NOT BE POSSIBLE FOR HOT FLUID DUE TO RISK OF ADHERED ICE PELLETS.</td></tr>
</table>

Table 5.6: Summary of Type IV Moderate Ice Pellets Allowance Time Test Results

Run #	Fluid	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE, TE, Flap)	Before Takeoff Status	Visual Contamination Rating at Rotation (LE, TE, Flap)	At Rotation Status	% Lift Loss	Lift Loss Status	Overall Status
OAT Less than -10°C 100 Kts (5 MINUTES)											
337	Launch	-20.6	IP=75	5	2.6, 2.5, 3.7	**Good**	1.1, 1.8, 2.2	**Review**	8.66%	**Review**	**Review**
115 Kts (10 MINUTES)											
330	Launch	-18.1	IP=75	10	2.5, 3, 3.6	**Good**	1, 1.9, 2.4	**Good**	7.67%	**Review**	**Review**
331	Launch	-16.3	IP=75	10	2.7, 2.8, 3.6	**Good**	1.1, 2.1, 2.5	**Review**	8.95%	**Review**	**Review**
332	Launch	-17	IP=75	10	2.9, 2.8, 3.8	**Good**	1.1, 1.7, 2.5	**Review**	9.25%	**Bad**	**Bad**
333	Launch	-16.4	IP=75	10	3, 2.8, 3.8	**Good**	1.1, 1.9, 2.4	**Review**	9.42%	**Bad**	**Bad**
334	Launch	-18.8	IP=75	10	2.9, 2.8, 3.8	**Good**	1.1, 1.9, 2.3	**Review**	10.82%	**Bad**	**Bad**
335	Launch	-20	IP=75	10	2.8, 2.8, 3.8	**Good**	1.1, 1.9, 2.2	**Review**	9.55%	**Bad**	**Bad**
336	Launch	-19.6	IP=75	10	3, 2.8, 3.8	**Good**	1.1, 1.6, 2.2	**Review**	9.35%	**Bad**	**Bad**
340	Polar Guard Advance	-21.4	IP=75	10	2.7, 2.4, 3.8	**Good**	1, 1.6, 2.2	**Good**	6.37%	**Review**	**Review**
357	AD-49	-14	IP=75	10	3, 2.8, 3.8	**Good**	1.2, 1.6, 2.2	**Review**	7.16%	**Review**	**Review**
358	ABC-S Plus	-12.2	IP=75	10	2.5, 2.3, 3.8	**Good**	1, 1.5, -	**Good**			
359	ABC-S Plus	-10.9	IP=75	10	2.4, 2.4, 3.8	**Good**	1.1, 1.5, 1.9	**Review**	7.31%	**Review**	**Review**
360	Launch	-12.1	IP=75	10	2.3, 2.3, 3.7	**Good**	1.1, 1.3, 1.9	**Review**	6.95%	**Review**	**Review**

Table 5.6: Summary of Type IV Moderate Ice Pellets Allowance Time Test Results (cont'd)

115 Kts (10 MINUTES) Cont'd											
361	Max-Flight	-10.9	IP=75	10	2.2, 2.3, 3.3	**Good**	1, 1.2, 1.7	**Good**	5.08%	**Good**	**Good**
362	Polar Guard Advance	-11	IP=75	10	2.3, 2.3, 3.3	**Good**	1, 1.3, 1.7	**Good**	6.01%	**Review**	**Review**
115 Kts (7 MINUTES)											
338	ABC-S Plus	-20.6	IP=75	7	2.8, 2.7, 3.8	**Good**	1, 1.7, 2.1	**Good**	6.61%	**Review**	**Review**
339	Max-Flight	-21.5	IP=75	7	2.6, 2.6, 3.9	**Good**	1, 1.7, 2.2	**Good**	7.35%	**Review**	**Review**
356	AD-49	-11.6	IP=75	7	2.7, 2.4, 3.5	**Good**	1.2, 1.6, 2	**Review**	6.66%	**Review**	**Review**
CONCLUSION: 10-MINUTE ALLOWANCE TIMES @ 115 KTS SHOULD BE LIMITED TO -16°C FOR PG FLUIDS. ALTERNATIVELY, SHORTER ALLOWANCE TIMES COULD BE EXPLORED.											

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6. LIGHT ICE PELLETS MIXED WITH LIGHT FREEZING RAIN ALLOWANCE TIMES

A summary of the Light Ice Pellets mixed with Light Freezing Rain tests conducted with Type III fluid in the wind tunnel is shown in Table 6.1. The table provides relevant information for each of the tests, as well as final values used for the data analysis. Each row contains data specific to one test. A more detailed test log of all conditions tested using the wind tunnel is provided in Subsection 3.1.

It should be noted that Type IV testing was not conducted in Light Ice Pellet Mixed with Light Freezing Rain conditions, as this was not an area of high priority for the 2013-14 research program. Also, allowance times developed for Light Ice Pellets Mixed with Light Freezing Rain are also applied to Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle as well as Light Ice Pellets Mixed with Light Rain, as this was determined to be a conservative approach based on the rate of precipitation and risk of adherence.

6.1 Analysis of Data Collected

The data collected has been sorted according to test parameters and included in the respective cells of the ice pellet allowance time table format for ease of reference; this is shown in Table 6.2. A more detailed analysis separating the data according to the allowance time cell and rotation speed has been conducted and is shown in Table 6.3. In addition, a conclusion regarding the test results has also been included for each condition in Table 6.3.

6.2 Overall Summary of Results

6.2.1 Type III Testing

The testing results indicated that allowance times of 7 minutes at -5°C and above and 5 minutes below -5°C were acceptable for Type III fluid when applied cold (air temperature). The data collected with heated fluid applications indicated risks of adhered contamination, especially at colder temperatures; therefore, providing allowance times was not feasible without more extensive testing to understand the potential effects.

Table 6.1: Summary of 2013-14 Type III Light Ice Pellets and Light Freezing Rain Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
19	IP- / ZR-	2031 - Cold	8	20	-9.2	-3.8	IP=25 ZR=25	7	2, 2, 2.15	1, 1, 1.5	1.57%	100
20	IP- / ZR-	2031 - Hot	8	20	-8.5	-3.3	IP=25 ZR=25	7	1.25, 1.5, 1.45	1, 1, 1	1.77%	100
350	IP- / ZR-	2031 - Cold	8	20	-12.2	-11.1	IP=25 ZR=25	5	2.5, 2.7, 2.9	1, 1.1, 1.5	2.68%	100
351	IP- / ZR-	2031 - Hot	8	20	-12.9	-9.6	IP=25 ZR=25	5	2, 2, 2.3	5, 5, 5	2.15%	100

Table 6.2: Type III Light Ice Pellets and Light Freezing Rain Allowance Time Tests Winter 2013-14

Light Ice Pellets Mixed with Moderate Rain	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 kts	7 Minutes Test # 19, 20 (h)	5 Minutes Test # 351 (h)	5 Minutes Test # 350

Note: (h) = Hot Application of Fluid

Table 6.3: Summary of Type III Light Ice Pellets and Light Freezing Rain Allowance Time Test Results

OAT -5°C AND ABOVE 100 Kts (7 MINUTES)

Run #	Fluid	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE, TE, Flap)	Before Takeoff Status	Visual Contamination Rating at Rotation (LE, TE, Flap)	At Rotation Status	% Lift Loss	Lift Loss Status	Overall Status
19	2031 - Cold	-3.8	IP=25 ZR=25	7	2, 2, 2.15	Good	1, 1, 1.5	Good	1.57%	Good	Good
20	2031 - Hot	-3.3	IP=25 ZR=25	7	1.25, 1.5, 1.45	Good	1, 1, 1	Good	1.77%	Good	Good

CONCLUSION: 7 MINUTES IS GOOD FOR COLD FLUID.
7 MINUTES MAY ALSO BE OK FOR HOT FLUID.

OAT LESS THAN -5°C TO -10°C 100 Kts (5 MINUTES)

Run #	Fluid	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE, TE, Flap)	Before Takeoff Status	Visual Contamination Rating at Rotation (LE, TE, Flap)	At Rotation Status	% Lift Loss	Lift Loss Status	Overall Status
351	2031 - Hot	-9.6	IP=25 ZR=25	5	2, 2, 2.3	Good	5, 5, 5	Bad	2.15%	Good	Bad

CONCLUSION:
ALLOWANCE TIMES MAY NOT BE POSSIBLE FOR HOT FLUID DUE TO RISK OF ADHERED ICE PELLETS.

OAT LESS THAN -10°C 100 Kts (5 MINUTES)

Run #	Fluid	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE, TE, Flap)	Before Takeoff Status	Visual Contamination Rating at Rotation (LE, TE, Flap)	At Rotation Status	% Lift Loss	Lift Loss Status	Overall Status
350	2031 - Cold	-11.1	IP=25 ZR=25	5	2.5, 2.7, 2.9	Good	1, 1.1, 1.5	Good	2.68%	Good	Good

CONCLUSION: 5 MINUTES IS GOOD FOR COLD FLUID.

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7. LIGHT ICE PELLETS MIXED WITH MODERATE RAIN ALLOWANCE TIMES

Testing in Light Ice Pellets mixed with Moderate Rain was not conducted with either Type III or Type IV fluids during the winter of 2013-14. As a result, no changes were made to the existing Type IV allowance times, and no new allowance times were issued for Type III fluid.

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8. LIGHT ICE PELLETS MIXED WITH LIGHT SNOW ALLOWANCE TIMES

A summary of the Light Ice Pellets Mixed with Light Snow tests conducted with Type III and Type IV fluids in the wind tunnel is shown in Table 8.1 and Table 8.2. The tables provide relevant information for each of the tests, as well as final values used for the data analysis. Each row contains data specific to one test. A more detailed test log of all conditions tested using the wind tunnel is provided in Subsection 3.1.

8.1 Analysis of Data Collected

The data collected has been sorted according to test parameters and included in the respective cells of the ice pellet allowance time table format for ease of reference; this is shown in Table 8.3 and Table 8.4. A more detailed analysis separating the data according to the allowance time cell and rotation speed has been conducted and is shown in Table 8.5 and Table 8.6. In addition, a conclusion regarding the test results has also been included for each condition in Table 8.5 and Table 8.6.

8.2 Overall Summary of Results

8.2.1 Type III Testing

The testing results indicated that an allowance time of 10 minutes was acceptable for Type III fluid when applied cold (air temperature). No testing was conducted with heated fluids as early indications with ice pellets showed that this was not feasible without more extensive testing to understand the potential effects.

8.2.2 Type IV Testing

The testing results showed that for OAT less than -10°C, a 10-minute allowance time at 100 knots or 15-minute allowance time at 115 knots could be feasible. Higher lift losses at the colder temperatures raised some concern, and therefore some additional tests and analysis are recommended to further substantiate these results.

Table 8.1: Summary of 2013-14 Type III Light Ice Pellets and Light Snow Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
14	IP- / SN-	2031 - Cold	8	20	-7.2	-4.2	IP=25 SN=10	10	2, 2, 2.1	1, 1.05, 1.25	1.64%	100
352	IP- / SN-	2031 - Cold	8	20	-12.8	-11	IP=25 SN=10	10	2.5, 2.8, 3.3	1.1, 1.4, 1.8	3.75%	100

Table 8.2: Summary of 2013-14 Type IV Light Ice Pellets and Light Snow Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
9	IP- / SN-	ABC-S Plus	8	20	-10.1	-7.3	IP=25 SN=10	10	2, 2, 2.5	1, 1.5, 1.75	6.47%	100
304	IP- / SN-	Polar Guard Advance	8	20	-23.5	-14.6	IP=25 SN=10	15	2.5, 2.7, 3.83	1.2, 1.9, 3.2	8.01%	115
305	IP- / SN-	Polar Guard Advance	8	20	-23.8	-11.4	IP=25 SN=10	15	2.5, 2.6, 3.8	1.2, 2, 3	7.80%	115
306	IP- / SN-	Polar Guard Advance	8	20	-24	-14.4	IP=25 SN=10	15	2.3, 2.3, 3.6	1.2, 1.8, 3	7.97%	115
309	IP- / SN-	Polar Guard Advance	8	20	-22.6	-9.6	IP=25 SN=10	15	2.8, 2.8, 4	1.1, 2, 3.3	7.94%	115
310	IP- / SN-	EG106	8	20	-23.1	-17.4	IP=25 SN=10	15	1.7, 1.7, 2.3	1, 1.3, 1.5	2.00%	115
311	IP- / SN-	EG106	8	20	-23.9	-18.1	IP=25 SN=10	15	1.9, 1.9, 2.3	1.1, 1.5, 1.7	4.06%	100
312	IP- / SN-	Launch	8	20	-24.3	-17.4	IP=25 SN=10	15	2.8, 2.7, 3.7	1.1, 1.9, 2.4	9.11%	115
313	IP- / SN-	Max-Flight	8	20	-24.5	-15.3	IP=25 SN=10	15	2.6, 2.5, 3.5	1.1, 1.8, 2.4	8.54%	115
314	IP- / SN-	AD-49	8	20	-24.8	-19.8	IP=25 SN=10	15	3, 2.4, 4	1.3, 2, 3.7	8.39%	115
315	IP- / SN-	AD-49	8	20	-25.1	-19.4	IP=25 SN=10	10	2.9, 2.8, 3.8	4.1, 2.1, 3.2	7.14%	115

Table 8.3: Type III Light Ice Pellets and Light Snow Allowance Time Tests Winter 2013-14

Light Ice Pellets Mixed with Light Snow	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 Kts	10 Minutes Test # 14	10 Minutes	10 Minutes Test # 352

Note: (h) = Hot Application of Fluid

Table 8.4: Type IV Light Ice Pellets and Light Snow Allowance Time Tests Winter 2013-14

Light Ice Pellets Mixed with Light Snow	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 Kts	25 Minutes	15 Minutes Test # 9	15 Minutes Test # 311
		10 Minutes	10 Minutes
115 Kts		15 Minutes Test # 309	10 Minutes Tests # 315
			15 Minutes Test # 304, 310, 312, 313, 314, 305, 306

Table 8.5: Summary of Type III Light Ice Pellets and Light Snow Allowance Time Test Results

<table>
<tr><th colspan="12">OAT -5°C AND ABOVE 100 Kts (10 MINUTES)</th></tr>
<tr><th>Run #</th><th>Fluid</th><th>Tunnel Temp. Before Test (°C)</th><th>Precipitation Rate (g/dm²/h)</th><th>Exposure Time (min)</th><th>Visual Contamination Rating Before Takeoff (LE, TE, Flap)</th><th>Before Takeoff Status</th><th>Visual Contamination Rating at Rotation (LE, TE, Flap)</th><th>At Rotation Status</th><th>% Lift Loss</th><th>Lift Loss Status</th><th>Overall Status</th></tr>
<tr><td>14</td><td>2031 - Cold</td><td>-4.2</td><td>IP=25 SN=10</td><td>10</td><td>2, 2, 2.1</td><td>Good</td><td>1, 1.05, 1.25</td><td>Good</td><td>1.64%</td><td>Good</td><td>Good</td></tr>
<tr><td colspan="12">CONCLUSION: 10 MINUTES IS GOOD FOR COLD FLUID.</td></tr>
</table>

<table>
<tr><th colspan="12">OAT LESS THAN -10°C (10 MINUTES)</th></tr>
<tr><th>Run #</th><th>Fluid</th><th>Tunnel Temp. Before Test (°C)</th><th>Precipitation Rate (g/dm²/h)</th><th>Exposure Time (min)</th><th>Visual Contamination Rating Before Takeoff (LE, TE, Flap)</th><th>Before Takeoff Status</th><th>Visual Contamination Rating at Rotation (LE, TE, Flap)</th><th>At Rotation Status</th><th>% Lift Loss</th><th>Lift Loss Status</th><th>Overall Status</th></tr>
<tr><td>352</td><td>2031 - Cold</td><td>-11</td><td>IP=25 SN=10</td><td>10</td><td>2.5, 2.8, 3.3</td><td>Good</td><td>1.1, 1.4, 1.8</td><td>Review</td><td>3.75%</td><td>Good</td><td>Review</td></tr>
<tr><td colspan="12">CONCLUSION: 10 MINUTES IS GOOD FOR COLD FLUID.</td></tr>
</table>

Table 8.6: Summary of Type IV Light Ice Pellets and Light Snow Allowance Time Test Results

<table>
<tr><th colspan="12">OAT LESS THAN -10°C</th></tr>
<tr><th>Run #</th><th>Fluid</th><th>Tunnel Temp. Before Test (°C)</th><th>Precipitation Rate (g/dm²/h)</th><th>Exposure Time (min)</th><th>Visual Contamination Rating Before Takeoff (LE, TE, Flap)</th><th>Before Takeoff Status</th><th>Visual Contamination Rating at Rotation (LE, TE, Flap)</th><th>At Rotation Status</th><th>% Lift Loss</th><th>Lift Loss Status</th><th>Overall Status</th></tr>
<tr><th colspan="12">100 Kts (10 MINUTES)</th></tr>
<tr><td>9</td><td>ABC-S Plus</td><td>-7.3</td><td>IP=25 SN=10</td><td>10</td><td>2, 2, 2.5</td><td>Good</td><td>1, 1.5, 1.75</td><td>Good</td><td>6.47%</td><td>Review</td><td>Review</td></tr>
</table>

Table 8.6: Summary of Type IV Light Ice Pellets and Light Snow Allowance Time Test Results (cont'd)

100 Kts (15 MINUTES)											
311	EG106	-18.1	IP=25 SN=10	15	1.9, 1.9, 2.3	Good	1.1, 1.5, 1.7	Review	4.06%	Good	Review
115 Kts (10 Minutes)											
315	AD-49	-19.4	IP=25 SN=10	10	2.9, 2.8, 3.8	Good	1.2, 1.9, 3.0	Review	7.14%	Review	Review
115 Kts (15 Minutes)											
304	Polar Guard Advance	-14.6	IP=25 SN=10	15	2.5, 2.7, 3.83	Good	1.2, 1.9, 3.2	Review	8.01%	Review	Review
309	Polar Guard Advance	-9.6	IP=25 SN=10	15	2.8, 2.8, 4	Good	1.1, 2, 3.3	Review	7.94%	Review	Review
310	EG106	-17.4	IP=25 SN=10	15	1.7, 1.7, 2.3	Good	1, 1.3, 1.5	Good	2.00%	Review	Review
312	Launch	-17.4	IP=25 SN=10	15	2.8, 2.7, 3.7	Good	1.1, 1.9, 2.4	Review	9.11%	Review	Review
113	Max-Flight	-15.3	IP=25 SN=10	15	2.6, 2.5, 3.5	Good	1.1, 1.8, 2.4	Review	8.54%	Review	Review
314	AD-49	-19.8	IP=25 SN=10	15	3, 2.4, 4	Good	1.3*, 2, 3.7	Review	8.39%	Review	Review
305	Polar Guard Advance	-11.4	IP=25 SN=10	15	2.5, 2.6, 3.8	Good	1.2, 2, 3	Review	7.80%	Review	Review
306	Polar Guard Advance	-14.4	IP=25 SN=10	15	2.3, 2.3, 3.6	Good	1.2, 1.8, 3	Review	7.97%	Review	Review
CONCLUSION: 10-MINUTE TO 15-MINUTE ALLOWANCE TIMES MAY BE POSSIBLE.											

Note: Runs #9 and #309 were run in cold conditions; however, significant warming in the tunnel caused the test temperature to rise above -10ºC prior to the start.

9. LIGHT ICE PELLETS MIXED WITH MODERATE SNOW ALLOWANCE TIMES

A summary of the Light Ice Pellets Mixed with Moderate Snow tests conducted with Type III and Type IV fluids in the wind tunnel is shown in Table 9.1 and Table 9.2. The tables provide relevant information for each of the tests, as well as final values used for the data analysis. Each row contains data specific to one test. A more detailed test log of all conditions tested using the wind tunnel is provided in Subsection 3.1.

9.1 Analysis of Data Collected

The data collected has been sorted according to test parameters and included in the respective cells of the ice pellet allowance time table format for ease of reference; this is shown in Table 9.3 and Table 9.4. A more detailed analysis separating the data according to the allowance time cell and rotation speed has been conducted and is shown in Table 9.5 and Table 9.6. In addition, a conclusion regarding the test results has also been included for each condition in Table 9.5 and Table 9.6.

9.2 Overall Summary of Results

9.2.1 Type III Testing

The testing results indicated that an allowance time of 10 minutes was acceptable for Type III fluid when applied cold (air temperature). Although only 5-minute data was collected with this airfoil, historical low-speed data from 2008-09 conducted with the LS-0417 wing section indicated that a 10-minute allowance time could be possible for the below -5 ºC to -10ºC range. If future testing is planned, it is suggested that testing be conducted to further validate this allowance time.

No testing was conducted with heated fluids as early indications with ice pellets showed that this was not feasible without more extensive testing to understand the potential effects.

9.2.2 Type IV Testing

The results indicated that the 10-minute allowance time above -5ºC is valid and has potential to be expanded.

Data also helped support the expansion of the Light Ice Pellets Mixed with Moderate Snow allowance times in the below -5º to -10ºC range. The data indicated that 10 minutes would be feasible; however, the allowance was limited to 7 minutes to be conservative based on the data collected from 2009-10 to 2012-13.

Table 9.1: Summary of 2013-14 Type III Light Ice Pellets Mixed with Moderate Snow Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
13	IP- / SN	2031 - Cold	8	20	-7.4	-3.1	IP=25 SN=25	10	2.25, 1.9, 3.5	1, 1.5, 1.95	2.32%	100
25	IP- / SN	2031 - Hot	8	20	-6.1	-2.3	IP=25 SN=25	10	2.5, 2, 3.75	1, 3.25, 3.75	1.76%	100
353	IP- / SN	2031 - Cold	8	20	-13	-10.2	IP=25 SN=25	5	2.5, 2.7, 3.5	1.1, 1.4, 2	3.83%	100

Table 9.2: Summary of 2013-14 Type IV Light Ice Pellets Mixed with Moderate Snow Testing

Test #	Test Condition	Fluid Name	Rotation Angle	Flap Angle (0°, 20°)	OAT Before Test (°C)	Tunnel Temp. Before Test (°C)	Precipitation Rate (g/dm²/h)	Exposure Time (min)	Visual Contamination Rating Before Takeoff (LE,TE,Flap)	Visual Contamination Rating at Rotation (LE,TE,Flap)	Corrected for 3D Effects % Lift Loss on 8° CL vs. Dry CL	Speed Kts
10	IP- / SN	ABC-S Plus	8	20	-9.6	-6.7	IP=25 SN=25	10	2, 2, 3	1, 1.5, 2.25	6.38%	100
11	IP- / SN	Launch	8	20	-9	-5.2	IP=25 SN=25	10	2, 1.75, 3.25	1, 1.35, 2.25	6.70%	100
12	IP- / SN	AD-49	8	20	-7.4	-3.3	IP=25 SN=25	10	2, 2, 3.5	1, 1.6, 2.25	5.75%	100

Table 9.3: Type III Light Ice Pellets Mixed with Moderate Snow Allowance Time Tests Winter 2013-14

Light Ice Pellets Mixed with Moderate Snow	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 kts	10 minutes Test # 13, 25(h)	10 Minutes N/A	5 Minutes Test # 353

Note: (h) = Hot Application of Fluid

Table 9.4: Type IV Light Ice Pellets Mixed with Moderate Snow Allowance Time Tests Winter 2013-14

Light Ice Pellets Mixed with Moderate Snow	OAT -5°C and Above	OAT Less than -5°C to -10°C	OAT Less than -10°C
100 kts	10 minutes Test # 12	10 Minutes Test # 10, 11	

Table 9.5: Summary of Type III Light Ice Pellets Mixed with Moderate Snow Allowance Time Test Results

OAT -5°C AND ABOVE 100 Kts (10 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
13	2031-Cold	-3.1	IP=25 SN=25	10	2.25, 1.9, 3.5	Good	1, 1.15, 1.2	Good	2.32%	Good	Review
25	2031 - Hot	-2.3	IP=25 SN=25	10	2.5, 2, 3.75	Good	1, 3.25, 3.75	Good	1.76%	Good	Good
CONCLUSION: 10 MINUTES IS GOOD FOR COLD FLUID.											

OAT LESS THAN -10°C 100 Kts (5 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
353	2031 - Cold	-10.2	IP=25 SN=25	5	2.5, 2.7, 3.5	Good	1.1, 1.4, 2	Review	3.83%	Good	Review
CONCLUSION: 5 MINUTES IS GOOD FOR COLD FLUID. 10 MINUTES MAY BE FEASIBLE BASED ON HISTORICAL 2008-09 DATA.											

Table 9.6: Summary of Type IV Light Ice Pellets Mixed with Moderate Snow Allowance Time Test Results

OAT -5°C AND ABOVE 100 Kts (10 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
12	AD-49	-3.3	IP = 25 SN = 25	10	2, 2, 3.5	Good	1, 1.6, 2.25	Good	5.75%	Review	Review
CONCLUSION: 10-MINUTE ALLOWANCE TIME IS VALID AND COULD BE EXPANDED.											

OAT LESS THAN-5°C TO -10°C 100 Kts (10 MINUTES)											
Run #	**Fluid**	**Tunnel Temp. Before Test (°C)**	**Precipitation Rate (g/dm²/h)**	**Exposure Time (min)**	**Visual Contamination Rating Before Takeoff (LE, TE, Flap)**	**Before Takeoff Status**	**Visual Contamination Rating at Rotation (LE, TE, Flap)**	**At Rotation Status**	**% Lift Loss**	**Lift Loss Status**	**Overall Status**
10	ABC-S Plus	-6.7	IP = 25 SN = 25	10	2, 2, 3	Good	1, 1.5, 2.25	Good	6.38%	Review	Review
11	Launch	-5.2	IP = 25 SN = 25	10	2, 1.75, 3.25	Good	1, 1.35, 2.25	Good	6.70%	Review	Review
CONCLUSION: 10-MINUTE ALLOWANCE TIME IS GOOD; HOWEVER, HISTORICAL DATA LIMITS TO 7 MINUTES.											

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10. CONCLUSIONS AND OBSERVATIONS

These observations and conclusions were derived from the testing conducted during the winter of 2013-14.

10.1 Type III High-Speed Allowance Times

Testing was conducted during the winter of 2013-14 with the objective of substantiating the low-speed Type III allowance time table previously developed (but not published) in 2008-09 for use with high-speed performance aircraft. This approach was conservative, however, to minimize the costs associated with developing a brand new table and to help accelerate the development process.

The data collected in 2013-14 supported the development of a comprehensive Type III unheated fluid allowance time table for use with high-speed rotation aircraft. Preliminary data was also collected with heated Type III fluid applications; however, the tests showed risks of adhered contamination during takeoff, and therefore guidance could not be issued without further investigating the possible risks associated.

10.2 Type IV High-Speed Allowance Times

Testing was conducted during the winter of 2013-14 to validate and expand the existing allowance times. The data collected in 2013-14 supported the following changes:

- 10-minute allowance time for Moderate Ice Pellets at 115 knots rotation speed should be limited to -16°C for PG fluids due to the higher lift losses observed; and
- 7-minute allowance time for Light Ice Pellets Mixed with Moderate Snow below -5° to -10°C.

Some preliminary data also indicated the following; however, no guidance changes were made until further testing can be conducted:

- 10-minute allowance time at 100 knots or 15-minute allowance time at 115 knots could be feasible for Light Ice Pellets Mixed with Light Snow below -10°C; and
- 10-minute allowance time above -5°C for Light Ice Pellets Mixed with Moderate Snow has margin to be expanded.

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11. RECOMMENDATIONS

The following recommendations were compiled based on the work conducted during the winter of 2013-14.

11.1 Changes to Ice Pellet Allowance Time Guidance

The following changes were made to the Ice Pellet Allowance Time guidance material based on the 2013-14 wind tunnel test results.

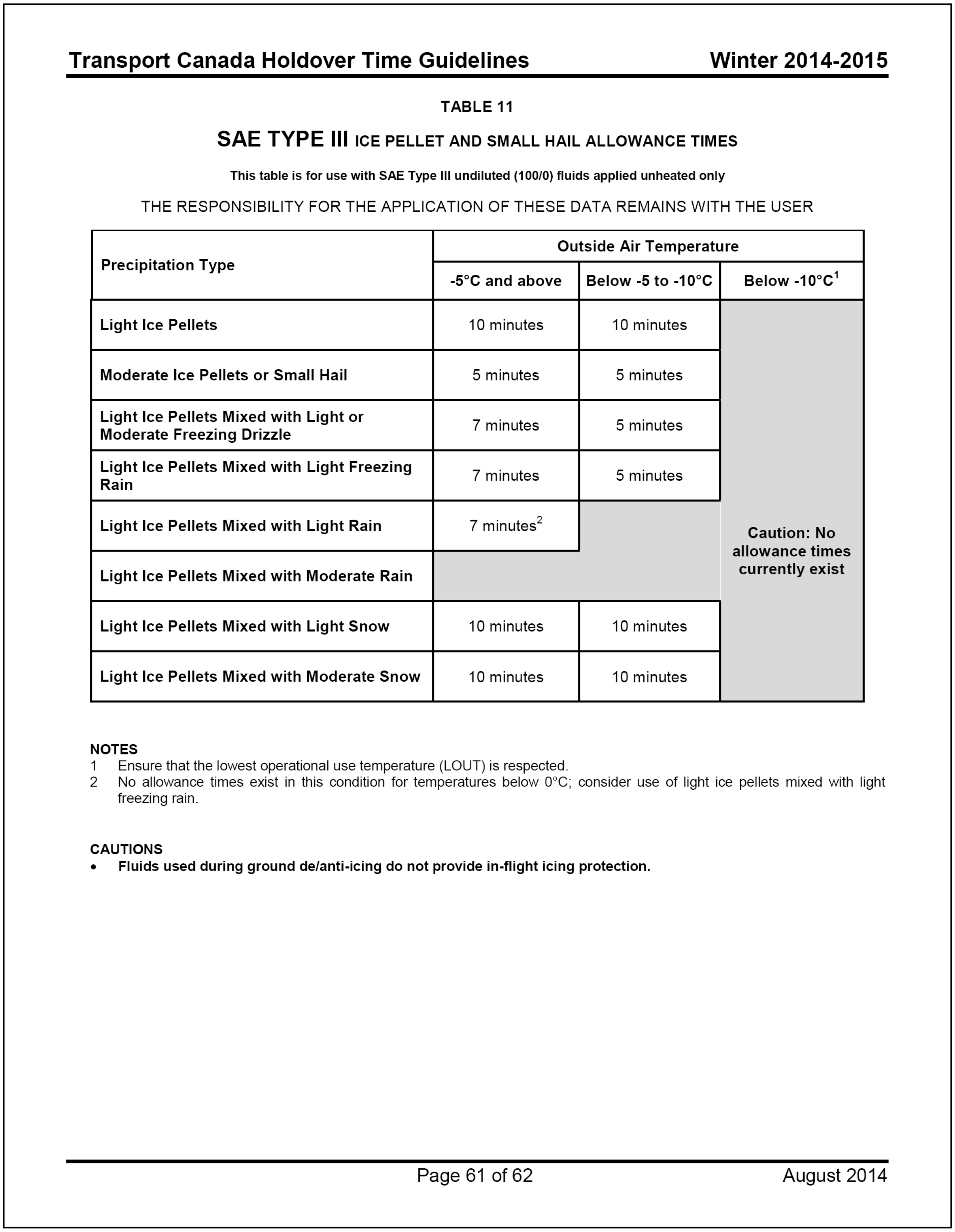
- Research was conducted to provide additional guidance for aircraft operations during ice pellet conditions when operating with undiluted (100/0) Type III fluid applied unheated. A separate ice pellet allowance time table has been developed for Type III fluids and is included in this document (Table 11.1 and Table 11.2).
- Small hail has been added to the allowance time tables as it has been determined to be meteorologically equivalent to moderate ice pellets (see previous section). It has also been added to the titles of the allowance time guidance section and allowance time tables (Table 11.1, Table 11.2, Table 11.3, and Table 11.4).
- Research has indicated that Type IV PG fluids are removed less effectively during takeoff when contaminated with moderate ice pellets at temperatures below -16°C. Therefore, operations in these conditions are not recommended, and no allowance times exist for PG fluids in conditions of moderate ice pellets at temperatures below -16°C, irrespective of aircraft rotation speed.
- Research has provided data to support a new Type IV allowance time of 7 minutes for light ice pellets mixed with moderate snow at temperatures below -5 to -10°C.

The brand new Type III allowance time table is shown in Table 11.1 and Table 11.2, and the updated Type IV allowance time table is shown in Table 11.3 and Table 11.4.

11.2 Future Testing Using the PIWT and Thin High-Performance Wing Model

The testing results have demonstrated the PIWT and thin high-performance wing model are appropriate for the testing and comparative evaluation of de/anti-icing fluid flow-off with and without contamination. It is recommended that testing continue using the existing methodologies with an outlook to continue improving on testing protocols and procedures.

Table 11.1: 2014-15 TC Type III Ice Pellet Allowance Time Table



Transport Canada Holdover Time Guidelines **Winter 2014-2015**

TABLE 11

SAE TYPE III ICE PELLET AND SMALL HAIL ALLOWANCE TIMES

This table is for use with SAE Type III undiluted (100/0) fluids applied unheated only

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

Precipitation Type	**Outside Air Temperature**		
	-5°C and above	**Below -5 to -10°C**	**Below -10°C[1]**
Light Ice Pellets	10 minutes	10 minutes	**Caution: No allowance times currently exist**
Moderate Ice Pellets or Small Hail	5 minutes	5 minutes	
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	7 minutes	5 minutes	
Light Ice Pellets Mixed with Light Freezing Rain	7 minutes	5 minutes	
Light Ice Pellets Mixed with Light Rain	7 minutes[2]		
Light Ice Pellets Mixed with Moderate Rain			
Light Ice Pellets Mixed with Light Snow	10 minutes	10 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes	10 minutes	

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected.

2 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with light freezing rain.

CAUTIONS

- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

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Table 11.2: 2014-15 FAA Type III Ice Pellet Allowance Time Table

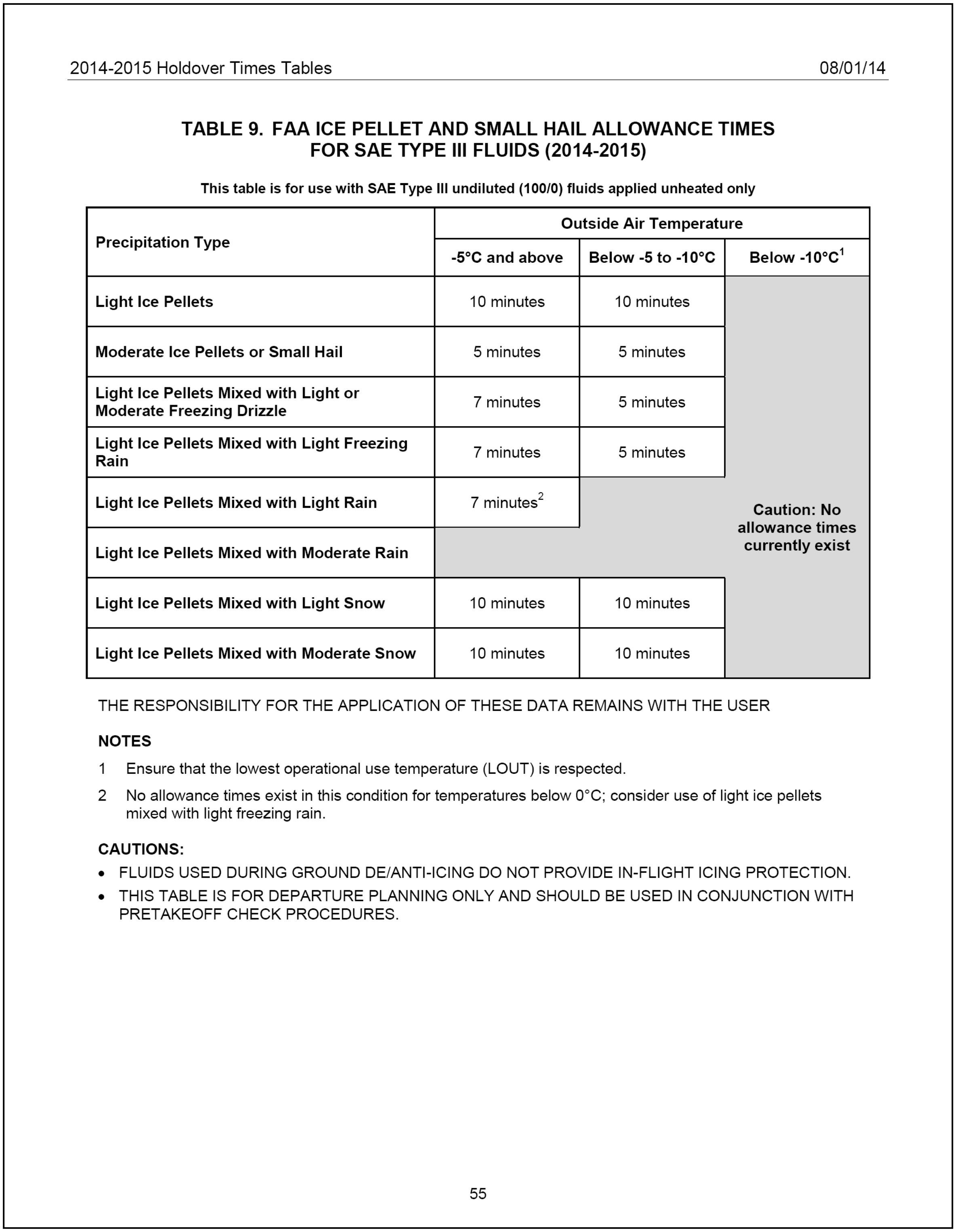

TABLE 9. FAA ICE PELLET AND SMALL HAIL ALLOWANCE TIMES FOR SAE TYPE III FLUIDS (2014-2015)

This table is for use with SAE Type III undiluted (100/0) fluids applied unheated only

Precipitation Type	**Outside Air Temperature**		
	-5°C and above	**Below -5 to -10°C**	**Below -10°C[1]**
Light Ice Pellets	10 minutes	10 minutes	**Caution: No allowance times currently exist**
Moderate Ice Pellets or Small Hail	5 minutes	5 minutes	
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	7 minutes	5 minutes	
Light Ice Pellets Mixed with Light Freezing Rain	7 minutes	5 minutes	
Light Ice Pellets Mixed with Light Rain	7 minutes[2]		
Light Ice Pellets Mixed with Moderate Rain			
Light Ice Pellets Mixed with Light Snow	10 minutes	10 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes	10 minutes	

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

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected.

2 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with light freezing rain.

CAUTIONS:

- FLUIDS USED DURING GROUND DE/ANTI-ICING DO NOT PROVIDE IN-FLIGHT ICING PROTECTION.
- THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Table 11.3: 2014-15 TC Type IV Ice Pellet Allowance Time Table

Transport Canada Holdover Time Guidelines Winter 2014-2015

TABLE 12

SAE TYPE IV ICE PELLET AND SMALL HAIL ALLOWANCE TIMES

This table is for use with SAE Type IV undiluted (100/0) fluids only.
All Type IV fluids are propylene glycol based with the exception of Dow EG106 and LNT Solutions E450 which are ethylene glycol based.

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

Precipitation Type	**Outside Air Temperature**		
	-5°C and above	**Below -5 to -10°C**	**Below -10°C**[1]
Light Ice Pellets	50 minutes	30 minutes	30 minutes[2]
Moderate Ice Pellets or Small Hail	25 minutes[3]	10 minutes	10 minutes[2,4]
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	25 minutes	10 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Light Freezing Rain	25 minutes	10 minutes	
Light Ice Pellets Mixed with Light Rain	25 minutes[5]		
Light Ice Pellets Mixed with Moderate Rain	25 minutes[6]		
Light Ice Pellets Mixed with Light Snow	25 minutes	15 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes	7 minutes	

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected.
2 No allowance times exist for propylene glycol (PG) fluids, when used on aircraft with rotation speeds less than 115 knots. (For these aircraft, if the fluid type is not known, assume zero allowance time).
3 Allowance time is 15 minutes for propylene glycol (PG) fluids or when the fluid type is unknown.
4 No allowance times exist for propylene glycol (PG) fluids in this condition for temperatures below -16°C.
5 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with light freezing rain.
6 No allowance times exist in this condition for temperatures below 0°C.

CAUTIONS

- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

Table 11.4: 2014-15 FAA Type IV Ice Pellet Allowance Time Table

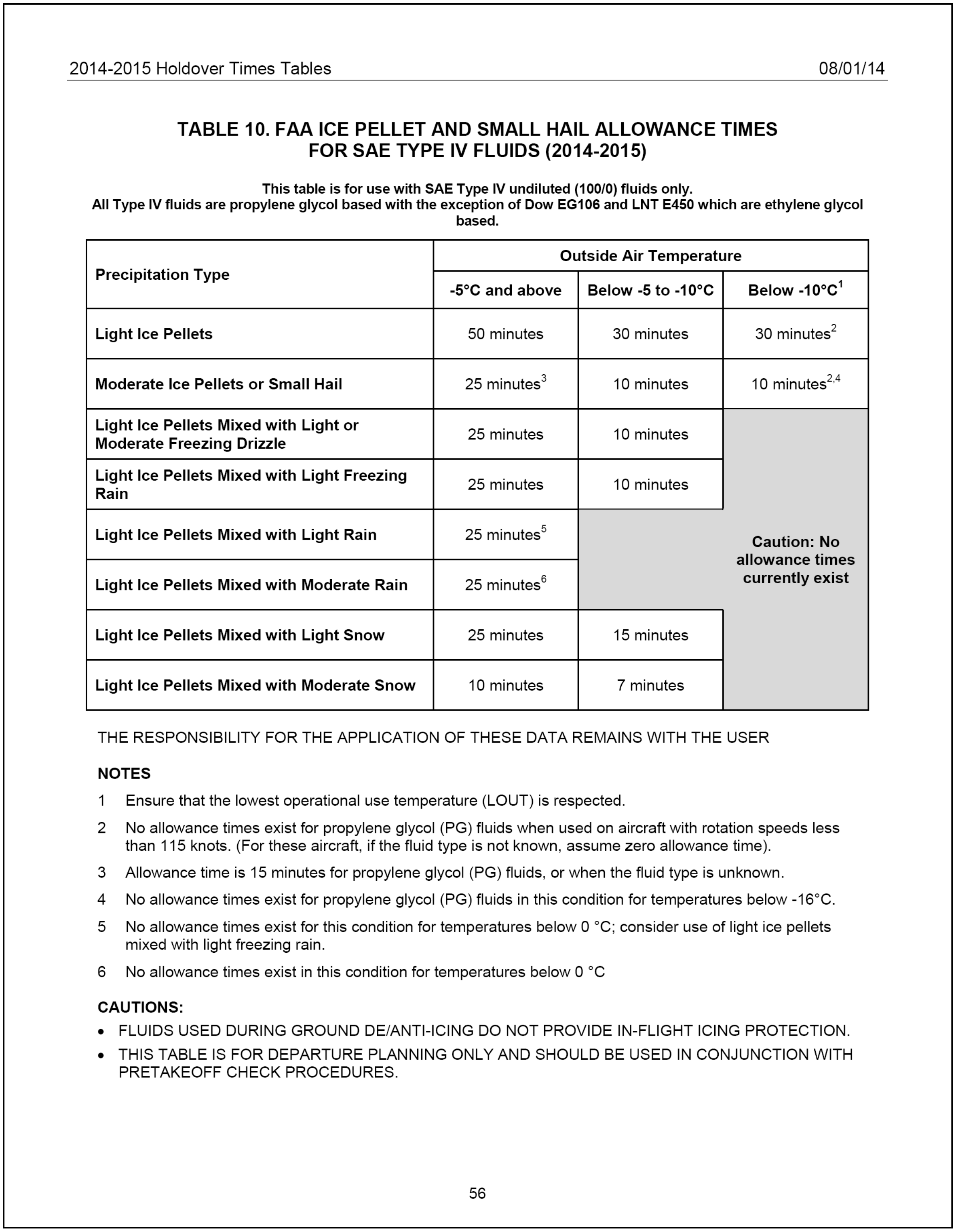

TABLE 10. FAA ICE PELLET AND SMALL HAIL ALLOWANCE TIMES FOR SAE TYPE IV FLUIDS (2014-2015)

This table is for use with SAE Type IV undiluted (100/0) fluids only.
All Type IV fluids are propylene glycol based with the exception of Dow EG106 and LNT E450 which are ethylene glycol based.

Precipitation Type	Outside Air Temperature		
	-5°C and above	Below -5 to -10°C	Below -10°C[1]
Light Ice Pellets	50 minutes	30 minutes	30 minutes[2]
Moderate Ice Pellets or Small Hail	25 minutes[3]	10 minutes	10 minutes[2,4]
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	25 minutes	10 minutes	Caution: No allowance times currently exist
Light Ice Pellets Mixed with Light Freezing Rain	25 minutes	10 minutes	
Light Ice Pellets Mixed with Light Rain	25 minutes[5]		
Light Ice Pellets Mixed with Moderate Rain	25 minutes[6]		
Light Ice Pellets Mixed with Light Snow	25 minutes	15 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes	7 minutes	

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

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected.

2 No allowance times exist for propylene glycol (PG) fluids when used on aircraft with rotation speeds less than 115 knots. (For these aircraft, if the fluid type is not known, assume zero allowance time).

3 Allowance time is 15 minutes for propylene glycol (PG) fluids, or when the fluid type is unknown.

4 No allowance times exist for propylene glycol (PG) fluids in this condition for temperatures below -16°C.

5 No allowance times exist for this condition for temperatures below 0 °C; consider use of light ice pellets mixed with light freezing rain.

6 No allowance times exist in this condition for temperatures below 0 °C

CAUTIONS:

- FLUIDS USED DURING GROUND DE/ANTI-ICING DO NOT PROVIDE IN-FLIGHT ICING PROTECTION.
- THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

11.3 Future Research

The following sections describe higher priority areas of possible future wind tunnel testing and research. These areas of future research have been determined based on consultations with TC, the FAA, and NASA and through industry discussions, and as such they may not be directly linked to the research described in this report. These areas of research have been listed below for ease of reference and to maintain continuity in the year-to-year reporting.

11.3.1 Allowance Time Expansion of Mixed Light Ice Pellets and Light and Moderate Snow Conditions

Historical winter weather data has indicated that a significant portion of ice pellet occurrences are mixed with light or moderate snow conditions. The data collected to date has indicated a potential to further expand the allowance times to include colder temperatures as well as to provide longer allowance times at the warmer temperatures. A more detailed multi-year analysis of the data collected in these conditions should be performed to determine future testing targets.

11.3.2 Lift Losses at LOUT

Previous testing has shown that lift losses in general significantly increase at the lower temperatures. Limited data is available at (or very near) the fluid LOUT. Additional testing is recommended to obtain data close to the fluid LOUT to determine the aerodynamic effects of ice pellet contamination at these colder temperatures.

11.3.3 Substantiation of Ice Pellet Allowance Times with New Fluids

Testing should continue to investigate different Type III and IV fluids to further substantiate the ice pellet allowance times. Testing should consider new fluids or fluids previously tested but with limited data.

11.3.4 Lift Loss Scaling with NASA LS-0417 and NACA 23012 Wing Sections

The extensive work conducted with the thin high-performance wing section has led to the development of a methodology for evaluating aerodynamic performance based on a lift loss scaling between the model results and the AS5900 aerodynamic acceptance test. If research capacities are available, it is recommended that limited testing be conducted with the wing sections previously tested in 2006-07 and 2008-09 to better understand the sensitivity of these models used in the development of the ice pellet allowance time tables.

REFERENCES

1. Ruggi, M., *Wind Tunnel Trials to Examine Anti-Icing Fluid Flow-Off Characteristics and to Support the Development of Ice Pellet Allowance Times, Winters 2009-10 to 2012-13,* APS Aviation Inc., Transportation Development Centre, Montreal, November 2013, TP 15232E, XX (to be published).

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APPENDIX A

TRANSPORTATION DEVELOPMENT CENTRE WORK STATEMENT EXCERPT – AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2013-14

TRANSPORTATION DEVLOPMENT CENTRE
WORK STATEMENT EXCERPT –
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2013-14

5.39 Wind Tunnel Testing

5.39.1 Testing to Further Refine Ice Pellet Allowance Times (1 Week)

NOTE: This task is scheduled for 3 total weeks of testing: 1 week related to ice pellet allowance time development, 1 week to support the development of aircraft ground deicing related procedures and technologies. The 3rd week will consist of 2 days to evaluate Type I LOUT for very low speed aircraft, and 3 days to conduct Type III allowance time testing. As such, the costing has been split accordingly.

a) Meet and discuss with NRC personnel to arrange for access to the Propulsion Wind Tunnel (PWT) in M46 at the NRC Montreal Road facility in Ottawa;

   NOTE: The NRC facility costs associated with testing at M46 are not included in this task and are dealt with directly with TC through a M.O.U. agreement with NRC.

b) Develop a procedure and test plan with the NRC staff who operates the PIWT. It is anticipated that much of the testing will be conducted during overnight hours; The procedure will specify the collection of the following data during the tests:

   i. Type and amount of fluid applied;

   ii. Type and rate of contamination applied;

   iii. Extent of fluid contamination prior to the test run;

   iv. Fluid Brix, thickness, and temperature measurements; and

   v. High speed photography and videography.

c) Conduct pre-testing setup and calibration work;

d) Perform wind tunnel tests over a period of five (5) days to further refine ice pellet allowance times with ethylene glycol and propylene glycol anti-icing fluids, to validate and possibly expand current allowance times published by TC and FAA for super-critical airfoils; and

   i. A portion of the testing will be to perform correlation testing to calibrate the TC model and to demonstrate repeatability with dry wing, fluid, and fluid and contamination. Changes or upgrades to equipment (such as ice pellet dispensers) will need to be evaluated to demonstrate repeatability through comparative testing;

  ii. Testing will attempt to expand the ice pellet allowance times in cells where allowance times are restrictive, or not currently available;
  iii. Testing will attempt to validate the ice pellet allowance times cells for use with new fluids; and
  iv. Testing will attempt to collect additional data in ice pellet allowance times cells where data with specific fluids previously tested may be limited, typically at colder temperatures.

e) Analyze the data collected, Report the findings, and prepare presentation material for the SAE G-12 meetings.

5.39.4 Type III Ice Pellet Allowance Timed Testing - Phase 1 (3 Days)

Testing will be done according to the procedures and methodologies used for "Testing to Further Refine Ice Pellet Allowance Times".

a) Identify other aircraft types that may be affected by lack of current operational guidance. Identify current operational performance limitations associated with dispatching during ice pellet conditions in affected aircraft types;

b) Conduct a thorough review of Type III data collected in previous years of ice pellet testing to determine information gaps;

c) Develop procedure for conducting wind tunnel testing in accordance with the existing ice pellet allowance time testing methodology;

d) Conduct testing over a period of three (3) days at the NRC PIWT. Testing will target obtaining data to fill the information gaps from previous years, and to provide guidance that could be useful for the operation at Toronto Island Airport;

e) Analyze the data and develop preliminary Type III allowance time guidance;

f) Report the findings, and prepare presentation material for the SAE G-12 meetings; and

g) If appropriate publish limited Type III allowance times in the Transport Canada 2014-2015 HOT Guidelines.

APPENDIX B

PROCEDURE:
WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

CM2265.003

WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

Winter 2013-14

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Marco Ruggi and Victoria Zoitakis

Reviewed by: John D'Avirro

January 6, 2014
Final Version 1.0

WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

1. BACKGROUND

Prior to the winter of 2006-07, Holdover Time (HOT) guidance material did not exist for ice pellet conditions, however aircraft could still depart during ice pellet conditions following aircraft deicing and a pre take off contamination check. This protocol was feasible for common air carrier aircraft that provided access to emergency exit windows overlooking the leading edge of the aircraft wings; however, it posed a significant problem for cargo aircraft that have limited visibility of the wings from the cabin.

On December 22, 2004, United Parcel Service (UPS) aircraft in Louisville were grounded for several hours due to extended ice pellet conditions. Due to cargo aircraft configuration, pre-take off contamination checks by the on-board crew were not possible. FedEx had been faced with similar problems in Memphis. Following this event, in October 2005, the FAA issued two notices restricting take offs in ice pellet conditions.

As a result of this costly incident, UPS set out to obtain experimental data to provide guidance and allow operations to continue in ice pellet conditions. During the winter of 2004-05, aerodynamic and endurance time testing were conducted in simulated ice pellet conditions. APS also conducted some preliminary flat plate research (see TP 14718E). Based on the preliminary data, an allowance of 20 minutes in light ice pellet conditions was proposed, however no changes to the HOT guidelines were made.

During the following winter of 2006-07, the FAA provided a 25 minute allowance as a preliminary guideline; TC issued a note indicating that no changes would be made to the HOT guidelines. This allowance was based on the previous research conducted during the winter of 2005-06, primarily as a result of Falcon 20 aerodynamic research (see TP 14716E); these results were presented at the Society of Automotive Engineers (SAE) meeting in Lisbon in May 2006. To address the option of a pre-take off contamination check, the 20 minute targeted allowance was extended to 25 minutes; pre-take off contamination checks would no longer apply. This allowance was followed by a list of conditions; one restriction was that operations would be limited to ice pellets alone (no mixed conditions).

Due to the high occurrence of ice pellets combined with freezing rain or snow, the industry requested additional guidance material for operations in mixed ice pellet conditions. Additional endurance time testing and aerodynamic research were conducted in simulated ice pellet conditions during the winter of 2006-07.

During the winter of 2007-08, the TC and FAA provided allowance time guidance material for operations in mixed conditions with ice pellets guideline. These allowance times were based on the research conducted during the winter of 2006-07 (see TP 14779E). The recommended allowance times were based on aerodynamic research conducted using the 3 m x 6 m Open Circuit Propulsion and Icing Wind Tunnel (PIWT) and the NRC Falcon 20 aircraft; these results were presented at the SAE meeting in San Diego in May 2007. These allowance time guidelines were followed by a list of restrictions based on the results obtained through the research conducted, and the lack of data in specific conditions.

During the winter of 2008-09, additional endurance time testing and aerodynamic research was conducted to support and further expand the ice pellet allowance times (see TP 14935E). Full-scale testing with the NRC PIWT was conducted in mixed conditions with ice pellets and in non precipitation conditions. Testing was geared towards validating the current ice pellet allowance times, and potentially expanding the guidance material to include different conditions, fluids, and acceleration profiles. A revised version of the ice pellet allowance times was published for the winter of 2009-10; changes were made to the high speed table allowance times only.

During the winter of 2009-10, additional aerodynamic research using a generic super-critical wing model was conducted at the NRC PIWT to support and further expand the ice pellet allowance times for use with newer generation aircraft. During the testing, fluid flow-off issues with the supercritical wing were observed with PG fluids at the lower temperatures; more specifically during light ice pellets and moderate ice pellet conditions below -10°C. In addition fluid failure issues with the supercritical wing were observed with PG fluids during moderate ice pellets above -5°C; the relatively flat surface of the wing had less fluid flow off during contamination and resulted in an earlier fluid failure for PG fluids. In general, higher lift losses were observed with the supercritical wing as compared to previous wings tested. A revised version of the ice pellet allowance times was published for the winter of 2009-10. Additional analysis paired with wind tunnel testing was recommended for the winter of 2010-11 to develop a correlation between the lift losses observed in the wind tunnel and those used as the basis of the aerodynamic acceptance tests for fluid certification.

Results from the 2010-11 testing demonstrated similar results to the 2009-10 testing in that the results indicated fluid flow-off issues with the supercritical wing when using PG fluids at the lower temperatures. The results indicated that the changes to the guidance material made the previous winter were still relevant and should remain in the allowance time table for the winter of 2011-12. However, a large part of the 2010-11 work was focused on developing a correlation between the PIWT and the aerodynamic acceptance test. Based on the work that was conducted by NASA and APS, it was determined that a maximum lift loss of 5.24% on the B737-200ADV airplane is equivalent to a lift loss of 7.29% on the PIWT model. Due to the scatter in the data, the standard error of the estimate resulted in a range of values which determined an upper limit of lift loss on the PIWT model of 9.2% and a lower limit of 5.4%. Currently the scatter in the “review” range is still large and causes complications when analyzing the data collected. It is anticipated that as future testing progresses, and as more data is collected, a single-value pass/fail cutoff maybe developed similar to the AAT and B737-200ADV airplane tests.

Due to industry concern with the validity of the results obtained, and the relevance of the test methods to operational aircraft, it was recommended that testing during the winter of 2011-12 focus on surveying and calibrating the wind tunnel to obtain a better sense of the repeatability of the results. With the support of NRC and under direction of NASA, a large series of test runs were conducted to better understand the performance characteristics of the wind tunnel and airfoil. The results indicated that the year-to-year equipment and facility upgrades have increased the integrity of the aerodynamic data produced, and the wind tunnel can closely simulate aircraft take-off profiles. The characterization of the current dry wing model with original endplates demonstrated appropriate aerodynamic behavior. The back-to-back fluid-only runs demonstrated excellent repeatability of test methods and this was reflected in the aerodynamic data collected. The repeatability of the testing was considered acceptable for this type of aerodynamic testing work and was not indicative of systematic errors in procedures or equipment.

FAA and TC were satisfied with calibration technical evaluation results, and therefore it was recommended that testing during the winter of 2012-13 revert back to the initial research and development objectives of further refining and substantiating the ice pellet allowance times. During the winter of 2012-13, the clean, dry wing aerodynamic repeatability was confirmed in comparison with previous data and the additional data collected in 2012-13 helped in substantiating these findings. The stalling characteristics of the wing with fluid (or fluid with contamination) appeared to be driven by secondary wave effects near the leading edge; these effects were difficult to interpret on the two-dimensional model relative to a fully three-dimensional wing and therefore should not be used in developing allowance times. Additional lift-loss scaling correlation data with different fluids at colder temperatures confirmed that previous lift loss limits were still valid. Forty ice pellet allowance time tests were conducted to validate and possibly expand the current guidance material. The data validated the current allowance times with new fluids and also indicated a potential to expand the allowance times for light ice pellets mixed with light snow and moderate snow.

For the Winter 2013-14, the primary focus of testing will be on the ice pellet allowance time validation and development and other R&D activities.

2. OBJECTIVES

The objective of this testing is to conduct aerodynamic testing with a super critical airfoil to:

- Ensure the repeatability of the dry wing performance;
- Expand the ice pellet allowance times for light ice pellets mixed with light or moderate snow conditions;
- Substantiate the current ice pellet allowance times with new fluids, fluids previously tested but with limited data, and temperatures close to the lowest operational use temperature (LOUT);
- Evaluate the equivalency of the new ice pellet/snow dispenser systems;
- Evaluate the effect of coatings on aerodynamics with and without fluids;
- Support the development of a Type III ice pellet allowance time table; and
- Evaluate Type I fluid flow-off performance for low speed rotation less than 80 knots.

Attachments I to VII provide additional information for performing some of these activities which may not use the typical wind tunnel testing methodology.

As lower priority objectives, testing may be conducted to investigate other objectives of high importance to industry which may include (and is described further in Section 6.11):

- o Evaluation of an airfoil performance monitor (APM) system;
- o Heavy snow;
- o Heavy contamination;
- o Effect of cooling system on testing repeatability;
- o Effect of fluid viscosity;
- o Fluid and contamination at LOUT;
- o Small hail;

  - Frost simulation in the wind tunnel;
  - Flaps/Slats testing to support YMX tests;
  - Mixed HOT conditions;
  - Snow on an un-protected wing;
  - Feasibility of IP testing at higher speed (130-150kts);
  - Windshield washer used as a Type I deicer;
  - Effect of fluid seepage on dry wing performance; and
  - Second wave of fluid at rotation.

To satisfy these objectives, a super-critical wing section (Figure 2.1) will be subjected to a series of tests in the NRC PIWT. The dimensions indicated are in inches. This wing section was constructed by NRC in 2009 specifically for the conduct of these tests following extensive consultations with an airframe manufacturer to ensure a representative super-critical design.

Fifteen days of testing have been scheduled for the conduct of these tests. The available testing days will be from January 8th to the 31st (see Figure 2.2). Testing will likely be conducted during overnight periods (i.e. 10 pm – 6 am), unless temperatures are suitable for day/evening testing. The weekends will be considered only if deemed necessary.

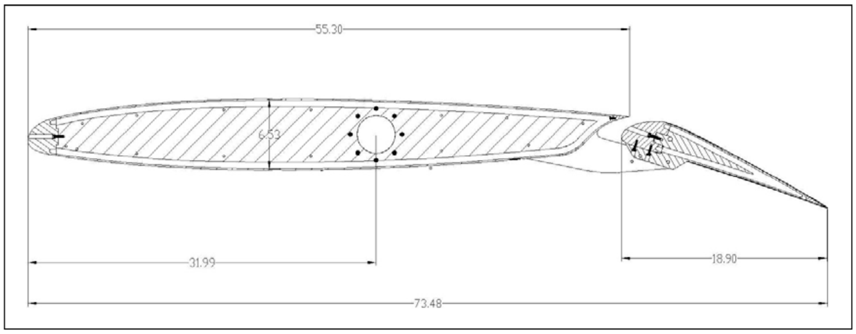
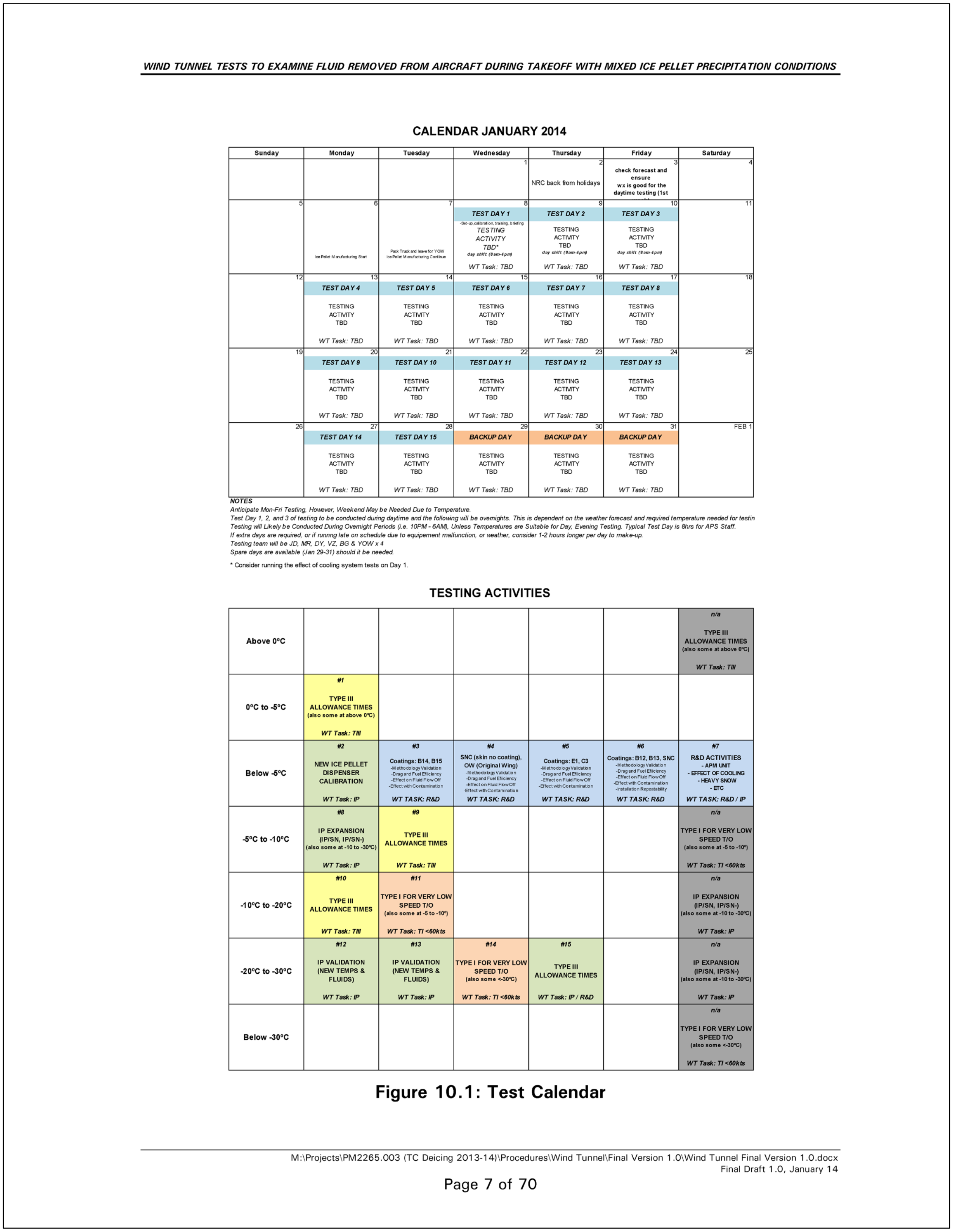


Figure 2.1: Super-Critical Wing Section



WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

CALENDAR JANUARY 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2 NRC back from holidays	3 check forecast and ensure wx is good for the daytime testing (1st	4
5	6 Ice Pellet Manufacturing Start	7 Pack Truck and leave for YOW Ice Pellet Manufacturing Continue	8 *TEST DAY 1* -Set-up,calibration, training, briefing *TESTING ACTIVITY TBD** *day shift (8am-4pm)* *WT Task: TBD*	9 *TEST DAY 2* TESTING ACTIVITY TBD *day shift (8am-4pm)* *WT Task: TBD*	10 *TEST DAY 3* TESTING ACTIVITY TBD *day shift (8am-4pm)* *WT Task: TBD*	11
12	13 *TEST DAY 4* TESTING ACTIVITY TBD *WT Task: TBD*	14 *TEST DAY 5* TESTING ACTIVITY TBD *WT Task: TBD*	15 *TEST DAY 6* TESTING ACTIVITY TBD *WT Task: TBD*	16 *TEST DAY 7* TESTING ACTIVITY TBD *WT Task: TBD*	17 *TEST DAY 8* TESTING ACTIVITY TBD *WT Task: TBD*	18
19	20 *TEST DAY 9* TESTING ACTIVITY TBD *WT Task: TBD*	21 *TEST DAY 10* TESTING ACTIVITY TBD *WT Task: TBD*	22 *TEST DAY 11* TESTING ACTIVITY TBD *WT Task: TBD*	23 *TEST DAY 12* TESTING ACTIVITY TBD *WT Task: TBD*	24 *TEST DAY 13* TESTING ACTIVITY TBD *WT Task: TBD*	25
26	27 *TEST DAY 14* TESTING ACTIVITY TBD *WT Task: TBD*	28 *TEST DAY 15* TESTING ACTIVITY TBD *WT Task: TBD*	29 *BACKUP DAY* TESTING ACTIVITY TBD *WT Task: TBD*	30 *BACKUP DAY* TESTING ACTIVITY TBD *WT Task: TBD*	31 *BACKUP DAY* TESTING ACTIVITY TBD *WT Task: TBD*	FEB 1

NOTES

Anticipate Mon-Fri Testing, However, Weekend May be Needed Due to Temperature.

Test Day 1, 2, and 3 of testing to be conducted during daytime and the following will be overnights. This is dependent on the weather forecast and required temperature needed for testin

Testing will Likely be Conducted During Overnight Periods (i.e. 10PM - 6AM), Unless Temperatures are Suitable for Day, Evening Testing. Typical Test Day is 8hrs for APS Staff.

If extra days are required, or if runnng late on schedule due to equipement malfunction, or weather, consider 1-2 hours longer per day to make-up.

Testing team will be JD, MR, DY, VZ, BG & YOW x 4

Spare days are available (Jan 29-31) should it be needed.

* Consider running the effect of cooling system tests on Day 1.

TESTING ACTIVITIES

Above 0°C						*n/a* **TYPE III ALLOWANCE TIMES** **(also some at above 0°C)** ***WT Task: TIII***
0°C to -5°C	*#1* **TYPE III ALLOWANCE TIMES** **(also some at above 0°C)** ***WT Task: TIII***					
Below -5°C	*#2* **NEW ICE PELLET DISPENSER CALIBRATION** ***WT Task: IP***	*#3* **Coatings: B14, B15** -Methodology Validation -Drag and Fuel Efficiency -Effect on Fluid Flow Off -Effect with Contamination ***WT TASK: R&D***	*#4* **SNC (skin no coating), OW (Original Wing)** -Methodology Validation -Drag and Fuel Efficiency -Effect on Fluid Flow Off -Effect with Contamination ***WT TASK: R&D***	*#5* **Coatings: E1, C3** -Methodology Validation -Drag and Fuel Efficiency -Effect on Fluid Flow Off -Effect with Contamination ***WT TASK: R&D***	*#6* **Coatings: B12, B13, SNC** -Methodology Validation -Drag and Fuel Efficiency -Effect on Fluid Flow Off -Effect with Contamination -Installation Repeatability ***WT TASK: R&D***	*#7* **R&D ACTIVITIES** **- APM UNIT** **- EFFECT OF COOLING** **- HEAVY SNOW** **- ETC** ***WT TASK: R&D / IP***
-5°C to -10°C	*#8* **IP EXPANSION (IP/SN, IP/SN-)** **(also some at -10 to -30°C)** ***WT Task: IP***	*#9* **TYPE III ALLOWANCE TIMES** ***WT Task: TIII***				*n/a* **TYPE I FOR VERY LOW SPEED T/O** **(also some at -5 to -10°)** ***WT Task: TI <60kts***
-10°C to -20°C	*#10* **TYPE III ALLOWANCE TIMES** ***WT Task: TIII***	*#11* **TYPE I FOR VERY LOW SPEED T/O** **(also some at -5 to -10°)** ***WT Task: TI <60kts***				*n/a* **IP EXPANSION (IP/SN, IP/SN-)** **(also some at -10 to -30°C)** ***WT Task: IP***
-20°C to -30°C	*#12* **IP VALIDATION (NEW TEMPS & FLUIDS)** ***WT Task: IP***	*#13* **IP VALIDATION (NEW TEMPS & FLUIDS)** ***WT Task: IP***	*#14* **TYPE I FOR VERY LOW SPEED T/O** **(also some <-30°C)** ***WT Task: TI <60kts***	*#15* **TYPE III ALLOWANCE TIMES** ***WT Task: IP / R&D***		*n/a* **IP EXPANSION (IP/SN, IP/SN-)** **(also some at -10 to -30°C)** ***WT Task: IP***
Below -30°C						*n/a* **TYPE I FOR VERY LOW SPEED T/O** **(also some <-30°C)** ***WT Task: TI <60kts***

Figure 10.1: Test Calendar

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\Final Version 1.0\Wind Tunnel Final Version 1.0.docx
Final Draft 1.0, January 14

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3. TEST PLAN

The NRC wind tunnel is an open circuit tunnel. The temperature inside the wind tunnel is dependent on the outside ambient temperature. Prior to testing, the weather should be monitored to ensure proper temperatures for testing.

Representative Type I/III/IV propylene and ethylene fluids in Neat form (standard mix for Type I) shall be evaluated against their uncontaminated performance; Attachments VIII to XIV present the generic holdover time guidelines for Type I and III as well as the fluid-specific holdover time guidelines for the representative Type IV fluids that will be tested. The current Ice Pellet Allowance Time table has been included in Attachment XV.

A preliminary list of test objectives is shown in Table 3.1. It should be noted that the order in which the tests will be carried out will be depend on weather conditions and TC/FAA directive. A detailed preliminary test matrix is shown in Table 3.2.

NOTE: The numbering of the test runs will be done in a sequential order starting with number 1.

A rating system has been developed for fluid and contamination tests, and will be filled out by the onsite experts when applicable. The overall rating will provide insight into the severity of the conditions observed. A test failure (failure to shed the fluid at time of rotation) shall be determined by the on-site experts based on residual contamination.

4. PRE-TESTING SETUP ACTIVITIES

The activities to be performed for planning and preparation, on the first day of testing, and prior to each testing day thereafter, have been detailed in a list included in Attachment XVI.

Table 4.1: Preliminary List of Testing Objectives for Winter 2012-13 Wind Tunnel Testing

Item #	Objective	Priority	Description	# of Days
1	Dry Wing Baseline Repeatability	1	Baseline test at beginning of each day. Ensure repeatability	-
2	IP Expansion (IP-/SN and IP-/SN-)	1	Expand IP Allowance Time Table for IP-/SN and IP-/SN-	1
3	IP Validation (New Temps & Fluids)	1	Substantiate current times with new fluids, fluids previously tested but with limited data, and temperatures close to LOUT	2
4	New Ice Pellet Dispenser Calibration	1	Evaluate the equivalency of the new ice pellet/snow dispenser systems	1
5	Ice Phobic Coating R&D	1	Evaluate the effect of coatings on aerodynamics with and without fluids	4
6	Type III IP Allowance Times	1	Support the development of a Type III high speed ice pellet allowance time table	4
7	Type I for Very Low Speed T/O	1	Evaluate Type I fluid flow-off performance for low speed rotation less than 80 knots	2
8	Other R&D Activites	1	To be selected from item # 8.1 to 8.16	1
8.1	Evaluation of an APM Sensor	2	Testing an airfoil performance monitor (APM) to evaluate potential for use in ground icing operations with and without fluids	-
8.2	Heavy Snow	2	Continue Heavy Snow Research comparing lift losses with Light/Moderate Snow vs. heavy Snow	-
8.3	Heavy Contamination (Aero vs. Visual Failure)	2	Continue work looking at aerodynamic failure vs. HOT defined failure, and effect of surface roughness on lift degredation	-
8.4	Tunnel Test Section Cooling System Evaluation	2	Evaluate effectiveness of new wind tunnel colling system and potential effects on data results	-
8.5	Effect of Viscosity on Fluid Aerodynamics	3	Evaluate effect of viscosity on aero flow-off to better understand year to year differences with same fluid (test high and low visc)	-
8.6	Fluid + Cont @ LOUT	3	Effect of contamination on fluid performance at LOUT with IP, SN, ZF, Frost etc.	-
8.7	Small Hail	3	Develop HOT Guidance for small hail. Requires consult with meteorologist for specific conditions	-
8.8	Simulate Frost in Wind Tunnel	3	Attempt to simulate frost conditions in wind tunnel.	-
8.9	Flaps/Slats to Support YMX	3	Conduct flaps failure research to support UPS/SWA trials, comparative fluid/cont. and possibly sandpaper tests	-
8.10	Mixed HOT Conditions	3	Develop HOT Guidance for mixed conditions i.e. ZR/SN, R/SN, ZD/SN	-
8.11	Snow on Un-protected Wing	3	Continue previous research	-
8.12	130-150 Knots IP Testing	3	Conduct IP testing at 130-150 knots or validate feasibility MAY NEED TO MODIFY TUNNEL	-
8.13	Windshield Washer Fluid Testing	3	Conduct aero testing to support full testing conducted at Rockliffe Flying Club in Ottawa	-
8.14	Effect of Fluid Seepage	3	Evaluate the effect of fluid seepage on dry wing performance and repeatability	-
8.15	2nd Wave of Fluid During Rotation	3	Investigate the aero effects of the 2nd wave of fluid created from fluid at the stagnation point which flows over the LE during rotation	-
8.16	Other	3	Any potential suggestions from industry	-

Total # of Days for Priority 1 Tests	**15**

Table 3.1: Proposed Test Plan

Test Plan #	Objective	Objective Priority	Test Condition	Rotation Angle	Ramp (s/kts)	Target OAT (ºC)	Fluid	IP Rate (g/dm^2/h)	SN Rate (g/dm^2/h)	ZR Rate (g/dm^2/h)	R Rate (g/dm^2/h)	Exposure Time	Coating	Priority	COMMENT
P001	Baseline	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	-	1	to be conducted daily before start ot tests
P002	Baseline	1	Dry Wing	stall	100	any (target <-5ºC)	none	-	-	-	-	-	-	1	to be conducted daily before start ot tests
P003	Type I Low Speed	1	Fluid Only	8	100	below -30	Polar Plus	-	-	-	-	-	-	1	
P004	Type I Low Speed	1	Fluid Only	8	60	below -30	Polar Plus	-	-	-	-	-	-	1	
P005	Type I Low Speed	1	Fluid Only	8	55	below -30	Polar Plus	-	-	-	-	-	-	1	
P006	Type I Low Speed	1	Fluid Only	8	55+3 sec	below -30	Polar Plus	-	-	-	-	-	-	1	
P007	Type I Low Speed	1	Fluid Only	8	100	-20 to -30	Polar Plus	-	-	-	-	-	-	1	
P008	Type I Low Speed	1	Fluid Only	8	60	-20 to -30	Polar Plus	-	-	-	-	-	-	1	
P009	Type I Low Speed	1	Fluid Only	8	55	-20 to -30	Polar Plus	-	-	-	-	-	-	1	
P010	Type I Low Speed	1	Fluid Only	8	55+3 sec	-20 to -30	Polar Plus	-	-	-	-	-	-	1	
P011	Type I Low Speed	1	Fluid Only	8	100	-20 to -30	Polar Plus	-	-	-	-	-	-	2	
P012	Type I Low Speed	1	Fluid Only	8	60	-20 to -30	Polar Plus	-	-	-	-	-	-	2	
P013	Type I Low Speed	1	Fluid Only	8	55	-20 to -30	Polar Plus	-	-	-	-	-	-	2	
P014	Type I Low Speed	1	Fluid Only	8	55+3 sec	-20 to -30	Polar Plus	-	-	-	-	-	-	2	
P015	Type I Low Speed	1	Fluid Only	8	60	-20 to -30	Polar Plus	-	-	-	-	-	-	3	
P016	Type I Low Speed	1	Fluid Only	8	100	-20 to -30	Dow ADF	-	-	-	-	-	-	1	
P017	Type I Low Speed	1	Fluid Only	8	60	-20 to -30	Dow ADF	-	-	-	-	-	-	1	
P018	Type I Low Speed	1	Fluid Only	8	55	-20 to -30	Dow ADF	-	-	-	-	-	-	1	
P019	Type I Low Speed	1	Fluid Only	8	55+3 sec	-20 to -30	Dow ADF	-	-	-	-	-	-	1	
P020	Type I Low Speed	1	Fluid Only	8	100	-10 to -20	Polar Plus	-	-	-	-	-	-	1	
P021	Type I Low Speed	1	Fluid Only	8	60	-10 to -20	Polar Plus	-	-	-	-	-	-	1	
P022	Type I Low Speed	1	Fluid Only	8	55	-10 to -20	Polar Plus	-	-	-	-	-	-	1	
P023	Type I Low Speed	1	Fluid Only	8	55+3 sec	-10 to -20	Polar Plus	-	-	-	-	-	-	1	
P024	Type I Low Speed	1	Fluid Only	8	60	-10 to -20	Polar Plus	-	-	-	-	-	-	2	
P025	Type I Low Speed	1	Fluid Only	8	100	-5 to -10	Polar Plus	-	-	-	-	-	-	1	

Table 3.1: Proposed Test Plan (cont.)

P026	Type I Low Speed	1	Fluid Only	8	60	-5 to -10	Polar Plus	-	-	-	-	-	-	1	
P027	Type I Low Speed	1	Fluid Only	8	60	-5 to -10	Polar Plus	-	-	-	-	-	-	2	
P028	Type I Low Speed	1	Fluid Only	8	55	-5 to -10	Polar Plus	-	-	-	-	-	-	1	
P029	Type I Low Speed	1	Fluid Only	8	55+3 sec	-5 to -10	Polar Plus	-	-	-	-	-	-	1	
P030	Type III Allowance Times	1	IP-	8	100	-5 and above	2031 - Hot	25	-	-	-	10	-	1	
P031	Type III Allowance Times	1	IP Mod	8	100	-5 and above	2031 - Hot	75	-	-	-	5	-	1	
P032	Type III Allowance Times	1	IP- / ZR-	8	100	-5 and above	2031 - Hot	25	-	25	-	7	-	1	
P033	Type III Allowance Times	1	IP- / R	8	100	-5 and above	2031 - Hot	25	-	-	75	7	-	1	
P034	Type III Allowance Times	1	IP- / SN-	8	100	-5 and above	2031 - Hot	25	10	-	-	10	-	1	
P035	Type III Allowance Times	1	IP- / SN	8	100	-5 and above	2031 - Hot	25	25	-	-	10	-	1	
P036	Type III Allowance Times	1	IP-	8	100	-5 to -10	2031 - Hot	25	-	-	-	10	-	1	
P037	Type III Allowance Times	1	IP Mod	8	100	-5 to -10	2031 - Hot	75	-	-	-	5	-	1	
P038	Type III Allowance Times	1	IP- / ZR-	8	100	-5 to -10	2031 - Hot	25	-	25	-	5	-	1	
P039	Type III Allowance Times	1	IP- / SN-	8	100	-5 to -10	2031 - Hot	25	10	-	-	10	-	1	
P040	Type III Allowance Times	1	IP- / SN	8	100	-5 to -10	2031 - Hot	25	25	-	-	5	-	1	
P041	Type III Allowance Times	1	IP-	8	100	-10 to -20	2031 - Hot	25	-	-	-	10	-	1	
P042	Type III Allowance Times	1	IP Mod	8	100	-10 to -20	2031 - Hot	75	-	-	-	5	-	1	
P043	Type III Allowance Times	1	IP-	8	100	-20 to -30	2031 - Hot	25	-	-	-	10	-	1	
P044	Type III Allowance Times	1	IP Mod	8	100	-20 to -30	2031 - Hot	75	-	-	-	5	-	1	
P045	Type III Allowance Times	1	IP-	8	100	-5 and above	2031 - Cold	25	-	-	-	10	-	1	
P046	Type III Allowance Times	1	IP Mod	8	100	-5 and above	2031 - Cold	75	-	-	-	5	-	1	
P047	Type III Allowance Times	1	IP- / ZR-	8	100	-5 and above	2031 - Cold	25	-	25	-	7	-	1	
P048	Type III Allowance Times	1	IP- / SN-	8	100	-5 and above	2031 - Cold	25	10	-	-	10	-	1	
P049	Type III Allowance Times	1	IP- / SN	8	100	-5 and above	2031 - Cold	25	25	-	-	10	-	1	
P050	Type III Allowance Times	1	IP-	8	100	-5 and above	2031 - Cold	25	-	-	-	10	-	1	
P051	Type III Allowance Times	1	IP Mod	8	100	-5 to -10	2031 - Cold	75	-	-	-	5	-	1	
P052	Type III Allowance Times	1	IP- / ZR-	8	100	-5 to -10	2031 - Cold	25	-	25	-	5	-	1	

Table 3.1: Proposed Test Plan (cont.)

P053	Type III Allowance Times	1	IP- / R	8	100	-5 to -10	2031 - Cold	25	-	-	75	7	-	1	
P054	Type III Allowance Times	1	IP- / SN-	8	100	-5 to -10	2031 - Cold	25	10	-	-	10	-	1	
P055	Type III Allowance Times	1	IP- / SN	8	100	-5 to -10	2031 - Cold	25	25	-	-	5	-	1	
P056	Type III Allowance Times	1	IP-	8	100	-10 to -20	2031 - Cold	25	-	-	-	10	-	1	
P057	Type III Allowance Times	1	IP Mod	8	100	-10 to -20	2031 - Cold	75	-	-	-	5	-	1	
P058	Type III Allowance Times	1	IP-	8	100	-20 to -30	2031 - Cold	25	-	-	-	10	-	1	
P059	Type III Allowance Times	1	IP Mod	8	100	-20 to -30	2031 - Cold	75	-	-	-	5	-	1	
P060	IP Expansion	1	IP- / SN-	8	100	-10 to -20	ABC-S Plus	25	10	-	-	15		2	
P061	IP Expansion	1	IP- / SN-	8	100	-10 to -20	Launch	25	10	-	-	15		2	
P062	IP Expansion	1	IP- / SN-	8	100	-10 to -20	Max-Flight	25	10	-	-	15		2	
P063	IP Expansion	1	IP- / SN-	8	100	-10 to -20	AD-49	25	10	-	-	15		2	
P064	IP Expansion	1	IP- / SN-	8	100	-10 to -20	Polar Guard Advance	25	10	-	-	15		2	
P065	IP Expansion	1	IP- / SN-	8	100	-20 to -30	EG106	25	10	-	-	15		1	
P066	IP Expansion	1	IP- / SN-	8	100	-20 to -30	ABC-S Plus	25	10	-	-	15		1	
P067	IP Expansion	1	IP- / SN-	8	100	-20 to -30	Launch	25	10	-	-	15		1	
P068	IP Expansion	1	IP- / SN-	8	100	-20 to -30	Max-Flight	25	10	-	-	15		1	
P069	IP Expansion	1	IP- / SN-	8	100	-20 to -30	AD-49	25	10	-	-	15		1	
P070	IP Expansion	1	IP- / SN-	8	100	-20 to -30	Polar Guard Advance	25	10	-	-	15		1	
P071	IP Expansion	1	IP- / SN	8	100	-5 to -10	ABC-S Plus	25	10	-	-	10		1	
P072	IP Expansion	1	IP- / SN	8	100	-5 to -10	Launch	25	10	-	-	10		1	
P073	IP Expansion	1	IP- / SN	8	100	-5 to -10	AD-49	25	10	-	-	10		1	
P074	IP Expansion	1	IP- / SN	8	100	-5 to -10	Polar Guard Advance	25	10	-	-	10		1	failed in 2012-13 test
P075	IP Validation with New Temps & Fluids	1	IP-	8	115	-20 to -30	ABC-S Plus	25	-	-	-	50	-	1	run @ LOUT
P076	IP Validation with New Temps & Fluids	1	IP-	8	115	-20 to -30	EG106	25	-	-	-	50	-	1	run @ LOUT
P077	IP Validation with New Temps & Fluids	1	IP-	8	115	-20 to -30	Launch	25	-	-	-	50	-	1	run @ LOUT
P078	IP Validation with New Temps & Fluids	1	IP-	8	115	-20 to -30	Max-Flight	25	-	-	-	50	-	1	run @ LOUT
P079	IP Validation with New Temps & Fluids	1	IP-	8	115	-20 to -30	AD-49	25	-	-	-	50	-	1	run @ LOUT

Table 3.1: Proposed Test Plan (cont.)

P080	IP Validation with New Temps & Fluids	1	IP-	8	115	-20 to -30	Polar Guard Advance	25	-	-	-	50	-	1	run @ LOUT
P081	IP Validation with New Temps & Fluids	1	IP Mod	8	115	-20 to -30	ABC-S Plus	75	-	-	-	10	-	1	run @ LOUT
P082	IP Validation with New Temps & Fluids	1	IP Mod	8	115	-20 to -30	EG106	75	-	-	-	10	-	1	run @ LOUT
P083	IP Validation with New Temps & Fluids	1	IP Mod	8	115	-20 to -30	Launch	75	-	-	-	10	-	1	run @ LOUT
P084	IP Validation with New Temps & Fluids	1	IP Mod	8	115	-20 to -30	Max-Flight	75	-	-	-	10	-	1	run @ LOUT
P085	IP Validation with New Temps & Fluids	1	IP Mod	8	115	-20 to -30	AD-49	75	-	-	-	10	-	1	run @ LOUT
P086	IP Validation with New Temps & Fluids	1	IP Mod	8	115	-20 to -30	Polar Guard Advance	75	-	-	-	10	-	1	run @ LOUT
P087	IP Validation with New Temps & Fluids	1	Fluid Only	8	115	-20 to -30	ABC-S Plus	-	-	-	-	-	-	1	run @ LOUT
P088	IP Validation with New Temps & Fluids	1	Fluid Only	8	115	-20 to -30	EG106	-	-	-	-	-	-	1	run @ LOUT
P089	IP Validation with New Temps & Fluids	1	Fluid Only	8	115	-20 to -30	Launch	-	-	-	-	-	-	1	run @ LOUT
P090	IP Validation with New Temps & Fluids	1	Fluid Only	8	115	-20 to -30	Max-Flight	-	-	-	-	-	-	1	run @ LOUT
P091	IP Validation with New Temps & Fluids	1	Fluid Only	8	115	-20 to -30	AD-49	-	-	-	-	-	-	1	run @ LOUT
P092	IP Validation with New Temps & Fluids	1	Fluid Only	8	115	-20 to -30	Polar Guard Advance	-	-	-	-	-	-	1	run @ LOUT
P093	New Ice Pellet Dispenser Validation	1	IP Mod	8	100	below -5	Launch	75	-	-	-	10	-	1	new dispenser
P094	New Ice Pellet Dispenser Validation	1	IP Mod	8	100	below -5	Launch	75	-	-	-	10	-	1	new dispenser
P095	New Ice Pellet Dispenser Validation	1	IP Mod	8	100	below -5	Launch	75	-	-	-	10	-	2	new dispenser
P096	New Ice Pellet Dispenser Validation	1	IP Mod	8	100	below -5	Launch	75	-	-	-	10	-	1	old dispenser
P097	New Ice Pellet Dispenser Validation	1	IP Mod	8	100	below -5	Launch	75	-	-	-	10	-	1	old dispenser
P098	New Ice Pellet Dispenser Validation	1	IP Mod	8	100	below -5	Launch	75	-	-	-	10	-	2	old dispenser
P099	New Ice Pellet Dispenser Validation	1	IP-/SN-	8	100	below -5	Polar Guard Advance	25	25	-	-	15	-	1	new dispenser
P100	New Ice Pellet Dispenser Validation	1	IP-/SN-	8	100	below -5	Polar Guard Advance	25	25	-	-	15	-	1	new dispenser
P101	New Ice Pellet Dispenser Validation	1	IP-/SN-	8	100	below -5	Polar Guard Advance	25	25	-	-	15	-	1	old dispenser
P102	New Ice Pellet Dispenser Validation	1	IP-/SN-	8	100	below -5	Polar Guard Advance	25	25	-	-	15	-	1	old dispenser
P103	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B14	1	objective: baseline
P104	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B14	1	objective: baseline
P105	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B14	2	objective: baseline
P106	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B14	1	objective: baseline

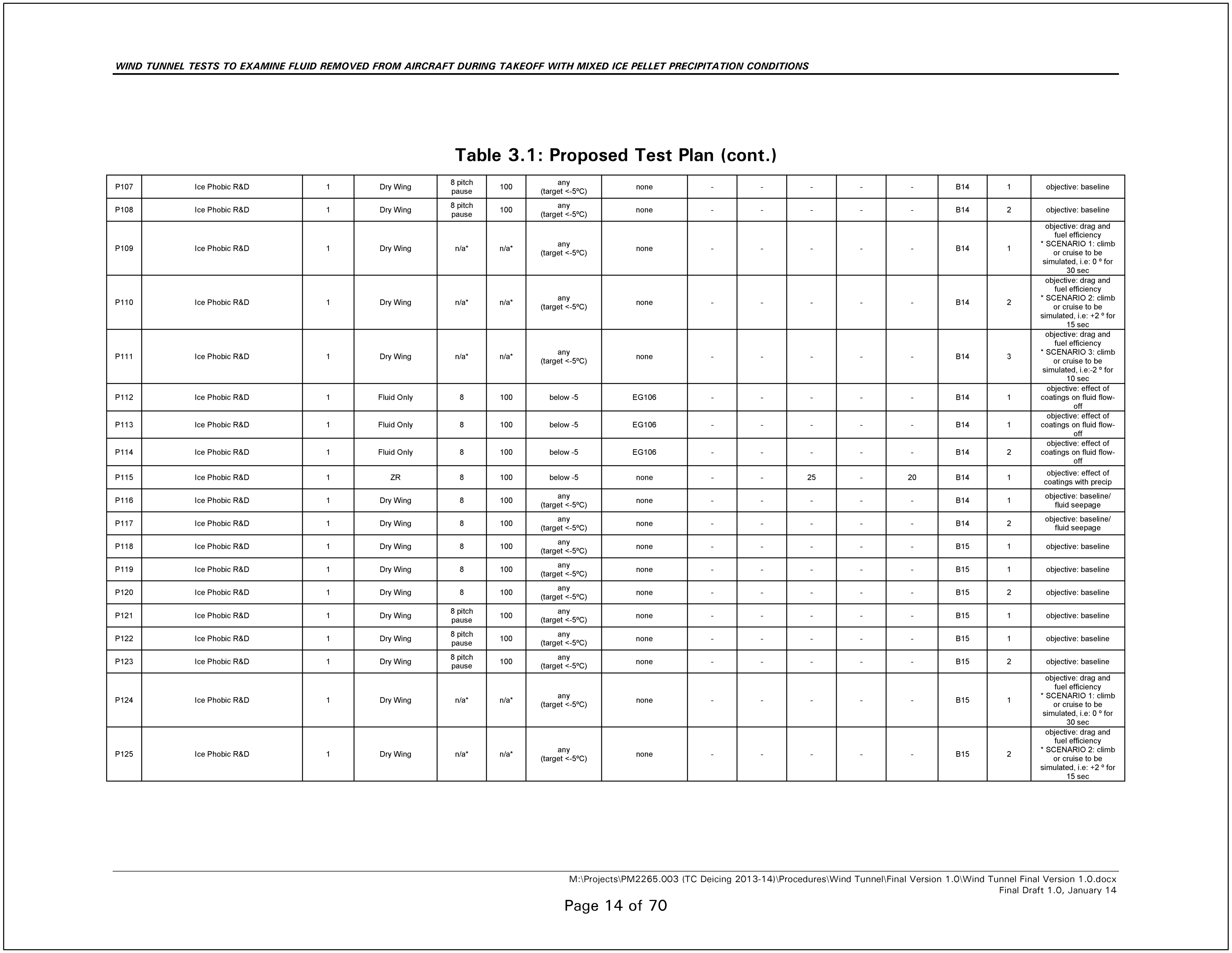


Table 3.1: Proposed Test Plan (cont.)

P107	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B14	1	objective: baseline
P108	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B14	2	objective: baseline
P109	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B14	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P110	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B14	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec
P111	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B14	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P112	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B14	1	objective: effect of coatings on fluid flow-off
P113	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B14	1	objective: effect of coatings on fluid flow-off
P114	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B14	2	objective: effect of coatings on fluid flow-off
P115	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	B14	1	objective: effect of coatings with precip
P116	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B14	1	objective: baseline/ fluid seepage
P117	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B14	2	objective: baseline/ fluid seepage
P118	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B15	1	objective: baseline
P119	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B15	1	objective: baseline
P120	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B15	2	objective: baseline
P121	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B15	1	objective: baseline
P122	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B15	1	objective: baseline
P123	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B15	2	objective: baseline
P124	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B15	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P125	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B15	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec

Table 3.1: Proposed Test Plan (cont.)

P126	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B15	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P127	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B15	1	objective: effect of coatings on fluid flow-off
P128	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B15	1	objective: effect of coatings on fluid flow-off
P129	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B15	2	objective: effect of coatings on fluid flow-off
P130	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	B15	1	objective: effect of coatings with precip
P131	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B15	1	objective: baseline/ fluid seepage
P132	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B15	2	objective: baseline/ fluid seepage
P133	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline
P134	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline
P135	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	2	objective: baseline
P136	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline
P137	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline
P138	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	2	objective: baseline
P139	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P140	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec
P141	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P142	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	skin no coating	1	objective: effect of coatings on fluid flow-off
P143	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	skin no coating	1	objective: effect of coatings on fluid flow-off
P144	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	skin no coating	2	objective: effect of coatings on fluid flow-off
P145	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	skin no coating	1	objective: effect of coatings with precip
P146	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline/ fluid seepage

Table 3.1: Proposed Test Plan (cont.)

P147	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	2	objective: baseline/ fluid seepage
P148	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	1	objective: baseline
P149	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	1	objective: baseline
P150	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	2	objective: baseline
P151	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	1	objective: baseline
P152	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	1	objective: baseline
P153	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	2	objective: baseline
P154	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	original wing	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P155	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	original wing	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec
P156	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	original wing	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P157	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	original wing	1	objective: effect of coatings on fluid flow-off
P158	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	original wing	1	objective: effect of coatings on fluid flow-off
P159	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	original wing	2	objective: effect of coatings on fluid flow-off
P160	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	original wing	1	objective: effect of coatings with precip
P161	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	1	objective: baseline/ fluid seepage
P162	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	original wing	2	objective: baseline/ fluid seepage
P163	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	E1	1	objective: baseline
P164	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	E1	1	objective: baseline
P165	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	E1	2	objective: baseline
P166	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	E1	1	objective: baseline
P167	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	E1	1	objective: baseline

Table 3.1: Proposed Test Plan (cont.)

P168	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	E1	2	objective: baseline
P169	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	E1	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P170	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	E1	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec
P171	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	E1	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P172	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	E1	1	objective: effect of coatings on fluid flow-off
P173	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	E1	1	objective: effect of coatings on fluid flow-off
P174	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	E1	2	objective: effect of coatings on fluid flow-off
P175	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	E1	1	objective: effect of coatings with precip
P176	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	E1	1	objective: baseline/ fluid seepage
P177	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	E1	2	objective: baseline/ fluid seepage
P178	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	C3	1	objective: baseline
P179	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	C3	1	objective: baseline
P180	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	C3	2	objective: baseline
P181	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	C3	1	objective: baseline
P182	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	C3	1	objective: baseline
P183	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	C3	2	objective: baseline
P184	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	C3	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P185	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	C3	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec

Table 3.1: Proposed Test Plan (cont.)

P186	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	C3	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P187	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	C3	1	objective: effect of coatings on fluid flow-off
P188	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	C3	1	objective: effect of coatings on fluid flow-off
P189	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	C3	2	objective: effect of coatings on fluid flow-off
P190	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	C3	1	objective: effect of coatings with precip
P191	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	C3	1	objective: baseline/ fluid seepage
P192	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	C3	2	objective: baseline/ fluid seepage
P193	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B12	1	objective: baseline
P194	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B12	1	objective: baseline
P195	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B12	2	objective: baseline
P196	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B12	1	objective: baseline
P197	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B12	1	objective: baseline
P198	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B12	2	objective: baseline
P199	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B12	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P200	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B12	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec
P201	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B12	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P202	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B12	1	objective: effect of coatings on fluid flow-off
P203	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B12	1	objective: effect of coatings on fluid flow-off
P204	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B12	2	objective: effect of coatings on fluid flow-off
P205	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	B12	1	objective: effect of coatings with precip
P206	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B12	1	objective: baseline/ fluid seepage

Table 3.1: Proposed Test Plan (cont.)

P207	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B12	2	objective: baseline/ fluid seepage
P208	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B13	1	objective: baseline
P209	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B13	1	objective: baseline
P210	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B13	2	objective: baseline
P211	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B13	1	objective: baseline
P212	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B13	1	objective: baseline
P213	Ice Phobic R&D	1	Dry Wing	8 pitch pause	100	any (target <-5ºC)	none	-	-	-	-	-	B13	2	objective: baseline
P214	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B13	1	objective: drag and fuel efficiency * SCENARIO 1: climb or cruise to be simulated, i.e: 0 º for 30 sec
P215	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B13	2	objective: drag and fuel efficiency * SCENARIO 2: climb or cruise to be simulated, i.e: +2 º for 15 sec
P216	Ice Phobic R&D	1	Dry Wing	n/a*	n/a*	any (target <-5ºC)	none	-	-	-	-	-	B13	3	objective: drag and fuel efficiency * SCENARIO 3: climb or cruise to be simulated, i.e:-2 º for 10 sec
P217	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B13	1	objective: effect of coatings on fluid flow-off
P218	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B13	1	objective: effect of coatings on fluid flow-off
P219	Ice Phobic R&D	1	Fluid Only	8	100	below -5	EG106	-	-	-	-	-	B13	2	objective: effect of coatings on fluid flow-off
P220	Ice Phobic R&D	1	ZR	8	100	below -5	none	-	-	25	-	20	B13	1	objective: effect of coatings with precip
P221	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B13	1	objective: baseline/ fluid seepage
P222	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	B13	2	objective: baseline/ fluid seepage
P223	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline/installation repeatability
P224	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	1	objective: baseline/installation repeatability
P225	Ice Phobic R&D	1	Dry Wing	8	100	any (target <-5ºC)	none	-	-	-	-	-	skin no coating	2	objective: baseline/installation repeatability
P226	R&D	1	APM Unit	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	1	
P227	R&D	1	S+++	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	1	
P228	R&D	1	HEAVY CONTAMINATION	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	1	
P229	R&D	1	EFFECT OF COOLING SYSTEM	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	1	

Table 3.1: Proposed Test Plan (cont.)

P230	R&D	1	Effect of Viscosity	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P231	R&D	1	FLUID & CONT @ LOUT	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P232	R&D	1	SMALL HAIL	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P233	R&D	1	FROST	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P234	R&D	1	FLAPS/SLATS	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P235	R&D	1	MIXED CONDITIONS	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P236	R&D	1	SNOW NO FLUID	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P237	R&D	1	IP TESTs @ 130-150 KTS	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P238	R&D	1	WINDSHIELD WASHER FLUID	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P239	R&D	1	FLUID SEEPAGE	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	
P240	R&D	1	2ND WAVE	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	-	2	

5. DATA FORMS

The following data forms are required for the January 2014 wind tunnel tests:

- Attachment XVII – General Form;
- Attachment XVIII – Wing Temperature, Fluid Thickness and Fluid Brix Measurements and Condition of Wing and Plate Form;
- Attachment XIX, XX and XXI – Ice Pellet, Snow and Sifted Snow Dispensing Forms;
- Attachment XXII – Visual Evaluation Rating Form
- Attachment XXIII – Fluid Receipt Form (Generic form used by APS; will be used for this project as appropriate);
- Attachment XXIV – Log of Fluid Sample Bottles.

When and how the data forms will be used is described throughout Section 6.

6. PROCEDURE

The following sections describe the tasks to be performed during each test conducted. It should be noted that some sections (i.e. fluid application and contamination application) will be omitted depending on the objective of the test.

6.1 Initial Test Conditions Survey

- Record ambient conditions of the test (Attachment XVII); and
- Record wing temperature (Attachment XVIII).

6.2 Fluid Application (Pour)

- Hand pour 20L of anti-icing fluid over the test area (fluid can be poured directly out of pales or transferred into smaller 3L jugs);
- Record fluid application times (Attachment XVII);
- Record fluid application quantities (Attachment XVII);
- Let fluid settle for 5 minutes (as the wing section is relatively flat, last winter it required tilting the wing for 1-minute to enable fluid to be uniform);
- Measure fluid thickness at pre-determined locations on the wing (Attachment XVIII);
- Record wing temperature (Attachment XVIII).

- Measure fluid Brix value (Attachment XVIII); and
- Photograph and videotape the appearance of the fluid on the wing;
- Begin the time-lapse camera to gather photos of the precipitation application phase.

Note: At the request of TC/FAA, a standard aluminum test plate can be positioned on the wing in order to run a simultaneous endurance time test.

6.3 Application of Contamination

6.3.1 Ice Pellet/Snow Dispenser Calibration and Set-Up

Calibration work was performed during the winter of 2007-08 on the modified ice pellet/snow dispensers prior to testing with the Falcon 20. The purpose of this calibration work was to attain the dispenser's distribution footprint for both ice pellets and snow. A series of tests were performed in various conditions:

1. Ice Pellets, Low Winds (0 to 5 km/h);
2. Ice Pellets, Moderate Winds (10 km/h);
3. Snow, Low Wind (0 to 5 km/h); and
4. Snow, Moderate Wind (10 km/h).

These tests were conducted using 121 collection pans, each measuring 6 x 6 inches, over an area 11 x 11 feet. Pre-measured amounts of ice pellets/snow were dispersed over this area and the amount collected by each pan was recorded. A distribution footprint of the dispenser was attained and efficiency for the dispenser was computed.

6.3.2 Dispensing Ice Pellets/Snow for Wind Tunnel Tests

Using the results from these calibration tests, a decision was made to use two dispensers on each of the leading and trailing edges of wing; each of the four dispensers are moved to four different positions along each edge during the dispensing process. Attachments XIX and XX display the data sheets that will be used during testing in the wind tunnel. These data sheets will provide all the necessary information related to the amount of ice pellets/snow needed, effective rates and dispenser positions. During the winter of 2009-10, snow was also dispensed manually using sieves. This technique was used when higher rates of precipitation were required (for heavy snow) or when winds in the tunnel made dispensing difficult. The efficiency of this technique was estimated at 90% and a form to be used for this dispensing process along with dispensing instructions is included in Attachment XXI.

Note: Dispensing forms should be filled out and saved for each run and included and pertinent information shall be included in the general form (Attachment XVII). Any comments regarding dispensing activities should be documented directly on the form.

6.3.3 New Ice Pellets/Snow Dispensing Systems for 2014 Onwards

Yardworks seed spreaders were modified and used for applying ice pellets and snow during wind tunnel and flat plate testing. The spreaders are no longer available as the manufacturer has stopped production. A new replacement seed spreader system, Wolf Garten, was found which is similar (but not identical), and may be a suitable replacement (with necessary modifications). Some calibration work was required to demonstrate an equivalency in the two systems: the historical system versus the new replacement system. TC requested to evaluate the new system while at NRC Cold Chamber in September 2013.

The data collected demonstrates that the new system is very similar to old system. Some small variation is present in distribution within the footprint, but equivalent efficiency on the overall footprint. Based on this it was concluded that for ice pellets, the use of the new system can be made as a direct replacement. For snow, the new system is more efficient, therefore a reduction of 10% shall be used for the snow mass requested. The details of this calibration are described in TC report, TP 15230E*, Aircraft Ground Icing General Research Activities During the 2012-13 Winter.*

6.4 Prior to Engines-On Wind Tunnel Test

- Measure fluid thickness at the pre-determined locations on the wing (Attachment XVIII);
- Measure fluid Brix value (Attachment XVIII);
- Record wing temperatures (Attachment XVIII);
- Record start time of test (Attachment XVII); and
- Fill out visual evaluation rating form (Attachment XXII).

Note: In order to minimize the measurement time post precipitation, temperature should be measured 5 minutes before the end of precipitation, thickness measured 3 minutes before the end of precipitation, and Brix measured when the precipitation ends. Also consideration as been given to reducing the number of measures that are taken for this phase (i.e. locations 2 and 5 only).

6.5 During Wind Tunnel Test:

- Take still pictures and video the behavior of the fluid on the wing during the takeoff run, capturing any movement of fluid/contamination;
- Fill out visual evaluation rating form at the time of rotation (Attachment XXII); and
- Record wind tunnel operation start and stop times.

6.6 After the Wind Tunnel Test:

- Measure fluid thickness at the pre-determined locations on the wing (Attachment XVIII);
- Measure fluid Brix value (Attachment XVIII);
- Record wing temperatures (Attachment XVIII);
- Observe and record the status of the fluid/contamination (Attachment XVIII);
- Fill out visual evaluation rating form (Attachment XXII);
- Obtain lift data (excel file) from NRC; and
- Update APS test log with pertinent information.

6.7 Fluid Sample Collection for Viscosity Testing

Two litres of each fluid to be tested are to be collected on the first day of testing. The fluid receipt form (Attachment XXIII) should be completed indicating quantity of fluid and date received. Any samples extracted for viscosity purposes should be documented in the log of fluid samples data form (Attachment XXIV). A falling ball viscosity test should be performed on site to confirm that fluid viscosity is appropriate before testing.

6.8 At the End of Each Test Session

If required, APS personnel will collect the waste solution. At the end of the testing period, the glycol recovery service provider will be employed to safely dispose of the waste glycol fluid.

6.9 Camera Setup

It is anticipated that the camera setup will be similar to the setup used during the winter of 2011-12. Modifications may be necessary to account for the different airfoil. The flashes will be positioned on the control-room side of the tunnel, and the cameras will be positioned on the opposite side. The final positioning of the cameras and flashes should be documented to identify any deviation from the previous year's setup.

6.10 Demonstration of a Typical Wind Tunnel Test Sequence

Table 6.1 demonstrates a typical Wind Tunnel test sequence of activities, assuming the test starts at 08:00:00. Figure 6.1 demonstrates a typical wind tunnel run timeline.

Table 6.1: Typical Wind Tunnel Test

TIME	TASK
8:30:00	START OF TEST. ALL EQUIPMENT READY.
8:30:00	- Record test conditions.
8:35:00	- Prepare wing for fluid application (clean wing, etc).
8:45:00	- Measure wing temperature. - Ensure clean wing for fluid application
8:50:00	- Pour fluid over test area.
9:00:00	- Measure Brix, thickness, wing temperature. - Photograph test area.
9:05:00	- Apply contamination over test area. (i.e. 30 min)
9:35:00	- Measure Brix, thickness, wing temperature. - Photograph test area.
9:40:00	- Clear area and start wind tunnel
9:55:00	- Wind tunnel stopped
10:05:00	- Measure Brix, thickness, wing temperature. - Photograph test area. - Record test observations.
10:35:00	END OF TEST

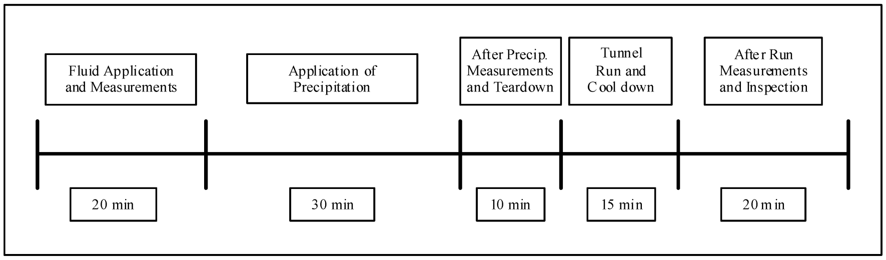


Figure 6.1: Typical Wind Tunnel Run Timeline

6.11 Procedures for R&D Activities

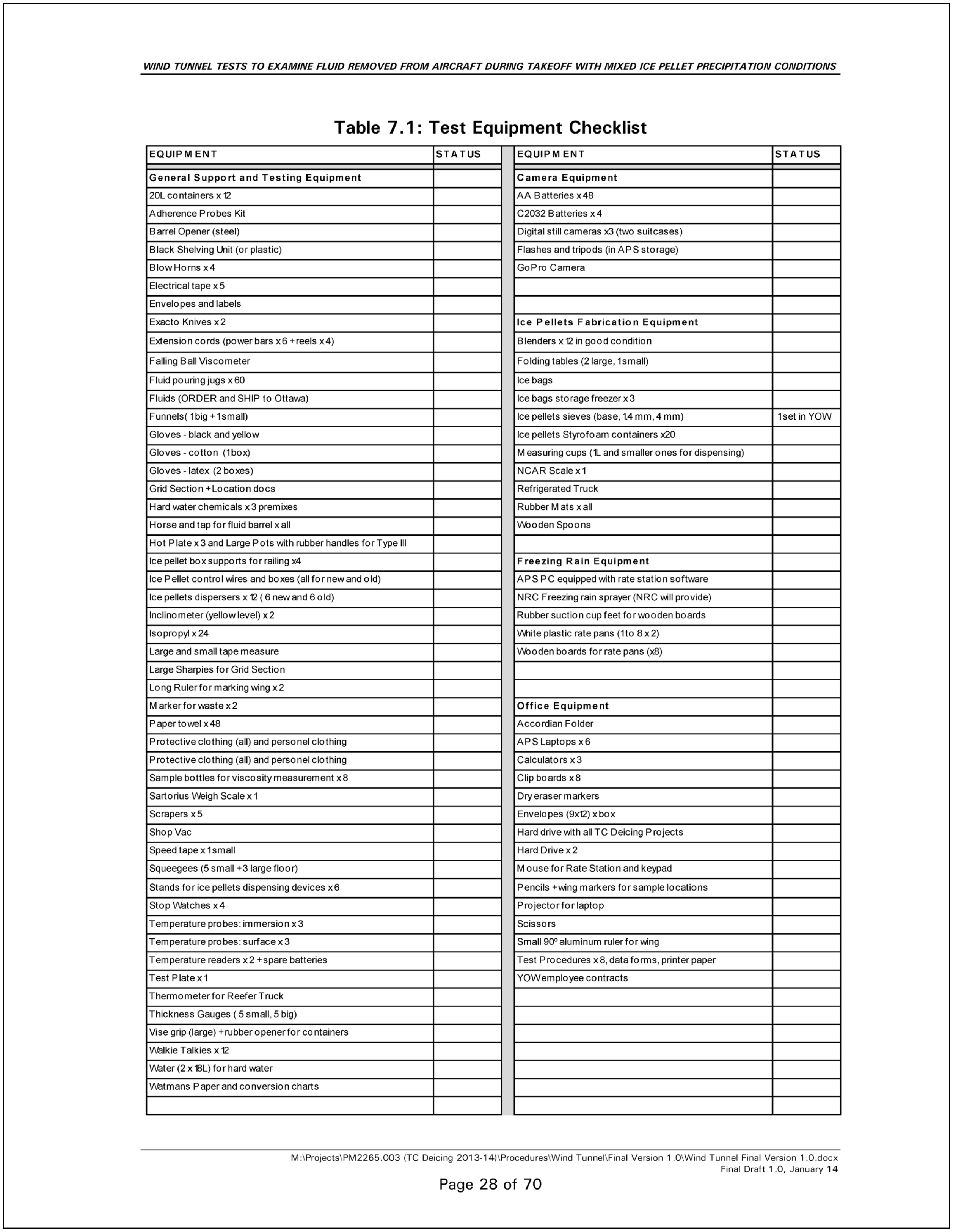
It is anticipated that testing will be conducted to support several research and development (R&D) activities. The objectives of these lower priority activities are as follows:

- Evaluation of an airfoil performance monitor (APM) system;
- Heavy snow;
- Heavy contamination;
- Effect of cooling system on testing repeatability;
- Effect of fluid viscosity;
- Fluid and contamination at LOUT;
- Small hail;
- Frost simulation in the wind tunnel;
- Flaps/Slats testing to support YMX tests;
- Mixed HOT conditions;
- Snow on an un-protected wing;
- Feasibility of IP testing at higher speed (130-150kts);
- Windshield washer used as a Type I deicer;
- Effect of fluid seepage on dry wing performance; and
- Second wave of fluid at rotation.

As these full-scale R&D activities have in general not been previously attempted, therefore brief summaries of the anticipated procedures have been prepared to provide guidance at the time of testing. These procedures are attached to this document as Attachments XXV to XXXIX. The procedures are preliminary and may change based on the quality of the results obtained in the wind tunnel.

7. EQUIPMENT

Equipment to be employed is shown in Table 7.1.



WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

Table 7.1: Test Equipment Checklist

EQUIPMENT	STATUS
General Support and Testing Equipment	
20L containers x 12	
Adherence Probes Kit	
Barrel Opener (steel)	
Black Shelving Unit (or plastic)	
Blow Horns x 4	
Electrical tape x 5	
Envelopes and labels	
Exacto Knives x 2	
Extension cords (power bars x 6 + reels x 4)	
Falling Ball Viscometer	
Fluid pouring jugs x 60	
Fluids (ORDER and SHIP to Ottawa)	
Funnels(1big + 1small)	
Gloves - black and yellow	
Gloves - cotton (1box)	
Gloves - latex (2 boxes)	
Grid Section + Location docs	
Hard water chemicals x 3 premixes	
Horse and tap for fluid barrel x all	
Hot Plate x 3 and Large Pots with rubber handles for Type III	
Ice pellet box supports for railing x4	
Ice Pellet control wires and boxes (all for new and old)	
Ice pellets dispersers x 12 (6 new and 6 old)	
Inclinometer (yellow level) x 2	
Isopropyl x 24	
Large and small tape measure	
Large Sharpies for Grid Section	
Long Ruler for marking wing x 2	
Marker for waste x 2	
Paper towel x 48	
Protective clothing (all) and personel clothing	
Protective clothing (all) and personel clothing	
Sample bottles for viscosity measurement x 8	
Sartorius Weigh Scale x 1	
Scrapers x 5	
Shop Vac	
Speed tape x 1small	
Squeegees (5 small + 3 large floor)	
Stands for ice pellets dispensing devices x 6	
Stop Watches x 4	
Temperature probes: immersion x 3	
Temperature probes: surface x 3	
Temperature readers x 2 + spare batteries	
Test Plate x 1	
Thermometer for Reefer Truck	
Thickness Gauges (5 small, 5 big)	
Vise grip (large) + rubber opener for containers	
Walkie Talkies x 12	
Water (2 x 18L) for hard water	
Watmans Paper and conversion charts	

EQUIPMENT	STATUS
Camera Equipment	
AA Batteries x 48	
C2032 Batteries x 4	
Digital still cameras x3 (two suitcases)	
Flashes and tripods (in APS storage)	
GoPro Camera	
Ice Pellets Fabrication Equipment	
Blenders x 12 in good condition	
Folding tables (2 large, 1small)	
Ice bags	
Ice bags storage freezer x 3	
Ice pellets sieves (base, 1.4 mm, 4 mm)	1set in YOW
Ice pellets Styrofoam containers x20	
Measuring cups (1L and smaller ones for dispensing)	
NCAR Scale x 1	
Refrigerated Truck	
Rubber Mats x all	
Wooden Spoons	
Freezing Rain Equipment	
APS PC equipped with rate station software	
NRC Freezing rain sprayer (NRC will provide)	
Rubber suction cup feet for wooden boards	
White plastic rate pans (1to 8 x 2)	
Wooden boards for rate pans (x8)	
Office Equipment	
Accordian Folder	
APS Laptops x 6	
Calculators x 3	
Clip boards x 8	
Dry eraser markers	
Envelopes (9x12) x box	
Hard drive with all TC Deicing Projects	
Hard Drive x 2	
Mouse for Rate Station and keypad	
Pencils + wing markers for sample locations	
Projector for laptop	
Scissors	
Small 90º aluminum ruler for wing	
Test Procedures x 8, data forms, printer paper	
YOW employee contracts	

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Final Draft 1.0, January 14

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8. FLUIDS

Mid-viscosity samples of ethylene glycol and propylene glycol IV fluid will be used in the wind tunnel tests. Although the number of tests conducted will be determined based on the results obtained, the fluid quantities available are shown in Table 8.1 (quantities to be confirmed once fluid is received). Fluid application will be performed by pouring the fluid (rather than spraying) to reduce any shearing to the fluid.

Table 8.1: Fluid Available for Wind Tunnel Tests

FLUID	QUANTITY ORDERED	QUANTITY ALREADY IN STOCK	COMBINED TOTAL OF FLUID AVAILABLE	TOTAL QUANTITY RQ'D
Kilfrost ABC-S Plus	400	250	**650**	120
Dow FlightGuard AD-49	0	440	**440**	120
Dow EG106	0	600	**600**	560
Clariant MP III 2031 ECO	200	150	**350**	300
Clariant MP IV Launch	0	200	**200**	240
Clariant Max-Flight	0	160	**160**	100
Cryotech Polar Guard Advance	400	120	**520**	200
Cryotech Polar Plus	240	0	**240**	230
Dow Type I ADF	60	0	**60**	40

3600 L Ordered For 2009-10 Testing (18 Days)
3200 L Ordered For 2010-11 Testing (15 Days)
1800 L Ordered For 2011-12 Testing (7 of 15 days will be fluid testing)
4200 L Ordered for 2012-13 Testing (15 Days)

9. PERSONNEL

Four APS staff members are required for the tests at the NRC wind tunnel. Four additional persons (with one back-up) will be required from Ottawa for making and dispensing the ice pellets and snow. One additional person from

Ottawa will be required to photograph the testing. Table 9.1 demonstrates the personnel required and their associated tasks.

Fluid and ice pellets applications will be performed by APS/YOW personnel at the NRC wind tunnel. NRC personnel will operate the NRC wind tunnel and operate the freezing rain/drizzle sprayer (if requested).

Table 9.1: Personnel List

Wind Tunnel 11-12- Tentative	
Person	**Responsibility**
John	Overall Co-ordinator
Marco	Co-ordinator / General
Victoria	Forms & Data Collection Manager / IP Manager / YOW Pers. Manager / Camera Documentation
Dave	Data Collection / IP Support / Fluid Application / Fluid Manager
YOW Personnel	
Ben/Jesse	Photography
James	Fluids / IP / Dispensing / General Support
YOW 1	Fluids / IP / Dispensing
YOW 2	Fluids / IP / Dispensing
YOW 3	Fluids / IP / Dispensing
YOW 4	Back-up

NRC Institute of Aerospace Research Contacts

- Lucio Del Ciotto: (613) 913-9720
- Catherine Clark: (613) 998-6932

10. SAFETY

- A safety briefing will be done on the first day of testing;
- Personnel should be familiar with NRC emergency procedures i.e. DO NOT CALL 9-1-1, instead call the NRC Emergency Center as they will contact and direct the necessary services;
- All personnel must be familiar with the Material Safety Data Sheets (MSDS) for fluids;
- Prior to operating the wind tunnel, loose objects should be removed from the vicinity;
- When wind tunnel is operating, ensure that ear plugs are worn if necessary and personnel keep safe distances;

- When working on ladders, ensure equipment is stable;
- CSA approved footwear and appropriate clothing for frigid temperatures are to be worn by all personnel;
- Caution should be taken when walking in the test section due to slippery floors, and dripping fluid from the wing section;
- If fluid comes into contact with skin, rinse hands under running water; and
- If fluid comes into contact with eyes, flush with the portable eye wash station.

ATTACHMENT I – Procedure: Dry Wing Performance

Background

A significant amount of work has been done in conjunction with NASA and NRC in order to calibrate and characterize the wind tunnel and airfoil model during the last two winter seasons. This work has further increased the confidence in the data produced, however ongoing verification is necessary in order to identify potential changes in the system performance.

Objective

Verify that clean model aerodynamic data agree with the data acquired in previous years with the same model. Given the various issues with repeatability and angle of attack offsets in the past, this is an important step prior to fluids testing.

Methodology

- Ensure the wing is clean and dry;
- Conduct a dry wing test using the regular take-off profile;
- Conduct a dry wing test using a take-off profile with rotation to stall;
- Compare lift performance to historical data; and
- Address potential discrepancies accordingly.

Test Plan

This testing should be conducted at the start of each testing day.

ATTACHMENT II – Procedure: Allowance Times in Light Ice Pellets Mixed with Light or Moderate Snow Conditions

Background

Historical winter weather data has indicated that a significant portion of "light ice pellets mixed with light snow" precipitation occurs below -10°C and "light ice pellets mixed with moderate snow" precipitation occurs below -5 to -10°C where no allowance times currently exist. Some additional data has been collected in 2012-13 which supports a potential for guidance in these conditions, however testing is still required in order to substantiate any proposed changes to the allowance times.

Objective

To conduct testing in conditions of "light ice pellets mixed with light snow" below -10°C and "light ice pellets mixed with moderate snow" below -5 to -10°C to support potential changes to the allowance times table.

Methodology

- Analyze existing data;
- Identify data gaps (fluids, temperatures, etc);
- Conduct testing with appropriate conditions to address data gaps;
- Adjust testing plan accordingly based on aerodynamic data collected.

Test Plan

One day of testing is planned, however testing could be expanded to 3 days.

ATTACHMENT III – Procedure: Ice Pellet Allowance Time Substantiation with New Fluids, Fluids Previously Tested with Limited Data, and Temperatures Close to the LOUT

Background

Previous testing has shown that typically lift losses will significantly increase at the lower temperatures. Limited data is available at (or very near) the fluid Lowest Operational Use Temperature (LOUT). Additional testing is recommended to obtain data close to the fluid LOUT to determine the aerodynamic effects of ice pellet contamination at these colder temperatures.

Objective

To determine the aerodynamic effects of ice pellet contamination close to the fluid LOUT.

Methodology

- Analyze existing data;
- Identify data gaps (fluids, temperatures, etc);
- Conduct testing close to the fluid LOUT (-20 to -30°C) with appropriate conditions to address data gaps;
- Adjust testing plan accordingly based on aerodynamic data collected.

Test Plan

Two days of testing are planned, however this testing is temperature critical and requires very low temperatures below -20°C.

ATTACHMENT IV – Procedure: Equivalency of New IP/SN Dispenser Systems

Background

In the winter of 2012-13, seed spreaders historically modified and used for applying ice pellets during wind tunnel and flat plate testing, were no longer available as the manufacturer has stopped production of the model. A new replacement seed spreader system was found which is similar (but not identical). Some calibration work was required to demonstrate an equivalency in the two systems: testing was conducted to verify the distribution of the historical system versus the new replacement system. The data collected demonstrates that the new system is very similar to old system with some small variations. It is recommended comparative wind tunnel testing be conducted to validate the equivalency of the systems.

Objective

To evaluate the equivalency of the new and old generation dispenser systems through comparative wind tunnel testing.

Methodology

- Conduct 2-3 tests with the same fluid in an existing ice pellet only condition with the old dispenser systems;
- Conduct the same 2-3 tests with the new dispenser system;
- Compare the results and address discrepancies accordingly; and
- Repeat for snow conditions (consider doing 1-2 tests for each dispenser instead).

Test Plan

One day of testing is anticipated.

ATTACHMENT V – Procedure: Effect of Ice Phobic Coating on Aerodynamics With or Without Fluids

Background

In recent years, there has been significant industry interest in the use of coatings to protect aircraft critical surfaces. These coatings can sometimes designed and marketed as ice phobic coatings, but the behavior and performance of these coatings during ground icing operations has yet to be fully investigated Previous flat plate and wind tunnel work has been conducted since 2009-10 and has helped identify both strengths and weaknesses associated with these technologies. Additional aerodynamic testing was recommended to further develop the evaluation methodology and to investigate new product formulations.

Objective

To investigate the aerodynamic performance of ice phobic coatings with and without de/anti-icing fluids.

Methodology

Testing will be conducted using wing skins specifically manufactured to fit onto the existing thin high performance wing section and be secured by bolts. To cover the entire test wing, two individual wing skin halves are required.

Testing will consist of comparative test sets done with different sets of wing skins. The test set will consist of the following:

- Dry wing tests to 8degrees and to stall to understand effects of coatings and to evaluate the repeatability of the tests;
- Simulated climb-out or cruise runs to evaluate drag and fuel efficiency;
- Fluid only testing with a known fluid;
- Freezing rain with no fluid test to evaluate how contamination forms on the surface and the aerodynamic effects (beads of ice vs. smooth ice);
- Repeat dry wing tests to investigate fluid seepage issues associated with the wing skins and effect on repeatability;
- Un-install and re-install a wing skin to evaluate the repeatability of the installation process; and
- Compare the results with the coated wing skins to the un-coated wing skins. An additional comparison to the original wing is also useful.

Test Plan

Four days of testing are planned.

ATTACHMENT VI – Procedure: Development of a Type III Ice Pellet Allowance Time Table

Background

Several Canadian regional air operators (Porter & Skyregional) operating out of the Toronto Island airport, use Type III fluid for deicing and anti-icing of their turbo-prop aircraft. These operators were driven to use Type III fluids instead of Type IV fluids, due to aircraft performance penalties when using Type IV fluids. As this airport (and several other Canadian airports) is subject to ice pellet conditions, Porter has requested guidance from TC on the use of Type III fluids in ice pellet conditions. It is likely that other air operators will be requesting similar guidance in the near future, since both Skyregional and WestJet Encore also operate Dash 8-400 aircraft. Additional operational research is required by TC prior to providing operational guidance in this area due to the limited knowledge in using Type III fluids during ice pellet events.

Objective

To develop preliminary ice pellet allowance times for use with Type III fluids.

Methodology

- Conduct a thorough review of Type III data collected in previous years of ice pellet testing to determine information availability and requirements;
- Identify data requirements (fluids, temperatures, etc);
- Conduct testing with appropriate conditions to address data requirements. Both hot and cold fluid application data should be collected; and
- Adjust testing plan accordingly based on aerodynamic data collected to support the development of a Type III allowance time table.

Test Plan

Four days of testing are anticipated.

ATTACHMENT VII – Procedure: Evaluation of Type I Fluid Flow-off for Low Speed Rotation Less than 80 Knots

Background

The lowest operational use temperature (LOUT) for a fluid is determined based on the higher of the fluid freeze point plus a buffer, or the lowest temperature which passes the aerodynamic test (AS5900) for either the low speed or high speed ramp. Currently the high speed ramp is representative of aircraft rotating at 100 knots or higher, whereas the low speed ramp is representative of aircraft rotating between 67 knots and 100 knots.

There currently does not exist any fluid qualification for aircraft rotating below 67 knots, however several operators have aircraft that rotate below 67 knots that encounter ground icing conditions during winter months. Aerodynamic testing in the NRC wind tunnel, and possibly according to AS5900, can provide insight into alternatives for operating in such conditions; i.e. limit LOUT for lower rotation speeds, use diluted fluid, delay rotation when at Vr, increase the rotation speed etc. These operators have requested that TC provide operational guidance when using Type I fluids on these aircraft. Additional operational research is required by TC prior to providing operational guidance in this area.

Objective

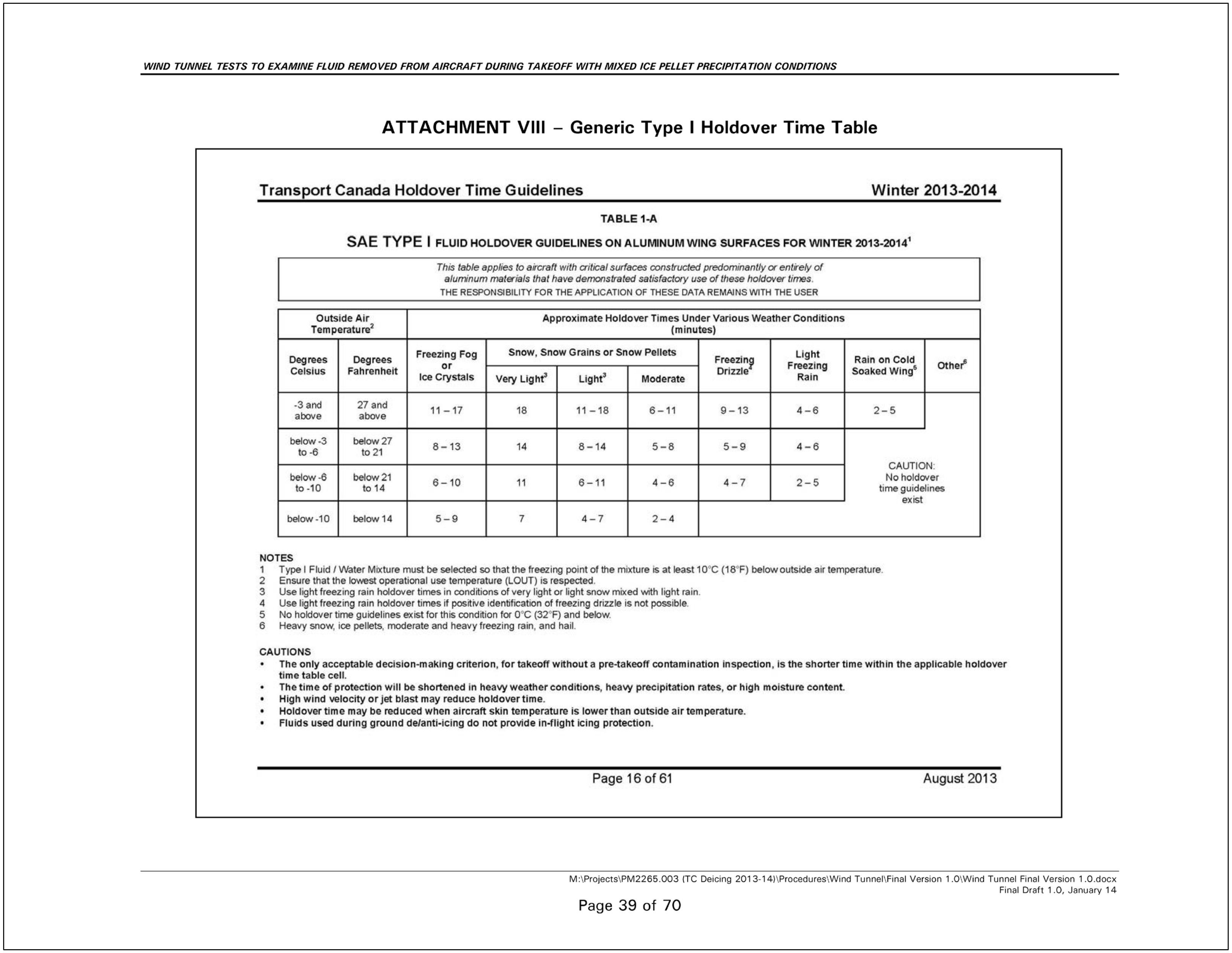
To evaluate the aerodynamic impact of using Type I fluid on aircraft with rotation speeds below 67 knots and resulting effect on the LOUT.

Methodology

- Comparative test sets should be done at all temperatures below -5°C, but specifically data at or near the Polar Plus LOUT is especially useful;
- Conduct a high speed (100kts) test with Polar Plus Type I fluid to identify acceptable lift losses;
- Conduct comparative test runs with the same fluid at 60 kts, 55kts, and at 55kts with a 3 second delayed rotation to determine likely increases in lift losses;
- When testing close to the Polar Plus LOUT, conduct an additional set of test with a Type I EG fluid with a lower LOUT (i.e. Dow ADF).
- Analyze results and modify test plan accordingly.
-

Test Plan

Two days of testing are anticipated.



ATTACHMENT VIII – Generic Type I Holdover Time Table

TABLE 1-A

SAE TYPE I FLUID HOLDOVER GUIDELINES ON ALUMINUM WING SURFACES FOR WINTER 2013-2014[1]

This table applies to aircraft with critical surfaces constructed predominantly or entirely of aluminum materials that have demonstrated satisfactory use of these holdover times.
THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Approximate Holdover Times Under Various Weather Conditions (minutes)							
Degrees Celsius	Degrees Fahrenheit	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
			Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	11 – 17	18	11 – 18	6 – 11	9 – 13	4 – 6	2 – 5	
below -3 to -6	below 27 to 21	8 – 13	14	8 – 14	5 – 8	5 – 9	4 – 6	CAUTION: No holdover time guidelines exist	
below -6 to -10	below 21 to 14	6 – 10	11	6 – 11	4 – 6	4 – 7	2 – 5		
below -10	below 14	5 – 9	7	4 – 7	2 – 4				

NOTES

1 Type I Fluid / Water Mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

ATTACHMENT IX – Generic Type III Holdover Time Table

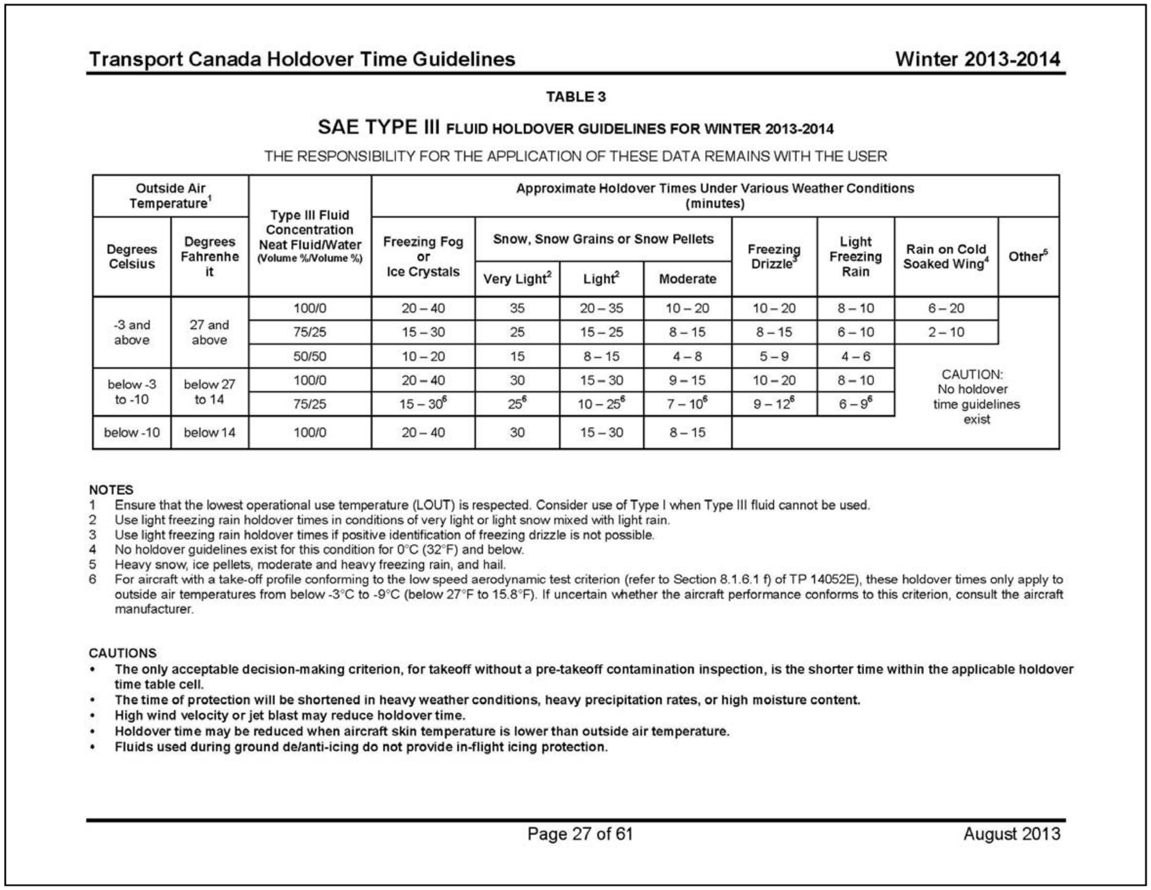


TABLE 3

SAE TYPE III FLUID HOLDOVER GUIDELINES FOR WINTER 2013-2014

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

Outside Air Temperature[1]		Type III Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[3]	Light Freezing Rain	Rain on Cold Soaked Wing[4]	Other[5]
				Very Light[2]	Light[2]	Moderate				
-3 and above	27 and above	100/0	20 – 40	35	20 – 35	10 – 20	10 – 20	8 – 10	6 – 20	CAUTION: No holdover time guidelines exist
		75/25	15 – 30	25	15 – 25	8 – 15	8 – 15	6 – 10	2 – 10	
		50/50	10 – 20	15	8 – 15	4 – 8	5 – 9	4 – 6		
below -3 to -10	below 27 to 14	100/0	20 – 40	30	15 – 30	9 – 15	10 – 20	8 – 10		
		75/25	15 – 30[6]	25[6]	10 – 25[6]	7 – 10[6]	9 – 12[6]	6 – 9[6]		
below -10	below 14	100/0	20 – 40	30	15 – 30	8 – 15				

NOTES
1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type III fluid cannot be used.
2 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
3 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
4 No holdover guidelines exist for this condition for 0°C (32°F) and below.
5 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
6 For aircraft with a take-off profile conforming to the low speed aerodynamic test criterion (refer to Section 8.1.6.1 f) of TP 14052E), these holdover times only apply to outside air temperatures from below -3°C to -9°C (below 27°F to 15.8°F). If uncertain whether the aircraft performance conforms to this criterion, consult the aircraft manufacturer.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

ATTACHMENT X – Dow Chemical UCAR Endurance EG106 Type IV Holdover Time Table

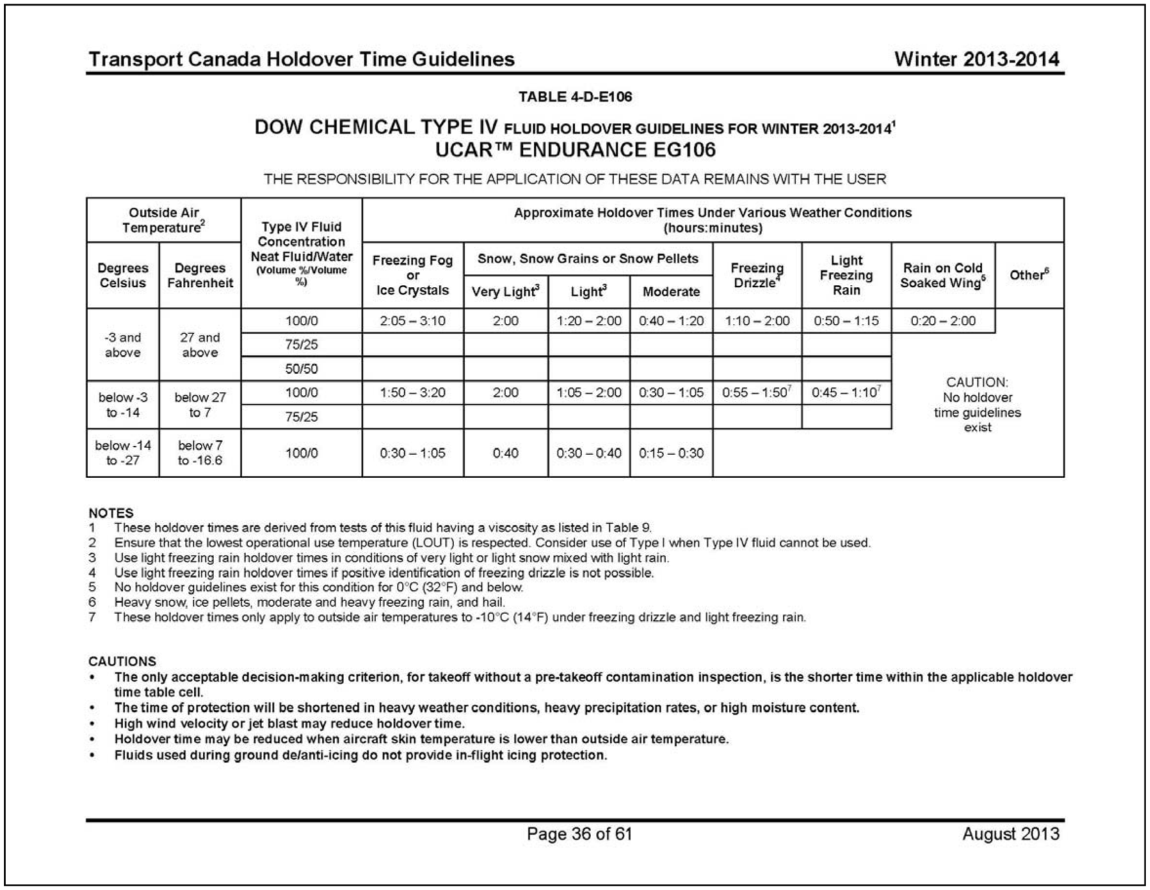


TABLE 4-D-E106

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2013-2014[1]
UCAR™ ENDURANCE EG106

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

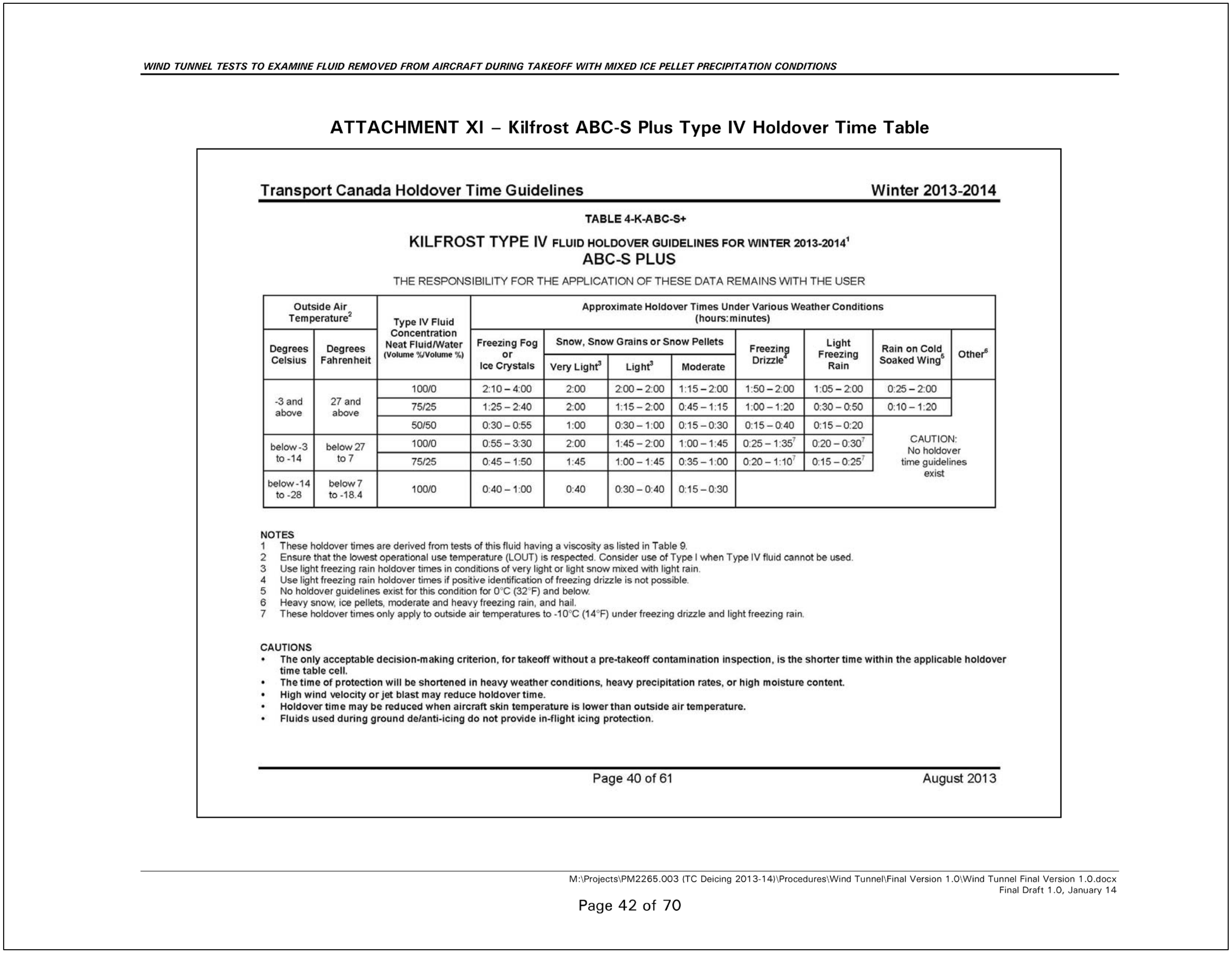
Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
				Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	100/0	2:05 – 3:10	2:00	1:20 – 2:00	0:40 – 1:20	1:10 – 2:00	0:50 – 1:15	0:20 – 2:00	CAUTION: No holdover time guidelines exist
		75/25								
		50/50								
below -3 to -14	below 27 to 7	100/0	1:50 – 3:20	2:00	1:05 – 2:00	0:30 – 1:05	0:55 – 1:50[7]	0:45 – 1:10[7]		
		75/25								
below -14 to -27	below 7 to -16.6	100/0	0:30 – 1:05	0:40	0:30 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**



ATTACHMENT XI – Kilfrost ABC-S Plus Type IV Holdover Time Table

TABLE 4-K-ABC-S+

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2013-2014[1]
ABC-S PLUS

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

Outside Air Temperature[2]		**Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)**	**Approximate Holdover Times Under Various Weather Conditions (hours:minutes)**							
			Freezing Fog or Ice Crystals	**Snow, Snow Grains or Snow Pellets**			**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
Degrees Celsius	**Degrees Fahrenheit**			**Very Light[3]**	**Light[3]**	**Moderate**				
-3 and above	27 and above	100/0	2:10 – 4:00	2:00	2:00 – 2:00	1:15 – 2:00	1:50 – 2:00	1:05 – 2:00	0:25 – 2:00	
		75/25	1:25 – 2:40	2:00	1:15 – 2:00	0:45 – 1:15	1:00 – 1:20	0:30 – 0:50	0:10 – 1:20	
		50/50	0:30 – 0:55	1:00	0:30 – 1:00	0:15 – 0:30	0:15 – 0:40	0:15 – 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:55 – 3:30	2:00	1:45 – 2:00	1:00 – 1:45	0:25 – 1:35[7]	0:20 – 0:30[7]		
		75/25	0:45 – 1:50	1:45	1:00 – 1:45	0:35 – 1:00	0:20 – 1:10[7]	0:15 – 0:25[7]		
below -14 to -28	below 7 to -18.4	100/0	0:40 – 1:00	0:40	0:30 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

ATTACHMENT XII – Clariant Safewing MP IV Launch Type IV Holdover Time Table

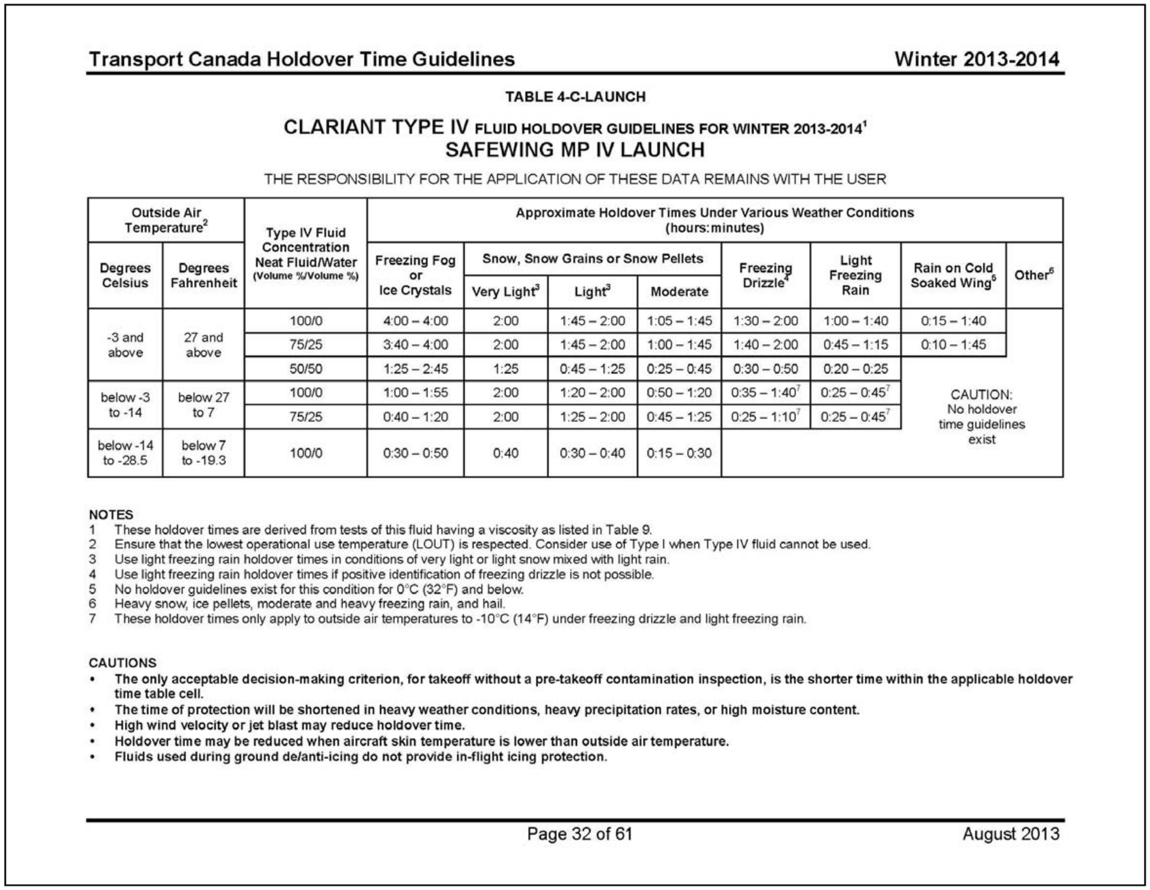


TABLE 4-C-LAUNCH

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2013-2014[1]
SAFEWING MP IV LAUNCH

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

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
				Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	100/0	4:00 – 4:00	2:00	1:45 – 2:00	1:05 – 1:45	1:30 – 2:00	1:00 – 1:40	0:15 – 1:40	
		75/25	3:40 – 4:00	2:00	1:45 – 2:00	1:00 – 1:45	1:40 – 2:00	0:45 – 1:15	0:10 – 1:45	
		50/50	1:25 – 2:45	1:25	0:45 – 1:25	0:25 – 0:45	0:30 – 0:50	0:20 – 0:25	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	1:00 – 1:55	2:00	1:20 – 2:00	0:50 – 1:20	0:35 – 1:40[7]	0:25 – 0:45[7]		
		75/25	0:40 – 1:20	2:00	1:25 – 2:00	0:45 – 1:25	0:25 – 1:10[7]	0:25 – 0:45[7]		
below -14 to -28.5	below 7 to -19.3	100/0	0:30 – 0:50	0:40	0:30 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

ATTACHMENT XIII – Cryotech Polar Guard Advance Type IV Holdover Time Table

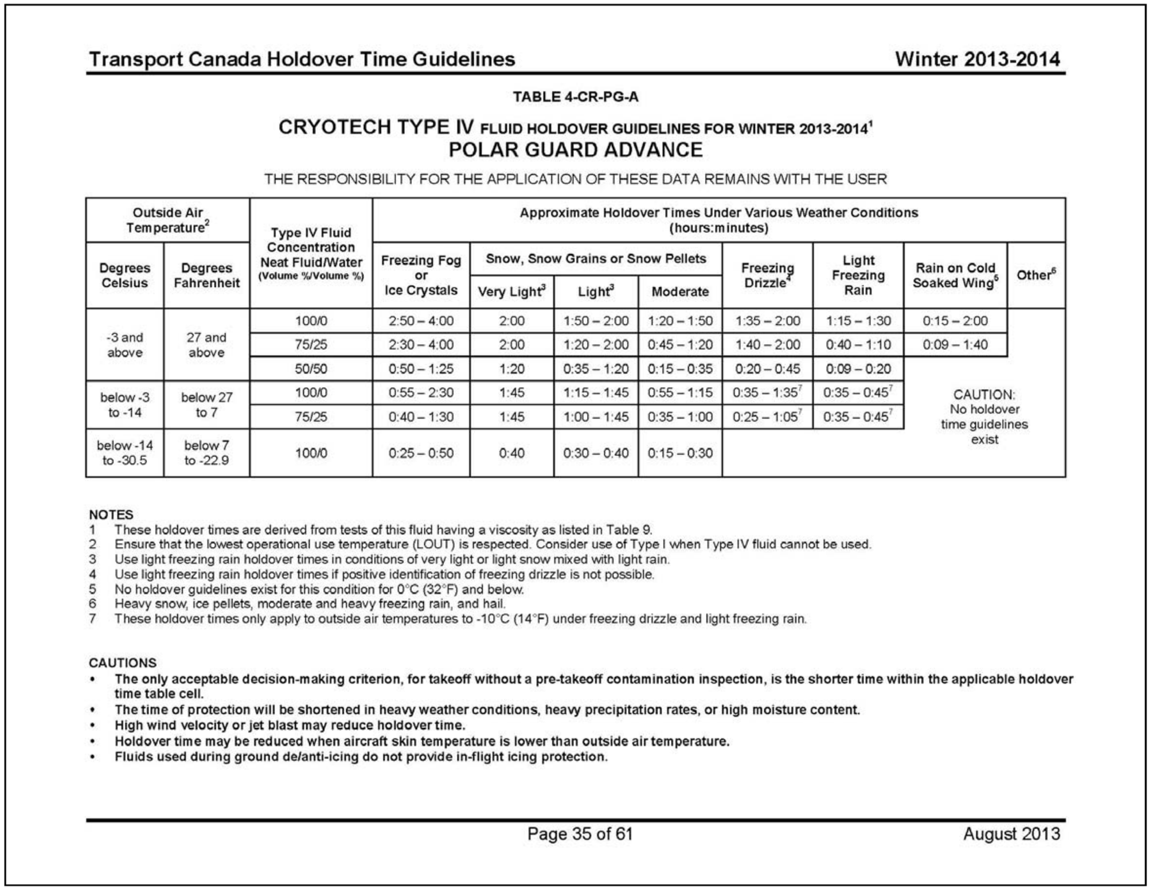


TABLE 4-CR-PG-A

CRYOTECH TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2013-2014[1]
POLAR GUARD ADVANCE

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

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
				Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	100/0	2:50 – 4:00	2:00	1:50 – 2:00	1:20 – 1:50	1:35 – 2:00	1:15 – 1:30	0:15 – 2:00	
		75/25	2:30 – 4:00	2:00	1:20 – 2:00	0:45 – 1:20	1:40 – 2:00	0:40 – 1:10	0:09 – 1:40	
		50/50	0:50 – 1:25	1:20	0:35 – 1:20	0:15 – 0:35	0:20 – 0:45	0:09 – 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:55 – 2:30	1:45	1:15 – 1:45	0:55 – 1:15	0:35 – 1:35[7]	0:35 – 0:45[7]		
		75/25	0:40 – 1:30	1:45	1:00 – 1:45	0:35 – 1:00	0:25 – 1:05[7]	0:35 – 0:45[7]		
below -14 to -30.5	below 7 to -22.9	100/0	0:25 – 0:50	0:40	0:30 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

ATTACHMENT XIV – ABAX ECOWING AD-49 Type IV Holdover Time Table

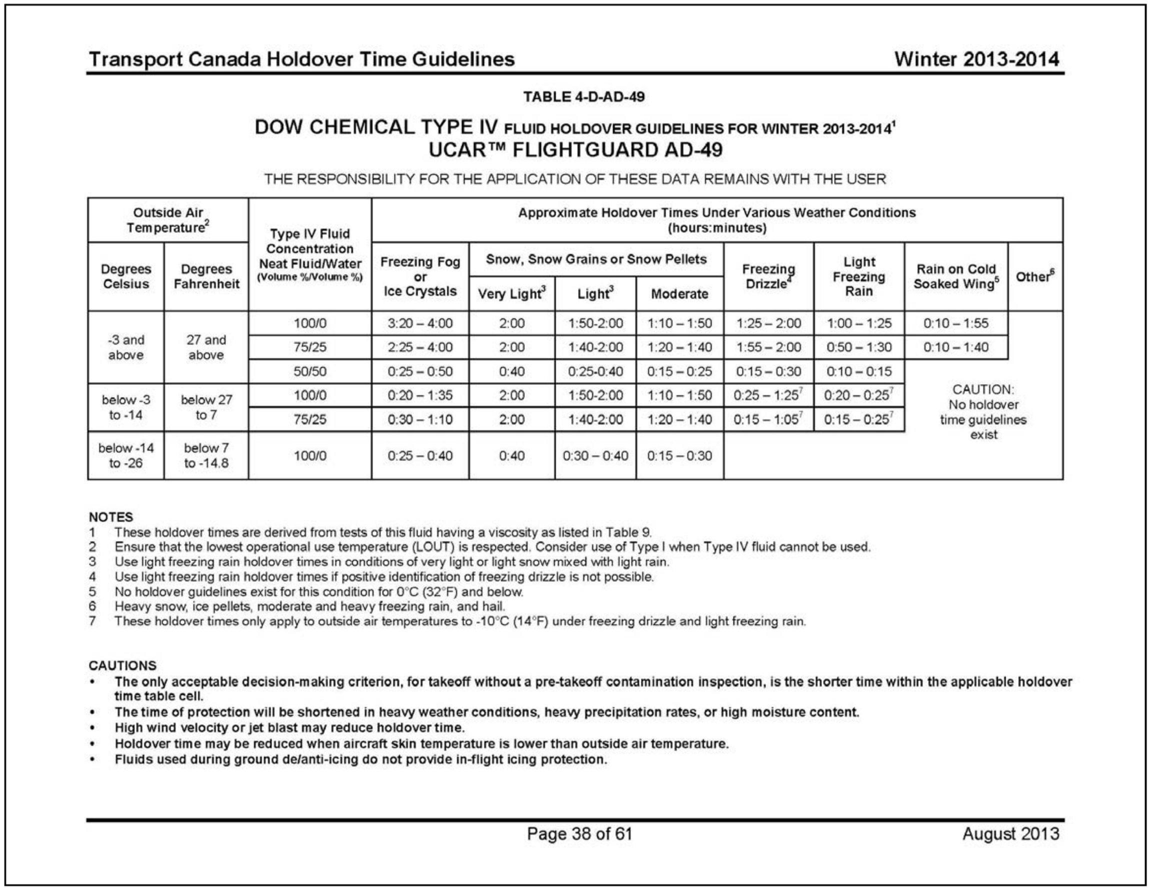


TABLE 4-D-AD-49

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2013-2014[1]
UCAR™ FLIGHTGUARD AD-49

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

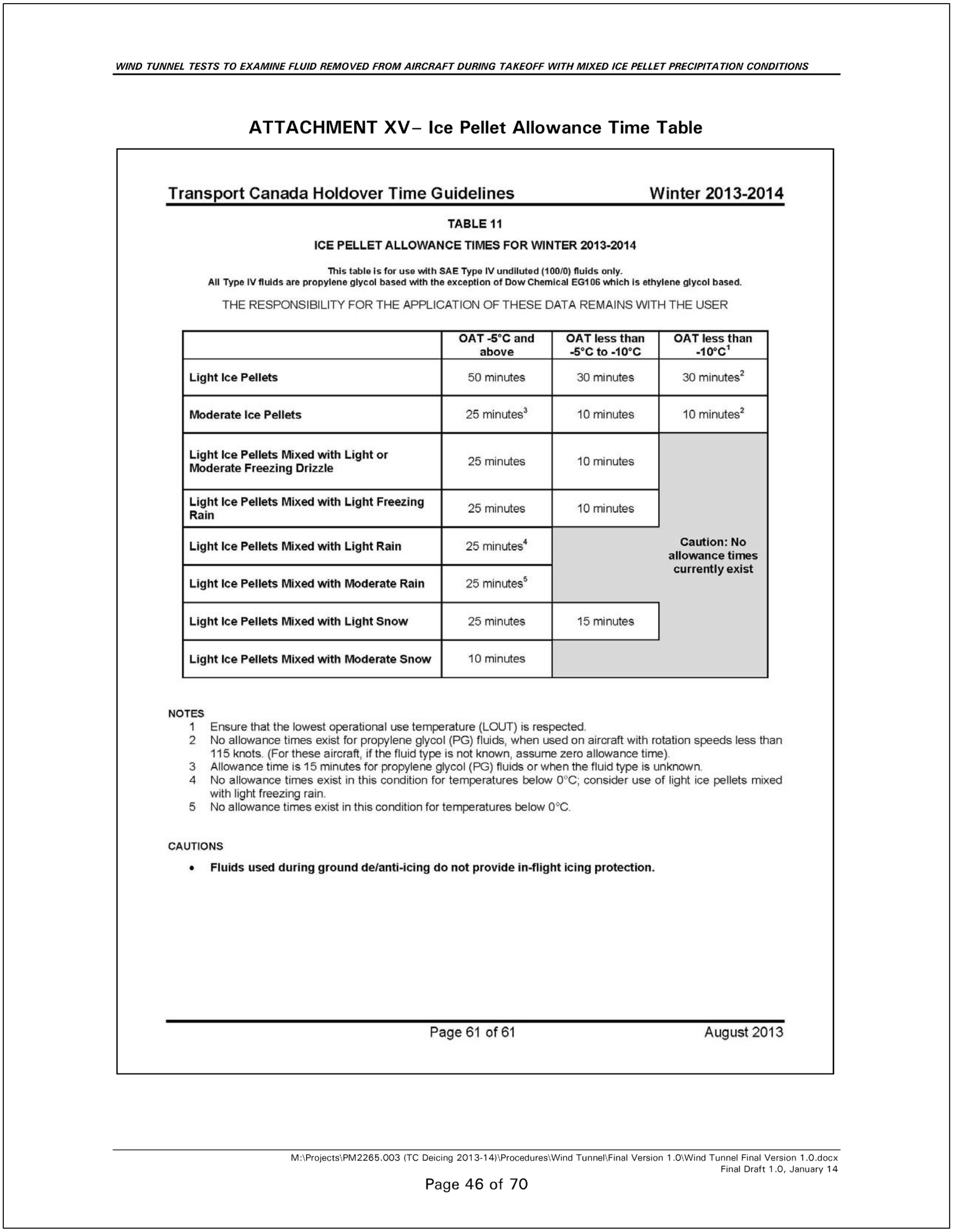
Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
				Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	100/0	3:20 – 4:00	2:00	1:50-2:00	1:10 – 1:50	1:25 – 2:00	1:00 – 1:25	0:10 – 1:55	
		75/25	2:25 – 4:00	2:00	1:40-2:00	1:20 – 1:40	1:55 – 2:00	0:50 – 1:30	0:10 – 1:40	
		50/50	0:25 – 0:50	0:40	0:25-0:40	0:15 – 0:25	0:15 – 0:30	0:10 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:20 – 1:35	2:00	1:50-2:00	1:10 – 1:50	0:25 – 1:25[7]	0:20 – 0:25[7]		
		75/25	0:30 – 1:10	2:00	1:40-2:00	1:20 – 1:40	0:15 – 1:05[7]	0:15 – 0:25[7]		
below -14 to -26	below 7 to -14.8	100/0	0:25 – 0:40	0:40	0:30 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content.**
- **High wind velocity or jet blast may reduce holdover time.**
- **Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.**
- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**



ATTACHMENT XV– Ice Pellet Allowance Time Table

Transport Canada Holdover Time Guidelines **Winter 2013-2014**

TABLE 11

ICE PELLET ALLOWANCE TIMES FOR WINTER 2013-2014

This table is for use with SAE Type IV undiluted (100/0) fluids only.
All Type IV fluids are propylene glycol based with the exception of Dow Chemical EG106 which is ethylene glycol based.

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

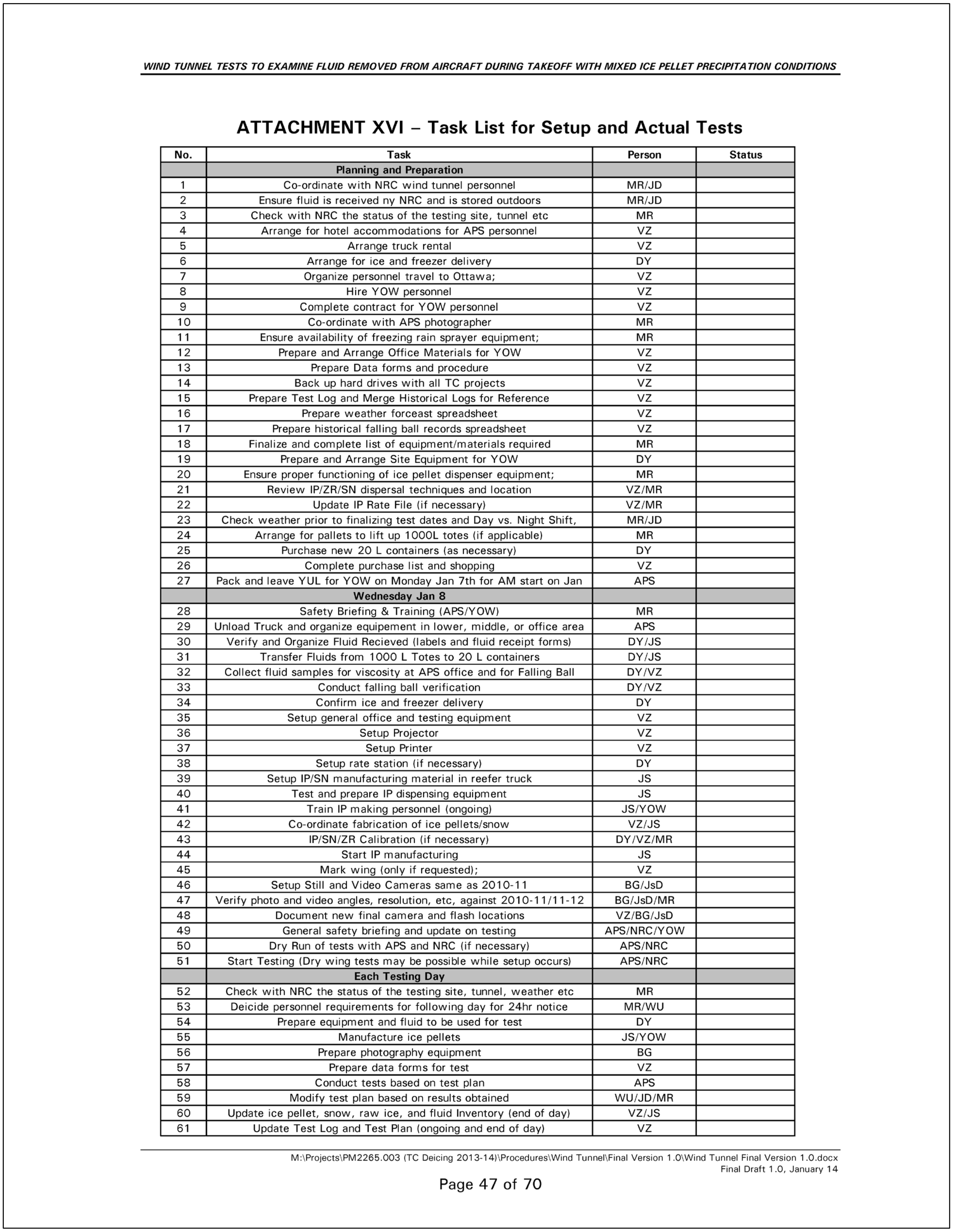
	OAT -5°C and above	OAT less than -5°C to -10°C	OAT less than -10°C[1]
Light Ice Pellets	50 minutes	30 minutes	30 minutes[2]
Moderate Ice Pellets	25 minutes[3]	10 minutes	10 minutes[2]
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	25 minutes	10 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Light Freezing Rain	25 minutes	10 minutes	
Light Ice Pellets Mixed with Light Rain	25 minutes[4]		
Light Ice Pellets Mixed with Moderate Rain	25 minutes[5]		
Light Ice Pellets Mixed with Light Snow	25 minutes	15 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes		

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected.
2 No allowance times exist for propylene glycol (PG) fluids, when used on aircraft with rotation speeds less than 115 knots. (For these aircraft, if the fluid type is not known, assume zero allowance time).
3 Allowance time is 15 minutes for propylene glycol (PG) fluids or when the fluid type is unknown.
4 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with light freezing rain.
5 No allowance times exist in this condition for temperatures below 0°C.

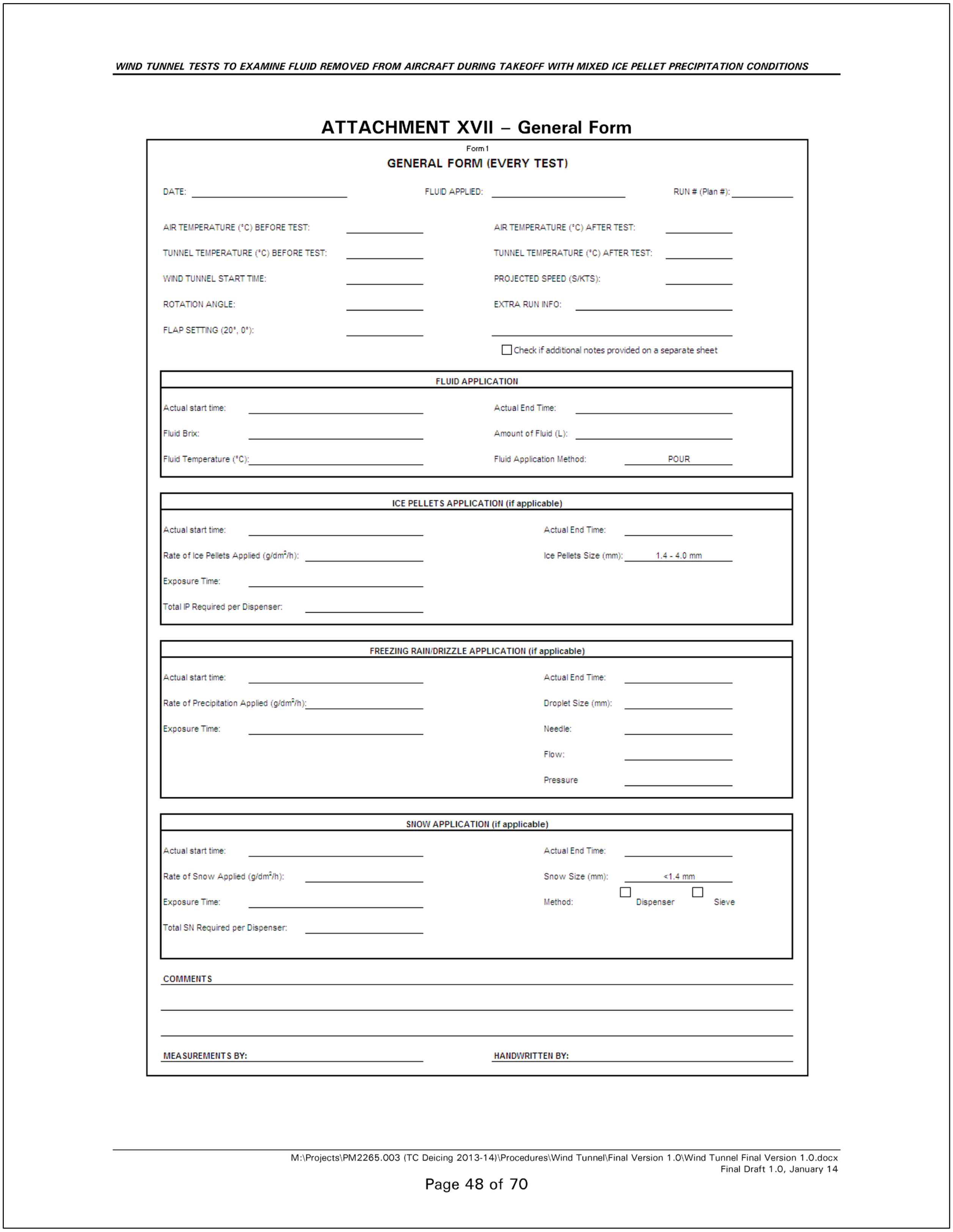
CAUTIONS

- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**



ATTACHMENT XVI – Task List for Setup and Actual Tests

No.	Task	Person	Status
	Planning and Preparation		
1	Co-ordinate with NRC wind tunnel personnel	MR/JD	
2	Ensure fluid is received ny NRC and is stored outdoors	MR/JD	
3	Check with NRC the status of the testing site, tunnel etc	MR	
4	Arrange for hotel accommodations for APS personnel	VZ	
5	Arrange truck rental	VZ	
6	Arrange for ice and freezer delivery	DY	
7	Organize personnel travel to Ottawa;	VZ	
8	Hire YOW personnel	VZ	
9	Complete contract for YOW personnel	VZ	
10	Co-ordinate with APS photographer	MR	
11	Ensure availability of freezing rain sprayer equipment;	MR	
12	Prepare and Arrange Office Materials for YOW	VZ	
13	Prepare Data forms and procedure	VZ	
14	Back up hard drives with all TC projects	VZ	
15	Prepare Test Log and Merge Historical Logs for Reference	VZ	
16	Prepare weather forceast spreadsheet	VZ	
17	Prepare historical falling ball records spreadsheet	VZ	
18	Finalize and complete list of equipment/materials required	MR	
19	Prepare and Arrange Site Equipment for YOW	DY	
20	Ensure proper functioning of ice pellet dispenser equipment;	MR	
21	Review IP/ZR/SN dispersal techniques and location	VZ/MR	
22	Update IP Rate File (if necessary)	VZ/MR	
23	Check weather prior to finalizing test dates and Day vs. Night Shift,	MR/JD	
24	Arrange for pallets to lift up 1000L totes (if applicable)	MR	
25	Purchase new 20 L containers (as necessary)	DY	
26	Complete purchase list and shopping	VZ	
27	Pack and leave YUL for YOW on Monday Jan 7th for AM start on Jan	APS	
	Wednesday Jan 8		
28	Safety Briefing & Training (APS/YOW)	MR	
29	Unload Truck and organize equipement in lower, middle, or office area	APS	
30	Verify and Organize Fluid Recieved (labels and fluid receipt forms)	DY/JS	
31	Transfer Fluids from 1000 L Totes to 20 L containers	DY/JS	
32	Collect fluid samples for viscosity at APS office and for Falling Ball	DY/VZ	
33	Conduct falling ball verification	DY/VZ	
34	Confirm ice and freezer delivery	DY	
35	Setup general office and testing equipment	VZ	
36	Setup Projector	VZ	
37	Setup Printer	VZ	
38	Setup rate station (if necessary)	DY	
39	Setup IP/SN manufacturing material in reefer truck	JS	
40	Test and prepare IP dispensing equipment	JS	
41	Train IP making personnel (ongoing)	JS/YOW	
42	Co-ordinate fabrication of ice pellets/snow	VZ/JS	
43	IP/SN/ZR Calibration (if necessary)	DY/VZ/MR	
44	Start IP manufacturing	JS	
45	Mark wing (only if requested);	VZ	
46	Setup Still and Video Cameras same as 2010-11	BG/JsD	
47	Verify photo and video angles, resolution, etc, against 2010-11/11-12	BG/JsD/MR	
48	Document new final camera and flash locations	VZ/BG/JsD	
49	General safety briefing and update on testing	APS/NRC/YOW	
50	Dry Run of tests with APS and NRC (if necessary)	APS/NRC	
51	Start Testing (Dry wing tests may be possible while setup occurs)	APS/NRC	
	Each Testing Day		
52	Check with NRC the status of the testing site, tunnel, weather etc	MR	
53	Deicide personnel requirements for following day for 24hr notice	MR/WU	
54	Prepare equipment and fluid to be used for test	DY	
55	Manufacture ice pellets	JS/YOW	
56	Prepare photography equipment	BG	
57	Prepare data forms for test	VZ	
58	Conduct tests based on test plan	APS	
59	Modify test plan based on results obtained	WU/JD/MR	
60	Update ice pellet, snow, raw ice, and fluid Inventory (end of day)	VZ/JS	
61	Update Test Log and Test Plan (ongoing and end of day)	VZ	



ATTACHMENT XVII – General Form

Form 1

GENERAL FORM (EVERY TEST)

DATE: ____________________ FLUID APPLIED: ____________________ RUN # (Plan #): __________

AIR TEMPERATURE (°C) BEFORE TEST: __________

AIR TEMPERATURE (°C) AFTER TEST: __________

TUNNEL TEMPERATURE (°C) BEFORE TEST: __________

TUNNEL TEMPERATURE (°C) AFTER TEST: __________

WIND TUNNEL START TIME: __________

PROJECTED SPEED (S/KTS): __________

ROTATION ANGLE: __________

EXTRA RUN INFO: ____________________

FLAP SETTING (20°, 0°): __________

☐ Check if additional notes provided on a separate sheet

FLUID APPLICATION

Actual start time: ____________________

Actual End Time: ____________________

Fluid Brix: ____________________

Amount of Fluid (L): ____________________

Fluid Temperature (°C): ____________________

Fluid Application Method: POUR

ICE PELLETS APPLICATION (if applicable)

Actual start time: ____________________

Actual End Time: ____________________

Rate of Ice Pellets Applied (g/dm²/h): ____________________

Ice Pellets Size (mm): 1.4 - 4.0 mm

Exposure Time: ____________________

Total IP Required per Dispenser: ____________________

FREEZING RAIN/DRIZZLE APPLICATION (if applicable)

Actual start time: ____________________

Actual End Time: ____________________

Rate of Precipitation Applied (g/dm²/h): ____________________

Droplet Size (mm): ____________________

Exposure Time: ____________________

Needle: ____________________

Flow: ____________________

Pressure ____________________

SNOW APPLICATION (if applicable)

Actual start time: ____________________

Actual End Time: ____________________

Rate of Snow Applied (g/dm²/h): ____________________

Snow Size (mm): <1.4 mm

Exposure Time: ____________________

Method: ☐ Dispenser ☐ Sieve

Total SN Required per Dispenser: ____________________

COMMENTS ____

____

____

MEASUREMENTS BY: ____________________ **HANDWRITTEN BY:** ____________________

ATTACHMENT XVIII – Wing Temperature, Fluid Thickness and Fluid Brix Form

Date: ______________________________

Run: ____________________

WING TEMPERATURE (Taken From NRC Logger)

Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2				
T5				
TU				
Time:				

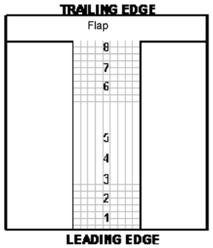
FLUID BRIX

Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2			
8	▨		
Flap	▨		
Time:			

FLUID THICKNESS (mil)

Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2			
3	▨	▨	▨
4	▨	▨	▨
5			
6	▨	▨	▨
7	▨	▨	▨
8			
Flap			
Time:			

Wing and Plate Condition
After the Takeoff Run
Time: ___________



Comments:______________________
____
____
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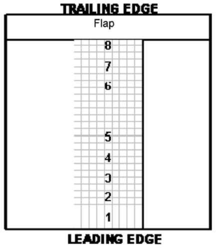
Wing and Plate Condition
Before the Takeoff Run
Time: ___________



Comments:______________________
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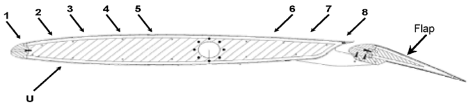
____
____
____



Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

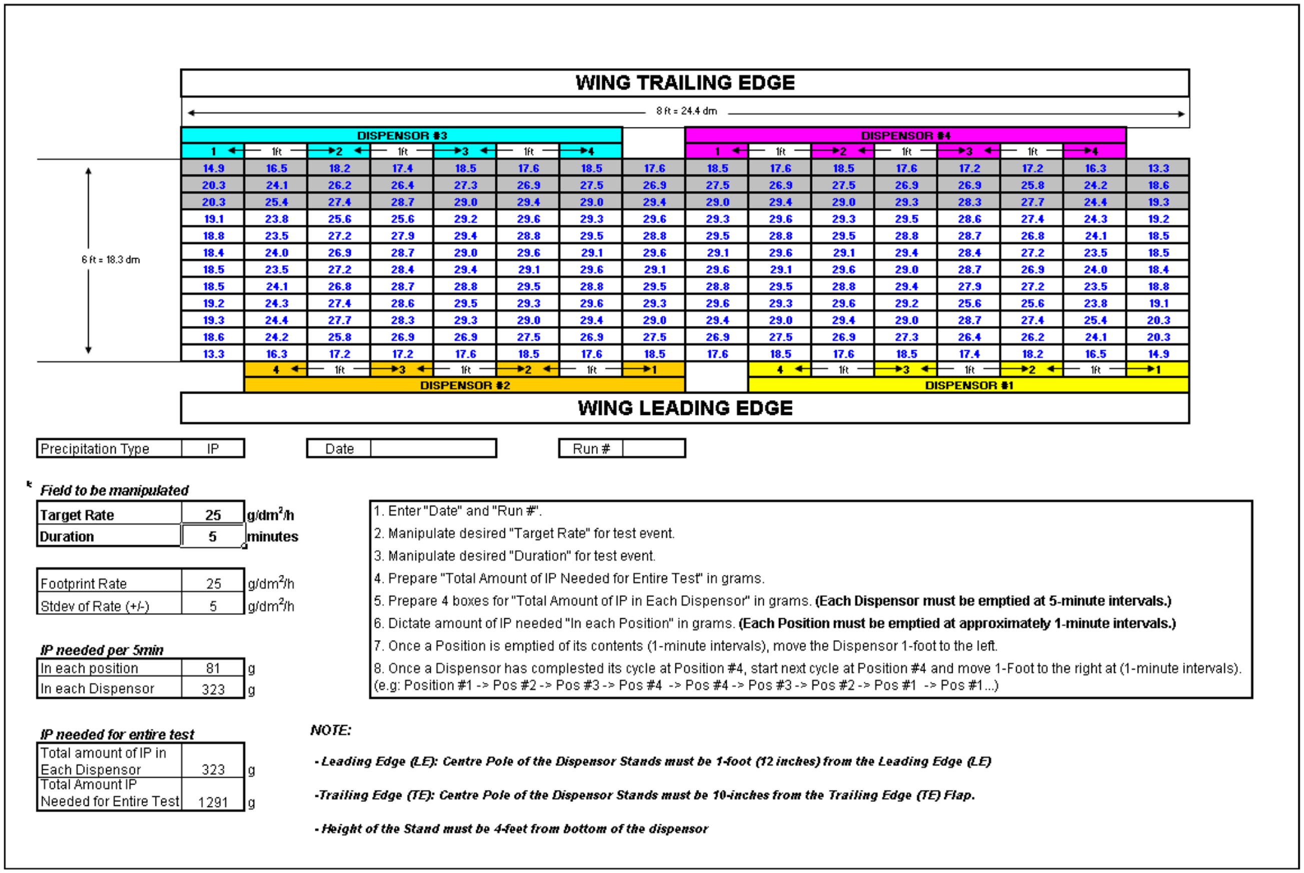
Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ______________________
____
____
____

OBSERVER: ______________________

ASSISTED BY: ______________________

ATTACHMENT XIX – Example Ice Pellet Dispensing Form



WING TRAILING EDGE

8 ft = 24.4 dm

6 ft = 18.3 dm

DISPENSOR #3								DISPENSOR #4							
1 ←	1ft	→2 ←	1ft	→3 ←	1ft	→4		1 ←	1ft	→2 ←	1ft	→3 ←	1ft	→4	
14.9	16.5	18.2	17.4	18.5	17.6	18.5	17.6	18.5	17.6	18.5	17.6	17.2	17.2	16.3	13.3
20.3	24.1	26.2	26.4	27.3	26.9	27.5	26.9	27.5	26.9	27.5	26.9	26.9	25.8	24.2	18.6
20.3	25.4	27.4	28.7	29.0	29.4	29.0	29.4	29.0	29.4	29.0	29.3	28.3	27.7	24.4	19.3
19.1	23.8	25.6	25.6	29.2	29.6	29.3	29.6	29.3	29.6	29.3	29.5	28.6	27.4	24.3	19.2
18.8	23.5	27.2	27.9	29.4	28.8	29.5	28.8	29.5	28.8	29.5	28.8	28.7	26.8	24.1	18.5
18.4	24.0	26.9	28.7	29.0	29.6	29.1	29.6	29.1	29.6	29.1	29.4	28.4	27.2	23.5	18.5
18.5	23.5	27.2	28.4	29.4	29.1	29.6	29.1	29.6	29.1	29.6	29.0	28.7	26.9	24.0	18.4
18.5	24.1	26.8	28.7	28.8	29.5	28.8	29.5	28.8	29.5	28.8	29.4	27.9	27.2	23.5	18.8
19.2	24.3	27.4	28.6	29.5	29.3	29.6	29.3	29.6	29.3	29.6	29.2	25.6	25.6	23.8	19.1
19.3	24.4	27.7	28.3	29.3	29.0	29.4	29.0	29.4	29.0	29.4	29.0	28.7	27.4	25.4	20.3
18.6	24.2	25.8	26.9	26.9	27.5	26.9	27.5	26.9	27.5	26.9	27.3	26.4	26.2	24.1	20.3
13.3	16.3	17.2	17.2	17.6	18.5	17.6	18.5	17.6	18.5	17.6	18.5	17.4	18.2	16.5	14.9
	4 ←	1ft	→3 ←	1ft	→2 ←	1ft	→1		4 ←	1ft	→3 ←	1ft	→2 ←	1ft	→1
	DISPENSOR #2								DISPENSOR #1						

WING LEADING EDGE

Precipitation Type	IP

Date	

Run #	

Field to be manipulated

Target Rate	**25**	**g/dm²/h**
Duration	**5**	**minutes**

Footprint Rate	25	g/dm²/h
Stdev of Rate (+/-)	5	g/dm²/h

IP needed per 5min

In each position	81	g
In each Dispensor	323	g

IP needed for entire test

Total amount of IP in Each Dispensor	323	g
Total Amount IP Needed for Entire Test	1291	g

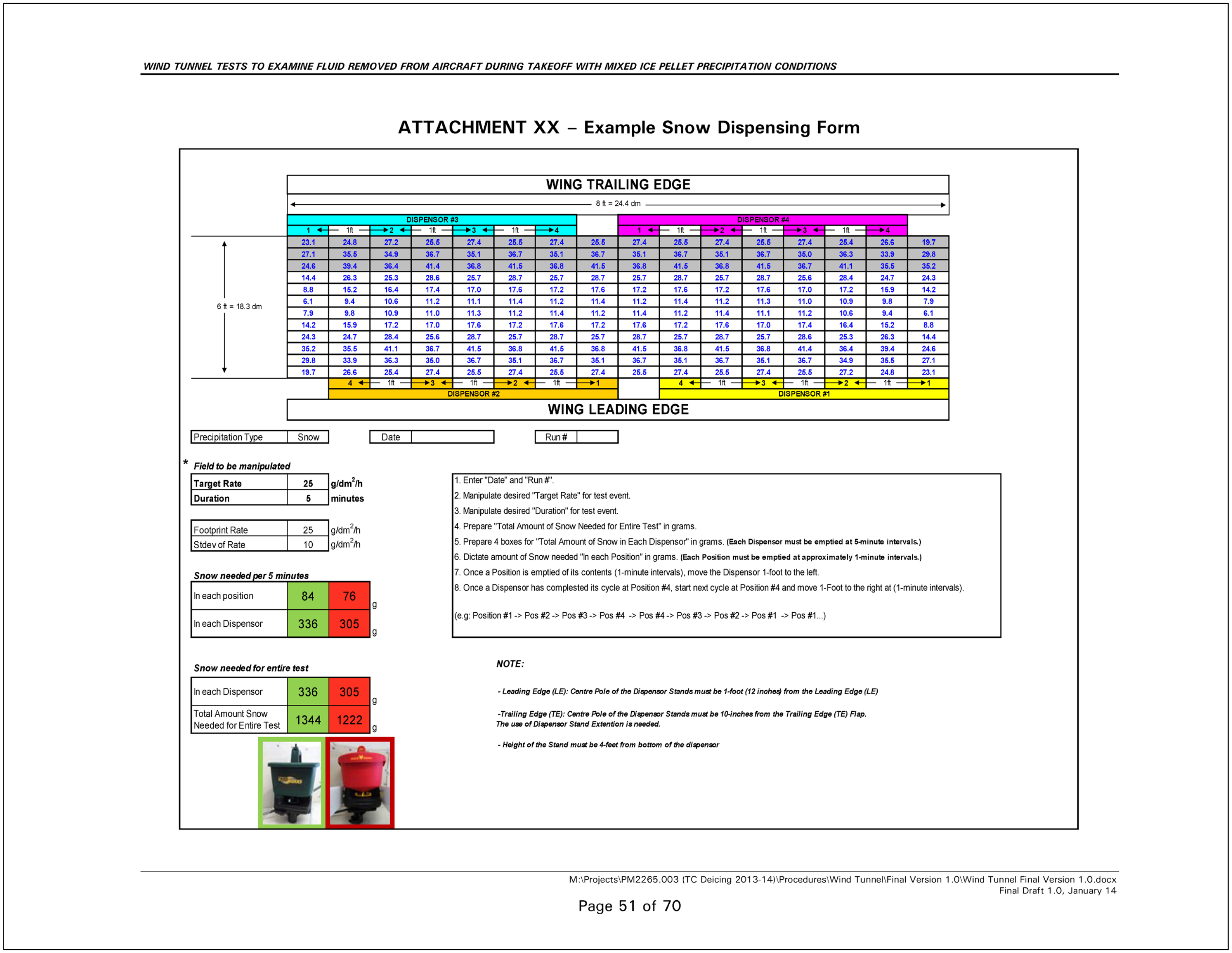
1. Enter "Date" and "Run #".
2. Manipulate desired "Target Rate" for test event.
3. Manipulate desired "Duration" for test event.
4. Prepare "Total Amount of IP Needed for Entire Test" in grams.
5. Prepare 4 boxes for "Total Amount of IP in Each Dispensor" in grams. **(Each Dispensor must be emptied at 5-minute intervals.)**
6. Dictate amount of IP needed "In each Position" in grams. **(Each Position must be emptied at approximately 1-minute intervals.)**
7. Once a Position is emptied of its contents (1-minute intervals), move the Dispensor 1-foot to the left.
8. Once a Dispensor has completed its cycle at Position #4, start next cycle at Position #4 and move 1-Foot to the right at (1-minute intervals). (e.g: Position #1 -> Pos #2 -> Pos #3 -> Pos #4 -> Pos #4 -> Pos #3 -> Pos #2 -> Pos #1 -> Pos #1...)

NOTE:

- Leading Edge (LE): Centre Pole of the Dispensor Stands must be 1-foot (12 inches) from the Leading Edge (LE)

-Trailing Edge (TE): Centre Pole of the Dispensor Stands must be 10-inches from the Trailing Edge (TE) Flap.

- Height of the Stand must be 4-feet from bottom of the dispensor



WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

ATTACHMENT XX – Example Snow Dispensing Form

WING TRAILING EDGE

8 ft = 24.4 dm

6 ft = 18.3 dm

DISPENSOR #3								DISPENSOR #4							
1	← 1ft →	2	← 1ft →	3	← 1ft →	4		1	← 1ft →	2	← 1ft →	3	← 1ft →	4	
23.1	24.8	27.2	25.5	27.4	25.5	27.4	25.5	27.4	25.5	27.4	25.5	27.4	25.4	26.6	19.7
27.1	35.5	34.9	36.7	35.1	36.7	35.1	36.7	35.1	36.7	35.1	36.7	35.0	36.3	33.9	29.8
24.6	39.4	36.4	41.4	36.8	41.5	36.8	41.5	36.8	41.5	36.8	41.5	36.7	41.1	35.5	35.2
14.4	26.3	25.3	28.6	25.7	28.7	25.7	28.7	25.7	28.7	25.7	28.7	25.6	28.4	24.7	24.3
8.8	15.2	16.4	17.4	17.0	17.6	17.2	17.6	17.2	17.6	17.2	17.6	17.0	17.2	15.9	14.2
6.1	9.4	10.6	11.2	11.1	11.4	11.2	11.4	11.2	11.4	11.2	11.3	11.0	10.9	9.8	7.9
7.9	9.8	10.9	11.0	11.3	11.2	11.4	11.2	11.4	11.2	11.4	11.1	11.2	10.6	9.4	6.1
14.2	15.9	17.2	17.0	17.6	17.2	17.6	17.2	17.6	17.2	17.6	17.0	17.4	16.4	15.2	8.8
24.3	24.7	28.4	25.6	28.7	25.7	28.7	25.7	28.7	25.7	28.7	25.7	28.6	25.3	26.3	14.4
35.2	35.5	41.1	36.7	41.5	36.8	41.5	36.8	41.5	36.8	41.5	36.8	41.4	36.4	39.4	24.6
29.8	33.9	36.3	35.0	36.7	35.1	36.7	35.1	36.7	35.1	36.7	35.1	36.7	34.9	35.5	27.1
19.7	26.6	25.4	27.4	25.5	27.4	25.5	27.4	25.5	27.4	25.5	27.4	25.5	27.2	24.8	23.1
	4	← 1ft →	3	← 1ft →	2	← 1ft →	1		4	← 1ft →	3	← 1ft →	2	← 1ft →	1
	DISPENSOR #2								DISPENSOR #1						

WING LEADING EDGE

Precipitation Type	Snow

Date	

Run #	

* ***Field to be manipulated***

Target Rate	**25**	**$g/dm^2/h$**
Duration	**5**	**minutes**

Footprint Rate	25	$g/dm^2/h$
Stdev of Rate	10	$g/dm^2/h$

Snow needed per 5 minutes

In each position	84	76	g
In each Dispensor	336	305	g

Snow needed for entire test

In each Dispensor	336	305	g
Total Amount Snow Needed for Entire Test	1344	1222	g

1. Enter "Date" and "Run #".
2. Manipulate desired "Target Rate" for test event.
3. Manipulate desired "Duration" for test event.
4. Prepare "Total Amount of Snow Needed for Entire Test" in grams.
5. Prepare 4 boxes for "Total Amount of Snow in Each Dispensor" in grams. **(Each Dispensor must be emptied at 5-minute intervals.)**
6. Dictate amount of Snow needed "In each Position" in grams. **(Each Position must be emptied at approximately 1-minute intervals.)**
7. Once a Position is emptied of its contents (1-minute intervals), move the Dispensor 1-foot to the left.
8. Once a Dispensor has complested its cycle at Position #4, start next cycle at Position #4 and move 1-Foot to the right at (1-minute intervals).

(e.g: Position #1 -> Pos #2 -> Pos #3 -> Pos #4 -> Pos #4 -> Pos #3 -> Pos #2 -> Pos #1 -> Pos #1...)

NOTE:

- Leading Edge (LE): Centre Pole of the Dispensor Stands must be 1-foot (12 inches) from the Leading Edge (LE)

-Trailing Edge (TE): Centre Pole of the Dispensor Stands must be 10-inches from the Trailing Edge (TE) Flap.
The use of Dispensor Stand Extention is needed.

- Height of the Stand must be 4-feet from bottom of the dispensor

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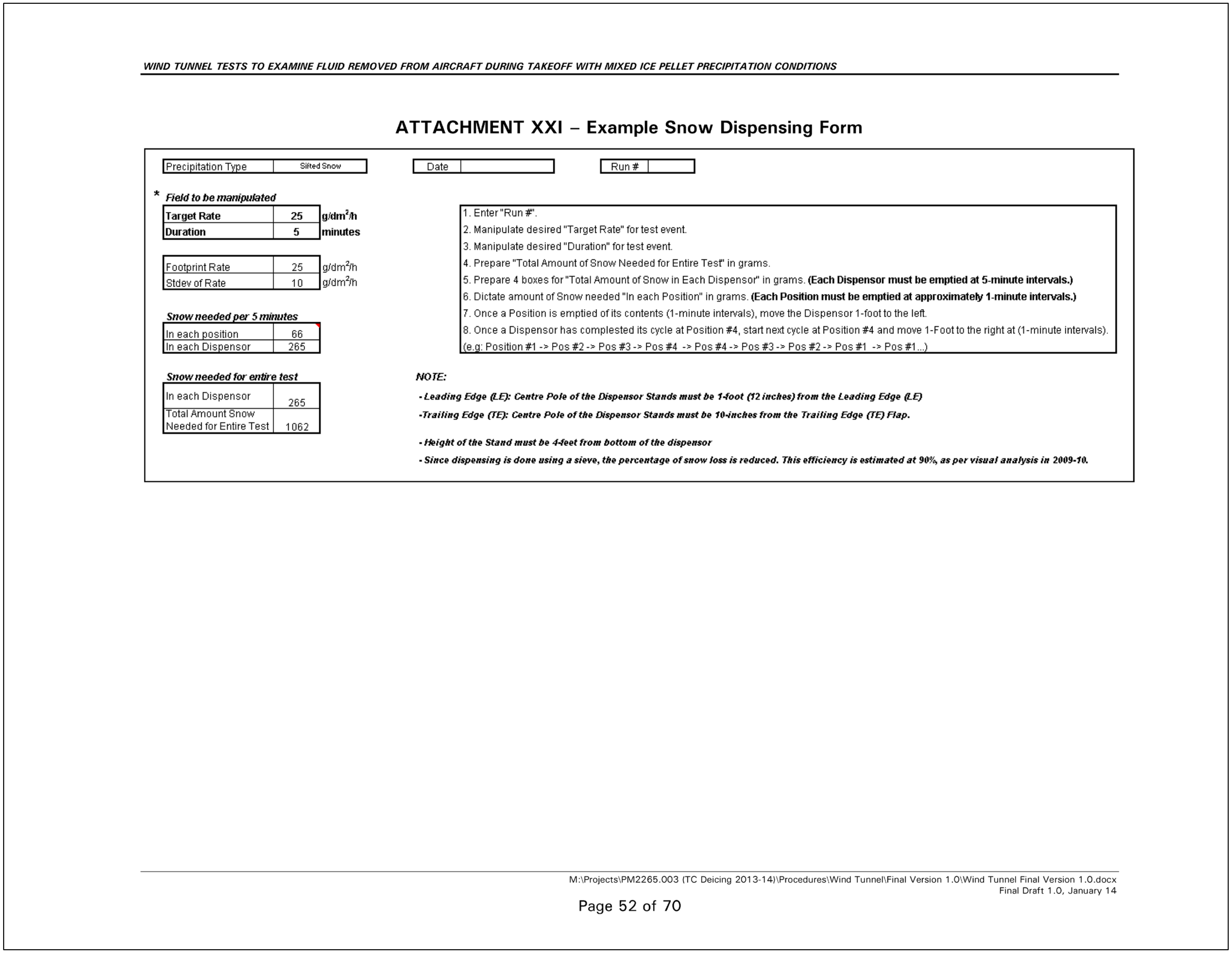


ATTACHMENT XXI – Example Snow Dispensing Form

Precipitation Type	Sifted Snow

Date

Run #

* ***Field to be manipulated***

Target Rate	**25**	**g/dm^2/h**
Duration	**5**	**minutes**

Footprint Rate	25	g/dm^2/h
Stdev of Rate	10	g/dm^2/h

Snow needed per 5 minutes

In each position	66
In each Dispensor	265

Snow needed for entire test

In each Dispensor	265
Total Amount Snow Needed for Entire Test	1062

1. Enter "Run #".
2. Manipulate desired "Target Rate" for test event.
3. Manipulate desired "Duration" for test event.
4. Prepare "Total Amount of Snow Needed for Entire Test" in grams.
5. Prepare 4 boxes for "Total Amount of Snow in Each Dispensor" in grams. **(Each Dispensor must be emptied at 5-minute intervals.)**
6. Dictate amount of Snow needed "In each Position" in grams. **(Each Position must be emptied at approximately 1-minute intervals.)**
7. Once a Position is emptied of its contents (1-minute intervals), move the Dispensor 1-foot to the left.
8. Once a Dispensor has complested its cycle at Position #4, start next cycle at Position #4 and move 1-Foot to the right at (1-minute intervals).
(e.g: Position #1 -> Pos #2 -> Pos #3 -> Pos #4 -> Pos #4 -> Pos #3 -> Pos #2 -> Pos #1 -> Pos #1...)

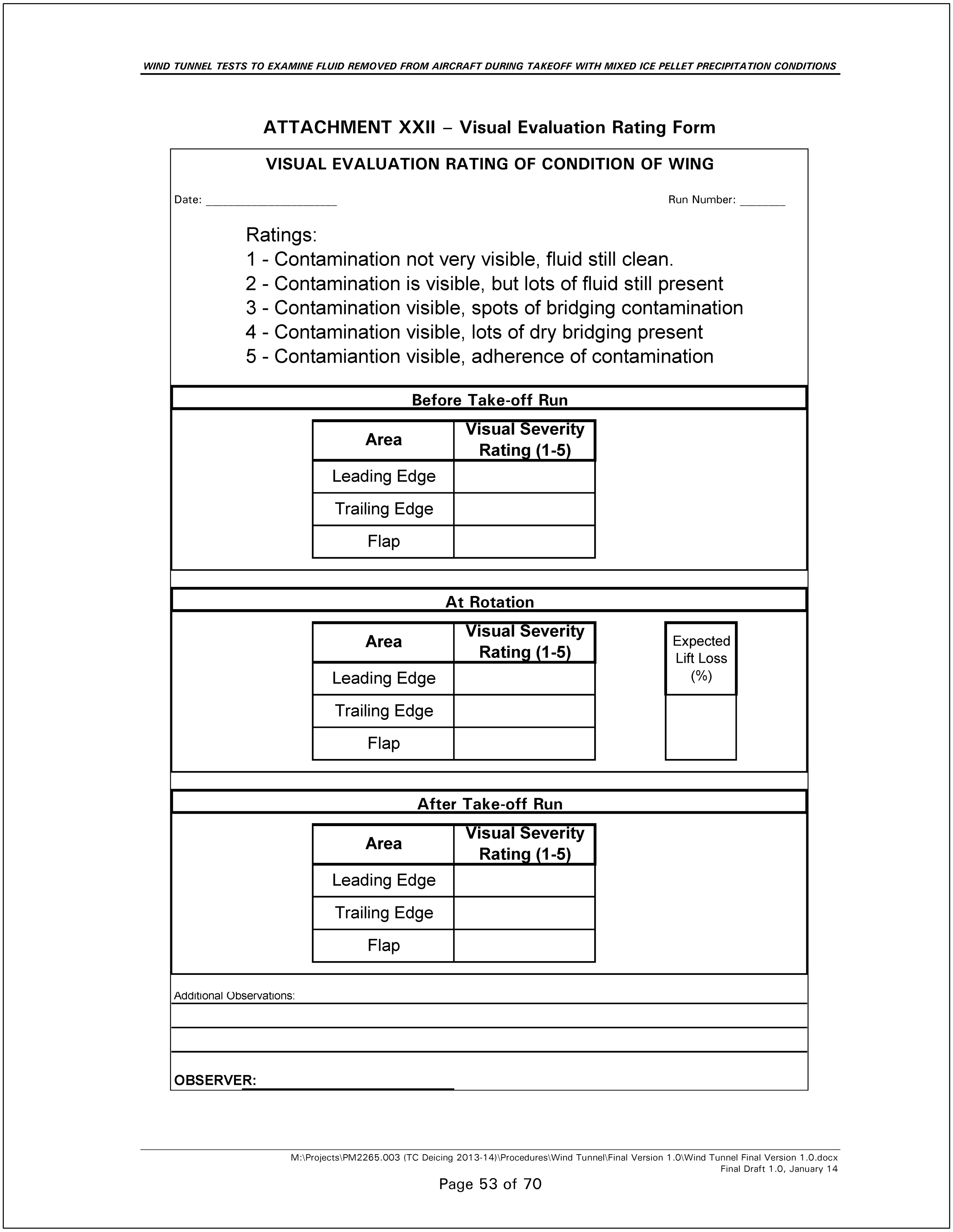
NOTE:

- Leading Edge (LE): Centre Pole of the Dispensor Stands must be 1-foot (12 inches) from the Leading Edge (LE)

-Trailing Edge (TE): Centre Pole of the Dispensor Stands must be 10-inches from the Trailing Edge (TE) Flap.

- Height of the Stand must be 4-feet from bottom of the dispensor

- Since dispensing is done using a sieve, the percentage of snow loss is reduced. This efficiency is estimated at 90%, as per visual analysis in 2009-10.



ATTACHMENT XXII – Visual Evaluation Rating Form

VISUAL EVALUATION RATING OF CONDITION OF WING

Date: ____________________

Run Number: _______

Ratings:
1 - Contamination not very visible, fluid still clean.
2 - Contamination is visible, but lots of fluid still present
3 - Contamination visible, spots of bridging contamination
4 - Contamination visible, lots of dry bridging present
5 - Contamiantion visible, adherence of contamination

Before Take-off Run

Area	Visual Severity Rating (1-5)
Leading Edge	
Trailing Edge	
Flap	

At Rotation

Area	Visual Severity Rating (1-5)
Leading Edge	
Trailing Edge	
Flap	

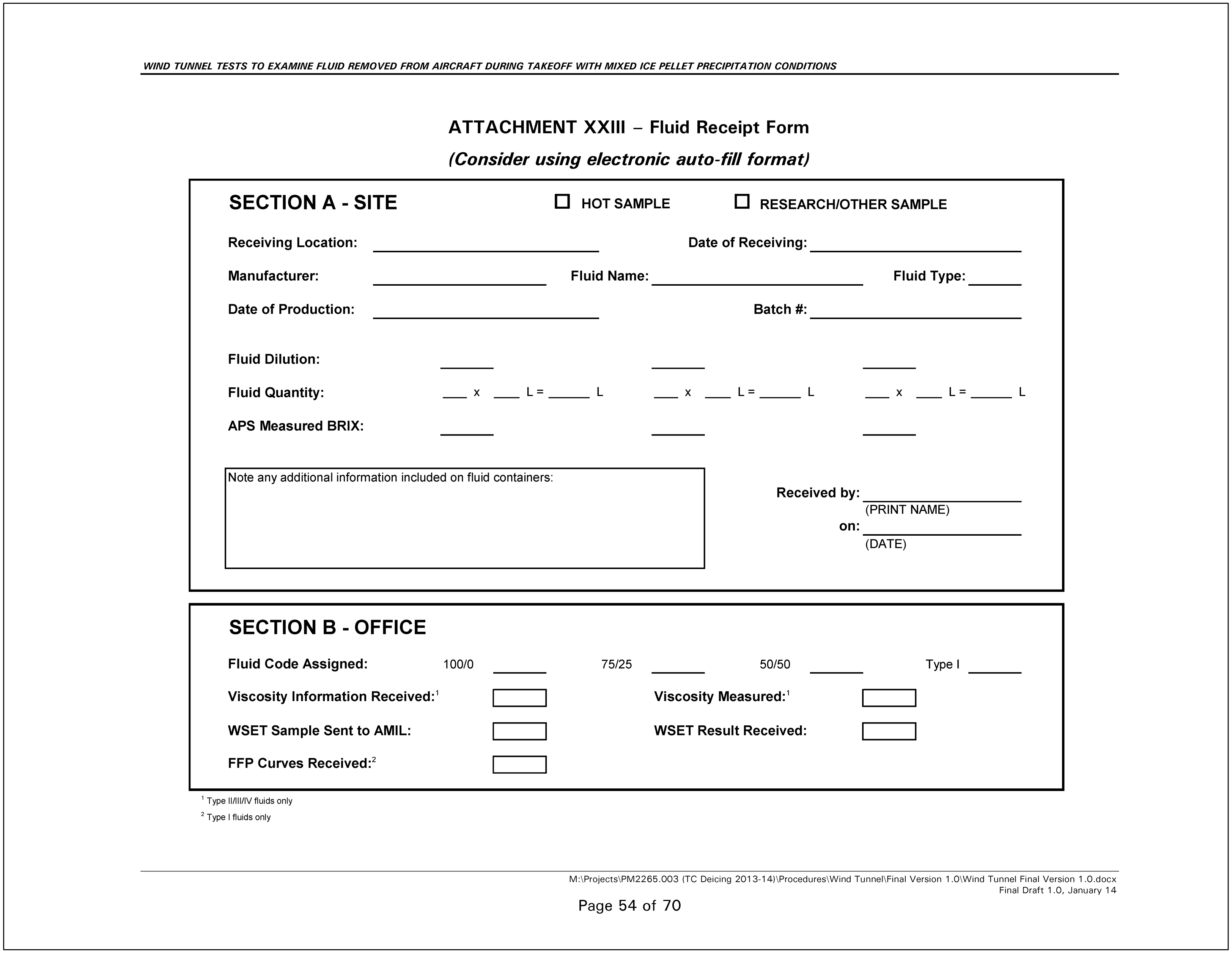
Expected Lift Loss (%)

After Take-off Run

Area	Visual Severity Rating (1-5)
Leading Edge	
Trailing Edge	
Flap	

Additional Observations:

OBSERVER: ____________________



WIND TUNNEL TESTS TO EXAMINE FLUID REMOVED FROM AIRCRAFT DURING TAKEOFF WITH MIXED ICE PELLET PRECIPITATION CONDITIONS

ATTACHMENT XXIII – Fluid Receipt Form

(Consider using electronic auto-fill format)

SECTION A - SITE

☐ **HOT SAMPLE** ☐ **RESEARCH/OTHER SAMPLE**

Receiving Location: ____________ **Date of Receiving:** ____________

Manufacturer: ____________ **Fluid Name:** ____________ **Fluid Type:** ______

Date of Production: ____________ **Batch #:** ____________

Fluid Dilution:	______	______	______
Fluid Quantity:	___ x ___ L = _____ L	___ x ___ L = _____ L	___ x ___ L = _____ L
APS Measured BRIX:	______	______	______

Note any additional information included on fluid containers:

Received by: ____________
(PRINT NAME)
on: ____________
(DATE)

SECTION B - OFFICE

Fluid Code Assigned: 100/0 ______ 75/25 ______ 50/50 ______ Type I ______

Viscosity Information Received:[1] ☐ **Viscosity Measured:**[1] ☐

WSET Sample Sent to AMIL: ☐ **WSET Result Received:** ☐

FFP Curves Received:[2] ☐

[1] Type II/III/IV fluids only

[2] Type I fluids only

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ATTACHMENT XXIV – Log of Fluid Sample Bottles

Date of Extraction	Fluid and Dilution	Batch #	Sample Source (i.e. drum)	Falling Ball Fluid Temp (°C)	Falling Ball Time (sec)	Comments

ATTACHMENT XXV – Procedure: Stall Warning Sensor

Background

Airfoil performance monitors (APM) are being developed and can be installed on any airfoil on an aircraft, including the tail. An APM is designed to measure the airflow over the wing, which reveals how well the wing is working. As a wing becomes contaminated, the APM should measure the changing or turbulent airflow and resulting lift generated by the wing. The APM is designed to alert the crew if the airflow degrades below a configurable threshold, giving the crew time to correct a potential stall before it happens. It was recommended that testing be conducted with a Canadian developed APM to support the development of the technology and aid in evaluating the potential for use in ground icing operations and to investigate whether or not the use of fluids with the systems would potentially obstruct the pressure ports which are critical to the systems operation.

Objective

To provide a testing platform to the manufacturer and allow them to evaluate the ability of the airfoil performance monitor to properly identify stall with and without icing conditions during aircraft ground operations with de/anti-icing fluid applications.

Methodology

- Conduct dry wing baseline testing with and without the installation to understand any potential aerodynamic influences the sensor may have;
- With the sensor installed, conduct dry wing tests to stall;
- Repeat tests with fluid only to stall;
- Evaluate ability of the APM to measure stall and compare to the stall observed through the aerodynamic data collected; and
- Evaluate the use of the APM unit with fluids.

Test Plan

Four tests are anticipated.

ATTACHMENT XXVI – Procedure: Heavy Snow

Background

As a direct result of the ice pellet research conducted, the use of HOTs for determining the protection time provided by anti-icing fluids was questioned. The focus has turned towards "aerodynamic failure" which can be defined as a significant lift loss resulting from contaminated anti-icing fluid. Heavy snow conditions have been selected for this study for two reasons. First, snow conditions account for the most significant portion of de-icing operations globally. Secondly, there has been a recent industry interest for holdover time for heavy snow conditions. Preliminary aerodynamic testing was conducted during the winters of 2006-07 and 2008-2011.

Objective

To investigate the fluid aerodynamic flow-off characteristics of anti-icing fluid contaminated with simulated heavy snow versus moderate snow.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical snow condition tests conducted in the wind tunnel.

- For a chosen fluid, conduct a test simulating moderate snow conditions (rate of 25 g/dm²/h) for an exposure time derived from the HOT table based on the tunnel temperature at the time of the test
- Record lift data, visual observations, and manually collected data;
- Conduct two comparative tests simulating heavy snow conditions (rate of 50 g/dm²/h or higher) for the same exposure time used during the moderate snow test.
  - NOTE: previous testing has indicated that using half, to ¾ of the moderate snow HOT generates similar end conditions, whereas using the full moderate HOT for heavy snow conditions generates a more sever fluid failure which behaves worse aerodynamically. ;
- Record lift data, visual observations, and manually collected data;
- Compare the heavy snow results to the moderate snow results. If the heavy snow results are worse, repeat the heavy snow test with a reduced exposure time, if the results are better, repeat the heavy snow test with an increased exposure time.
- Repeat until similar lift data, and visual observations are achieved for both heavy snow and moderate snow; and
- Document the percentage of the moderate snow HOT that is acceptable for heavy snow conditions.

Test Plan

Two to four comparative tests are anticipated. See previous reports for suggested test plan.

ATTACHMENT XXVII– Procedure: Heavy Contamination

Background

Previous testing in the wind tunnel demonstrated that although very heavy ice pellet and/or snow contamination was applied to a fluid covered wing section, significant lift losses were not apparent. The initial testing indicated that after a certain level of contamination, the dry loose ice pellets or snow no longer absorb into the fluid and easily fly off during the acceleration. The protection is due to a thin layer of fluid present underneath the contamination that prevents adherence. Questions of which point the lift losses become detrimental have been raised.

Objective

To continue previous research investigating heavy contamination effects on fluid flow off.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical ice pellet tests conducted in the wind tunnel.

- For a chosen fluid, conduct a test simulating ice pellets, snow, or freezing rain, for an exposure time far exceeding the recommended HOT or allowance time;
- Record lift data, visual observations, and manually collected data;
- Compare aerodynamic performance results to fluid only or fluid and contamination tests at the same temperature.

Test Plan

One to four tests are anticipated. Previous work should be referenced to identify starting levels of heavy contamination.

ATTACHMENT XXVIII – Procedure: Wind Tunnel Test Section Cooling

Background

Recent wind tunnel research has been limited by the ambient temperature in wind tunnel test section; in sunny conditions, the radiation will raise the temperature in the test section making testing difficult. To mitigate this effect, testing is often conducted overnight, however in some cases, even body heat from people working in the test area (specifically during long precipitation exposure tests) can effect the temperature. A new cooling system has been installed by the NRC to mitigate the effects of the radiation warming as well as from the heat generated by the personnel working in the test section. It was recommended that testing be condutced to evaluate the effects of the new cooling system on the test results.

Objective

To evaluate the effect of the cooling system on the aerodynamic test results produced.

Methodology

- Conduct a fluid only test without the cooling system. Have personnel standing on scaffolding for 20-minutes following fluid application to generate extra heat prior to running the wind tunnel;
- Conduct a second comparative fluid only test with the cooling system. Have personnel standing on scaffolding for 20-minutes following fluid application to generate extra heat prior to running the wind tunnel;
- Conduct a third comparative test at a suitable ambient temperature where the expected test area temperature with the cooling system is equal to the test area temperature of the test conducted without the cooling system.
- Compare aerodynamic performance results.

EXAMPLE OF COMPARATIVE DATA TO BE COLLECTED

Test #	Cooling System Status	OAT ºC	Test Area Temp ºC	Lift Loss %
1	Off	-18	-14	6.3
2	On	-18	-17	7.5
3	On	-15*	-14	5.7

* to be selected based on efficiency of cooling system based on test #2

Test Plan

Three tests at a minimum are expected.

ATTACHMENT XXIX- Procedure: Effect of Fluid Viscosity

Background

Testing was previously conducted to evaluate the aerodynamic effects of fluid viscosity on flow-off. To do so, comparative testing was conducted with both mid-production fluid (used for ice pellet allowance time testing) and with lowest on-wing viscosity fluid (LOWV) (used for holdover time testing). Testing was conducted with the thin high performance airfoil in fluid only conditions. Additional testing was recommended to further substantiate the testing results.

Objective

To continue previous research evaluating the effect of fluid viscosity on aerodynamics.

Methodology

For each comparative test set, a baseline mid-production test should be conducted, and immediately followed by a lowest on-wing viscosity test of the same fluid type. Testing should be done with fluid only and fluid and contamination.

Test Plan

Two to four tests are anticipated.

ATTACHMENT XXX – Procedure: Fluid and Contamination at LOUT

Background

Recent changes to the frost HOT guidance material allowing fluids to be used to the LOUT have raised concerns about whether or not this is an appropriate practice. In frost the major concern was the effect of radiation cooling and how it could affect the LOUT, however the concern also includes contamination at LOUT. This issue was also raised from the AWG for the ice pellet testing which allows fluids to be used to LOUT: will the added ice pellet contamination at the LOUT not bust BLDT? It was recommended that some testing be conducted at the fluid LOUT to investigate how contamination can affect the aerodynamic performance of the fluid.

Objective

To investigate the fluid aerodynamic flow-off characteristics of anti-icing fluid with contamination at the LOUT.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical ice pellet tests conducted in the wind tunnel.

- For a chosen fluid, conduct a test simulating ice pellets, snow, freezing fog, or frost, for an exposure time derived from the HOT table at the fluid LOUT.
- Record lift data, visual observations, and manually collected data;
- Conduct a fluid only baseline test at the same temperature (at LOUT);
- Compare the aerodynamic performance.

Test Plan

Four or more tests are anticipated at a minimum. If LOUT temperatures for neat fluids are not likely to occur, investigate the possibility of using diluted fluids to obtain a higher LOUT.

ATTACHMENT XXXI – Procedure: Small Hail

Background

Reports from primarily Asian operators have indicated that small hail can occur frequently during winter operations. The small hail will generally occur above freezing conditions; however no guidance for operating in the conditions is currently available. Questions have been raised as to whether the ice pellet allowance times can be used due to similarity in precipitation type. Although this concern has only been raised by Asian operators, it can be assumed that similar conditions can be expected by North American operators. WMO defines small hail as snow pellets encapsulated by ice, a precipitation halfway between graupel and hail.

Objective

To investigate the fluid aerodynamic flow-off characteristics of anti-icing fluid with contamination with small hail and to compare the results to ice pellets.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical ice pellet tests conducted in the wind tunnel.

- For a chosen fluid, conduct a test simulating small hail for an exposure time derived from the current ice pellet allowance time table as a starting point;
- Record lift data, visual observations, and manually collected data;
- Conduct a fluid only baseline test at the same temperature;
- Compare the aerodynamic performance.

Test Plan

One to four tests are anticipated. A meteorologist should be consulted prior to the conduct to narrow down the exact conditions and temperatures at which small hail will occur, as well as to obtain the desired small hail diameter.

ATTACHMENT XXXII – Procedure: Frost Simulation in the Wind Tunnel

Background

Frost is an important consideration in aircraft deicing. The irregular and rough frost accretion patterns can result in a significant loss of lift on critical aircraft surfaces. This potential hazard is amplified by the frequent occurrence of frost accretion in winter operations. Frost is an area of research that has yet to be fully explored. Discussions regarding the aerodynamic effects of frost have been raised, and the possibility of doing wind tunnel testing has been considered. It was recommended that initial testing be performed to investigate whether it would be feasible to simulate frost conditions in the PIWT.

Objective

To investigate the feasibility of simulating frost conditions in the PIWT.

Methodology

This work is exploratory, so no exact procedure exists. It is recommended that the frost generating parameters be explored to try and stimulate frost accretion. This can be done by causing a negative temperature differential between the wing and the ambient air i.e. air is warmer than skin. A more specific methodology may be determined on site following a brain-storm with onsite technicians.

Test Plan

One or two tests is anticipated.

ATTACHMENT XXXIII – Procedure: Flaps/Slats Testing to Support YMX Tests

Background

Flaps/slats testing has been conducted with the support of UPS during the winter sof 2011-12 and 2012-13, and is scheduled to continue during the winter of 2013-14. The initial results have indicated that extended configurations can result in earlier fluid failure on the flap and slats as compared to the main section of the wing. It was recommended that testing in the wind tunnel be conducted to evaluate how significant the aerodynamic penalties would be from having failed fluid in these isolated areas.

Objective

To investigate the aerodynamic performance degradation associated with failed fluid on flaps and slats.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical snow condition tests conducted in the wind tunnel.

- For a chosen fluid, conduct a test simulating moderate snow conditions (rate of 25 g/dm²/h) for an exposure time derived from the HOT table based on the tunnel temperature at the time of the test;
- Simulate early fluid failure on the fixed leading edge by applying higher rates of contamination on this area (record additional amounts);
- The flap is a hinged flap, so will be subject to early failure by design;
- Record lift data, visual observations, and manually collected data;
- Conduct a fluid only baseline test at the same temperature;
- Compare the aerodynamic performance;
- Consideration should be given to conducting Type I tests.

Test Plan

Two to four comparative tests are anticipated.

ATTACHMENT XXXIV – Procedure: Mixed HOT Conditions

Background

As the accuracy of meteorological reporting continues to improve, there has been a need to provide improved guidance material during these transitional periods of mixed precipitation. During the winter of 2008-09, guidance material was developed for operations during light snow mixed with light rain conditions. As a result of this work, there was industry interest in guidance material for operations during light freezing rain and moderate snow conditions as well as other mixed conditions. The objective of these tests is to collect data to determine if the current HOT guidelines can be expanded to include other operational mixed conditions which may be of current interest to industry.

Objective

To investigate if the current HOT guidelines can be expanded to include mixed conditions i.e. light freezing rain and moderate snow conditions.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for precipitation tests conducted in the wind tunnel.

- For a chosen fluid, conduct a test simulating mixed conditions for an exposure time derived from the HOT table based on relative condition.
- Record lift data, visual observations, and manually collected data;
- Conduct a fluid only baseline test at the same temperature; or
- Conduct a test with an existing relative HOT condition to evaluate the severity of the condition;
- Compare the aerodynamic performance.
- If the mixed condition results are severe, repeat the test with a reduced exposure time, if the results are good, repeat the test with a increased exposure time.

Test Plan

Two to four comparative tests are anticipated.

ATTACHMENT XXXV – Procedure: Snow on an Un-Protected Wing

Background

In colder northern operations, it is common for aircraft to depart with "loose, dry, un-adhered snow" on present on their wing sections. Although it is assumed most or all of this contamination will be removed at the time of rotation, it is unknown whether a certain level of contamination will reduce aerodynamic performance. Preliminary testing has demonstrated fluid seepage from the airfoil can lead to snow diluting and adhering to the airfoil during rotation; this effect has yet to be substantiated will operational data. During the winter of 2011-12, a video was leaked on the internet of an eastern European aircraft taking off with significant amounts of snow on the wing. As a result, additional wind tunnel testing was conducted during the winter of 2011-12. It was recommended that additional testing investigate the aerodynamic performance of a wing section contaminated with dry, un-adhered snow versus wet or humid snow.

Objective

To investigate the aerodynamic performance of a wing section contaminated with dry, un-adhered snow versus wet or humid snow.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical snow condition tests conducted in the wind tunnel.

- Ensure the wing section and tunnel temperature are well below freezing (-5ºC and below);
- Ensure the wing section is clean, dry, and free of any forms of contamination;
- Apply loose, dry snow contamination to the wing section;
- Record lift data, visual observations, and manually collected data;
- Compare the results to baseline fluid only and dry wing test results;

Test Plan

One to four comparative tests are anticipated.

ATTACHMENT XXXVI – Procedure: Feasibility of Ice Pellet Testing at Higher Speeds

Background

Historically, the ice pellet allowance time testing conducted in the wind tunnel simulated typical aircraft rotation of 100 knots, and more recently some limited work at 115 knots. As a result of some of the higher lift losses observed at colder temperatures with PG fluids applied to a thin high performance airfoil, it was recommended that higher speed testing be conducted to verify if the limitations in the allowance times would need to be applied to commercial aircraft with rotation speeds well above 115 knots. It was recommended that 130-150 knots be targeted, however modifications to the wind tunnel may be required as those higher speeds may increase stress on the wind tunnel engine and other structural systems.

Objective

To investigate the feasibility of conducting ice pellet testing at higher speeds of 130-150 knots. .

Methodology

This work is exploratory, so no exact procedure exists. A more specific methodology may be determined on site following a brain-storm with onsite technicians. It is expected that a series of tests may be conducted to try and achieve speeds above 115 knots without rotating the wing model.

Test Plan

One or two tests are anticipated, however more tests may be required based on the results.

ATTACHMENT XXXVII – Procedure: Windshield Washer Used as Type I Deicer

Background

Based on recent industry reports, it has become apparent that in more remote airports or with general aviation aircraft with smaller operations, aircraft deicing is not being conducted with SAE aircraft ground deicing Type I fluid, but rather with off-the-shelf windshield washer fluid. Although the basic chemistry of the windshield washer fluid may be similar, questions regarding the fluid freeze point, holdover time, aerodynamics, and material compatibility have been raised. It was recommended that some preliminary testing be conducted to investigate fluid flow off in the wind tunnel with and without contamination. Limited test was conducted during the winter of 2011-12. It was recommended that testing should continue if necessary based on operational needs.

Objective

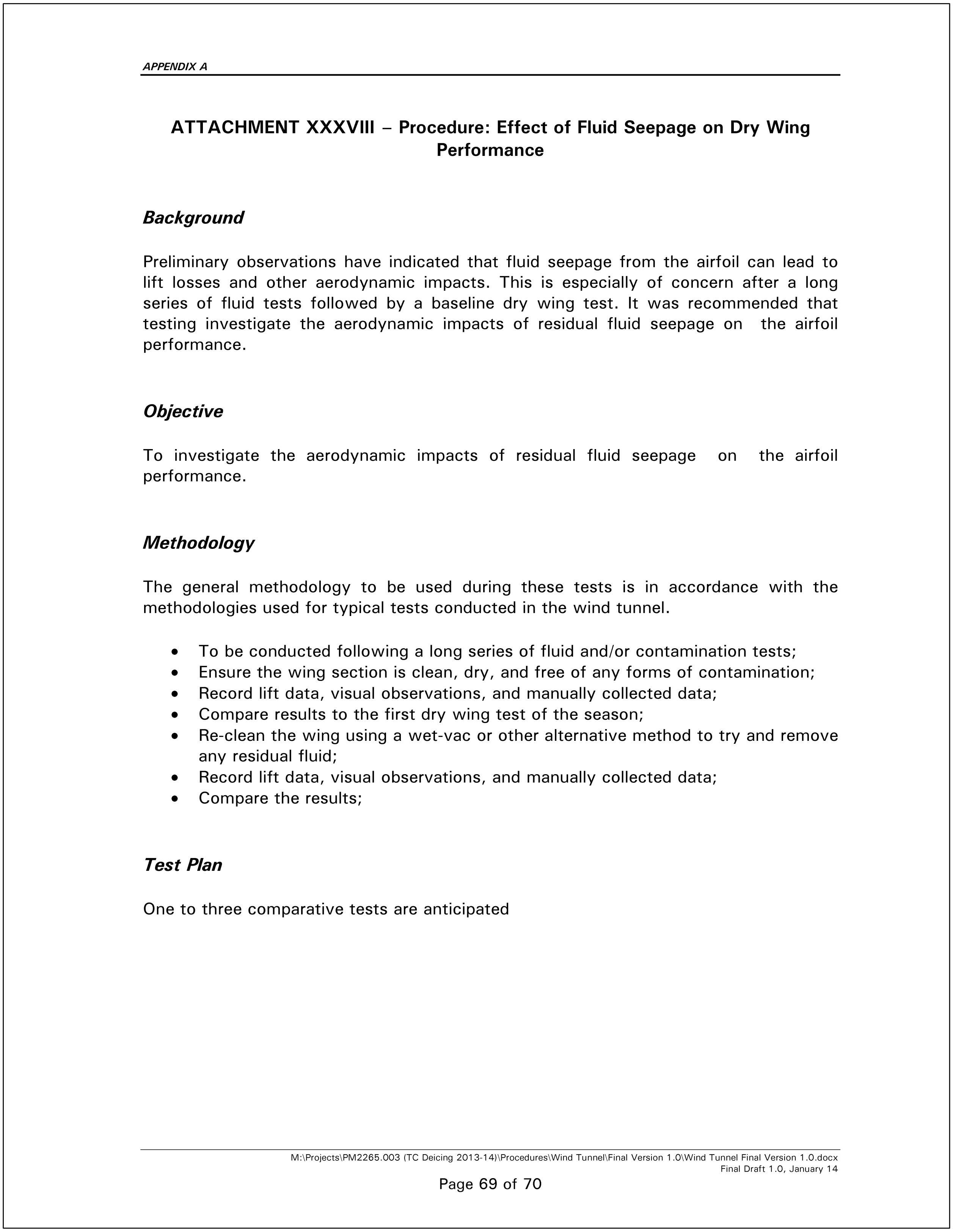
To evaluate the holdover time and aerodynamic effects windshield washer fluid when used a substitute for an aircraft ground deicing Type I fluid.

Methodology

- Purchase various formulations of windshield washer fluid with varying freeze points;
- Apply fluid heated to 20ºC using a garden sprayer;
- Expose to simulated freezing contamination (snow, freezing rain, or ice pellets). The exposure time is to be determined based on Type I fluid HOT's (45 minutes at a rate of 0.3 g/dm^2/h);
- Document condition of the wing;
- Run the wind tunnel and collect data; and
- Compare results to baseline uncontaminated windshield washer tests and potentially with standard Type I tests.

Test Plan

No testing is planned unless indicated otherwise by TC.



ATTACHMENT XXXVIII – Procedure: Effect of Fluid Seepage on Dry Wing Performance

Background

Preliminary observations have indicated that fluid seepage from the airfoil can lead to lift losses and other aerodynamic impacts. This is especially of concern after a long series of fluid tests followed by a baseline dry wing test. It was recommended that testing investigate the aerodynamic impacts of residual fluid seepage on the airfoil performance.

Objective

To investigate the aerodynamic impacts of residual fluid seepage on the airfoil performance.

Methodology

The general methodology to be used during these tests is in accordance with the methodologies used for typical tests conducted in the wind tunnel.

- To be conducted following a long series of fluid and/or contamination tests;
- Ensure the wing section is clean, dry, and free of any forms of contamination;
- Record lift data, visual observations, and manually collected data;
- Compare results to the first dry wing test of the season;
- Re-clean the wing using a wet-vac or other alternative method to try and remove any residual fluid;
- Record lift data, visual observations, and manually collected data;
- Compare the results;

Test Plan

One to three comparative tests are anticipated

ATTACHMENT XXXIX – Procedure: 2nd Wave of Fluid during Rotation

Background

Previous wind tunnel testing has shown that during a simulated take-off roll following de/anti-icing, fluid will shear off the wing section; however a small amount of fluid can remain trapped along the leading edge at the stagnation point. This "trapped" fluid begins to flow over the wing only once the wing is rotated; the stagnation point shifts below the leading edge, and the "trapped" fluid begins to shear off as a second wave. Previous testing was simulated in a static model using strips of speed tape and cork tape strategically located on the leading edge of the wing section (along the span where the separation bubble will typically occur). A separate set of dynamic tests simulated the second wave with actual anti-icing fluid; sheared fluid prior to rotation was left only in select areas either below or above the stagnation point and then the flow was observed during a typical rotation. The results showed the stalling characteristics of the wing with fluid (or fluid with contamination) appear to be driven by secondary wave effects near the leading edge; these effects are difficult to interpret on the two-dimensional model relative to a fully three-dimensional wing and should not be used in developing allowance times. Additional testing may be useful to better understand this effect.

Objective

To investigate the aerodynamic effects of the second wave of fluid flow during rotation.

Methodology

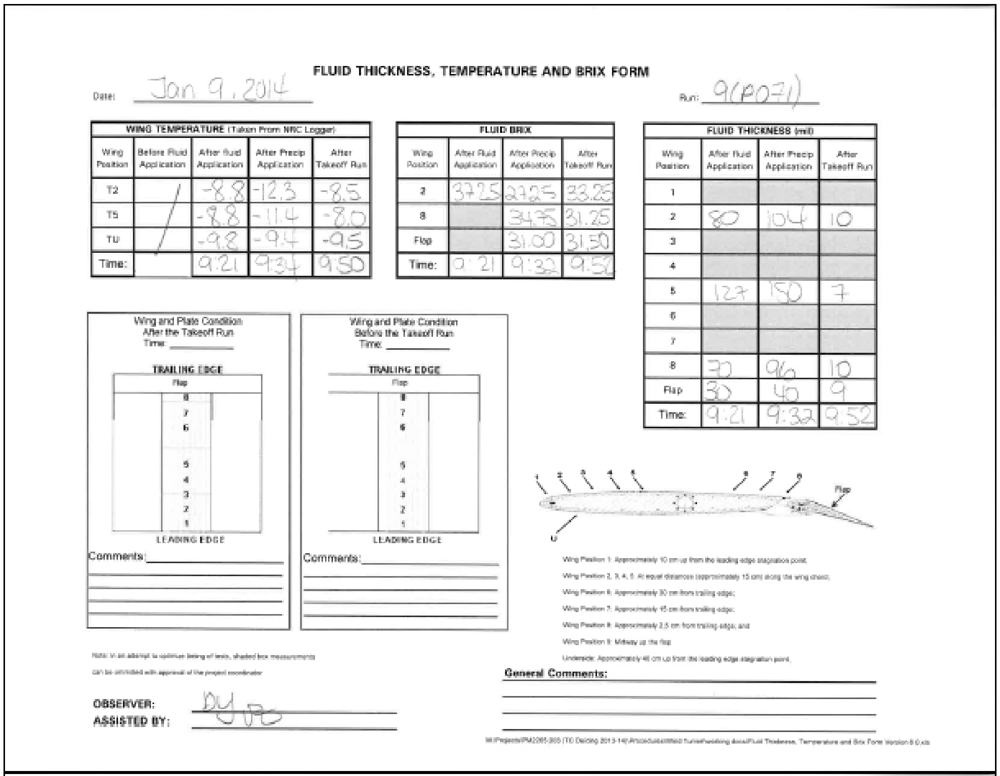
- Simulate the 2nd wave of fluid using strips of tape applied at specific areas at different thicknesses on the wing, or with fluid; and
- Compare the different results.

Test Plan

One to four tests are anticipated.

APPENDIX C

FLUID THICKNESS, TEMPERATURE, AND BRIX DATA FORM



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2014

Run: 9(P071)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-8.8	-12.3	-8.5
T5		-8.8	-11.4	-8.0
TU		-9.8	-9.4	-9.5
Time:		9:21	9:34	9:50

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.25	27.25	33.25
8	▨	34.75	31.25
Flap	▨	31.00	31.50
Time:	9:21	9:32	9:52

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	104	10
3	▨	▨	▨
4	▨	▨	▨
5	127	150	7
6	▨	▨	▨
7	▨	▨	▨
8	70	96	10
Flap	30	40	9
Time:	9:21	9:32	9:52

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

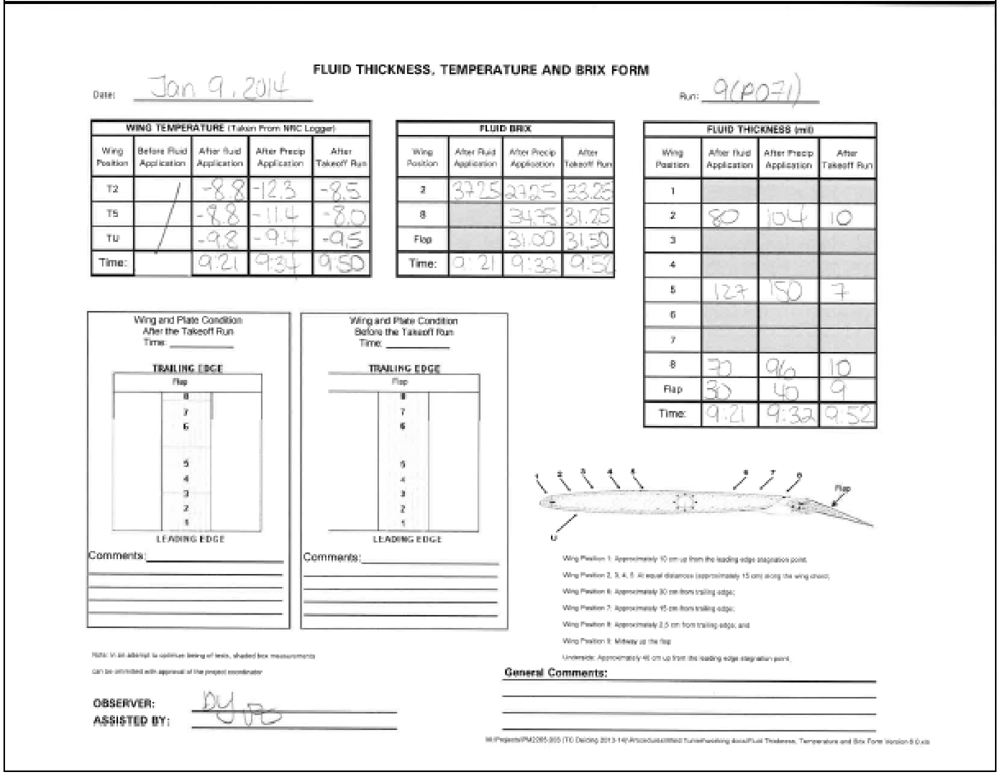
Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to continue timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: JP

General Comments: ______



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2014

Run: 9(P071)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-8.8	-12.3	-8.5
T5		-8.8	-11.4	-8.0
TU		-9.8	-9.4	-9.5
Time:		9:21	9:34	9:50

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.25	27.25	33.25
8	▨	34.75	31.25
Flap	▨	31.00	31.50
Time:	9:21	9:32	9:52

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	104	10
3	▨	▨	▨
4	▨	▨	▨
5	127	150	7
6	▨	▨	▨
7	▨	▨	▨
8	70	96	10
Flap	30	40	9
Time:	9:21	9:32	9:52

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

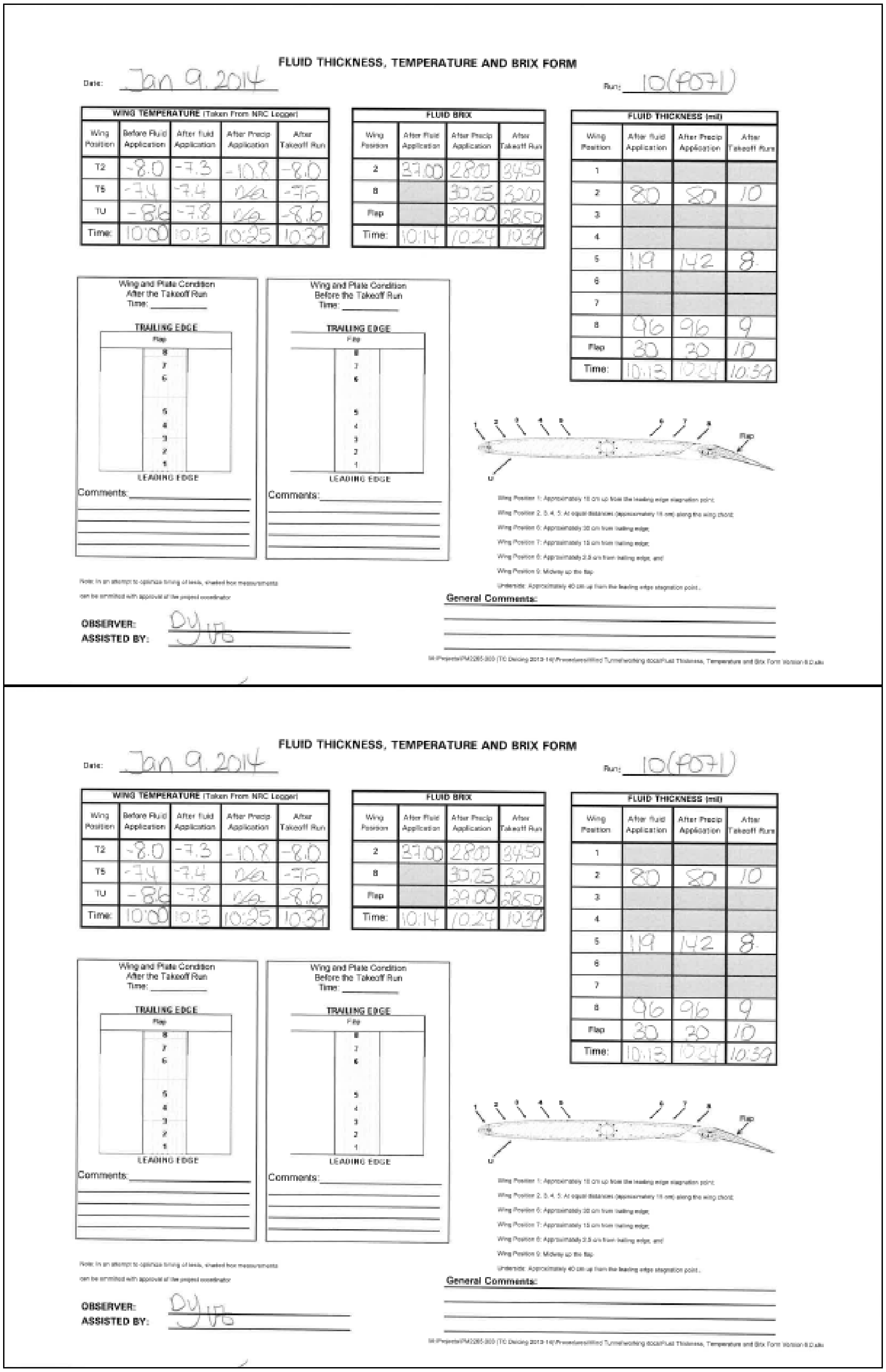
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to continue timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: JP

General Comments: ______

Figure C1: Test # 9



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9. 2014

Run: 10(P071)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-8.0	-7.3	-10.8	-8.0
T5	-7.4	-7.4	n/a	-7.5
TU	-8.6	-7.8	n/a	-8.6
Time:	10:00	10:13	10:25	10:39

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	28.00	34.50
8	▨	30.25	32.00
Flap	▨	29.00	28.50
Time:	10:14	10:24	10:39

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	80	10
3	▨	▨	▨
4	▨	▨	▨
5	119	142	8
6	▨	▨	▨
7	▨	▨	▨
8	96	96	9
Flap	30	30	10
Time:	10:13	10:24	10:39

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ________

OBSERVER: DY

ASSISTED BY: VB

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9. 2014

Run: 10(P071)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-8.0	-7.3	-10.8	-8.0
T5	-7.4	-7.4	n/a	-7.5
TU	-8.6	-7.8	n/a	-8.6
Time:	10:00	10:13	10:25	10:39

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	28.00	34.50
8	▨	30.25	32.00
Flap	▨	29.00	28.50
Time:	10:14	10:24	10:39

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	80	10
3	▨	▨	▨
4	▨	▨	▨
5	119	142	8
6	▨	▨	▨
7	▨	▨	▨
8	96	96	9
Flap	30	30	10
Time:	10:13	10:24	10:39

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

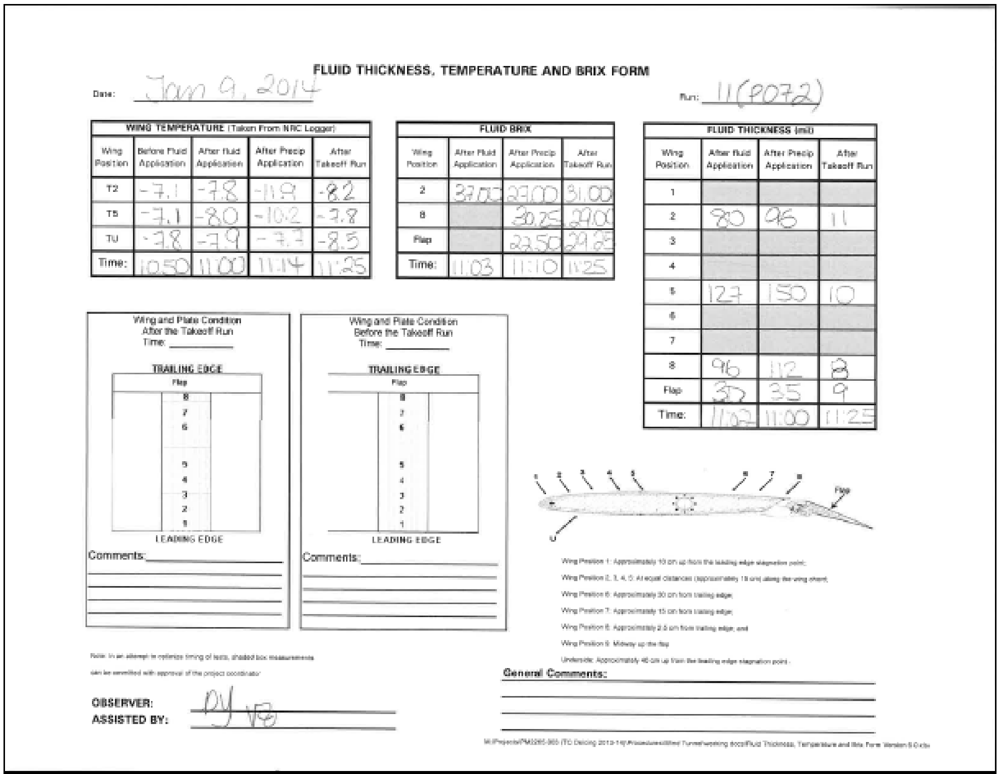
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ________

OBSERVER: DY

ASSISTED BY: VB

Figure 2: Test # 10



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2014

Run: 11(P072)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-7.1	-7.8	-11.9	-8.2
T5	-7.1	-8.0	-10.2	-7.8
TU	-7.8	-7.9	-7.7	-8.5
Time:	10:50	11:00	11:14	11:25

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	27.00	31.00
8	▨	30.25	29.00
Flap	▨	22.50	29.25
Time:	11:03	11:10	11:25

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	96	11
3	▨	▨	▨
4	▨	▨	▨
5	127	150	10
6	▨	▨	▨
7	▨	▨	▨
8	96	112	8
Flap	37	35	9
Time:	11:02	11:00	11:25

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE

Flap
8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE

Flap
8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 18 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

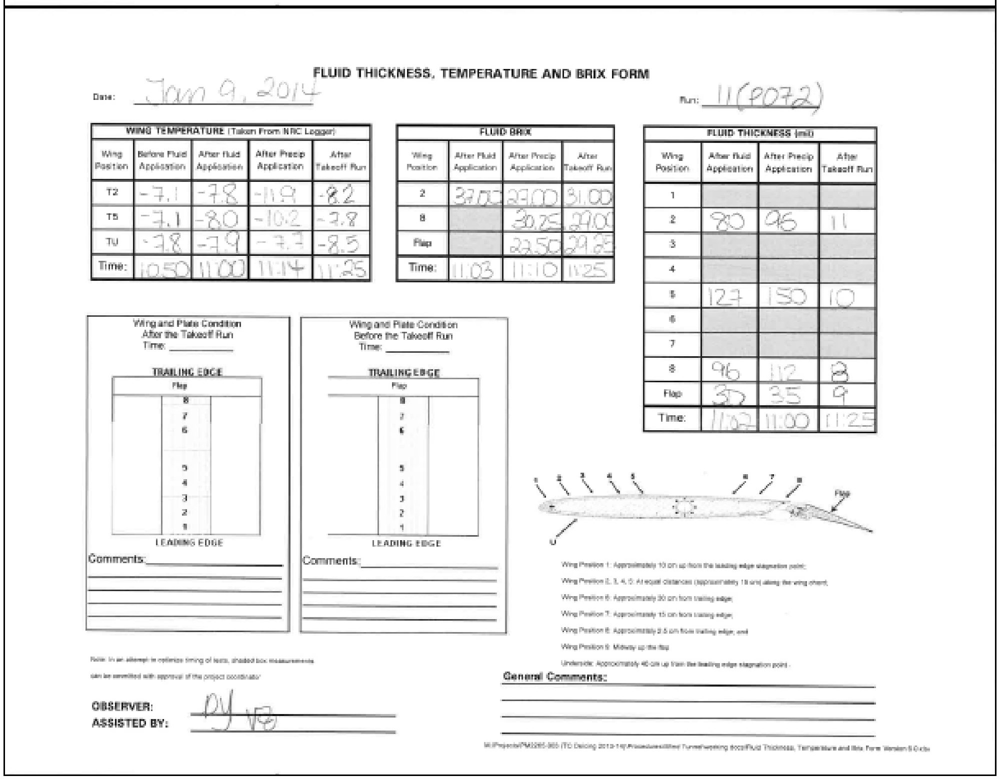
Wing Position 9: Midway up the flap

Underside: Approximately 46 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: VB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2014

Run: 11(P072)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-7.1	-7.8	-11.9	-8.2
T5	-7.1	-8.0	-10.2	-7.8
TU	-7.8	-7.9	-7.7	-8.5
Time:	10:50	11:00	11:14	11:25

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	27.00	31.00
8	▨	30.25	29.00
Flap	▨	22.50	29.25
Time:	11:03	11:10	11:25

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	96	11
3	▨	▨	▨
4	▨	▨	▨
5	127	150	10
6	▨	▨	▨
7	▨	▨	▨
8	96	112	8
Flap	37	35	9
Time:	11:02	11:00	11:25

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE

Flap
8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE

Flap
8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 18 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

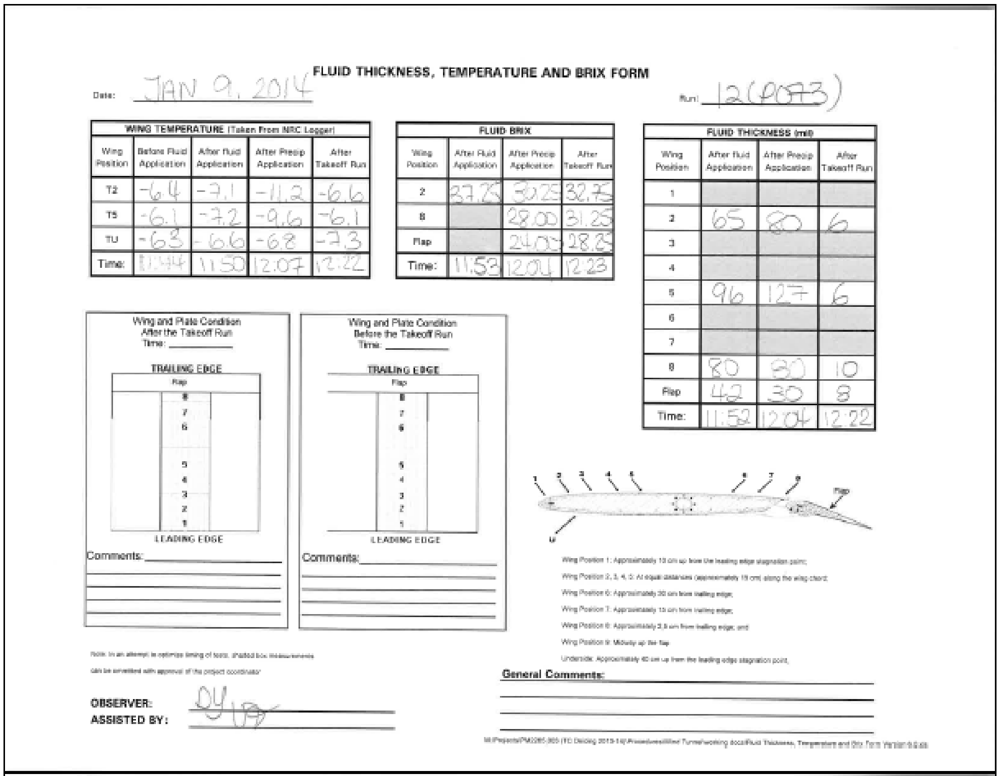
Underside: Approximately 46 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: VB

Figure C3: Test # 11



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: JAN 9, 2014

Run: 12(P073)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	-6.4	-7.1	-11.2	-6.6
T5	-6.1	-7.2	-9.6	-6.1
TU	-6.3	-6.6	-6.8	-7.3
Time:	11:44	11:50	12:07	12:22

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	27.25	30.25	32.75
8		28.00	31.25
Flap		24.00	28.25
Time:	11:53	12:04	12:23

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1			
2	65	80	6
3			
4			
5	96	127	6
6			
7			
8	80	80	10
Flap	42	30	8
Time:	11:52	12:04	12:22

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE

Flap

8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE

Flap

8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 3.8 cm from trailing edge; and

Wing Position 9: Midway up the flap.

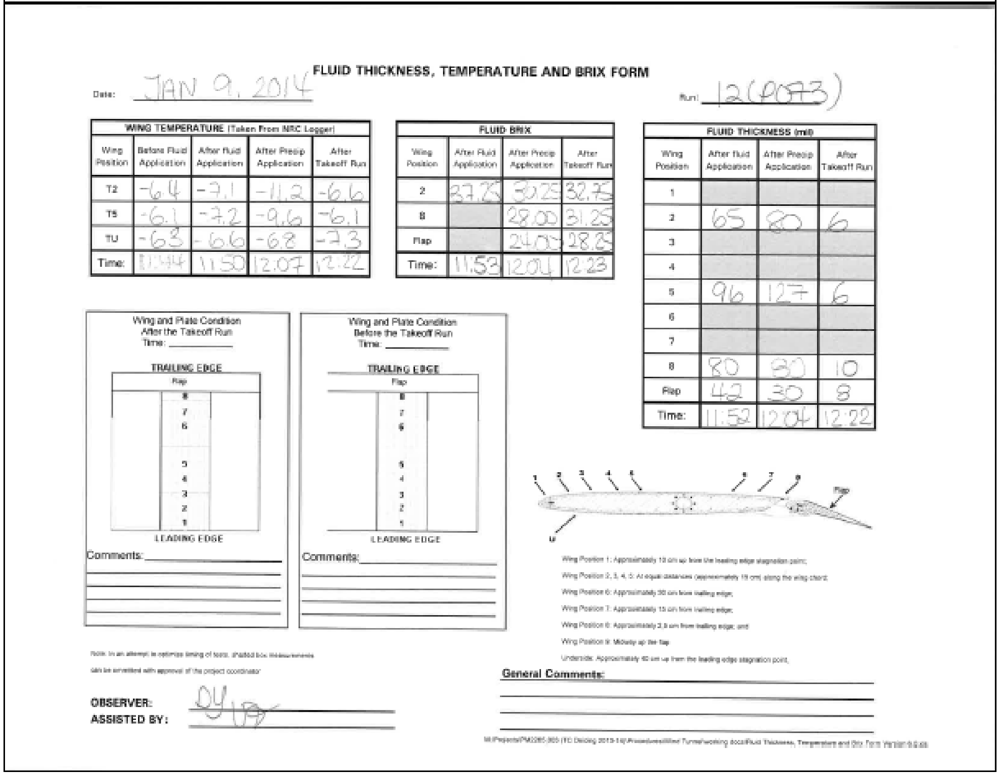
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY

ASSISTED BY:



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: JAN 9, 2014

Run: 12(P073)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	-6.4	-7.1	-11.2	-6.6
T5	-6.1	-7.2	-9.6	-6.1
TU	-6.3	-6.6	-6.8	-7.3
Time:	11:44	11:50	12:07	12:22

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	27.25	30.25	32.75
8		28.00	31.25
Flap		24.00	28.25
Time:	11:53	12:04	12:23

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1			
2	65	80	6
3			
4			
5	96	127	6
6			
7			
8	80	80	10
Flap	42	30	8
Time:	11:52	12:04	12:22

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE

Flap

8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE

Flap

8
7
6
5
4
3
2
1

LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 3.8 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

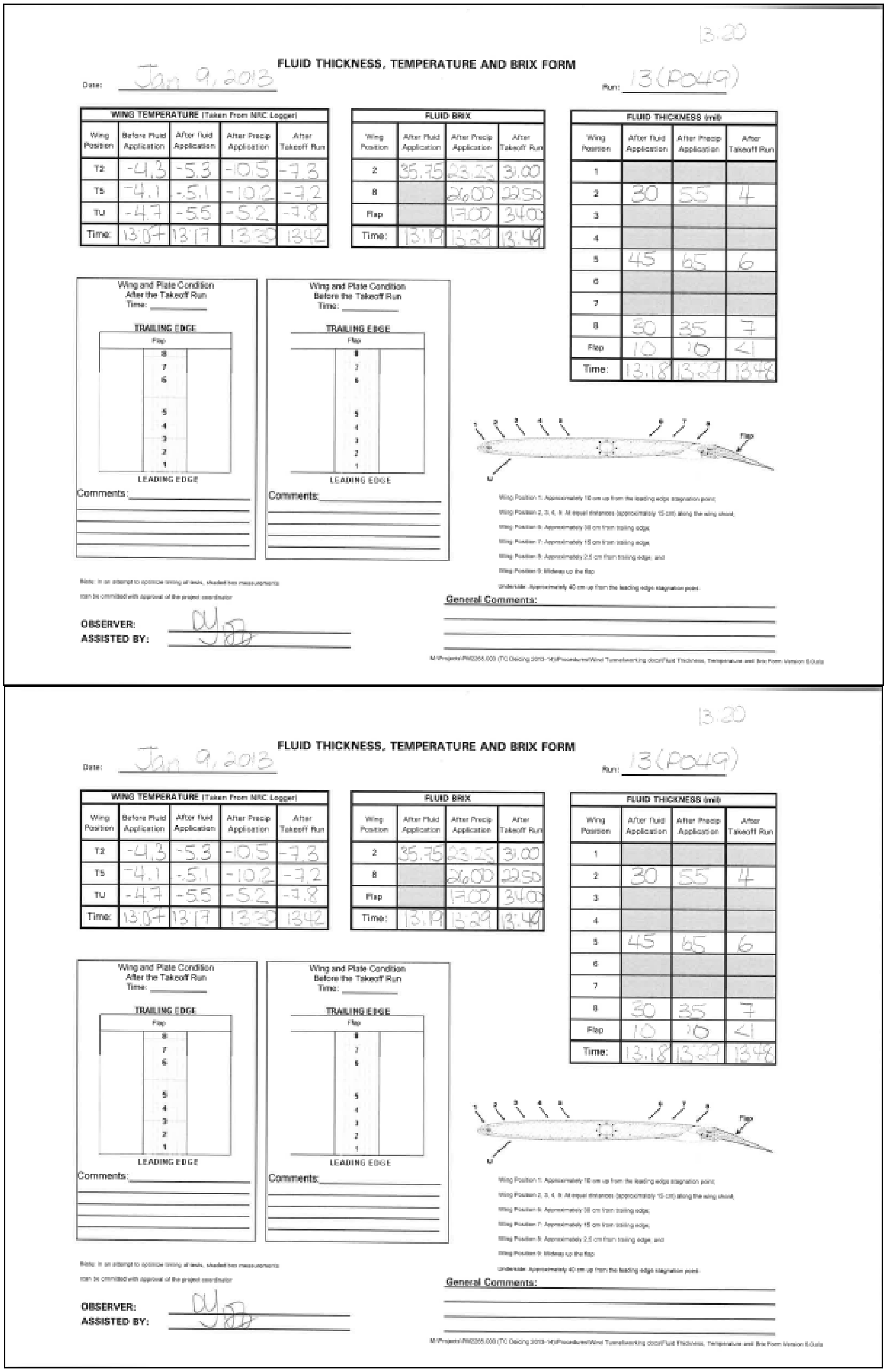
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY

ASSISTED BY:

Figure C4: Test # 12



13:20

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2013

Run: 13 (P049)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-4.3	-5.3	-10.5	-7.3
T5	-4.1	-5.1	-10.2	-7.2
TU	-4.7	-5.5	-5.2	-7.8
Time:	13:07	13:17	13:30	13:42

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.75	23.25	31.00
8	▨	26.00	22.50
Flap	▨	17.00	34.00
Time:	13:19	13:29	13:49

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	55	4
3	▨	▨	▨
4	▨	▨	▨
5	45	65	6
6	▨	▨	▨
7	▨	▨	▨
8	30	35	7
Flap	10	10	<1
Time:	13:18	13:29	13:48

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommited with approval of the project coordinator

OBSERVER: ____________
ASSISTED BY: ____________

General Comments: ____________

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13:20

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2013

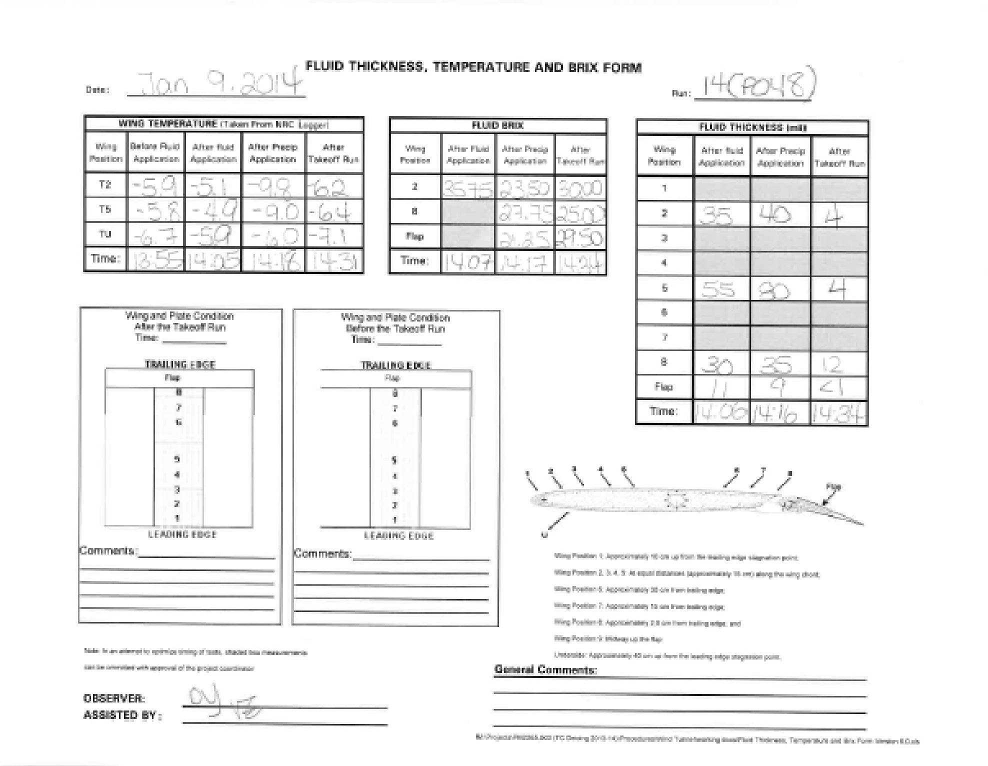
Run: 13 (P049)

WING TEMPERATURE (Taken From NRC Logger): T2 -4.3, -5.3, -10.5, -7.3; T5 -4.1, -5.1, -10.2, -7.2; TU -4.7, -5.5, -5.2, -7.8; Time: 13:07, 13:17, 13:30, 13:42

FLUID BRIX: 2 35.75, 23.25, 31.00; 8 26.00, 22.50; Flap 17.00, 34.00; Time: 13:19, 13:29, 13:49

FLUID THICKNESS (mil): 2 30, 55, 4; 5 45, 65, 6; 8 30, 35, 7; Flap 10, 10, <1; Time: 13:18, 13:29, 13:48

Figure C5: Test # 13



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9. 2014

Run: 14(P048)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-5.9	-5.1	-9.8	-6.2
T5	-5.8	-4.9	-9.0	-6.4
TU	-6.7	-5.9	-6.0	-7.1
Time:	13:55	14:05	14:16	14:31

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.75	23.50	30.00
8		27.75	25.00
Flap		21.25	29.50
Time:	14:07	14:17	14:24

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	35	40	4
3			
4			
5	55	80	4
6			
7			
8	30	35	12
Flap	11	9	<1
Time:	14:06	14:16	14:34

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

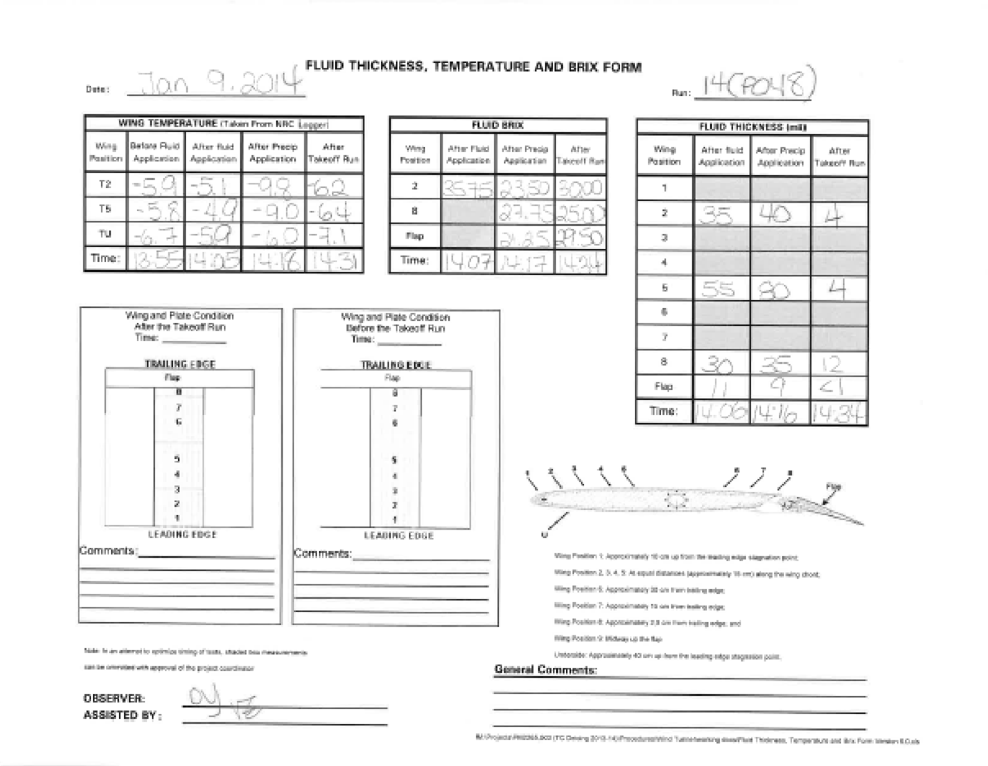
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER:
ASSISTED BY:

General Comments:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9. 2014

Run: 14(P048)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-5.9	-5.1	-9.8	-6.2
T5	-5.8	-4.9	-9.0	-6.4
TU	-6.7	-5.9	-6.0	-7.1
Time:	13:55	14:05	14:16	14:31

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.75	23.50	30.00
8		27.75	25.00
Flap		21.25	29.50
Time:	14:07	14:17	14:24

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	35	40	4
3			
4			
5	55	80	4
6			
7			
8	30	35	12
Flap	11	9	<1
Time:	14:06	14:16	14:34

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER:
ASSISTED BY:

General Comments:

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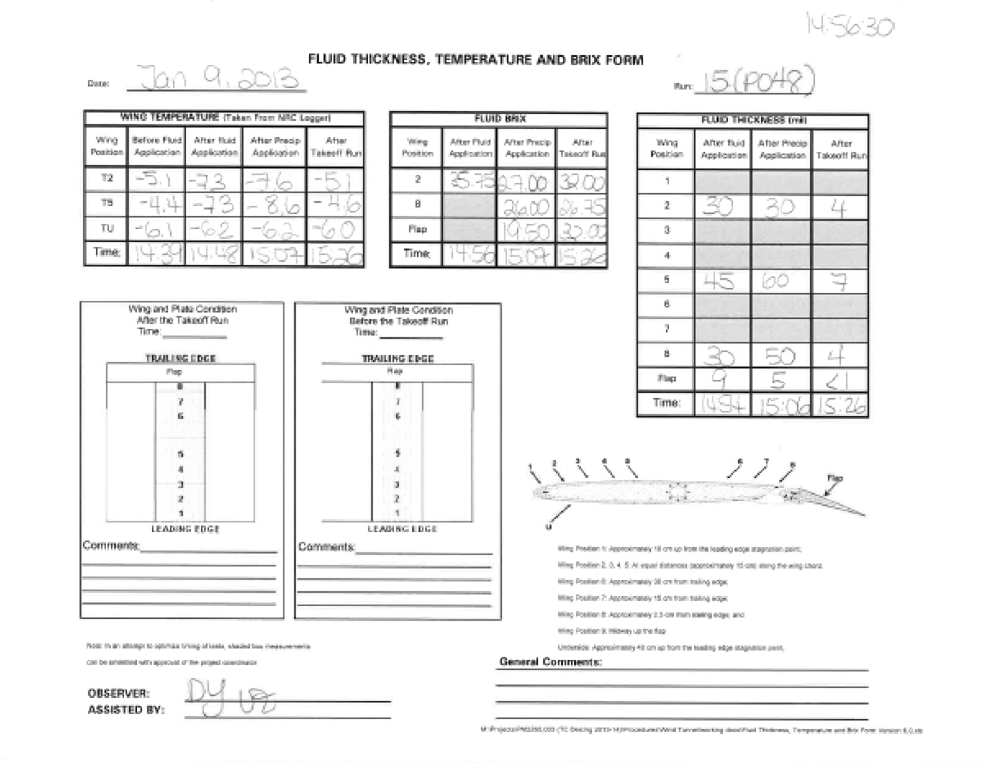
Figure C6: Test # 14



14:56:30

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2013

Run: 15 (P048)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-5.1	-73	-7.6	-51
T5	-4.4	-73	-8.6	-4.6
TU	-6.1	-62	-6.2	-60
Time:	14:39	14:48	15:07	15:26

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.75	27.00	32.00
8	▨	26.00	26.75
Flap	▨	19.50	32.00
Time:	14:56	15:07	15:26

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	30	4
3	▨	▨	▨
4	▨	▨	▨
5	45	60	7
6	▨	▨	▨
7	▨	▨	▨
8	30	50	4
Flap	9	5	<1
Time:	14:54	15:06	15:26

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

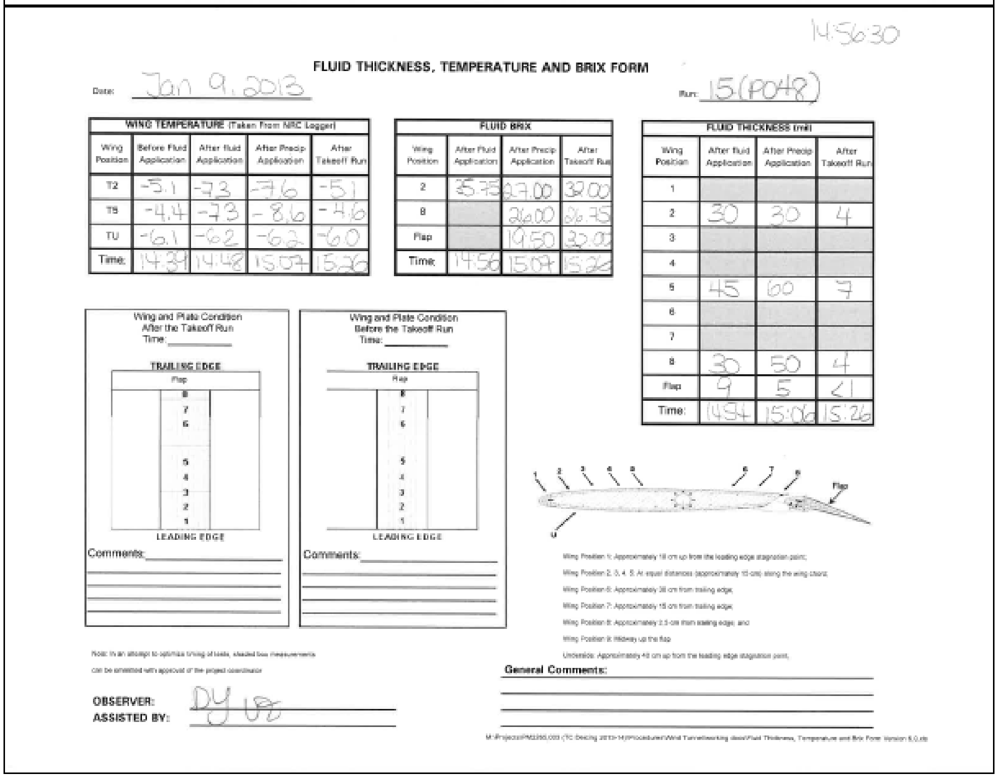
Comments: ________

Wing Position 1: Approximately 18 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 38 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ________

OBSERVER: DY
ASSISTED BY: UZ



14:56:30

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2013

Run: 15 (P048)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-5.1	-73	-7.6	-51
T5	-4.4	-73	-8.6	-4.6
TU	-6.1	-62	-6.2	-60
Time:	14:39	14:48	15:07	15:26

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.75	27.00	32.00
8	▨	26.00	26.75
Flap	▨	19.50	32.00
Time:	14:56	15:07	15:26

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	30	4
3	▨	▨	▨
4	▨	▨	▨
5	45	60	7
6	▨	▨	▨
7	▨	▨	▨
8	30	50	4
Flap	9	5	<1
Time:	14:54	15:06	15:26

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

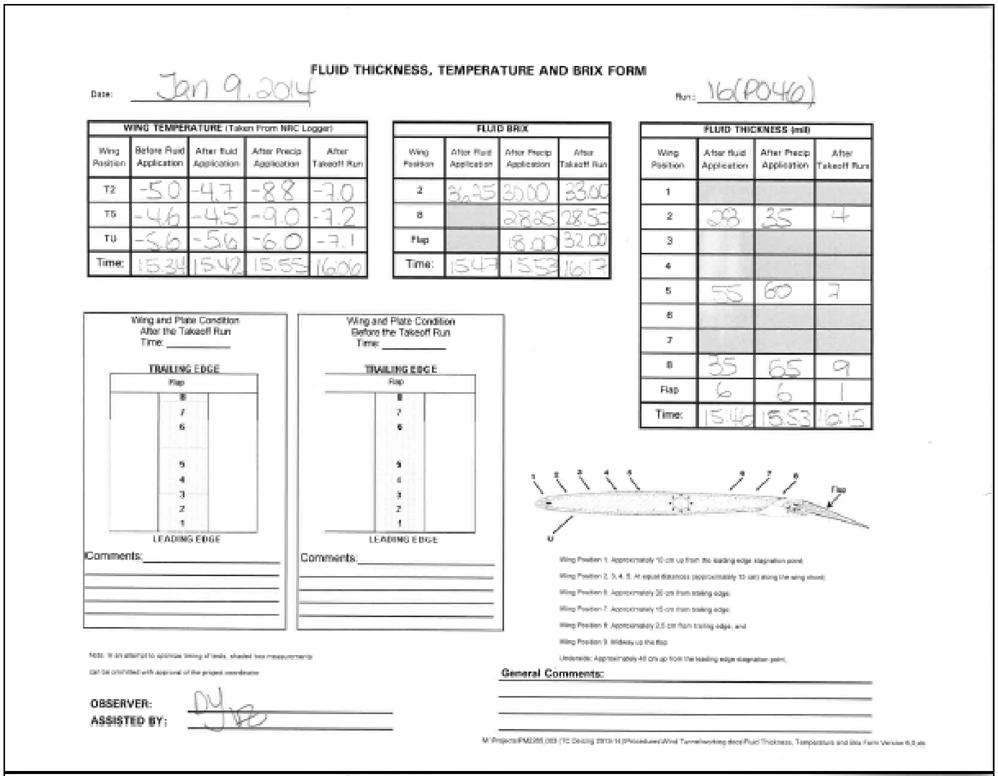
Wing Position 1: Approximately 18 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 38 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ________

OBSERVER: DY
ASSISTED BY: UZ

Figure C7: Test # 15



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2014

Run: 16(P046)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-5.0	-4.7	-8.8	-7.0
T5	-4.6	-4.5	-9.0	-7.2
TU	-5.6	-5.6	-6.0	-7.1
Time:	15:34	15:42	15:55	16:06

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.25	30.00	33.00
8	▨	28.25	28.50
Flap	▨	18.00	32.00
Time:	15:47	15:53	16:17

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	28	35	4
3	▨	▨	▨
4	▨	▨	▨
5	55	60	7
6	▨	▨	▨
7	▨	▨	▨
8	35	65	9
Flap	6	6	1
Time:	15:46	15:53	16:15

Wing and Plate Condition
After the Takeoff Run
Time: __________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: __________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

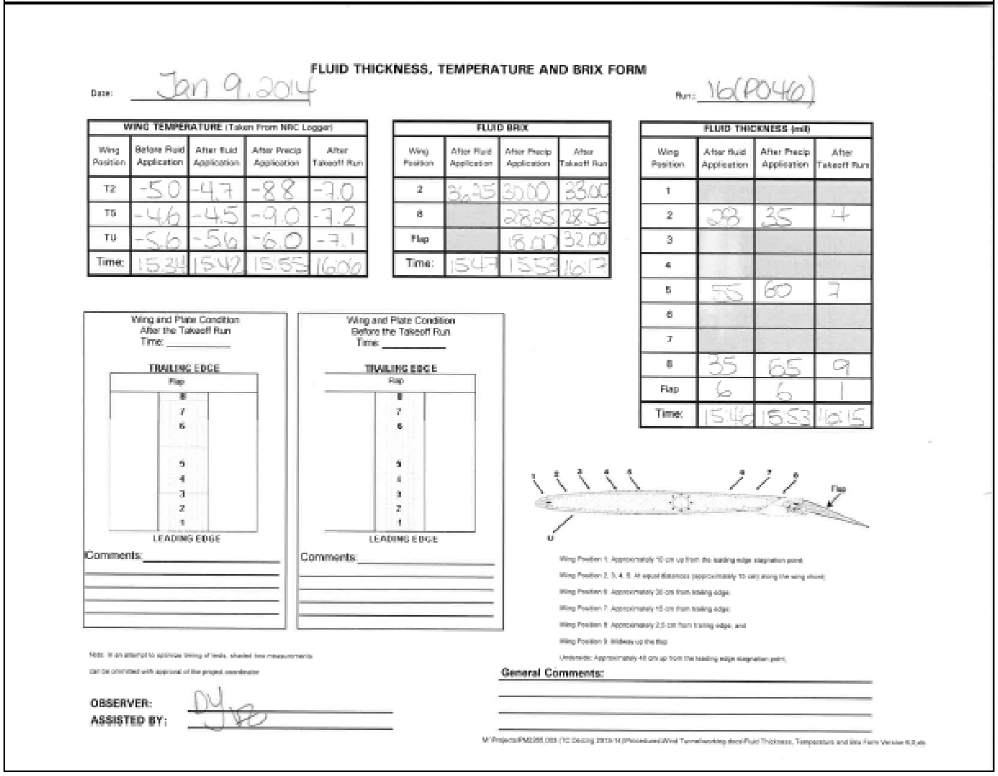
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 10 cm) along the wing chord;
Wing Position 6: Approximately 20 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point;

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: JB

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 9, 2014

Run: 16(P046)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-5.0	-4.7	-8.8	-7.0
T5	-4.6	-4.5	-9.0	-7.2
TU	-5.6	-5.6	-6.0	-7.1
Time:	15:34	15:42	15:55	16:06

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.25	30.00	33.00
8	▨	28.25	28.50
Flap	▨	18.00	32.00
Time:	15:47	15:53	16:17

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	28	35	4
3	▨	▨	▨
4	▨	▨	▨
5	55	60	7
6	▨	▨	▨
7	▨	▨	▨
8	35	65	9
Flap	6	6	1
Time:	15:46	15:53	16:15

Wing and Plate Condition
After the Takeoff Run
Time: __________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: __________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 10 cm) along the wing chord;
Wing Position 6: Approximately 20 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point;

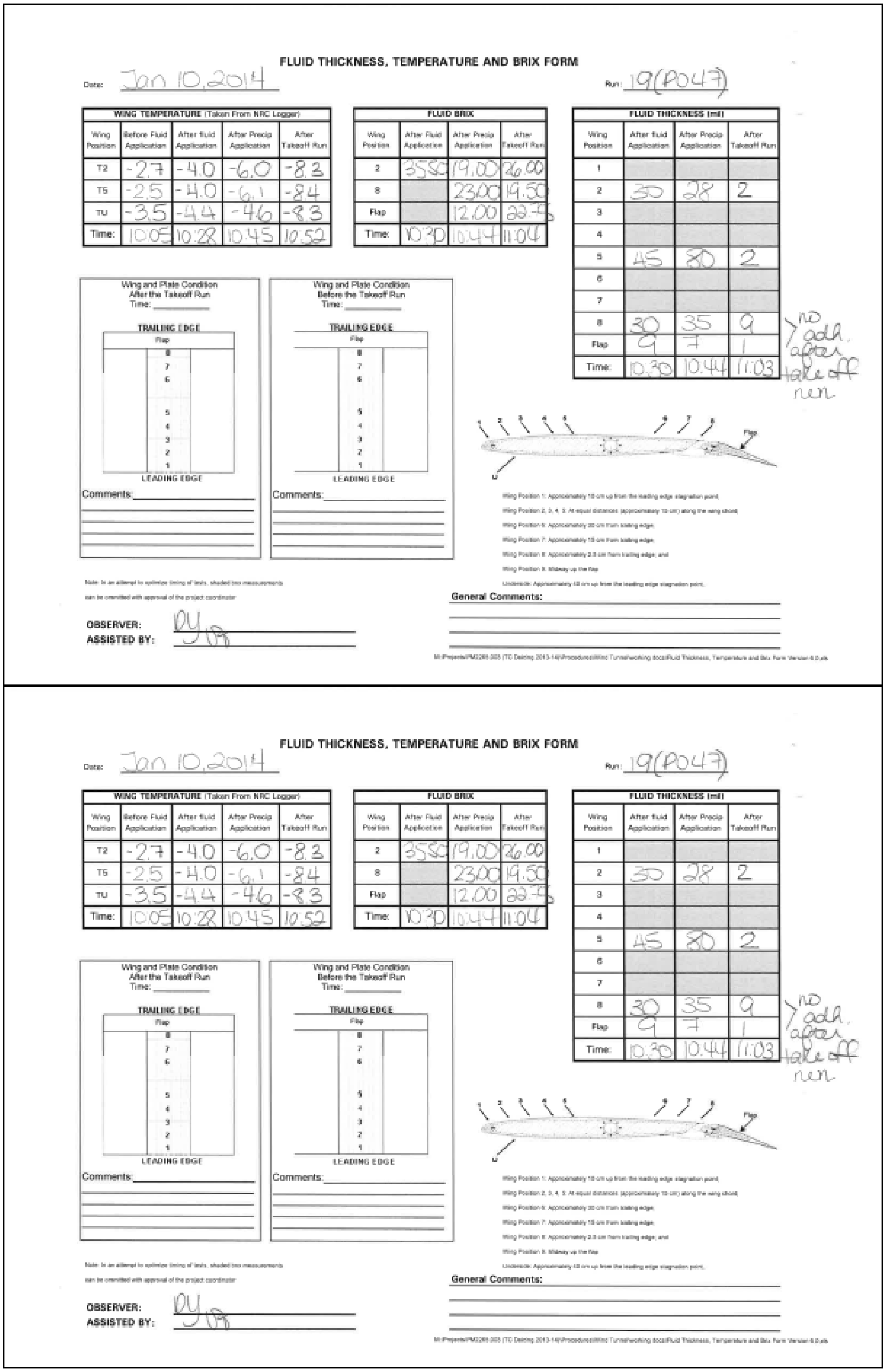
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: JB

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C8: Test # 16



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 19(P047)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.7	-4.0	-6.0	-8.3
T5	-2.5	-4.0	-6.1	-8.4
TU	-3.5	-4.4	-4.6	-8.3
Time:	10:05	10:28	10:45	10:52

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.50	19.00	26.00
8	▨	23.00	19.50
Flap	▨	12.00	22.75
Time:	10:30	10:44	11:04

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	28	2
3	▨	▨	▨
4	▨	▨	▨
5	45	80	2
6	▨	▨	▨
7	▨	▨	▨
8	30	35	9
Flap	9	7	1
Time:	10:30	10:44	11:03

no add. after take off run.

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 10 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 10 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY

ASSISTED BY: ______

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 19(P047)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.7	-4.0	-6.0	-8.3
T5	-2.5	-4.0	-6.1	-8.4
TU	-3.5	-4.4	-4.6	-8.3
Time:	10:05	10:28	10:45	10:52

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	35.50	19.00	26.00
8	▨	23.00	19.50
Flap	▨	12.00	22.75
Time:	10:30	10:44	11:04

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	28	2
3	▨	▨	▨
4	▨	▨	▨
5	45	80	2
6	▨	▨	▨
7	▨	▨	▨
8	30	35	9
Flap	9	7	1
Time:	10:30	10:44	11:03

no add. after take off run.

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 10 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 10 cm up from the leading edge stagnation point.

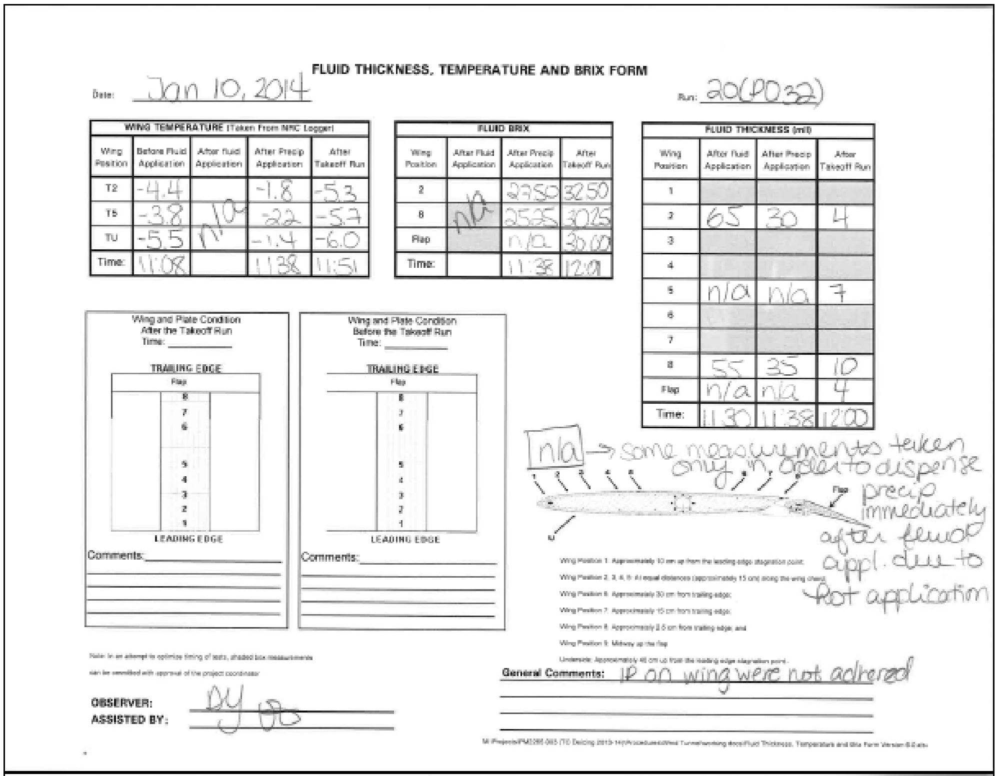
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY

ASSISTED BY: ______

Figure C9: Test # 19



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 20(P032)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-4.4		-1.8	-5.3
T5	-3.8	n/a	-22	-5.7
TU	-5.5		-1.4	-6.0
Time:	11:08		11:38	11:51

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	2750	3250
8		2525	3025
Flap		n/a	3000
Time:		11:38	12:01

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	65	30	4
3			
4			
5	n/a	n/a	7
6			
7			
8	55	35	10
Flap	n/a	n/a	4
Time:	11:30	11:38	12:00

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ________

n/a → some measurements taken only in order to dispense precip immediately after fluid appl. due to hot application

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

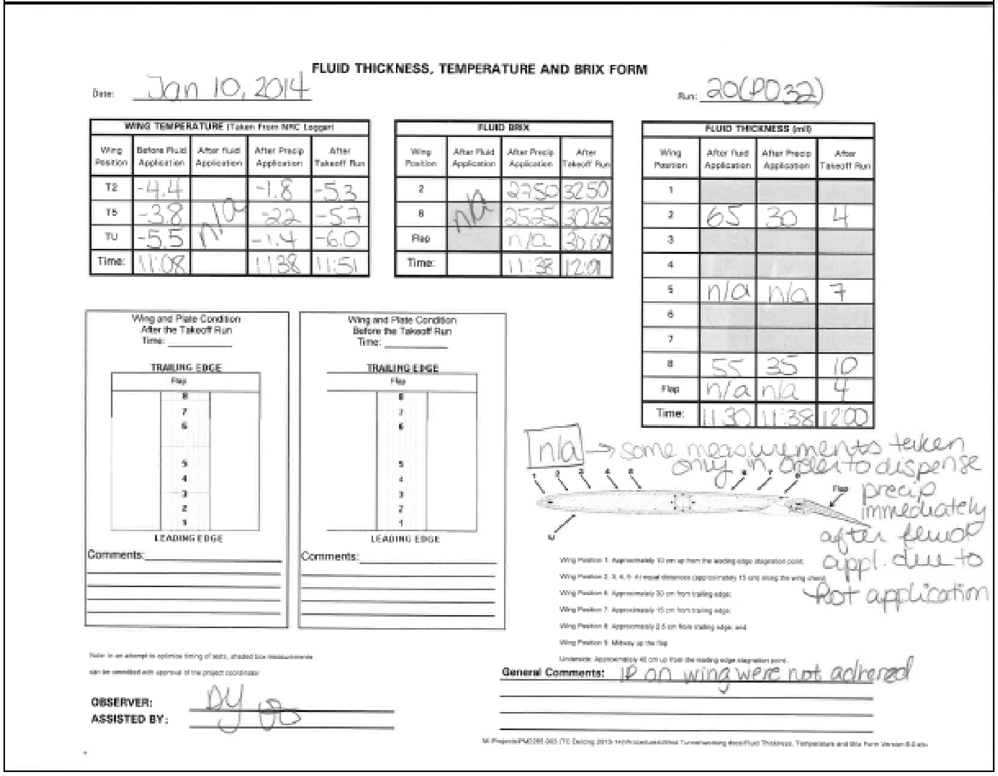
Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator.

General Comments: IP on wing were not adhered

OBSERVER: DY
ASSISTED BY: JB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 20(P032)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-4.4		-1.8	-5.3
T5	-3.8	n/a	-22	-5.7
TU	-5.5		-1.4	-6.0
Time:	11:08		11:38	11:51

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	2750	3250
8		2525	3025
Flap		n/a	3000
Time:		11:38	12:01

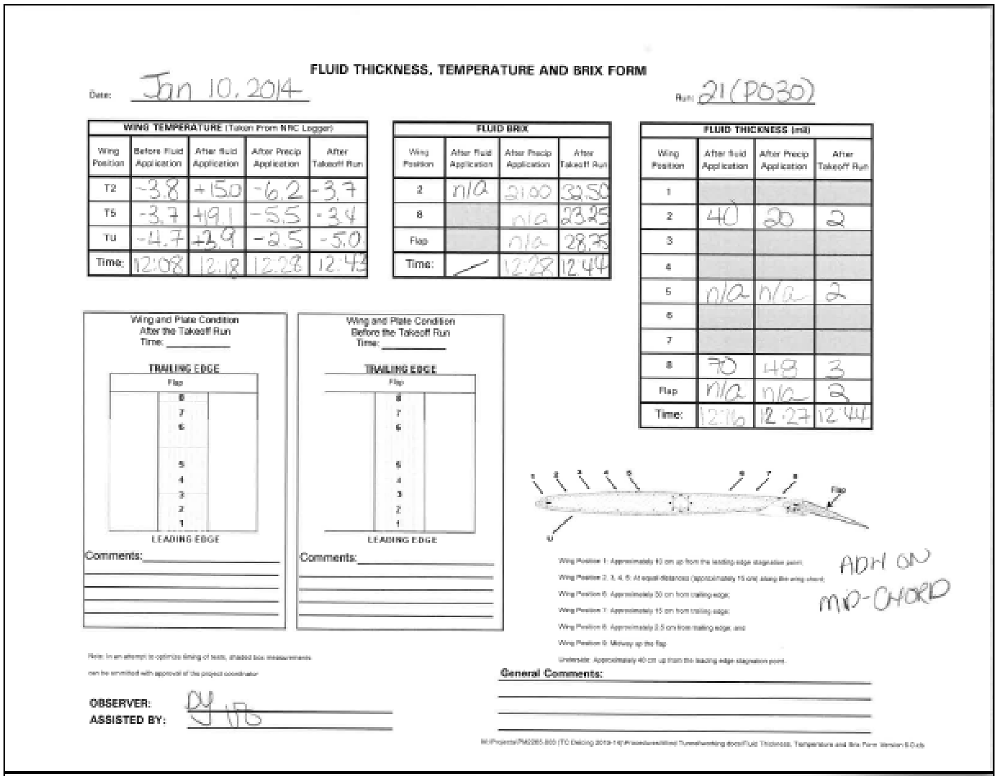
FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	65	30	4
3			
4			
5	n/a	n/a	7
6			
7			
8	55	35	10
Flap	n/a	n/a	4
Time:	11:30	11:38	12:00

n/a → some measurements taken only in order to dispense precip immediately after fluid appl. due to hot application

General Comments: IP on wing were not adhered

OBSERVER: DY
ASSISTED BY: JB

Figure C10: Test # 20



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 21 (P030)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-3.8	+15.0	-6.2	-3.7
T5	-3.7	+19.1	-5.5	-3.4
TU	-4.7	+3.9	-2.5	-5.0
Time:	12:08	12:18	12:28	12:43

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	21.00	32.50
8		n/a	23.25
Flap		n/a	28.75
Time:	/	12:28	12:44

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	40	20	2
3			
4			
5	n/a	n/a	2
6			
7			
8	70	48	3
Flap	n/a	n/a	2
Time:	12:16	12:27	12:44

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

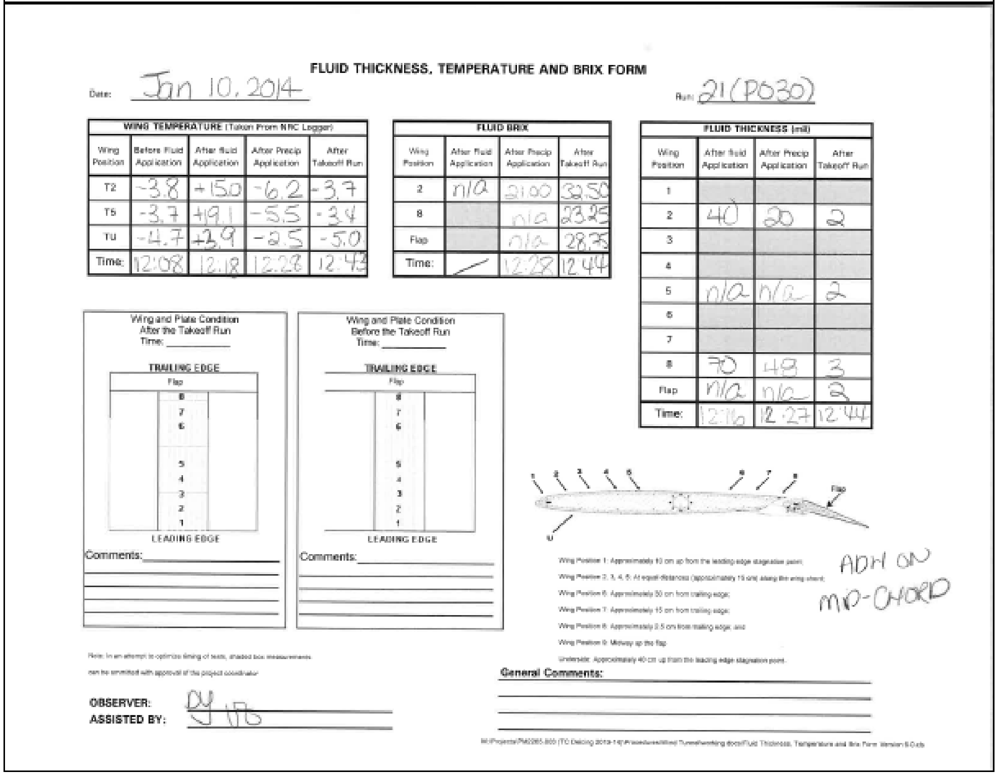
ADH ON
MID-CHORD

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: JB

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 21 (P030)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-3.8	+15.0	-6.2	-3.7
T5	-3.7	+19.1	-5.5	-3.4
TU	-4.7	+3.9	-2.5	-5.0
Time:	12:08	12:18	12:28	12:43

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	21.00	32.50
8		n/a	23.25
Flap		n/a	28.75
Time:	/	12:28	12:44

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	40	20	2
3			
4			
5	n/a	n/a	2
6			
7			
8	70	48	3
Flap	n/a	n/a	2
Time:	12:16	12:27	12:44

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

ADH ON
MID-CHORD

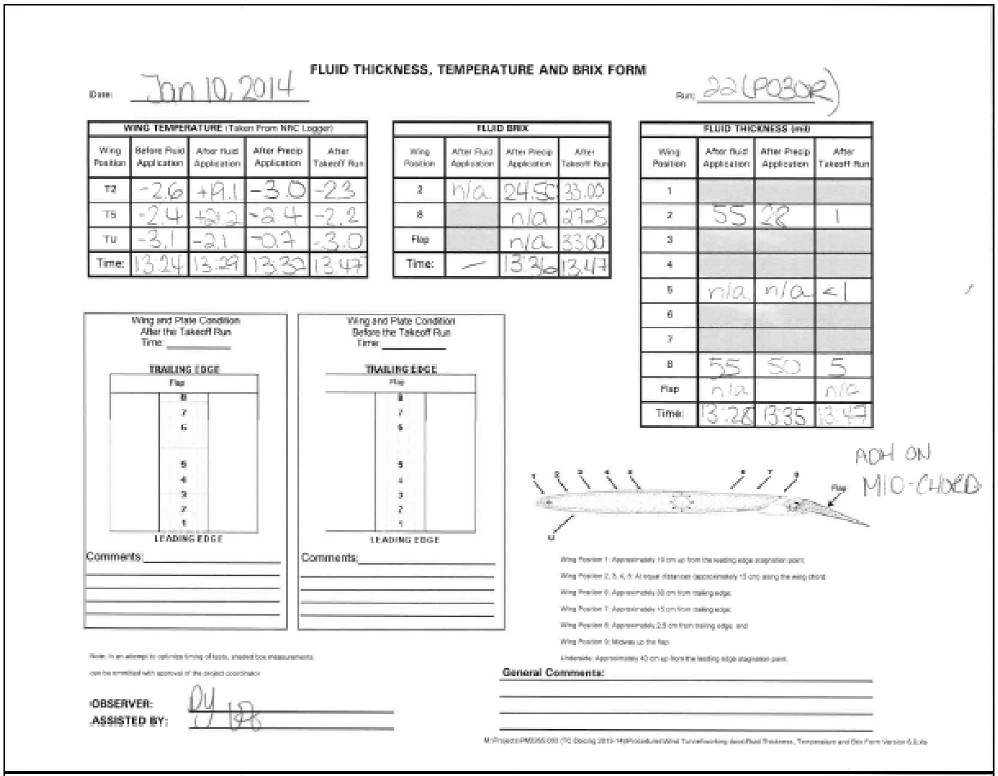
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: JB

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls

Figure C11: Test # 21



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 22 (P030R)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.6	+19.1	-3.0	-2.3
T5	-2.4	+21.2	-2.4	-2.2
Tu	-3.1	-2.1	-0.7	-3.0
Time:	13:24	13:29	13:32	13:47

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	24.50	33.00
8	▨	n/a	27.25
Flap	▨	n/a	33.00
Time:	—	13:36	13:47

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	55	28	1
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	<1
6	▨	▨	▨
7	▨	▨	▨
8	55	50	5
Flap	n/a		n/a
Time:	13:28	13:35	13:47

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

ADH ON MID-CHORD

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

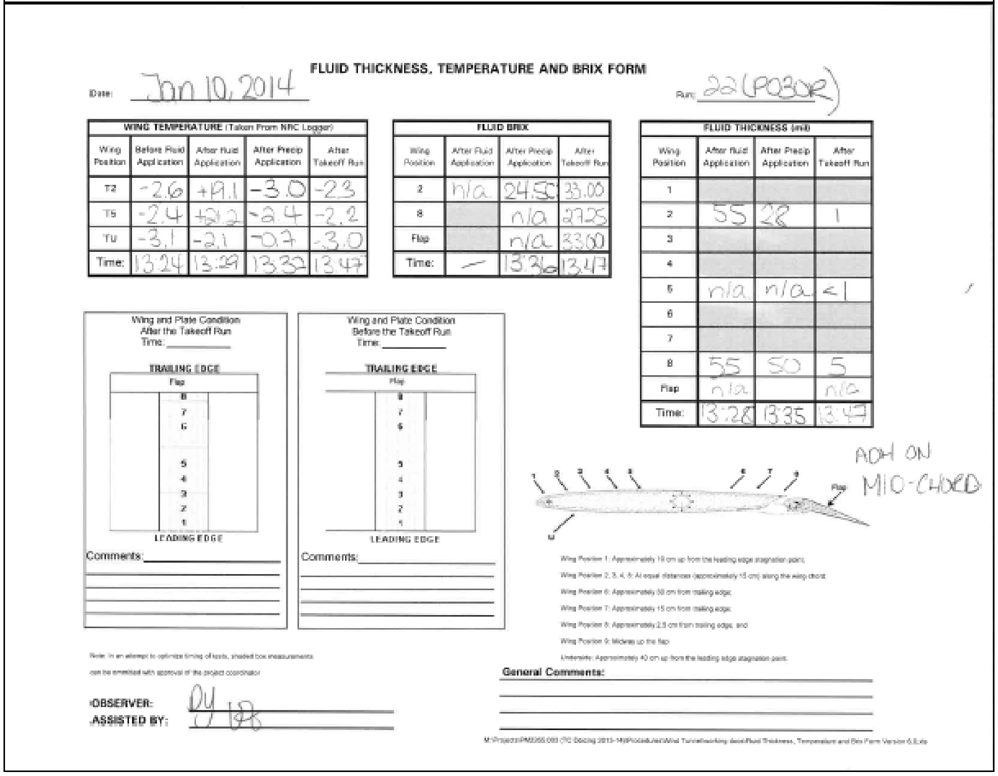
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY

ASSISTED BY: LB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 22 (P030R)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.6	+19.1	-3.0	-2.3
T5	-2.4	+21.2	-2.4	-2.2
Tu	-3.1	-2.1	-0.7	-3.0
Time:	13:24	13:29	13:32	13:47

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	24.50	33.00
8	▨	n/a	27.25
Flap	▨	n/a	33.00
Time:	—	13:36	13:47

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	55	28	1
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	<1
6	▨	▨	▨
7	▨	▨	▨
8	55	50	5
Flap	n/a		n/a
Time:	13:28	13:35	13:47

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

ADH ON MID-CHORD

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

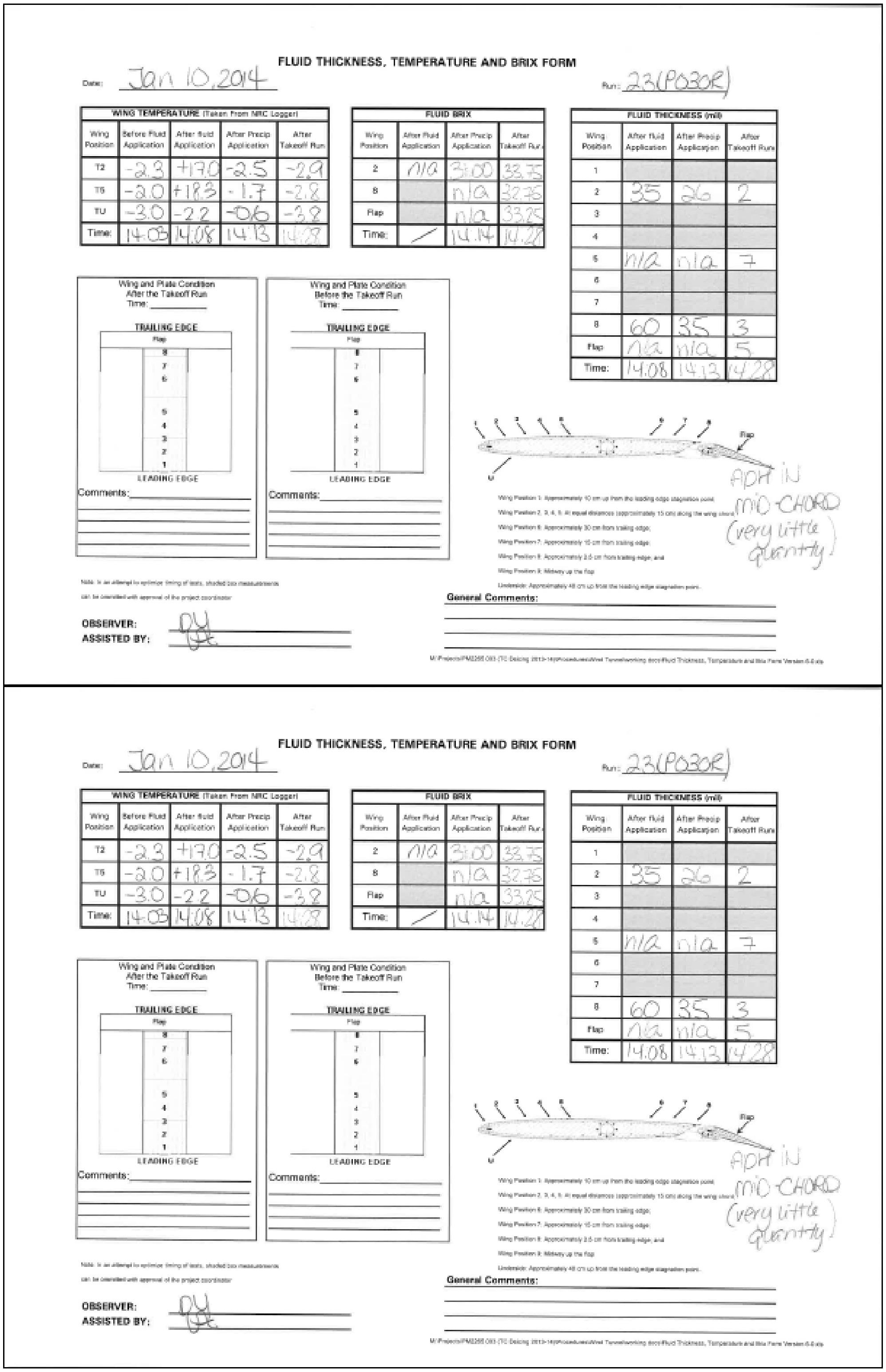
Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY

ASSISTED BY: LB

Figure C12: Test # 22



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 23(P030R)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.3	+17.0	-2.5	-2.9
T6	-2.0	+18.3	-1.7	-2.8
TU	-3.0	-2.2	-0.6	-3.8
Time:	14:03	14:08	14:13	14:28

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	3:00	33.75
8	▨	n/a	32.75
Flap	▨	n/a	33.25
Time:	/	14:14	14:28

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	35	26	2
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	7
6	▨	▨	▨
7	▨	▨	▨
8	60	35	3
Flap	n/a	n/a	5
Time:	14:08	14:13	14:28

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ___________

APH IN MID-CHORD (very little quantity)

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 48 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be cancelled with approval of the project coordinator

General Comments: ___________

OBSERVER: DY
ASSISTED BY:

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 23(P030R)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.3	+17.0	-2.5	-2.9
T6	-2.0	+18.3	-1.7	-2.8
TU	-3.0	-2.2	-0.6	-3.8
Time:	14:03	14:08	14:13	14:28

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	3:00	33.75
8	▨	n/a	32.75
Flap	▨	n/a	33.25
Time:	/	14:14	14:28

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	35	26	2
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	7
6	▨	▨	▨
7	▨	▨	▨
8	60	35	3
Flap	n/a	n/a	5
Time:	14:08	14:13	14:28

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ___________

APH IN MID-CHORD (very little quantity)

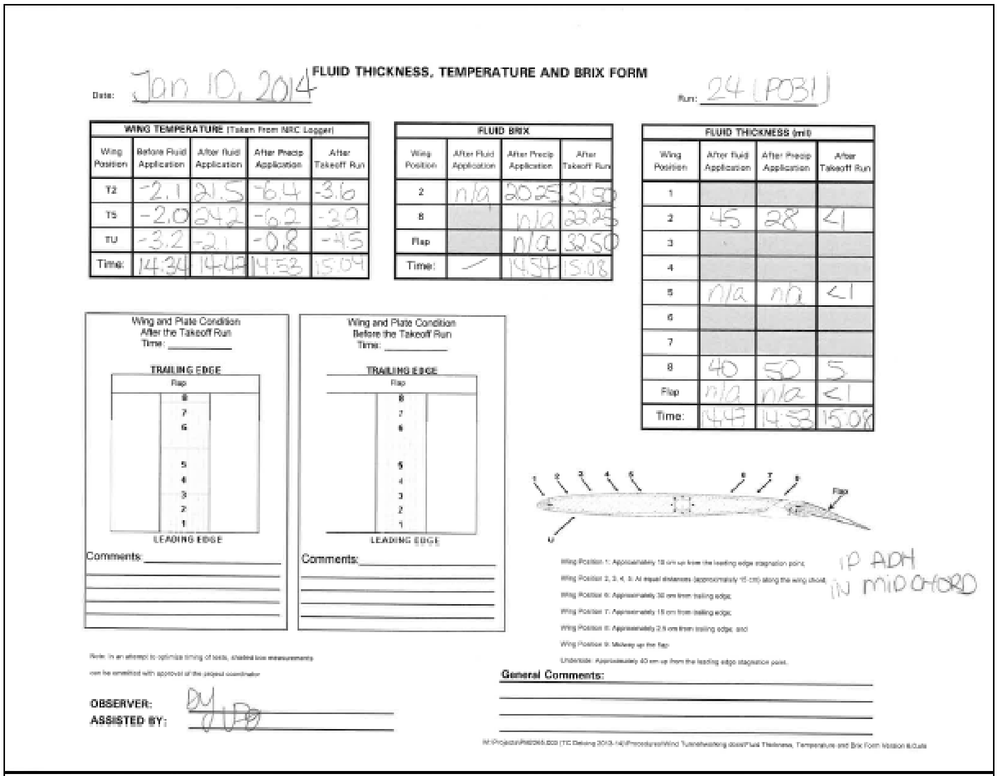
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 48 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be cancelled with approval of the project coordinator

General Comments: ___________

OBSERVER: DY
ASSISTED BY:

Figure C13: Test # 23



Date: Jan 10, 2014

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Run: 24 (P031)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.1	21.5	-6.4	-3.6
T5	-2.0	24.2	-6.2	-3.9
TU	-3.2	-2.1	-0.8	-4.5
Time:	14:34	14:42	14:53	15:04

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	20.25	31.50
8	▨	n/a	22.25
Flap	▨	n/a	32.50
Time:	—	14:54	15:08

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	45	28	<1
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	<1
6	▨	▨	▨
7	▨	▨	▨
8	40	50	5
Flap	n/a	n/a	<1
Time:	14:47	14:53	15:08

Wing and Plate Condition
After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

Comments: ____________

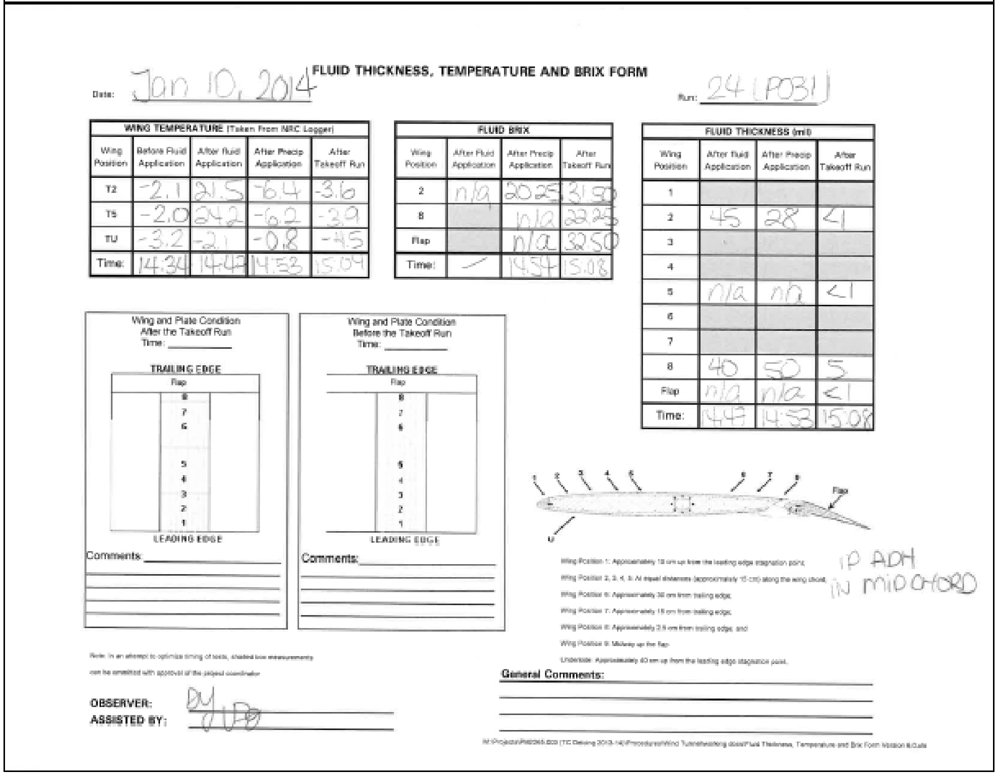
Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

IP ADH
IN MIDCHORD

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: ____________



Date: Jan 10, 2014

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Run: 24 (P031)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.1	21.5	-6.4	-3.6
T5	-2.0	24.2	-6.2	-3.9
TU	-3.2	-2.1	-0.8	-4.5
Time:	14:34	14:42	14:53	15:04

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	20.25	31.50
8	▨	n/a	22.25
Flap	▨	n/a	32.50
Time:	—	14:54	15:08

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	45	28	<1
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	<1
6	▨	▨	▨
7	▨	▨	▨
8	40	50	5
Flap	n/a	n/a	<1
Time:	14:47	14:53	15:08

Wing and Plate Condition
After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

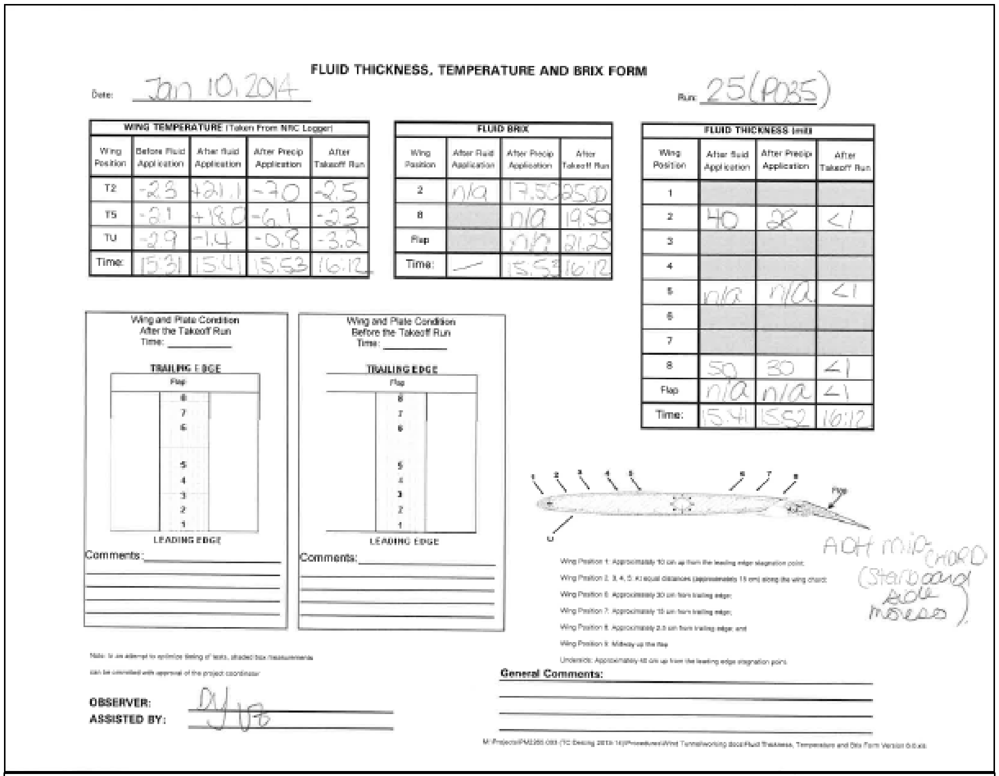
IP ADH
IN MIDCHORD

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: ____________

Figure C14: Test # 24



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 25(P035)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.3	+21.1	-7.0	-2.5
T5	-2.1	+18.0	-6.1	-2.3
TU	-2.9	-1.4	-0.8	-3.2
Time:	15:31	15:41	15:53	16:12

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	17.50	25.00
8	▨	n/a	19.50
Flap	▨	n/a	21.25
Time:	—	15:53	16:12

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	40	28	<1
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	<1
6	▨	▨	▨
7	▨	▨	▨
8	50	30	<1
Flap	n/a	n/a	<1
Time:	15:41	15:52	16:12

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

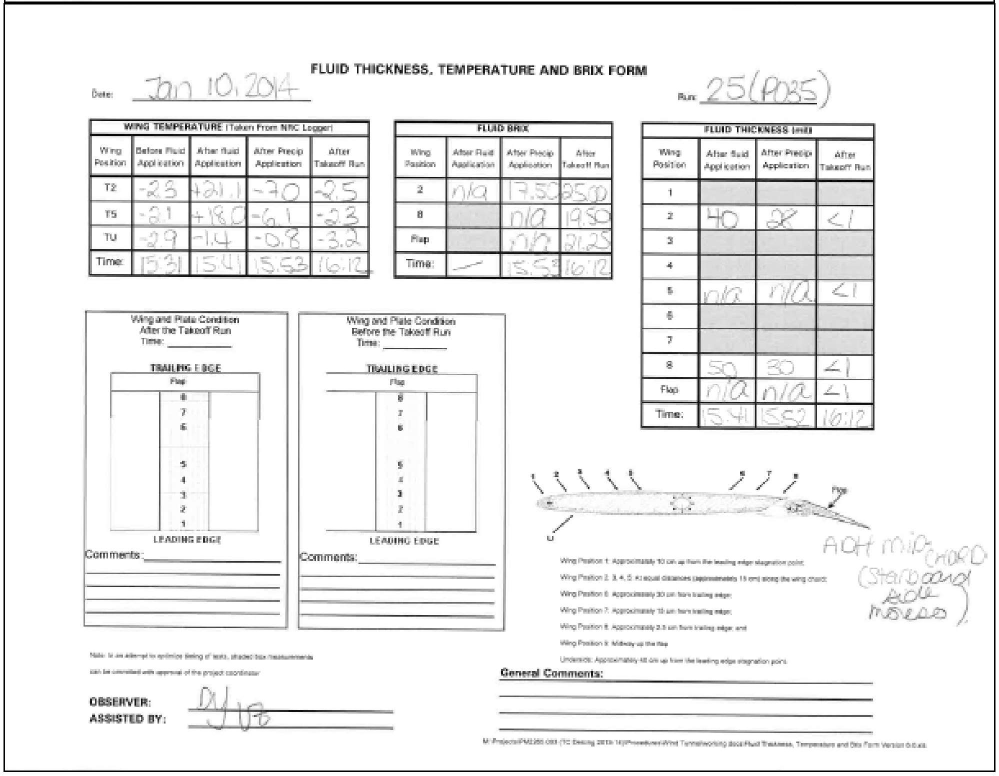
ACH mid-CHORD (Starboard side moved)

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be cancelled with approval of the project coordinator

General Comments: ________

OBSERVER: DY
ASSISTED BY: JB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 10, 2014

Run: 25(P035)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-2.3	+21.1	-7.0	-2.5
T5	-2.1	+18.0	-6.1	-2.3
TU	-2.9	-1.4	-0.8	-3.2
Time:	15:31	15:41	15:53	16:12

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	n/a	17.50	25.00
8	▨	n/a	19.50
Flap	▨	n/a	21.25
Time:	—	15:53	16:12

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	40	28	<1
3	▨	▨	▨
4	▨	▨	▨
5	n/a	n/a	<1
6	▨	▨	▨
7	▨	▨	▨
8	50	30	<1
Flap	n/a	n/a	<1
Time:	15:41	15:52	16:12

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

ACH mid-CHORD (Starboard side moved)

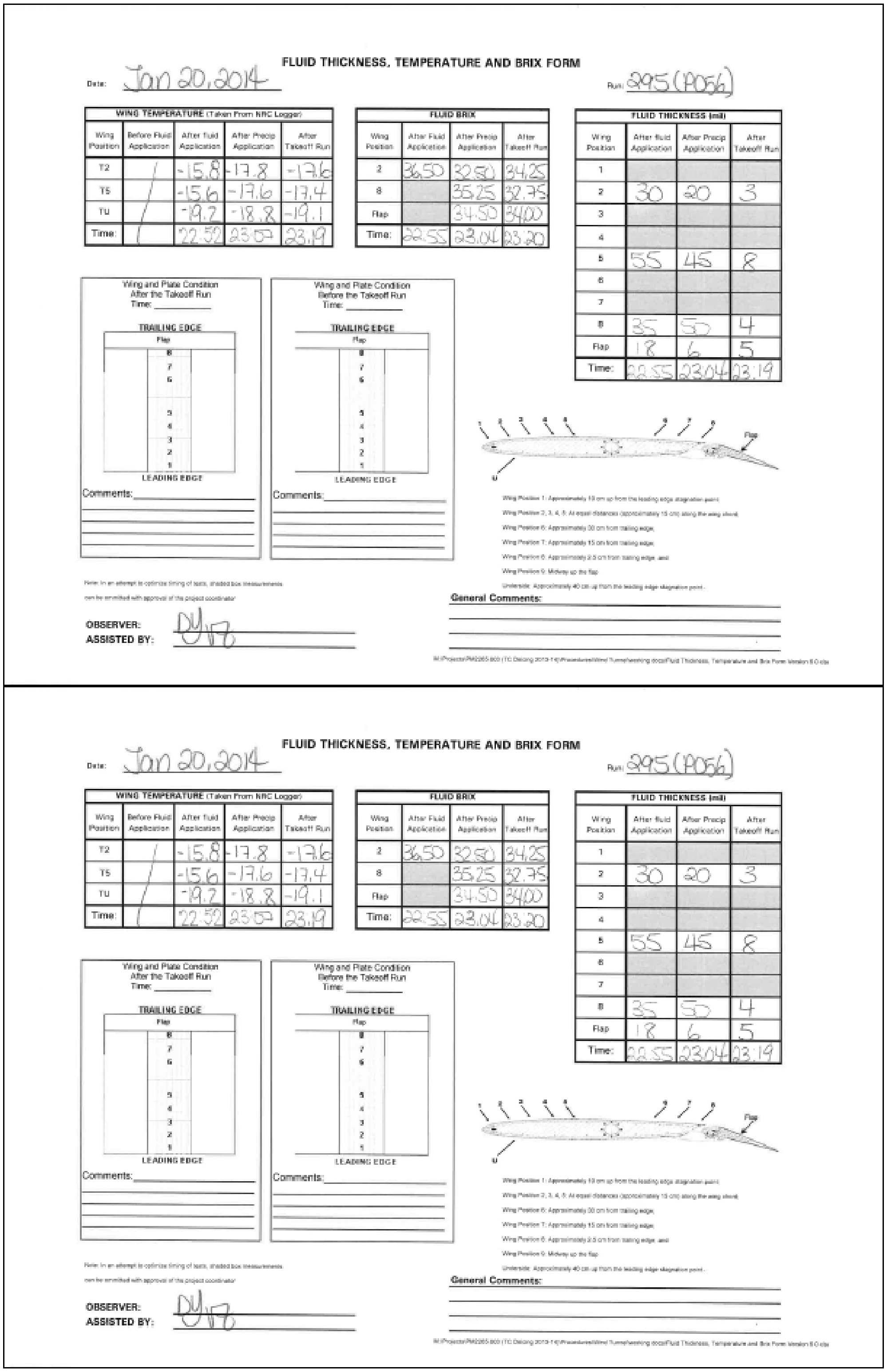
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be cancelled with approval of the project coordinator

General Comments: ________

OBSERVER: DY
ASSISTED BY: JB

Figure C15: Test # 25



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 20, 2014

Run: 295 (P056)

WING TEMPERATURE (Taken From NRC Logger)

Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-15.8	-17.8	-17.6
T5		-15.6	-17.6	-17.4
TU		-19.2	-18.8	-19.1
Time:		22.52	23.07	23.19

FLUID BRIX

Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	32.50	34.25
8	▨	35.25	32.75
Flap	▨	34.50	34.00
Time:	22.55	23.04	23.20

FLUID THICKNESS (mil)

Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	20	3
3	▨	▨	▨
4	▨	▨	▨
5	55	45	8
6	▨	▨	▨
7	▨	▨	▨
8	35	50	4
Flap	18	6	5
Time:	22.55	23.04	23.19

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point.
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord.
Wing Position 6: Approximately 30 cm from trailing edge.
Wing Position 7: Approximately 15 cm from trailing edge.
Wing Position 8: Approximately 2.5 cm from trailing edge, and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: VB

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 20, 2014

Run: 295 (P056)

WING TEMPERATURE (Taken From NRC Logger)

Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-15.8	-17.8	-17.6
T5		-15.6	-17.6	-17.4
TU		-19.2	-18.8	-19.1
Time:		22.52	23.07	23.19

FLUID BRIX

Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	32.50	34.25
8	▨	35.25	32.75
Flap	▨	34.50	34.00
Time:	22.55	23.04	23.20

FLUID THICKNESS (mil)

Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	20	3
3	▨	▨	▨
4	▨	▨	▨
5	55	45	8
6	▨	▨	▨
7	▨	▨	▨
8	35	50	4
Flap	18	6	5
Time:	22.55	23.04	23.19

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

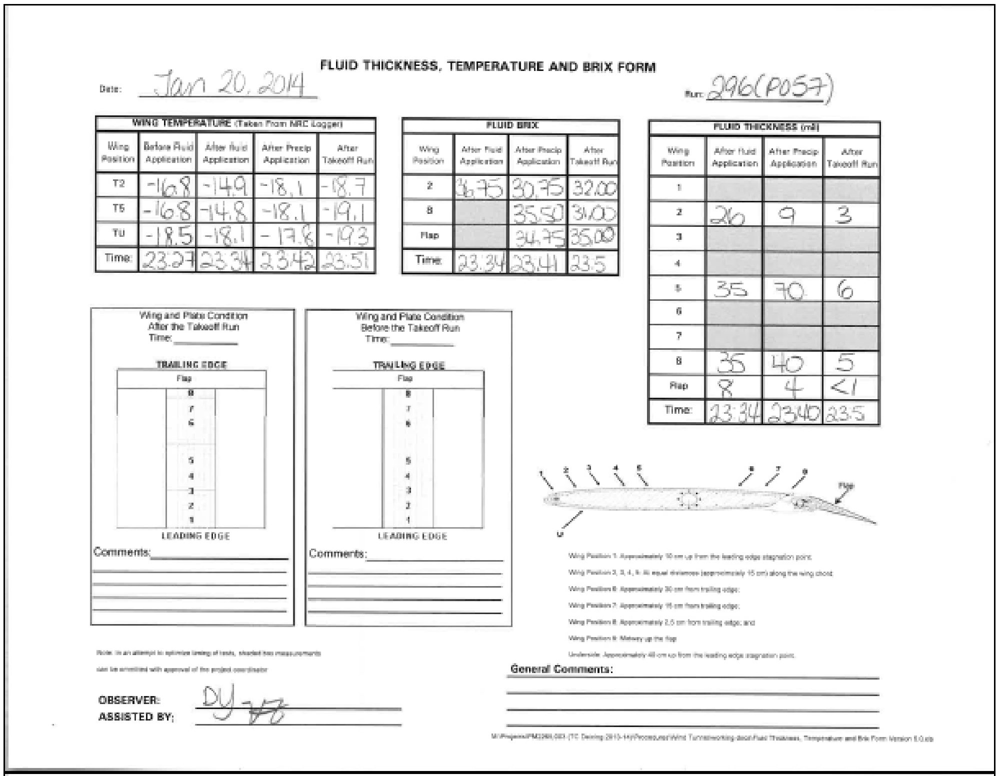
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point.
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord.
Wing Position 6: Approximately 30 cm from trailing edge.
Wing Position 7: Approximately 15 cm from trailing edge.
Wing Position 8: Approximately 2.5 cm from trailing edge, and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: VB

Figure C16: Test # 295



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 20, 2014

Run: 296(P057)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-16.8	-14.9	-18.1	-18.7
T5	-16.8	-14.8	-18.1	-19.1
TU	-18.5	-18.1	-17.8	-19.3
Time:	23:27	23:34	23:42	23:51

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.75	30.75	32.00
8		35.50	31.00
Flap		34.75	35.00
Time:	23:34	23:41	23:5

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	26	9	3
3			
4			
5	35	70	6
6			
7			
8	35	40	5
Flap	8	4	<1
Time:	23:34	2340	23:5

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

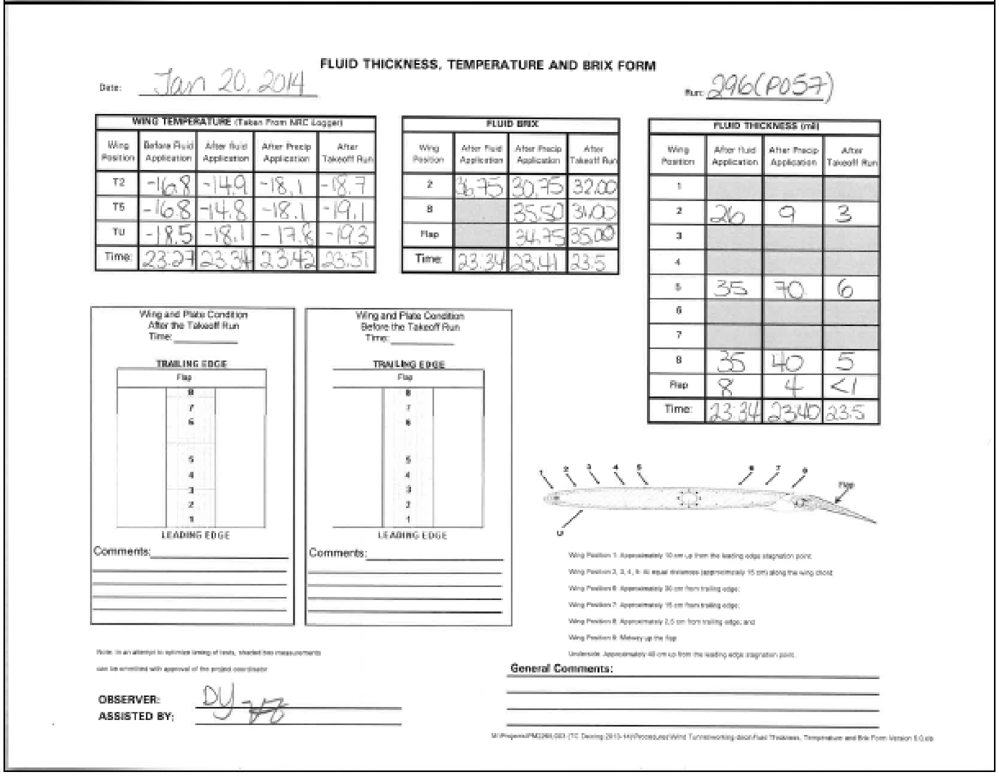
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY:

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 20, 2014

Run: 296(P057)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-16.8	-14.9	-18.1	-18.7
T5	-16.8	-14.8	-18.1	-19.1
TU	-18.5	-18.1	-17.8	-19.3
Time:	23:27	23:34	23:42	23:51

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.75	30.75	32.00
8		35.50	31.00
Flap		34.75	35.00
Time:	23:34	23:41	23:5

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	26	9	3
3			
4			
5	35	70	6
6			
7			
8	35	40	5
Flap	8	4	<1
Time:	23:34	2340	23:5

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

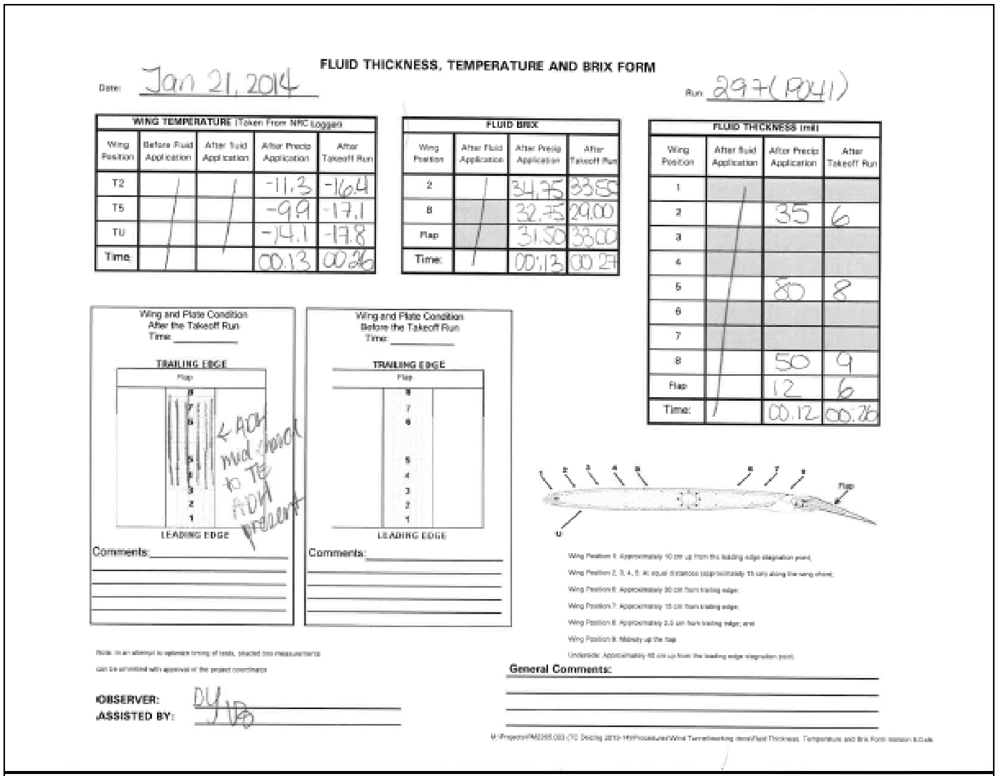
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY:

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls

Figure C17: Test # 296



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 297 (P041)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2			-11.3	-16.4
T5			-9.9	-17.1
TU			-14.1	-17.8
Time			00:13	00:26

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		34.75	33.50
8		32.75	29.00
Flap		31.50	33.00
Time:		00:13	00:27

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		35	6
3			
4			
5		80	8
6			
7			
8		50	9
Flap		12	6
Time:		00.12	00:26

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE

Flap

LEADING EDGE

← ADH mid chord to TE
ADH present

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE

Flap

LEADING EDGE

Comments: ______

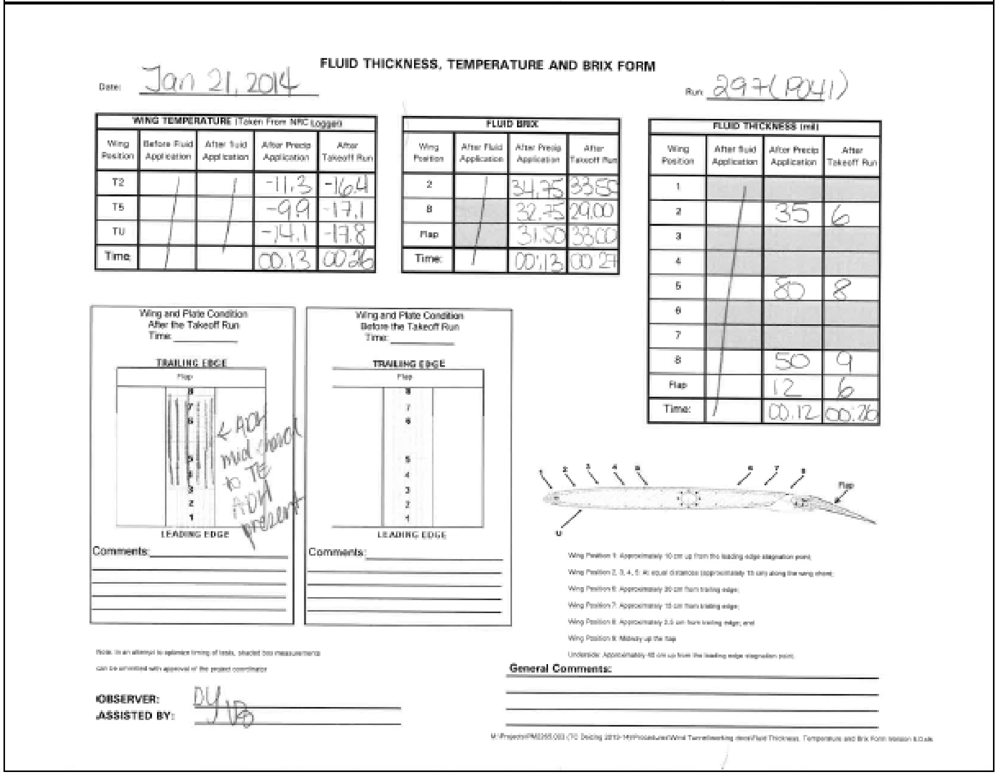
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 45 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY
ASSISTED BY: VB

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 297 (P041)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2			-11.3	-16.4
T5			-9.9	-17.1
TU			-14.1	-17.8
Time			00:13	00:26

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		34.75	33.50
8		32.75	29.00
Flap		31.50	33.00
Time:		00:13	00:27

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		35	6
3			
4			
5		80	8
6			
7			
8		50	9
Flap		12	6
Time:		00.12	00:26

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE

Flap

LEADING EDGE

← ADH mid chord to TE
ADH present

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE

Flap

LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 45 cm up from the leading edge stagnation point.

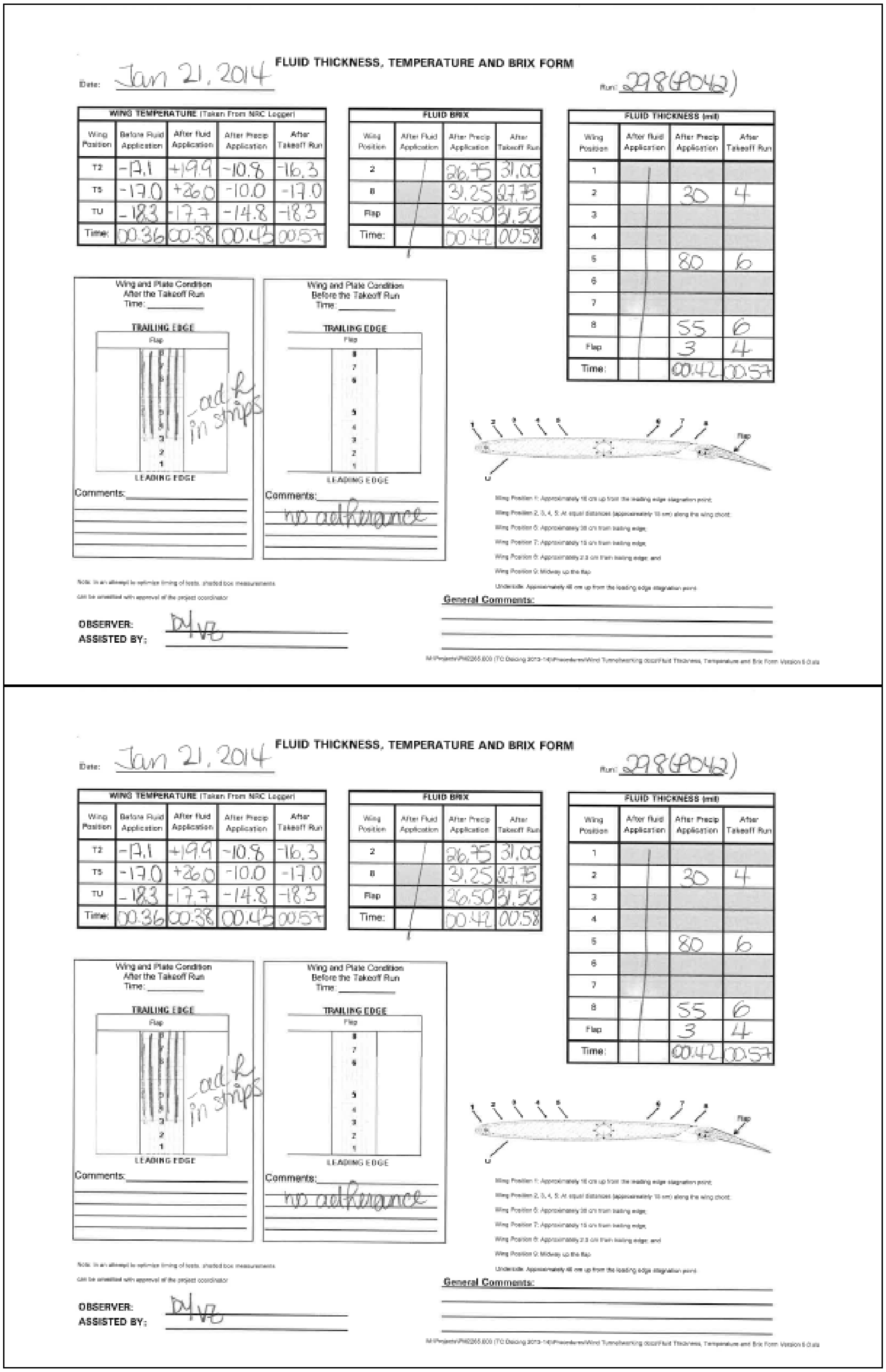
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY
ASSISTED BY: VB

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls

Figure C18: Test # 297



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 298(P042)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-17.1	+19.9	-10.8	-16.3
T5	-17.0	+26.0	-10.0	-17.0
TU	-18.3	-17.7	-14.8	-18.3
Time:	00:36	00:38	00:43	00:57

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		26.75	31.00
8		31.25	27.75
Flap		26.50	31.50
Time:		00:42	00:58

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		30	4
3			
4			
5		80	6
6			
7			
8		55	6
Flap		3	4
Time:		00:42	00:57

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
LEADING EDGE

– adh in strips

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
LEADING EDGE

Comments: no adherance

OBSERVER: DY
ASSISTED BY: VB

General Comments: ____________

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 298(P042)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-17.1	+19.9	-10.8	-16.3
T5	-17.0	+26.0	-10.0	-17.0
TU	-18.3	-17.7	-14.8	-18.3
Time:	00:36	00:38	00:43	00:57

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		26.75	31.00
8		31.25	27.75
Flap		26.50	31.50
Time:		00:42	00:58

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		30	4
3			
4			
5		80	6
6			
7			
8		55	6
Flap		3	4
Time:		00:42	00:57

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
LEADING EDGE

– adh in strips

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

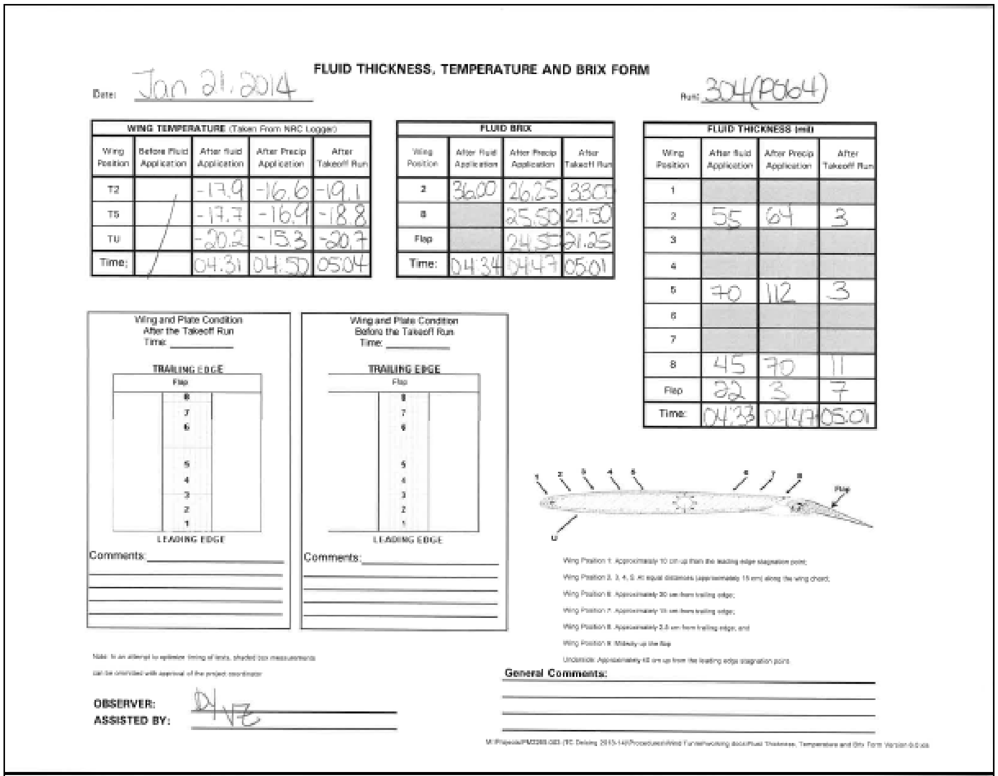
TRAILING EDGE
Flap
LEADING EDGE

Comments: no adherance

OBSERVER: DY
ASSISTED BY: VB

General Comments: ____________

Figure C19: Test # 298



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 304(P064)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-17.9	-16.6	-19.1
T5		-17.7	-16.9	-18.8
TU		-20.2	-15.3	-20.7
Time:		04:31	04:50	05:04

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	36.00	26.25	33.00
8	▨	25.50	27.50
Flap	▨	24.5	21.25
Time:	04:34	04:47	05:01

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	55	64	3
3	▨	▨	▨
4	▨	▨	▨
5	70	112	3
6	▨	▨	▨
7	▨	▨	▨
8	45	70	11
Flap	22	3	7
Time:	04:33	04:47	05:01

Wing and Plate Condition
After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 20 cm from trailing edge;
Wing Position 7: Approximately 10 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 10 cm up from the leading edge stagnation point

Note: In an attempt to optimize timing of tests, shaded box measurements can be overridden with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: VZ

General Comments: ____________

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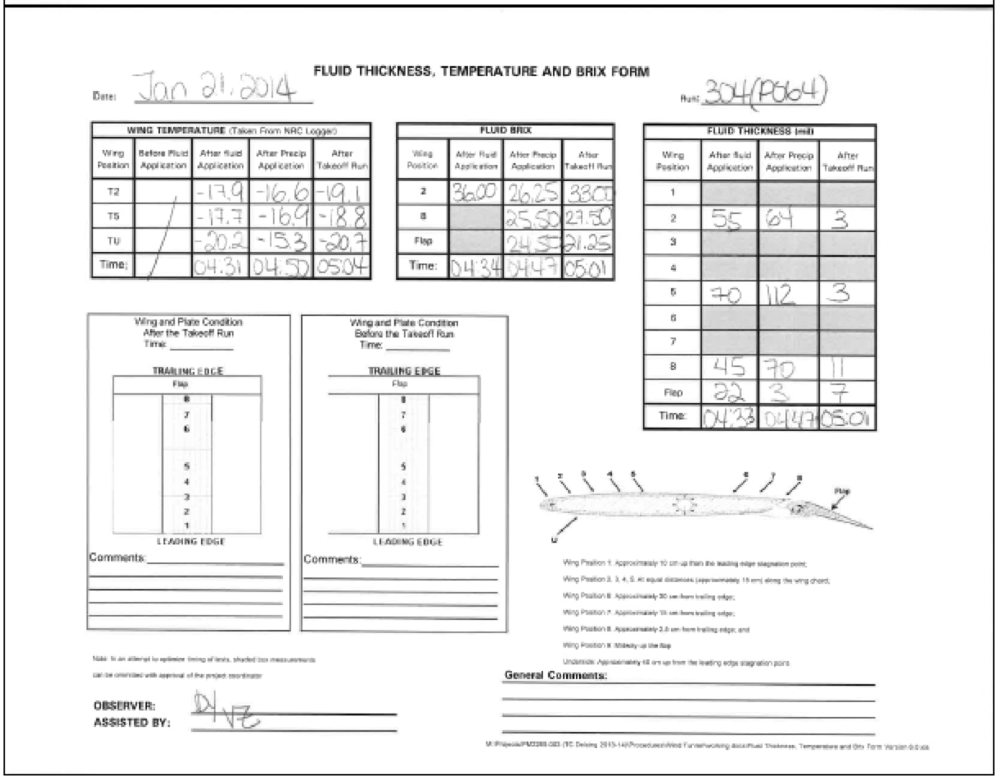


FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 304(P064)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-17.9	-16.6	-19.1
T5		-17.7	-16.9	-18.8
TU		-20.2	-15.3	-20.7
Time:		04:31	04:50	05:04

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	36.00	26.25	33.00
8	▨	25.50	27.50
Flap	▨	24.5	21.25
Time:	04:34	04:47	05:01

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	55	64	3
3	▨	▨	▨
4	▨	▨	▨
5	70	112	3
6	▨	▨	▨
7	▨	▨	▨
8	45	70	11
Flap	22	3	7
Time:	04:33	04:47	05:01

Wing and Plate Condition
After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 20 cm from trailing edge;
Wing Position 7: Approximately 10 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 10 cm up from the leading edge stagnation point

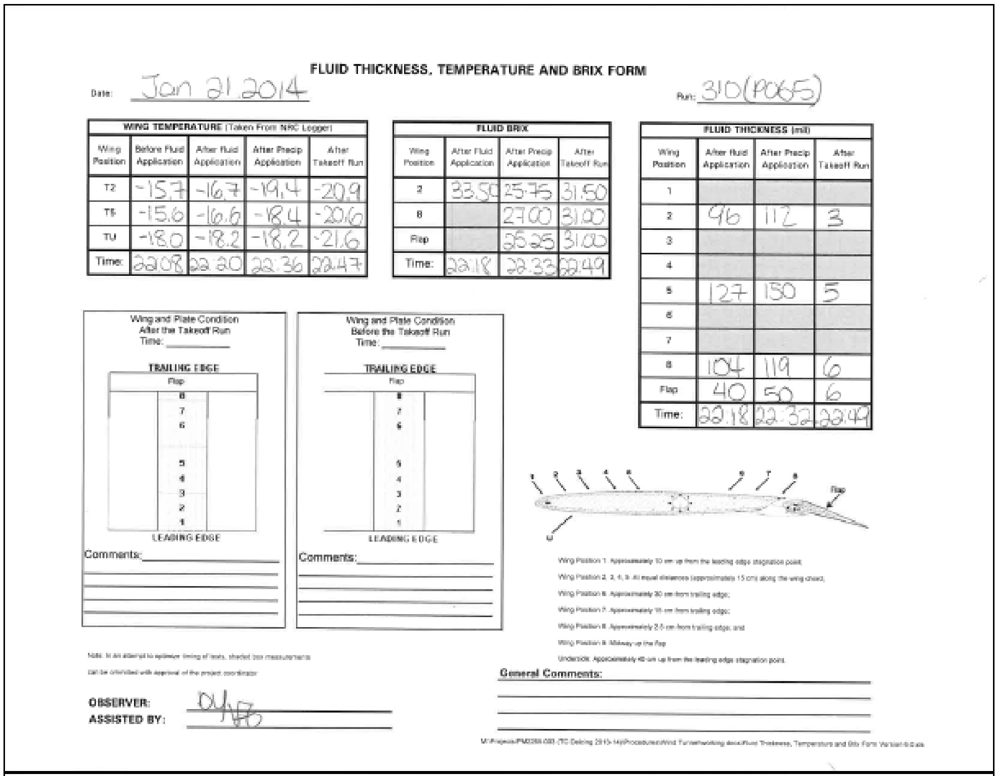
Note: In an attempt to optimize timing of tests, shaded box measurements can be overridden with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: VZ

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C20: Test # 304



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21 2014

Run: 310(P065)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-15.7	-16.7	-19.4	-20.9
T5	-15.6	-16.6	-18.4	-20.6
TU	-18.0	-18.2	-18.2	-21.6
Time:	22:08	22:20	22:36	22:47

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	33.50	25.75	31.50
8		27.00	31.00
Flap		25.25	31.00
Time:	22:18	22:33	22:49

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	96	112	3
3			
4			
5	127	150	5
6			
7			
8	104	119	6
Flap	40	50	6
Time:	22:18	22:32	22:49

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

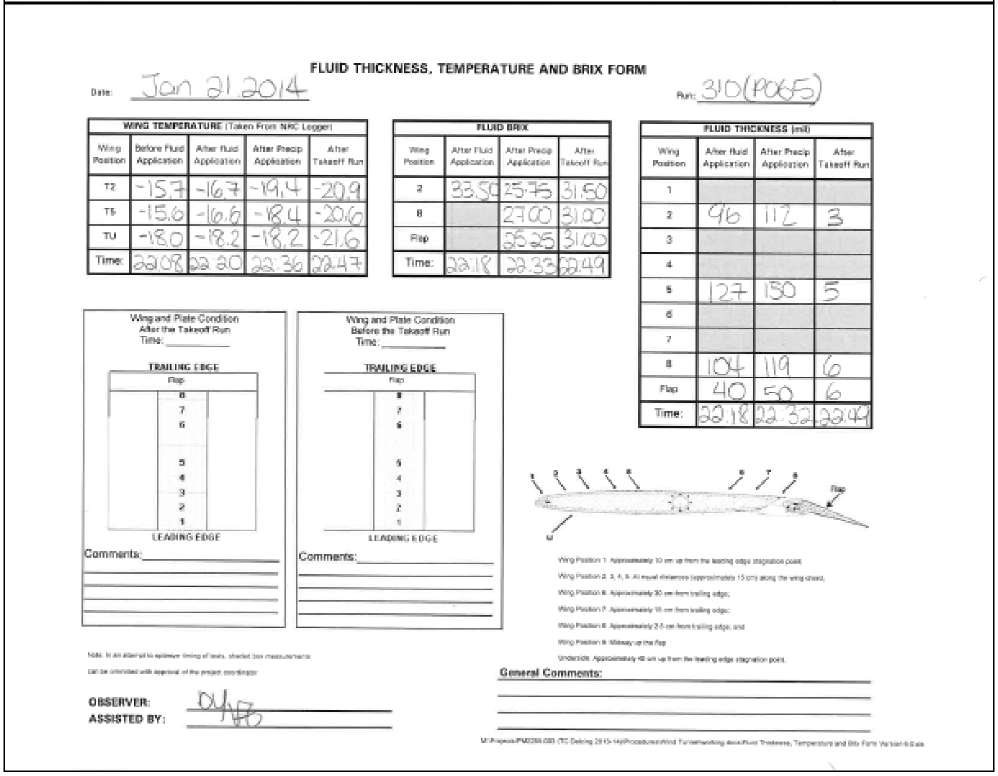
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER:
ASSISTED BY:

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21 2014

Run: 310(P065)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-15.7	-16.7	-19.4	-20.9
T5	-15.6	-16.6	-18.4	-20.6
TU	-18.0	-18.2	-18.2	-21.6
Time:	22:08	22:20	22:36	22:47

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	33.50	25.75	31.50
8		27.00	31.00
Flap		25.25	31.00
Time:	22:18	22:33	22:49

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	96	112	3
3			
4			
5	127	150	5
6			
7			
8	104	119	6
Flap	40	50	6
Time:	22:18	22:32	22:49

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

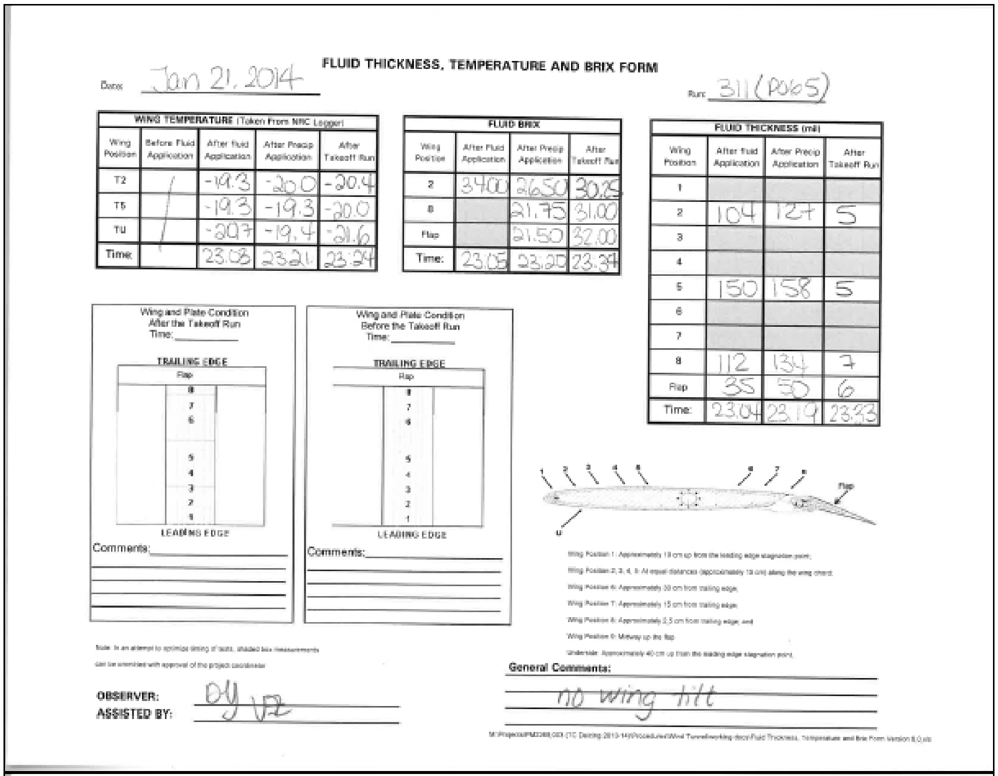
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER:
ASSISTED BY:

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C21: Test # 310



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 311 (P065)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-19.3	-20.0	-20.4
T5	/	-19.3	-19.3	-20.0
TU	/	-20.7	-19.4	-21.6
Time:		23:08	23:21	23:24

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	34.00	26.50	30.25
8		21.75	31.00
Flap		21.50	32.00
Time:	23:05	23:20	23:34

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	104	127	5
3			
4			
5	150	158	5
6			
7			
8	112	134	7
Flap	35	50	6
Time:	23:04	23:19	23:33

Wing and Plate Condition
After the Takeoff Run
Time:

TRAILING EDGE

Flap

8 7 6 5 4 3 2 1

LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time:

TRAILING EDGE

Flap

8 7 6 5 4 3 2 1

LEADING EDGE

Comments:

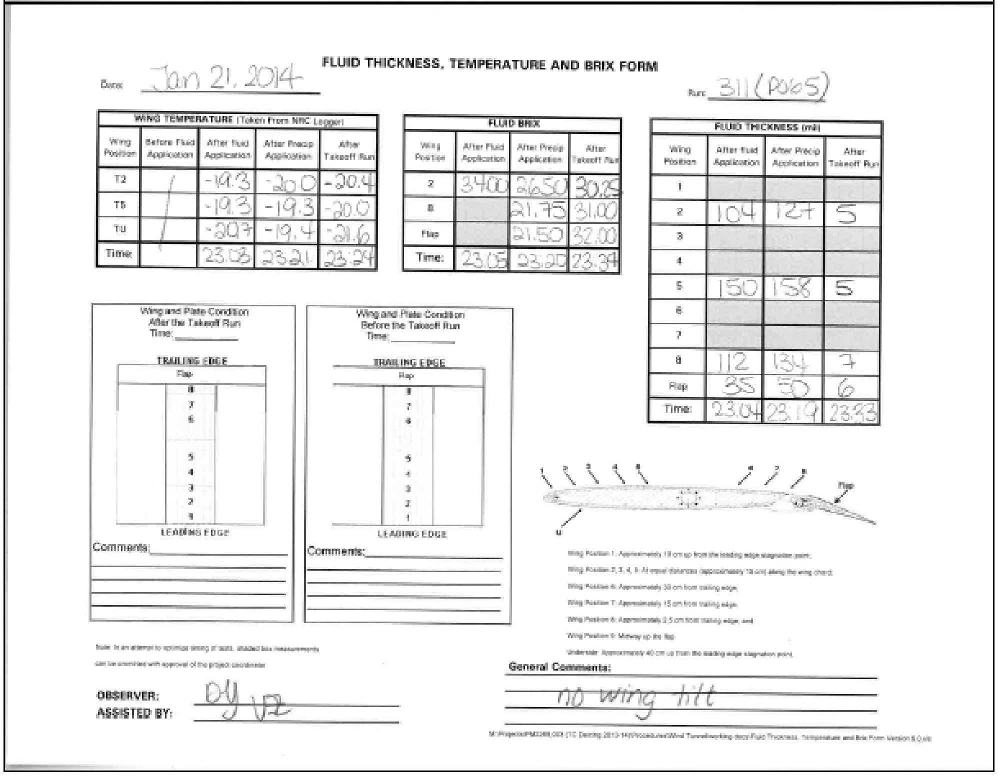
Wing Position 1: Approximately 18 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 13 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator.

General Comments: no wing tilt

OBSERVER: DY
ASSISTED BY: VZ

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 311 (P065)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-19.3	-20.0	-20.4
T5	/	-19.3	-19.3	-20.0
TU	/	-20.7	-19.4	-21.6
Time:		23:08	23:21	23:24

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	34.00	26.50	30.25
8		21.75	31.00
Flap		21.50	32.00
Time:	23:05	23:20	23:34

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	104	127	5
3			
4			
5	150	158	5
6			
7			
8	112	134	7
Flap	35	50	6
Time:	23:04	23:19	23:33

Wing and Plate Condition
After the Takeoff Run
Time:

TRAILING EDGE

Flap

8 7 6 5 4 3 2 1

LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time:

TRAILING EDGE

Flap

8 7 6 5 4 3 2 1

LEADING EDGE

Comments:

Wing Position 1: Approximately 18 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 13 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

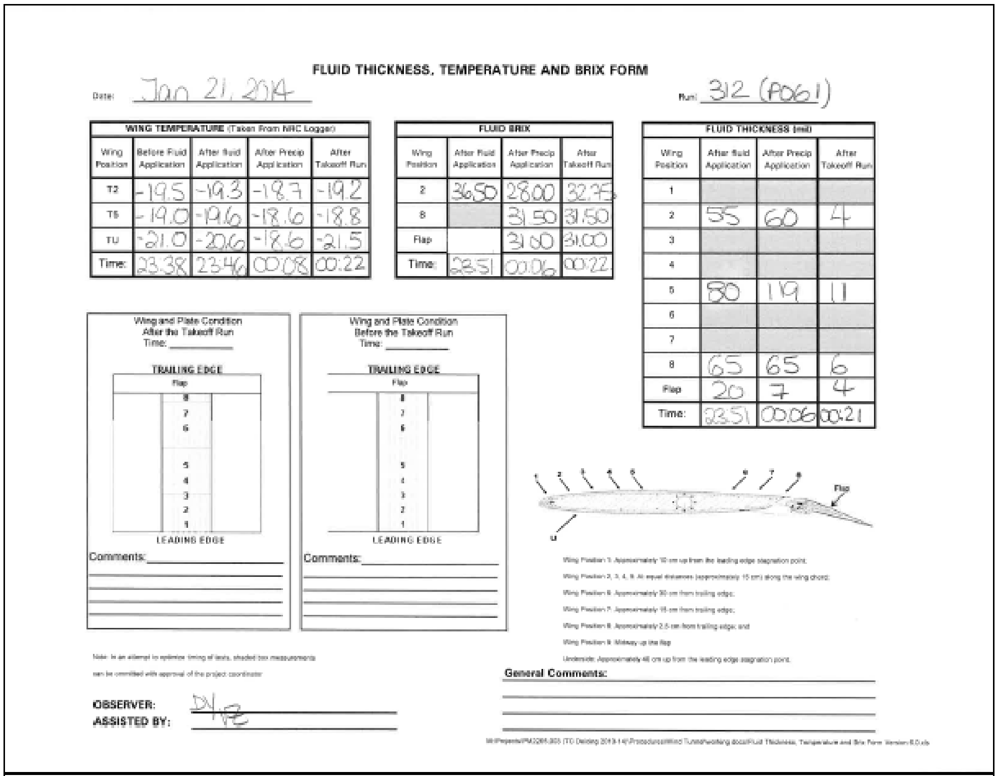
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator.

General Comments: no wing tilt

OBSERVER: DY
ASSISTED BY: VZ

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls

Figure C22: Test # 311



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 312 (P061)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-19.5	-19.3	-18.7	-19.2
T5	-19.0	-19.6	-18.6	-18.8
TU	-21.0	-20.6	-18.6	-21.5
Time:	23:38	23:46	00:08	00:22

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	28.00	32.75
8		31.50	31.50
Flap		31.00	31.00
Time:	23:51	00:06	00:22

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	55	60	4
3			
4			
5	80	119	11
6			
7			
8	65	65	6
Flap	20	7	4
Time:	23:51	00:06	00:21

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

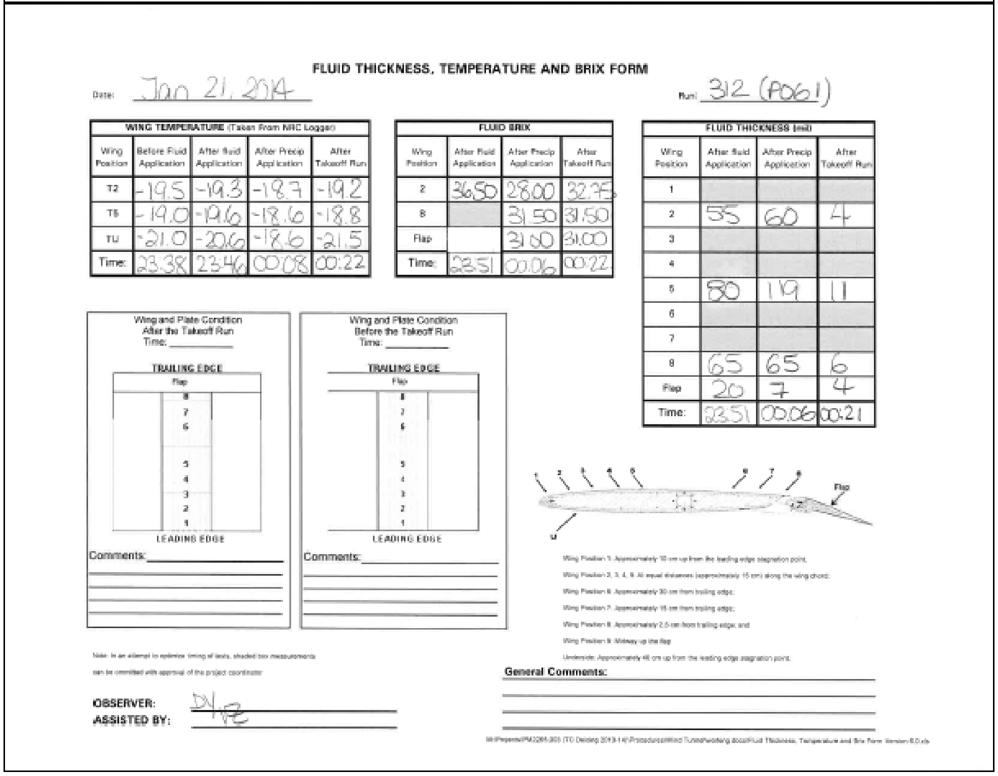
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 46 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DY
ASSISTED BY: VZ

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 21, 2014

Run: 312 (P061)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-19.5	-19.3	-18.7	-19.2
T5	-19.0	-19.6	-18.6	-18.8
TU	-21.0	-20.6	-18.6	-21.5
Time:	23:38	23:46	00:08	00:22

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	28.00	32.75
8		31.50	31.50
Flap		31.00	31.00
Time:	23:51	00:06	00:22

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	55	60	4
3			
4			
5	80	119	11
6			
7			
8	65	65	6
Flap	20	7	4
Time:	23:51	00:06	00:21

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 46 cm up from the leading edge stagnation point.

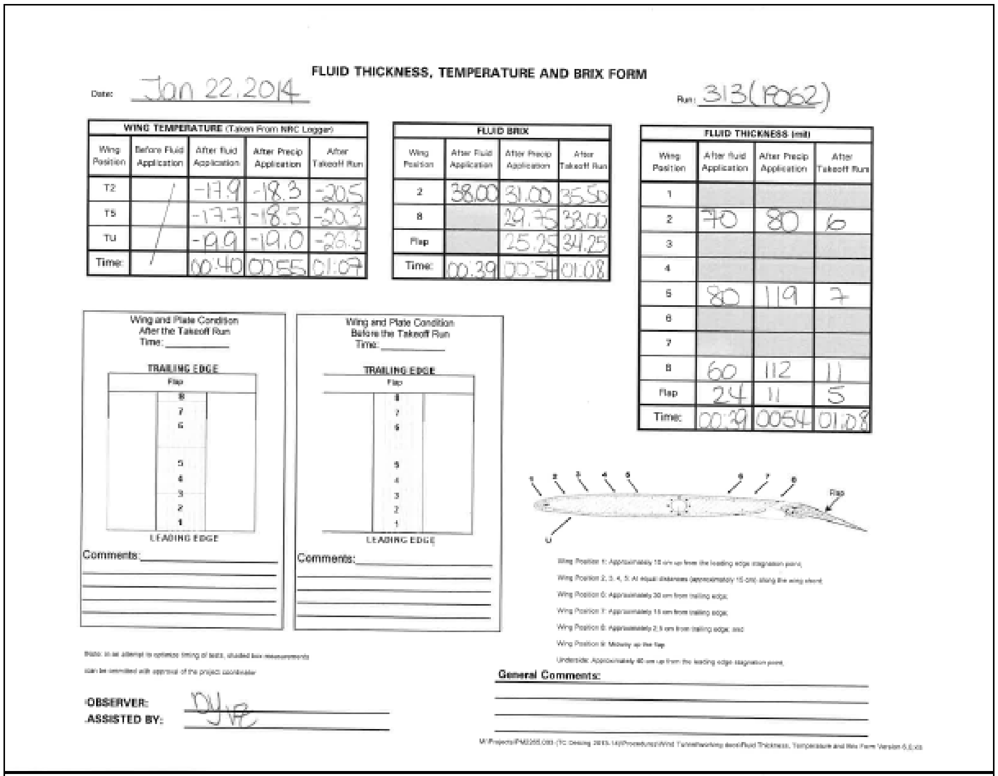
Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DY
ASSISTED BY: VZ

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls

Figure C23: Test # 312



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 22, 2014

Run: 313(P062)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-17.9	-18.3	-20.5
T5	/	-17.7	-18.5	-20.3
TU	/	-19.9	-19.0	-20.3
Time:	/	00:40	00:55	01:07

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	38.00	31.00	35.50
8		29.75	33.00
Flap		25.25	34.25
Time:	00:39	00:54	01:08

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	70	80	6
3			
4			
5	80	119	7
6			
7			
8	60	112	11
Flap	24	11	5
Time:	00:39	0054	01:08

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

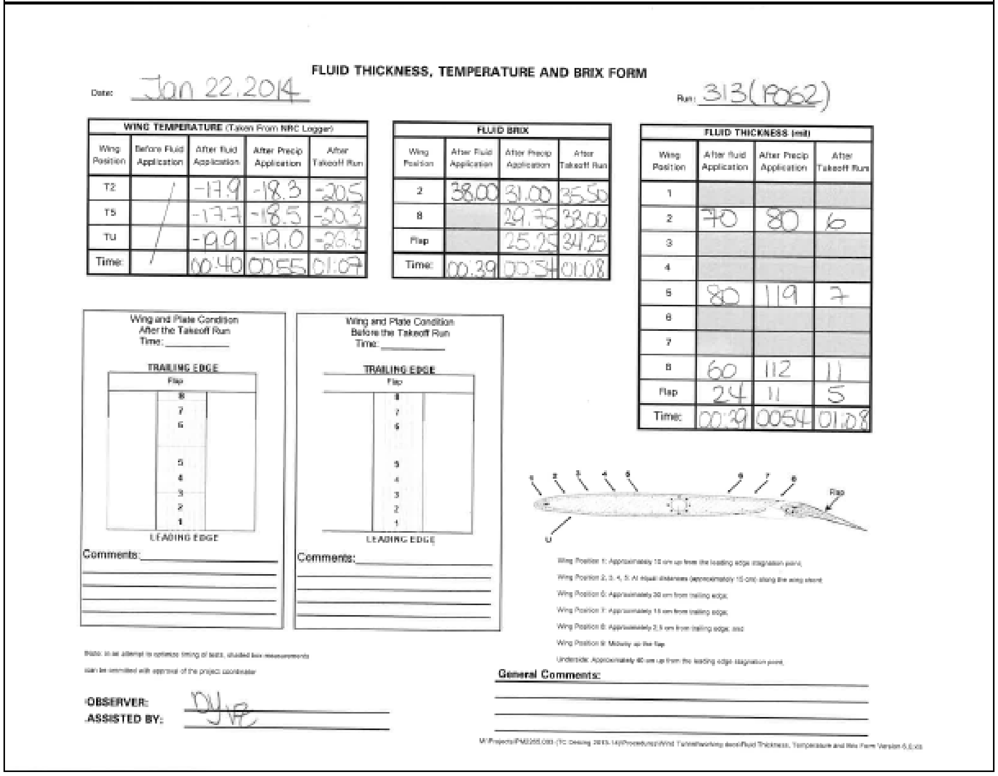
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: JP

General Comments: ________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\Working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 22, 2014

Run: 313(P062)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-17.9	-18.3	-20.5
T5	/	-17.7	-18.5	-20.3
TU	/	-19.9	-19.0	-20.3
Time:	/	00:40	00:55	01:07

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	38.00	31.00	35.50
8		29.75	33.00
Flap		25.25	34.25
Time:	00:39	00:54	01:08

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	70	80	6
3			
4			
5	80	119	7
6			
7			
8	60	112	11
Flap	24	11	5
Time:	00:39	0054	01:08

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap.
Underside: Approximately 40 cm up from the leading edge stagnation point.

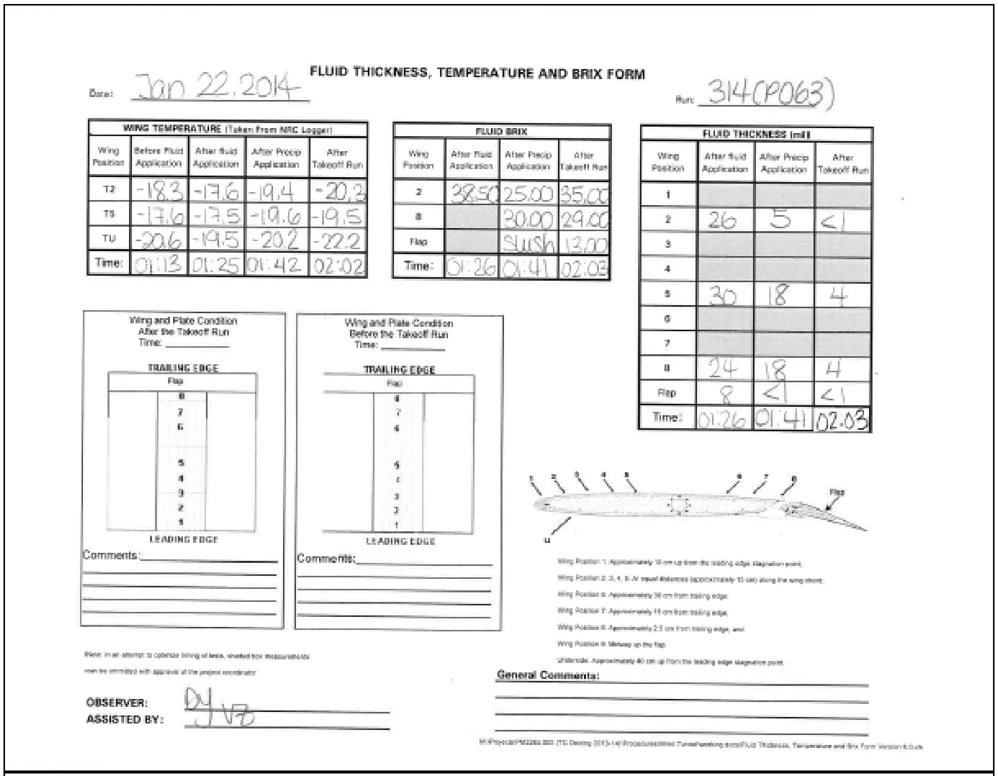
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: JP

General Comments: ________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\Working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C24: Test # 313



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 22, 2014

Run: 314(P063)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-18.3	-17.6	-19.4	-20.3
T5	-17.6	-17.5	-19.6	-19.5
TU	-20.6	-19.5	-20.2	-22.2
Time:	01:13	01:25	01:42	02:02

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	38.50	25.00	35.00
8	▨	30.00	29.00
Flap	▨	Slush	13.00
Time:	01:26	01:41	02:03

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	26	5	<1
3	▨	▨	▨
4	▨	▨	▨
5	30	18	4
6	▨	▨	▨
7	▨	▨	▨
8	24	18	4
Flap	8	<1	<1
Time:	01:26	01:41	02:03

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 10 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

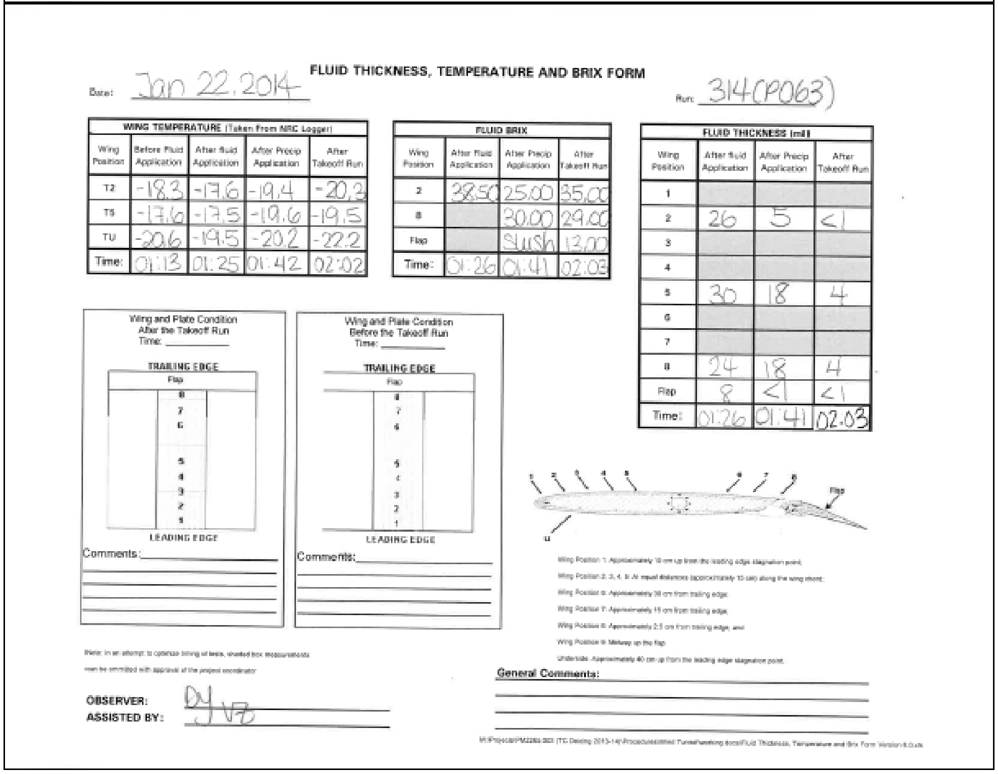
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY

ASSISTED BY: VB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 22, 2014

Run: 314(P063)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-18.3	-17.6	-19.4	-20.3
T5	-17.6	-17.5	-19.6	-19.5
TU	-20.6	-19.5	-20.2	-22.2
Time:	01:13	01:25	01:42	02:02

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	38.50	25.00	35.00
8	▨	30.00	29.00
Flap	▨	Slush	13.00
Time:	01:26	01:41	02:03

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	26	5	<1
3	▨	▨	▨
4	▨	▨	▨
5	30	18	4
6	▨	▨	▨
7	▨	▨	▨
8	24	18	4
Flap	8	<1	<1
Time:	01:26	01:41	02:03

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 10 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

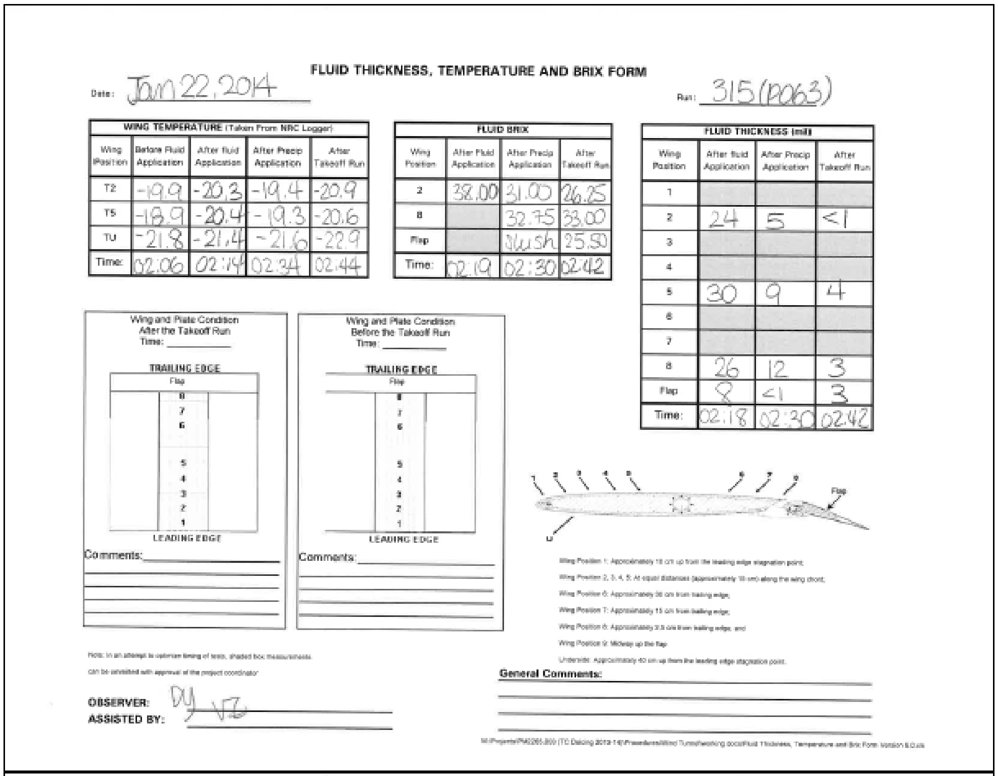
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY

ASSISTED BY: VB

Figure C25: Test # 314



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 22, 2014

Run: 315 (P063)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-19.9	-20.3	-19.4	-20.9
T5	-18.9	-20.4	-19.3	-20.6
TU	-21.8	-21.4	-21.6	-22.9
Time:	02:06	02:14	02:34	02:44

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	38.00	31.00	26.25
8	▨	32.75	33.00
Flap	▨	Slush	25.50
Time:	02:19	02:30	02:42

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	24	5	<1
3	▨	▨	▨
4	▨	▨	▨
5	30	9	4
6	▨	▨	▨
7	▨	▨	▨
8	26	12	3
Flap	8	<1	3
Time:	02:18	02:30	02:42

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 3.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

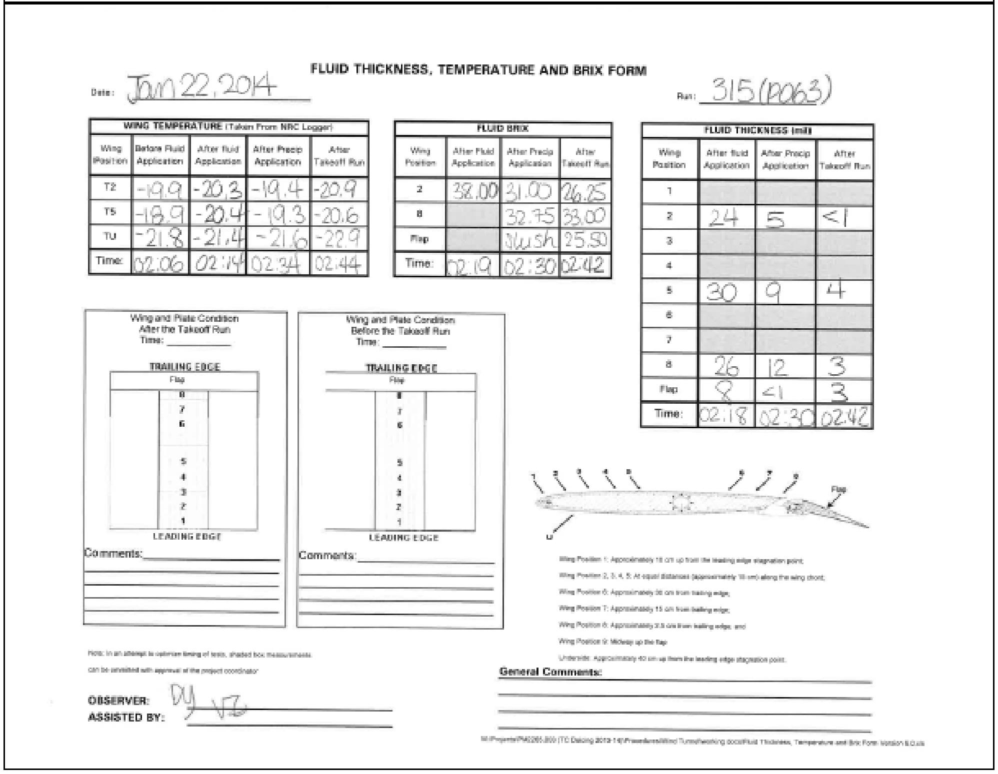
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY VZ
ASSISTED BY: ____________

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 22, 2014

Run: 315 (P063)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-19.9	-20.3	-19.4	-20.9
T5	-18.9	-20.4	-19.3	-20.6
TU	-21.8	-21.4	-21.6	-22.9
Time:	02:06	02:14	02:34	02:44

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	38.00	31.00	26.25
8	▨	32.75	33.00
Flap	▨	Slush	25.50
Time:	02:19	02:30	02:42

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	24	5	<1
3	▨	▨	▨
4	▨	▨	▨
5	30	9	4
6	▨	▨	▨
7	▨	▨	▨
8	26	12	3
Flap	8	<1	3
Time:	02:18	02:30	02:42

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 3.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

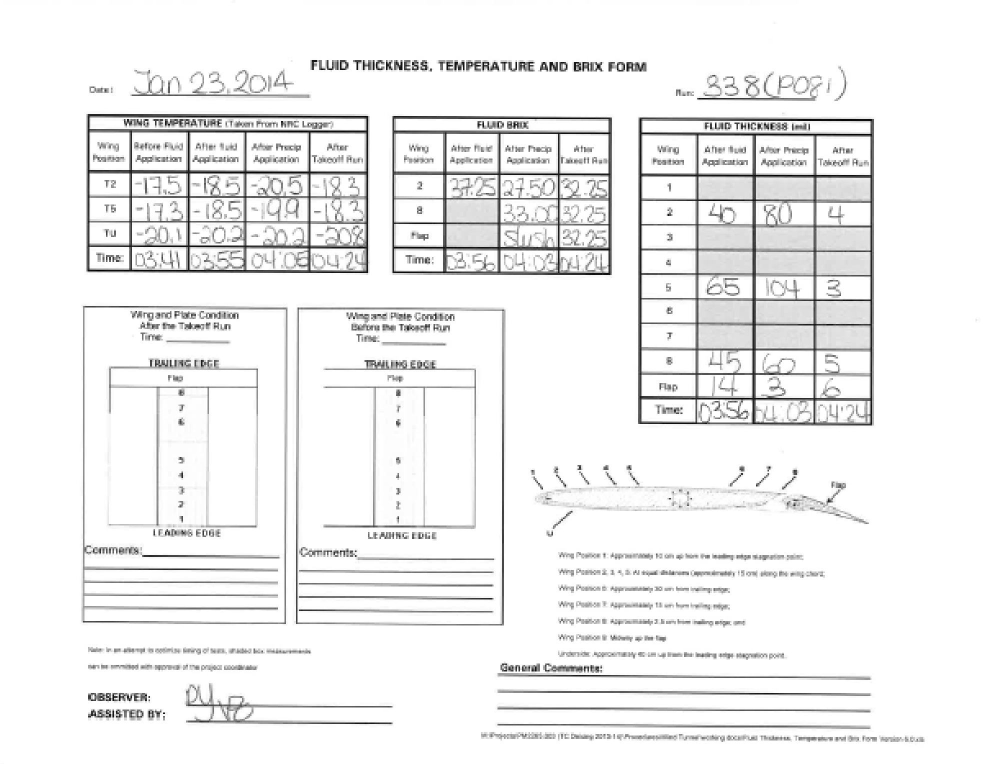
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY VZ
ASSISTED BY: ____________

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C26: Test # 315



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 23, 2014

Run: 338(P081)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-17.5	-18.5	-20.5	-18.3
T5	-17.3	-18.5	-19.9	-18.3
TU	-20.1	-20.2	-20.2	-20.8
Time:	03:41	03:55	04:05	04:24

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	37.25	27.50	32.25
8		33.00	32.25
Flap		Slush	32.25
Time:	03:56	04:03	04:24

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	40	80	4
3			
4			
5	65	104	3
6			
7			
8	45	60	5
Flap	14	3	6
Time:	03:56	04:03	04:24

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

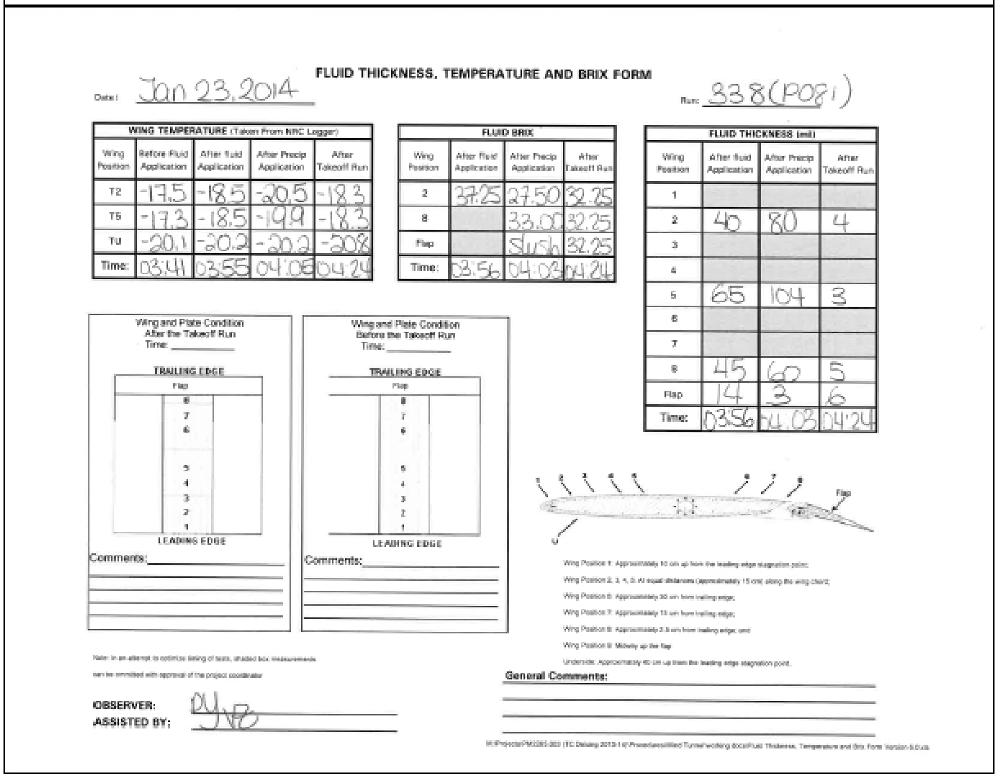
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 3.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommited with approval of the project coordinator

General Comments: ____________

OBSERVER:
ASSISTED BY:

H:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 23, 2014

Run: 338(P081)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-17.5	-18.5	-20.5	-18.3
T5	-17.3	-18.5	-19.9	-18.3
TU	-20.1	-20.2	-20.2	-20.8
Time:	03:41	03:55	04:05	04:24

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	37.25	27.50	32.25
8		33.00	32.25
Flap		Slush	32.25
Time:	03:56	04:03	04:24

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	40	80	4
3			
4			
5	65	104	3
6			
7			
8	45	60	5
Flap	14	3	6
Time:	03:56	04:03	04:24

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 3.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

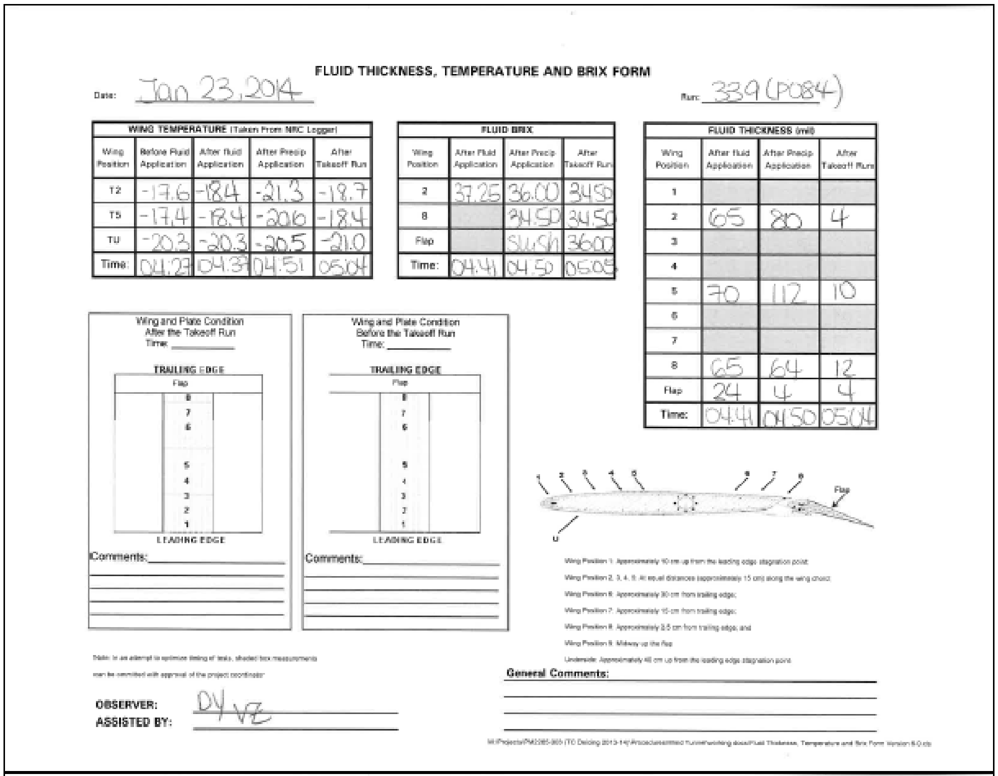
Note: In an attempt to optimize timing of tests, shaded box measurements can be ommited with approval of the project coordinator

General Comments: ____________

OBSERVER:
ASSISTED BY:

H:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls

Figure C27: Test # 338



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 23, 2014

Run: 339 (P084)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-17.6	-18.4	-21.3	-18.7
T5	-17.4	-18.4	-20.6	-18.4
TU	-20.3	-20.3	-20.5	-21.0
Time:	04:27	04:37	04:51	05:04

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.25	36.00	34.50
8		34.50	34.50
Flap		Slush	36.00
Time:	04:41	04:50	05:05

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	65	80	4
3			
4			
5	70	112	10
6			
7			
8	65	64	12
Flap	24	4	4
Time:	04:41	04:50	05:04

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

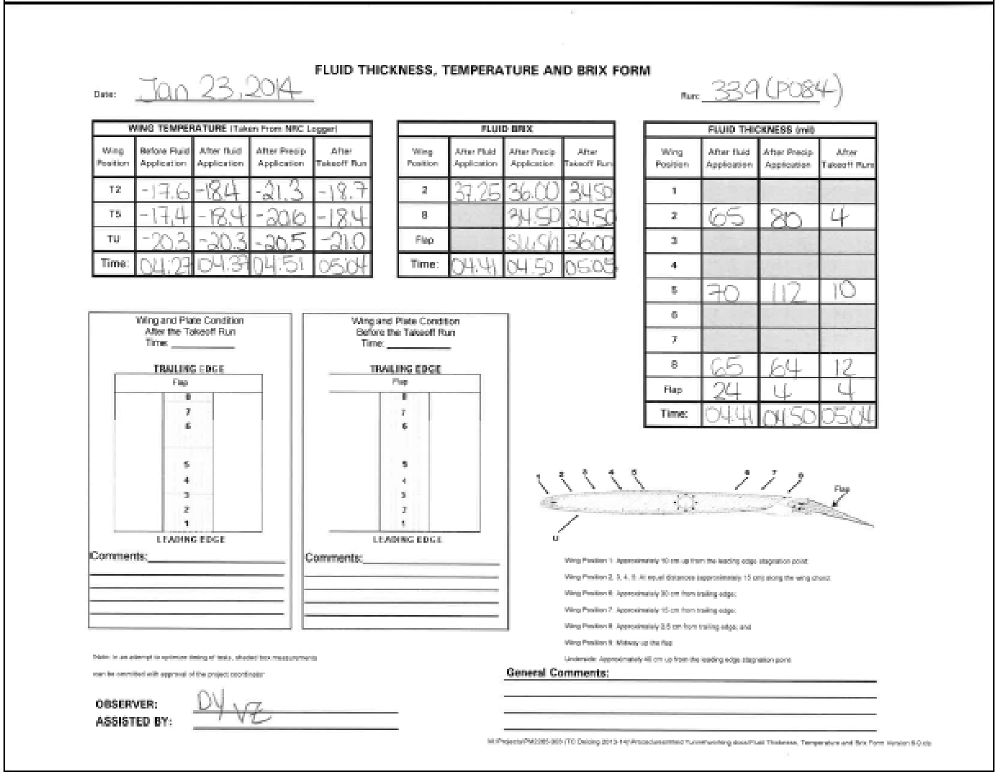
Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY
ASSISTED BY: VZ



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 23, 2014

Run: 339 (P084)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-17.6	-18.4	-21.3	-18.7
T5	-17.4	-18.4	-20.6	-18.4
TU	-20.3	-20.3	-20.5	-21.0
Time:	04:27	04:37	04:51	05:04

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.25	36.00	34.50
8		34.50	34.50
Flap		Slush	36.00
Time:	04:41	04:50	05:05

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	65	80	4
3			
4			
5	70	112	10
6			
7			
8	65	64	12
Flap	24	4	4
Time:	04:41	04:50	05:04

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

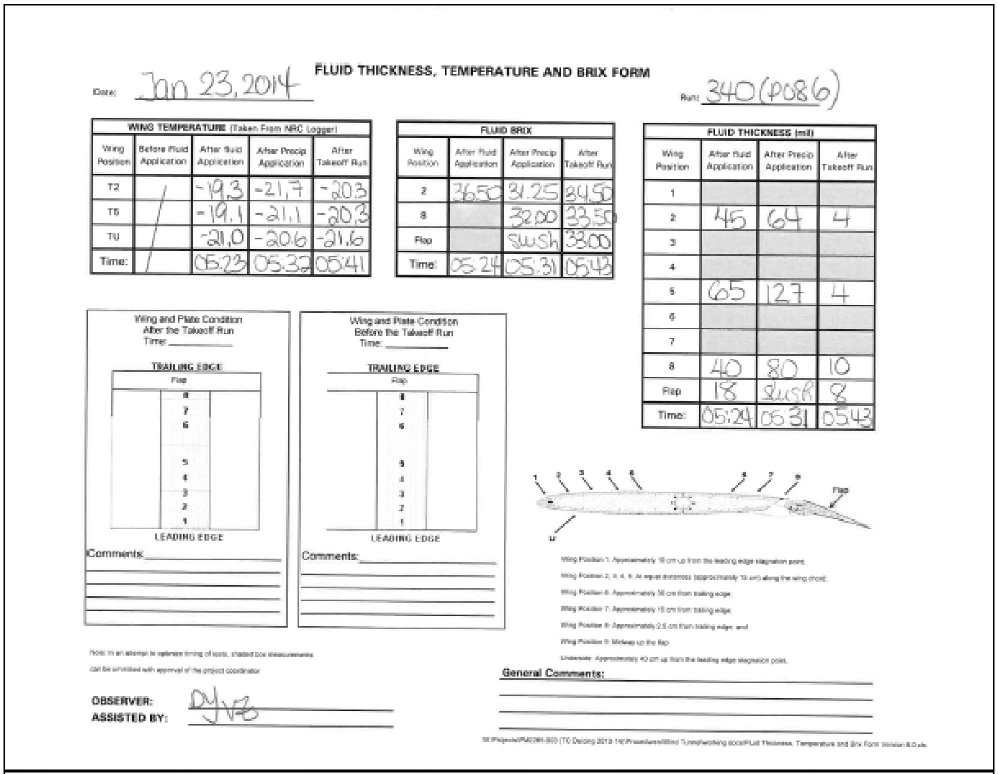
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY
ASSISTED BY: VZ

Figure C28: Test # 339



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 23, 2014

Run: 340 (P086)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-19.3	-21.7	-20.3
T5	/	-19.1	-21.1	-20.3
TU	/	-21.0	-20.6	-21.6
Time:	/	05:23	05:32	05:41

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	31.25	34.50
8		32.00	33.50
Flap		Slush	33.00
Time:	05:24	05:31	05:43

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	45	64	4
3			
4			
5	65	127	4
6			
7			
8	40	80	10
Flap	18	slush	8
Time:	05:24	05:31	05:43

Wing and Plate Condition
After the Takeoff Run
Time: __________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: __________

Wing and Plate Condition
Before the Takeoff Run
Time: __________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: __________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

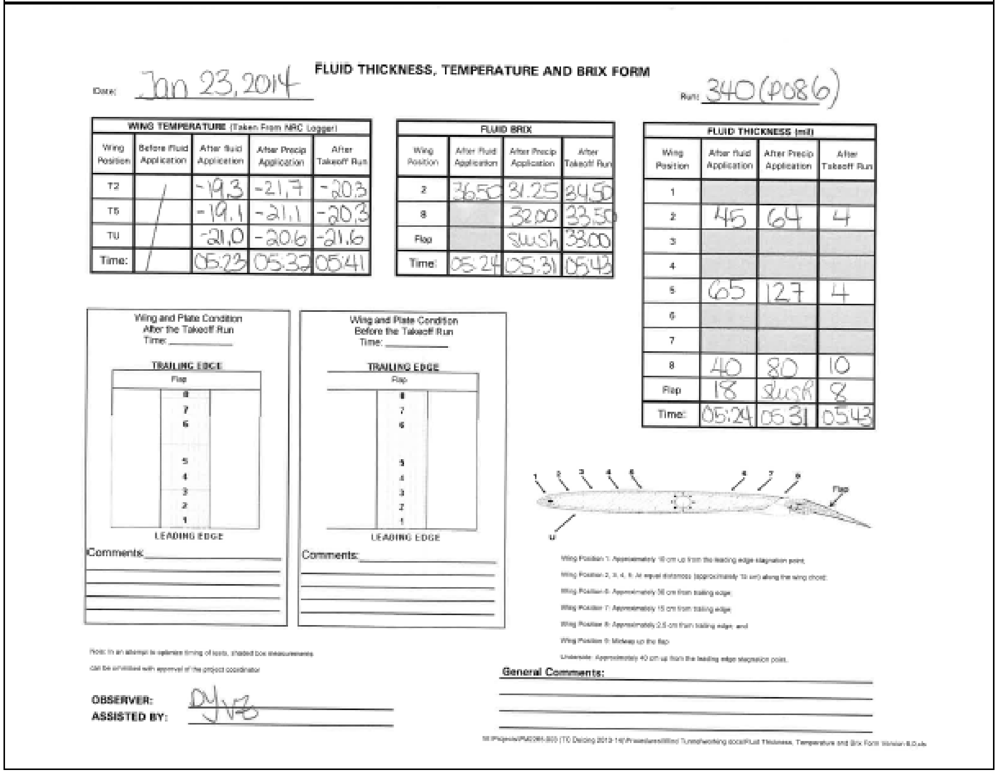
Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be eliminated with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: JVB

General Comments: __________



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 23, 2014

Run: 340 (P086)

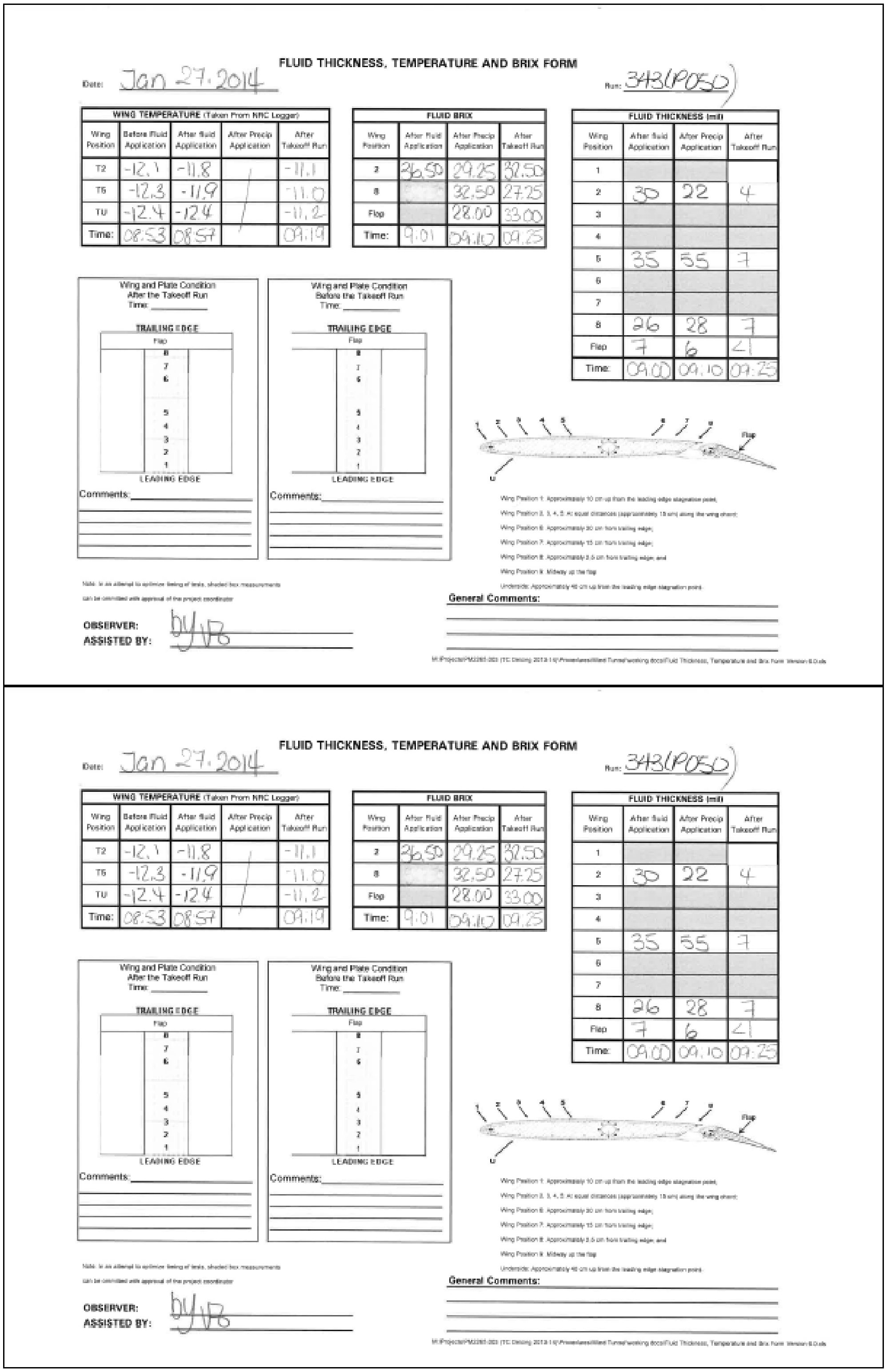
WING TEMPERATURE (Taken From NRC Logger)
T2 / -19.3 -21.7 -20.3
T5 / -19.1 -21.1 -20.3
TU / -21.0 -20.6 -21.6
Time: / 05:23 05:32 05:41

FLUID BRIX
2 36.50 31.25 34.50
8 32.00 33.50
Flap Slush 33.00
Time: 05:24 05:31 05:43

FLUID THICKNESS (mil)
2 45 64 4
5 65 127 4
8 40 80 10
Flap 18 slush 8
Time: 05:24 05:31 05:43

OBSERVER: DY
ASSISTED BY: JVB

Figure C29: Test # 340



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27.2014

Run: 343(P050)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-12.1	-11.8	/	-11.1
T6	-12.3	-11.9	/	-11.0
TU	-12.4	-12.4	/	-11.2
Time:	08:53	08:57		09:19

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	26.50	29.25	32.50
8	▨	32.50	27.25
Flap	▨	28.00	33.00
Time:	9:01	09:10	09:25

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	
2	30	22	4
3	▨	▨	▨
4	▨	▨	▨
5	35	55	7
6	▨	▨	▨
7	▨	▨	▨
8	26	28	7
Flap	7	6	<1
Time:	09:00	09:10	09:25

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 3.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be conducted with approval of the project coordinator

General Comments: ________

OBSERVER: bY
ASSISTED BY: VB

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27.2014

Run: 343(P050)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-12.1	-11.8	/	-11.1
T6	-12.3	-11.9	/	-11.0
TU	-12.4	-12.4	/	-11.2
Time:	08:53	08:57		09:19

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	26.50	29.25	32.50
8	▨	32.50	27.25
Flap	▨	28.00	33.00
Time:	9:01	09:10	09:25

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	
2	30	22	4
3	▨	▨	▨
4	▨	▨	▨
5	35	55	7
6	▨	▨	▨
7	▨	▨	▨
8	26	28	7
Flap	7	6	<1
Time:	09:00	09:10	09:25

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 3.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

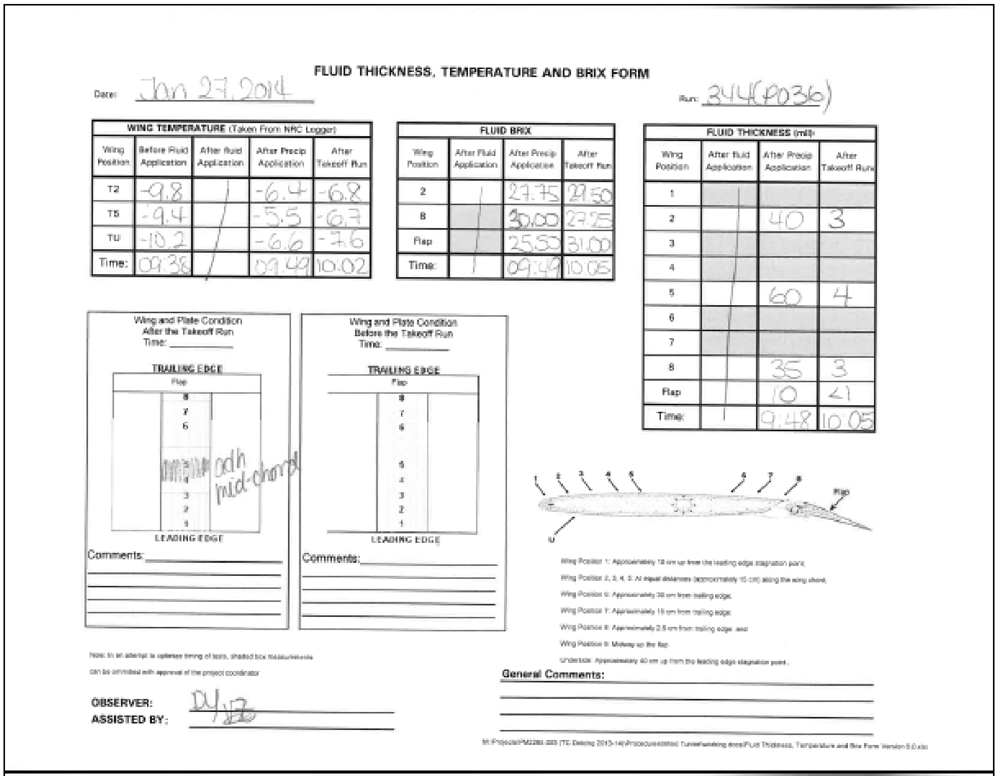
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be conducted with approval of the project coordinator

General Comments: ________

OBSERVER: bY
ASSISTED BY: VB

Figure C30: Test #343



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 344(P036)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.8		-6.4	-6.8
T5	-9.4		-5.5	-6.7
TU	-10.2		-6.6	-7.6
Time:	09:38		09:49	10:02

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		27.75	29.50
8		30.00	27.25
Flap		25.50	31.00
Time:		09:49	10:05

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		40	3
3			
4			
5		60	4
6			
7			
8		35	3
Flap		10	<1
Time:		9:48	10:05

Wing and Plate Condition
After the Takeoff Run
Time: ___________

odh mid-chord

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

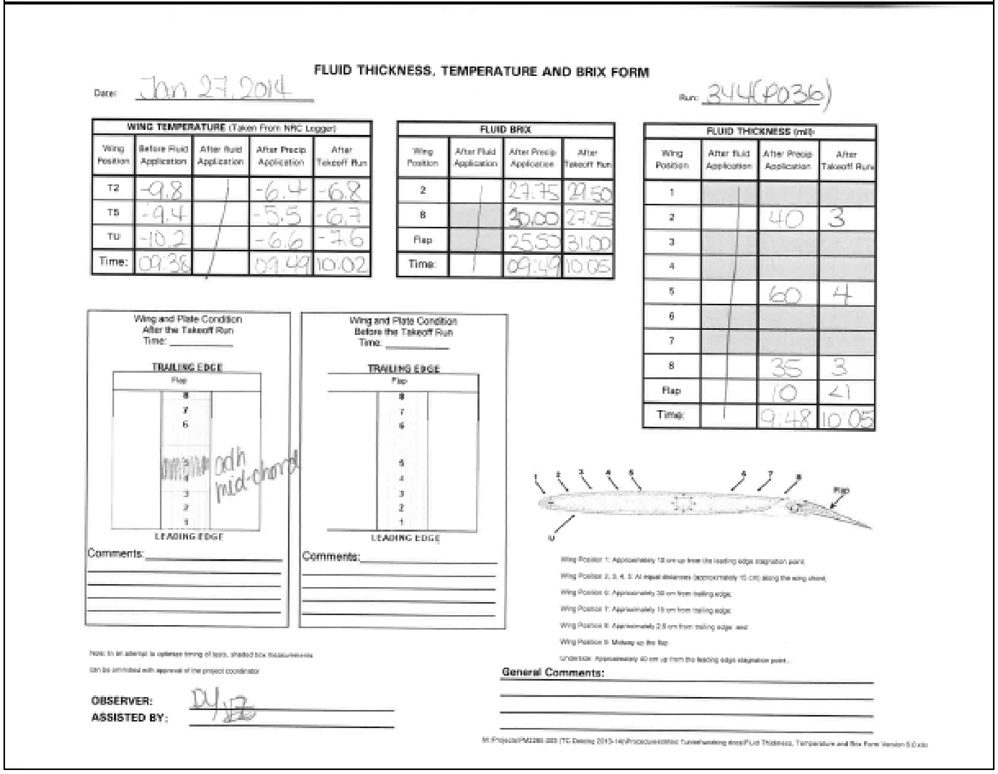
Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DY, JB
ASSISTED BY: ___________



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 344(P036)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.8		-6.4	-6.8
T5	-9.4		-5.5	-6.7
TU	-10.2		-6.6	-7.6
Time:	09:38		09:49	10:02

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		27.75	29.50
8		30.00	27.25
Flap		25.50	31.00
Time:		09:49	10:05

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		40	3
3			
4			
5		60	4
6			
7			
8		35	3
Flap		10	<1
Time:		9:48	10:05

Wing and Plate Condition
After the Takeoff Run
Time: ___________

odh mid-chord

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

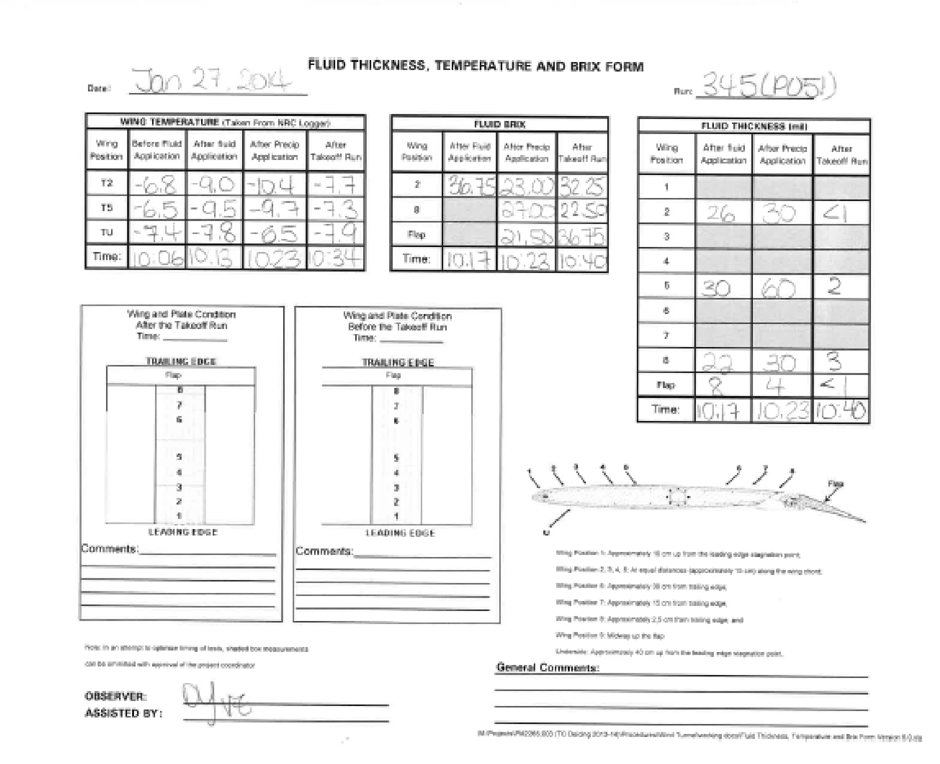
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DY, JB
ASSISTED BY: ___________

Figure C31: Test # 344



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 345(P051)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-6.8	-9.0	-10.4	-7.7
T5	-6.5	-9.5	-9.7	-7.3
TU	-7.4	-7.8	-6.5	-7.9
Time:	10:06	10:13	10:23	10:34

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.75	23.00	32.25
8		27.00	22.50
Flap		21.50	36.75
Time:	10:17	10:23	10:40

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	26	30	<1
3			
4			
5	30	60	2
6			
7			
8	22	30	3
Flap	8	4	<1
Time:	10:17	10:23	10:40

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point,

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord,

Wing Position 6: Approximately 38 cm from trailing edge,

Wing Position 7: Approximately 15 cm from trailing edge,

Wing Position 8: Approximately 2.5 cm from trailing edge, and

Wing Position 9: Midway up the flap

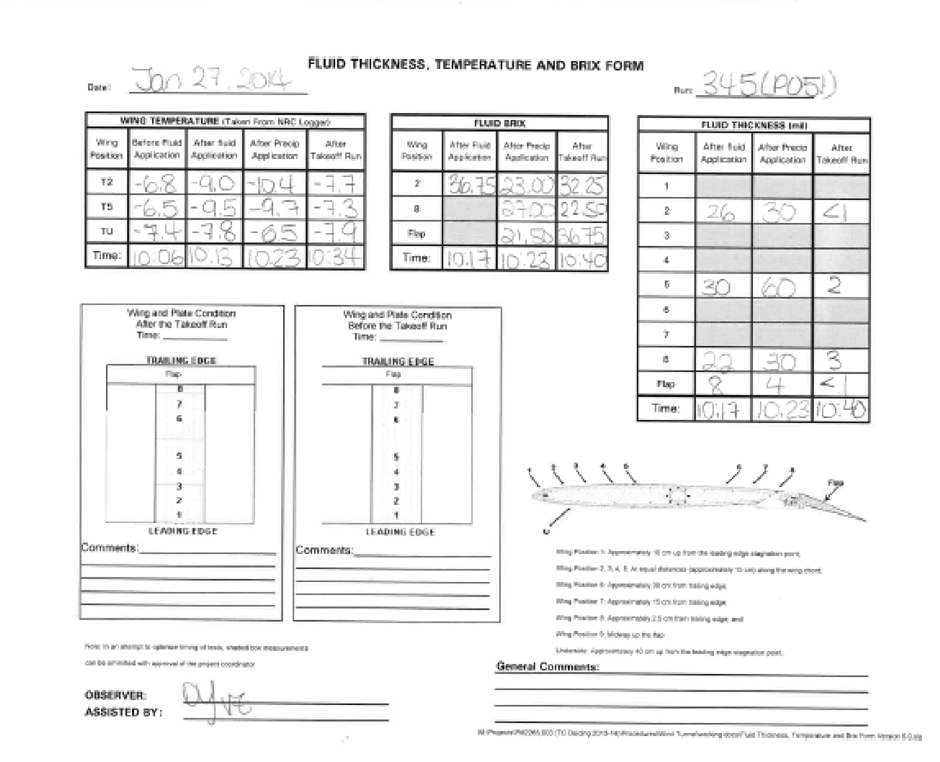
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER:
ASSISTED BY:

General Comments:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 345(P051)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-6.8	-9.0	-10.4	-7.7
T5	-6.5	-9.5	-9.7	-7.3
TU	-7.4	-7.8	-6.5	-7.9
Time:	10:06	10:13	10:23	10:34

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.75	23.00	32.25
8		27.00	22.50
Flap		21.50	36.75
Time:	10:17	10:23	10:40

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	26	30	<1
3			
4			
5	30	60	2
6			
7			
8	22	30	3
Flap	8	4	<1
Time:	10:17	10:23	10:40

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point,

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord,

Wing Position 6: Approximately 38 cm from trailing edge,

Wing Position 7: Approximately 15 cm from trailing edge,

Wing Position 8: Approximately 2.5 cm from trailing edge, and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

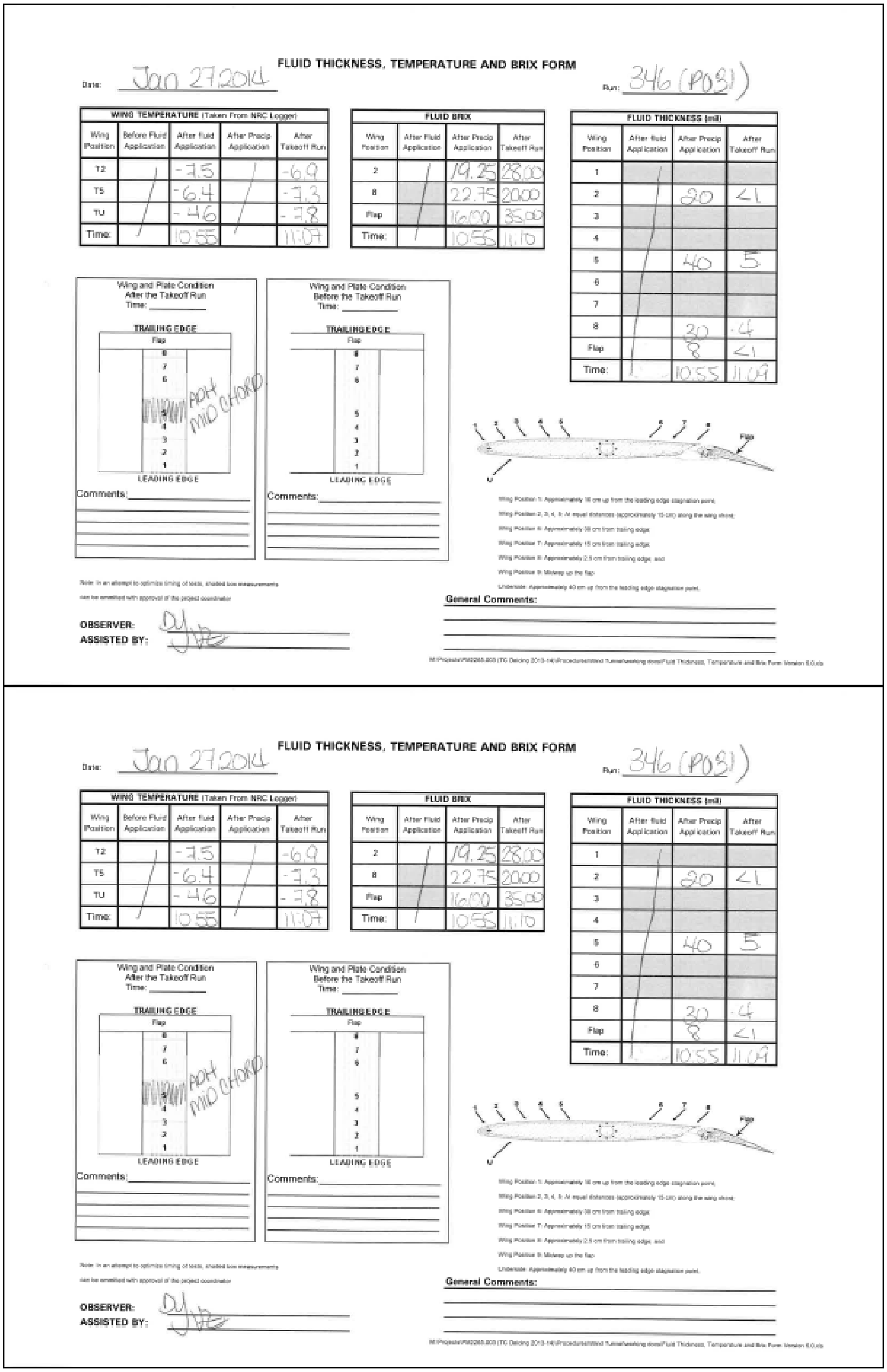
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER:
ASSISTED BY:

General Comments:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls

Figure C32: Test # 345



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27,2014

Run: 346 (P031)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-7.5	/	-6.9
T5	/	-6.4	/	-7.3
TU	/	-4.6	/	-7.8
Time:	/	10:55	/	11:07

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	19.25	28.00
8	/	22.75	20.00
Flap	/	16.00	35.00
Time:	/	10:55	11:10

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2	/	20	<1
3	/		
4	/		
5	/	40	5
6	/		
7	/		
8	/	20	4
Flap	/	8	<1
Time:	/	10:55	11:09

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

ADH MID CHORD

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 38 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY

ASSISTED BY:

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27,2014

Run: 346 (P031)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-7.5	/	-6.9
T5	/	-6.4	/	-7.3
TU	/	-4.6	/	-7.8
Time:	/	10:55	/	11:07

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	19.25	28.00
8	/	22.75	20.00
Flap	/	16.00	35.00
Time:	/	10:55	11:10

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2	/	20	<1
3	/		
4	/		
5	/	40	5
6	/		
7	/		
8	/	20	4
Flap	/	8	<1
Time:	/	10:55	11:09

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

ADH MID CHORD

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 38 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

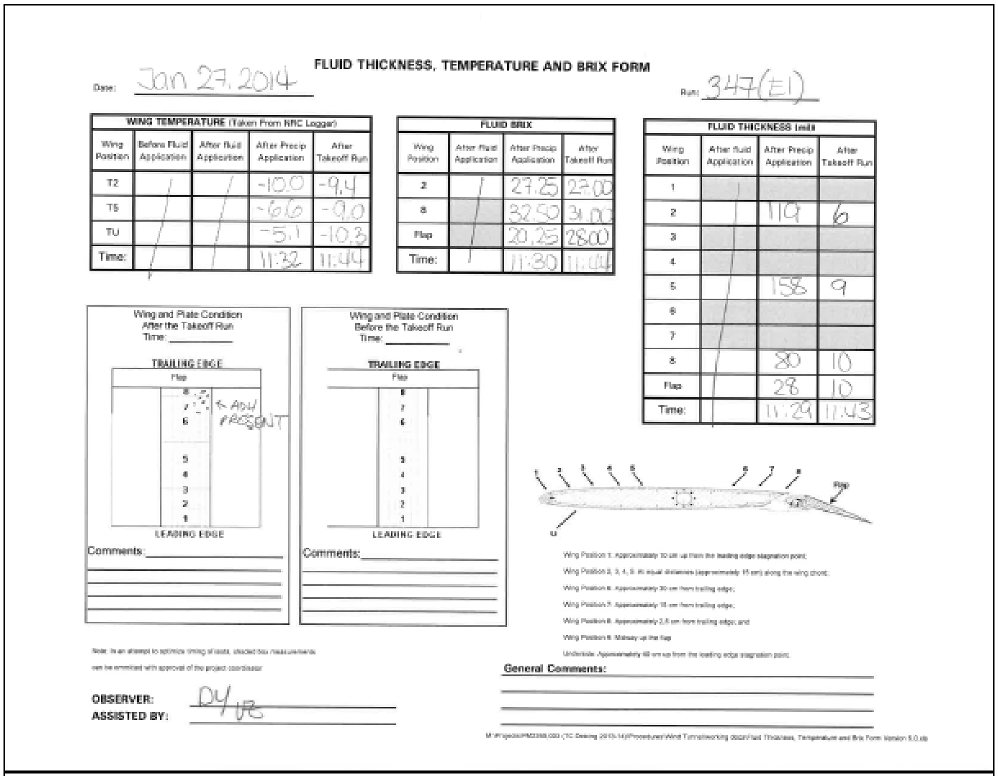
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY

ASSISTED BY:

Figure C33: Test # 346



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 347(E1)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	/	-10.0	-9.4
T5	/	/	-6.6	-9.0
TU	/	/	-5.1	-10.3
Time:	/	/	11:32	11:44

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	/	27.25	27.00
8	▨ /	32.50	31.00
Flap	▨ /	20.25	28.00
Time:	/	11:30	11:44

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨ /	▨	▨
2	/	119	6
3	▨ /	▨	▨
4	▨ /	▨	▨
5	/	158	9
6	▨ /	▨	▨
7	▨ /	▨	▨
8	/	80	10
Flap	/	28	10
Time:	/	11:29	11:43

Wing and Plate Condition
After the Takeoff Run
Time: ____

TRAILING EDGE
Flap
8
7 ← ADH PRESENT
6
5
4
3
2
1
LEADING EDGE

Comments: ____

Wing and Plate Condition
Before the Takeoff Run
Time: ____

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

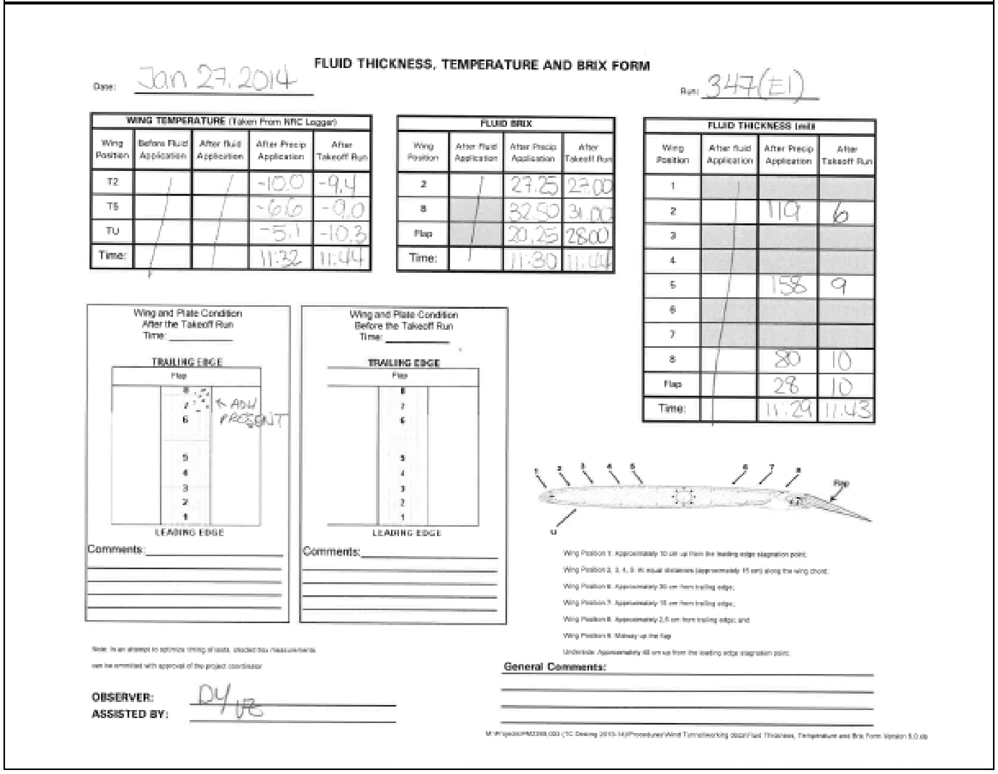
Comments: ____

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ____

OBSERVER: DY
ASSISTED BY: VB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 347(E1)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	/	-10.0	-9.4
T5	/	/	-6.6	-9.0
TU	/	/	-5.1	-10.3
Time:	/	/	11:32	11:44

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	/	27.25	27.00
8	▨ /	32.50	31.00
Flap	▨ /	20.25	28.00
Time:	/	11:30	11:44

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨ /	▨	▨
2	/	119	6
3	▨ /	▨	▨
4	▨ /	▨	▨
5	/	158	9
6	▨ /	▨	▨
7	▨ /	▨	▨
8	/	80	10
Flap	/	28	10
Time:	/	11:29	11:43

Wing and Plate Condition
After the Takeoff Run
Time: ____

TRAILING EDGE
Flap
8
7 ← ADH PRESENT
6
5
4
3
2
1
LEADING EDGE

Comments: ____

Wing and Plate Condition
Before the Takeoff Run
Time: ____

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____

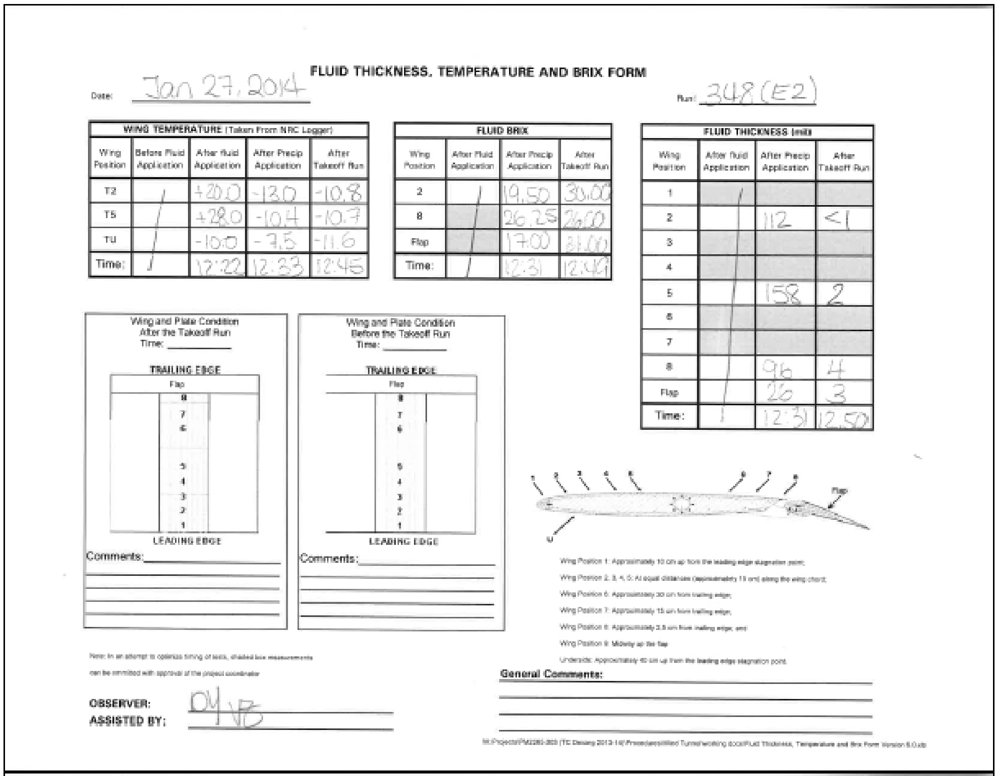
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ____

OBSERVER: DY
ASSISTED BY: VB

Figure C34: Test # 347



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 348 (E2)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		+20.0	-13.0	-10.8
T5		+28.0	-10.4	-10.7
TU		-10.0	-7.5	-11.6
Time:		12:22	12:33	12:45

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		19.50	30.00
8		26.25	26.00
Flap		17.00	31.00
Time:		12:31	12:49

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		112	<1
3			
4			
5		158	2
6			
7			
8		96	4
Flap		26	3
Time:		12:31	12:50

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

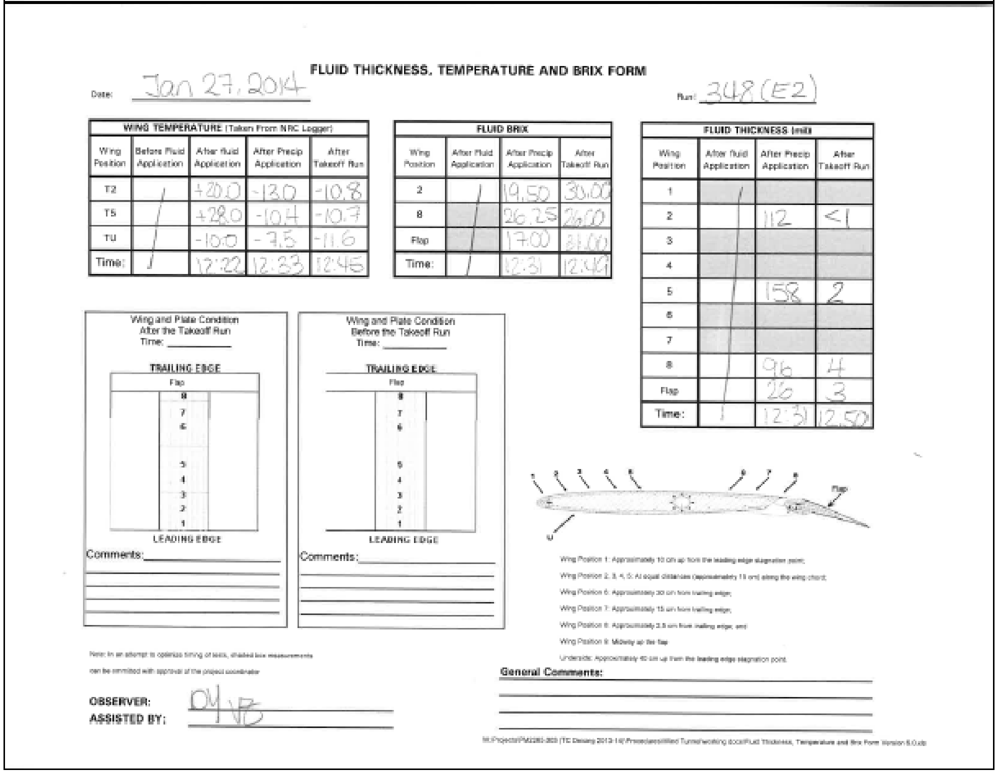
Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 3.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: VB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 348 (E2)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		+20.0	-13.0	-10.8
T5		+28.0	-10.4	-10.7
TU		-10.0	-7.5	-11.6
Time:		12:22	12:33	12:45

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2		19.50	30.00
8		26.25	26.00
Flap		17.00	31.00
Time:		12:31	12:49

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2		112	<1
3			
4			
5		158	2
6			
7			
8		96	4
Flap		26	3
Time:		12:31	12:50

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8 7 6 5 4 3 2 1
LEADING EDGE

Comments:

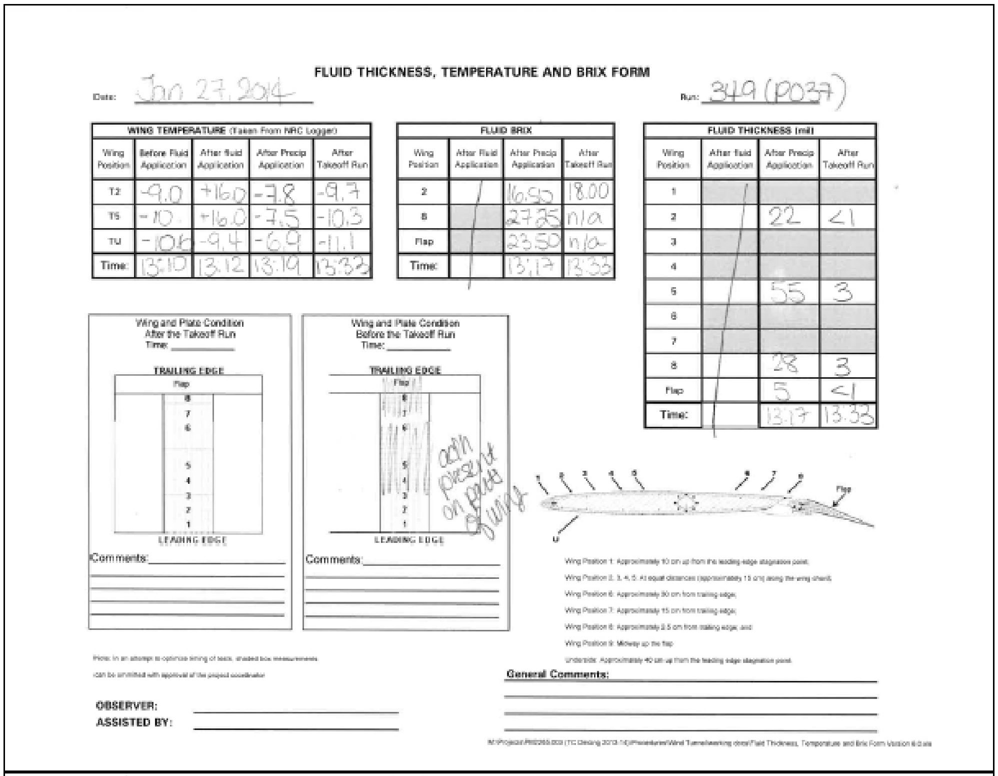
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 3.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: VB

Figure C35: Test # 348



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 349 (P037)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.0	+16.0	-7.8	-9.7
T5	-10.	+16.0	-7.5	-10.3
TU	-10.6	-9.4	-6.9	-11.1
Time:	13:10	13:12	13:19	13:32

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	/	16.50	18.00
8		27.25	n/a
Flap		23.50	n/a
Time:		13:17	13:33

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2		22	<1
3			
4			
5		55	3
6			
7			
8		28	3
Flap		5	<1
Time:		13:17	13:33

Wing and Plate Condition
After the Takeoff Run
Time: ___________

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

adh present on parts of wing

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

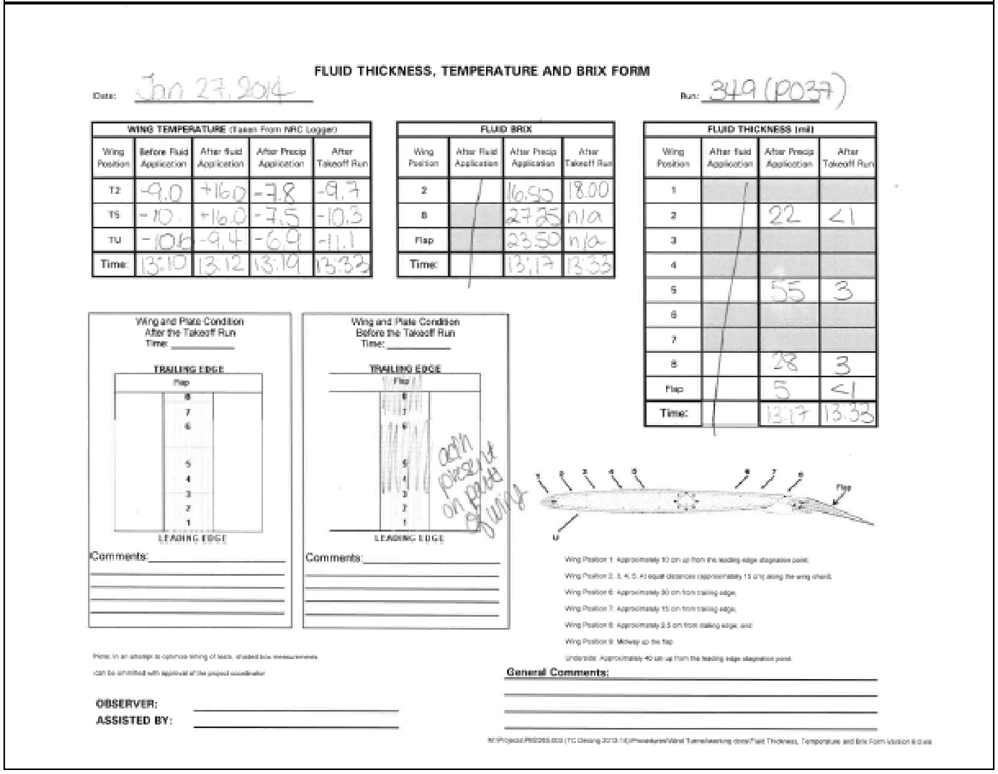
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ___________

OBSERVER: ___________

ASSISTED BY: ___________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 349 (P037)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.0	+16.0	-7.8	-9.7
T5	-10.	+16.0	-7.5	-10.3
TU	-10.6	-9.4	-6.9	-11.1
Time:	13:10	13:12	13:19	13:32

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	/	16.50	18.00
8		27.25	n/a
Flap		23.50	n/a
Time:		13:17	13:33

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2		22	<1
3			
4			
5		55	3
6			
7			
8		28	3
Flap		5	<1
Time:		13:17	13:33

Wing and Plate Condition
After the Takeoff Run
Time: ___________

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

adh present on parts of wing

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

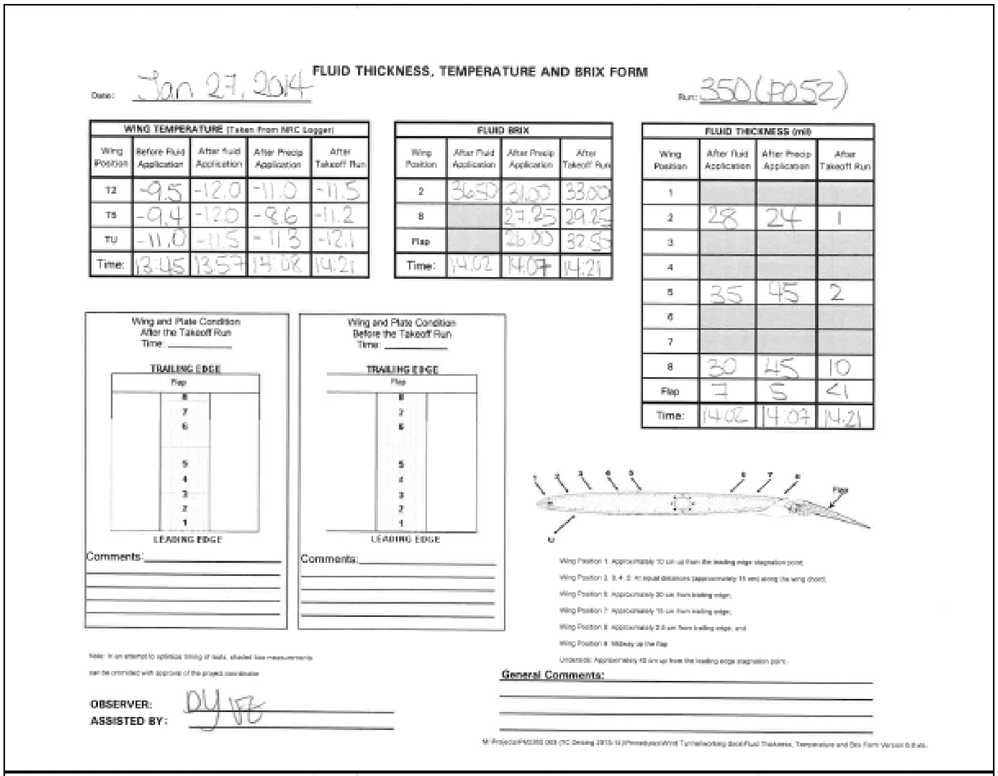
General Comments: ___________

OBSERVER: ___________

ASSISTED BY: ___________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C36: Test # 349



Date: Jan 27, 2014

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Run: 350 (P052)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.5	-12.0	-11.0	-11.5
T5	-9.4	-12.0	-8.6	-11.2
TU	-11.0	-11.5	-11.3	-12.1
Time:	13:45	13:57	14:08	14:21

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	31.00	33.00
8	▨	27.25	29.25
Flap	▨	26.00	32.5
Time:	14:02	14:07	14:21

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	28	24	1
3	▨	▨	▨
4	▨	▨	▨
5	35	45	2
6	▨	▨	▨
7	▨	▨	▨
8	30	45	10
Flap	7	5	<1
Time:	14:02	14:07	14:21

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE

LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE

LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 8: Midway up the flap

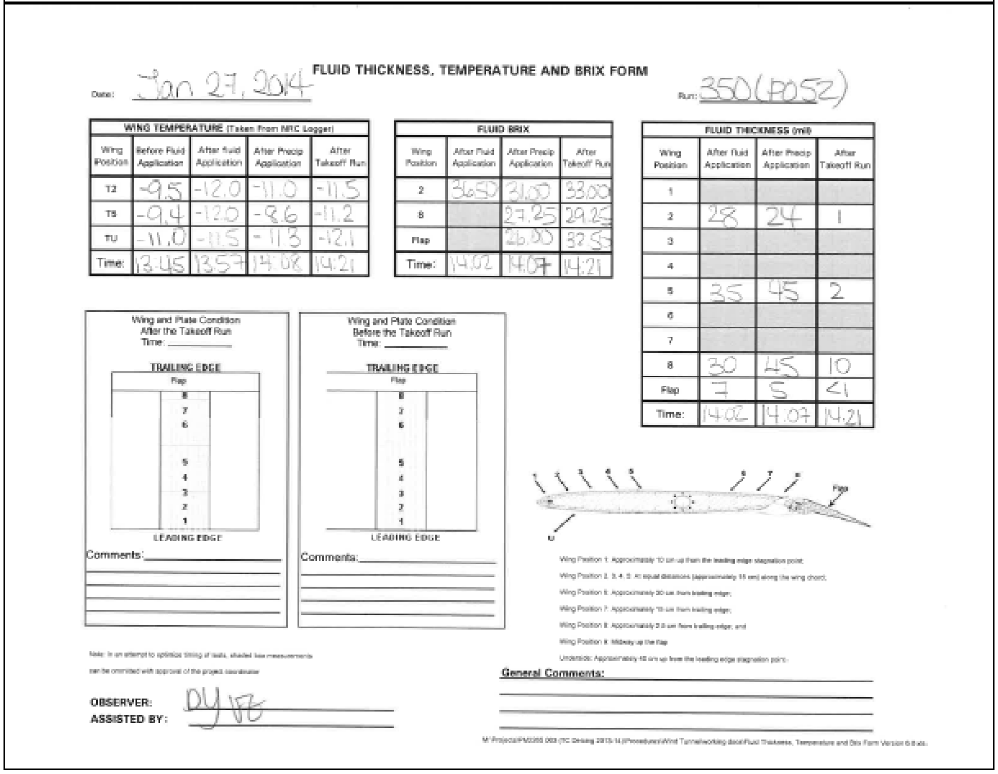
Underside: Approximately 10 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DY VB
ASSISTED BY:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



Date: Jan 27, 2014

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Run: 350 (P052)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.5	-12.0	-11.0	-11.5
T5	-9.4	-12.0	-8.6	-11.2
TU	-11.0	-11.5	-11.3	-12.1
Time:	13:45	13:57	14:08	14:21

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.50	31.00	33.00
8	▨	27.25	29.25
Flap	▨	26.00	32.5
Time:	14:02	14:07	14:21

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	28	24	1
3	▨	▨	▨
4	▨	▨	▨
5	35	45	2
6	▨	▨	▨
7	▨	▨	▨
8	30	45	10
Flap	7	5	<1
Time:	14:02	14:07	14:21

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE

LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE

LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 8: Midway up the flap

Underside: Approximately 10 cm up from the leading edge stagnation point.

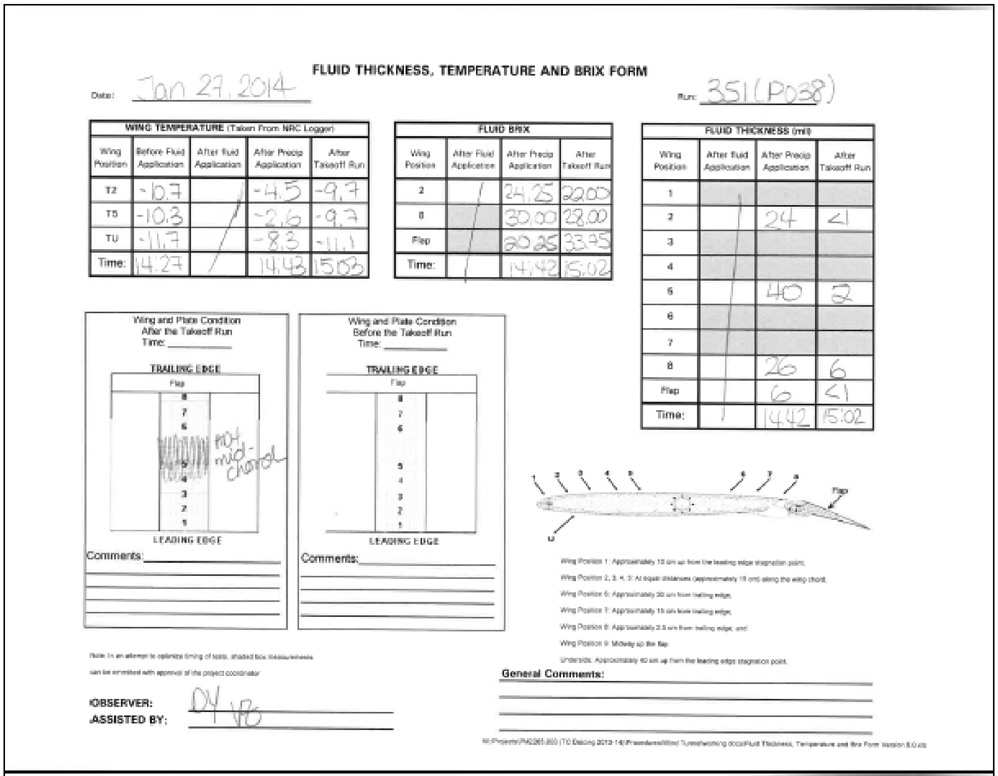
Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DY VB
ASSISTED BY:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls

Figure C37: Test # 350



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 351 (P038)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-10.7	/	-4.5	-9.7
T5	-10.3	/	-2.6	-9.7
TU	-11.7	/	-8.3	-11.1
Time:	14:27	/	14:43	15:03

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	24.25	22.00
8	/	30.00	28.00
Flap	/	30.25	33.75
Time:	/	14:42	15:02

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2	/	24	<1
3	/		
4	/		
5	/	40	2
6	/		
7	/		
8	/	26	6
Flap	/	6	<1
Time:	/	14:42	15:02

Wing and Plate Condition After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

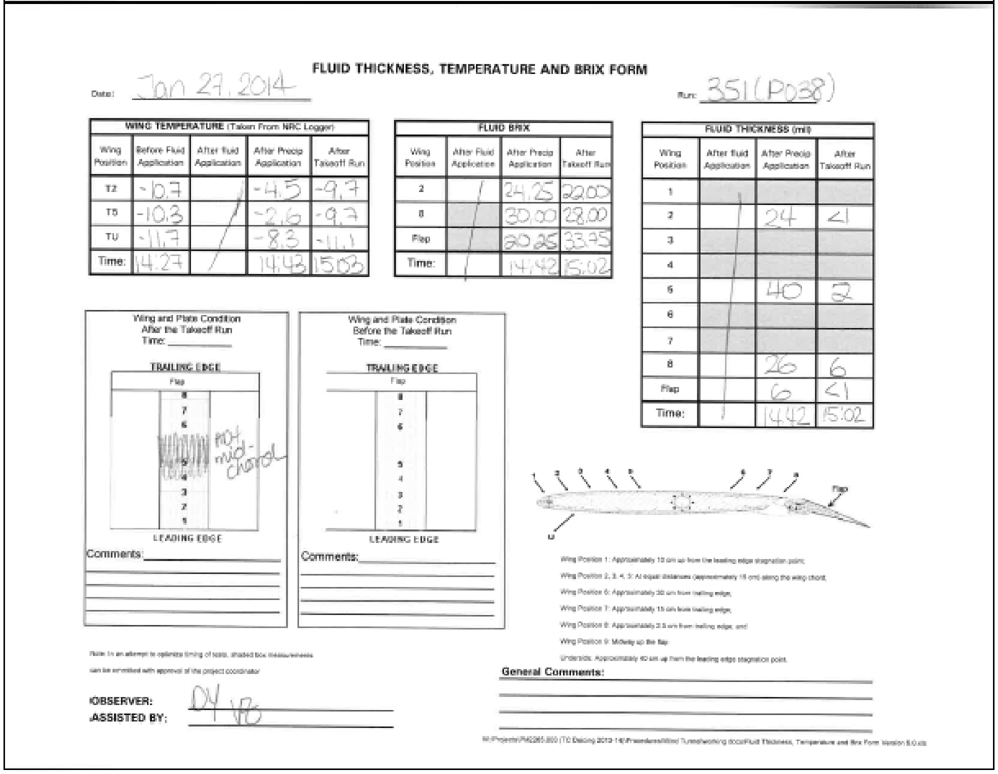
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: VB

H:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 351 (P038)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-10.7	/	-4.5	-9.7
T5	-10.3	/	-2.6	-9.7
TU	-11.7	/	-8.3	-11.1
Time:	14:27	/	14:43	15:03

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	24.25	22.00
8	/	30.00	28.00
Flap	/	30.25	33.75
Time:	/	14:42	15:02

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2	/	24	<1
3	/		
4	/		
5	/	40	2
6	/		
7	/		
8	/	26	6
Flap	/	6	<1
Time:	/	14:42	15:02

Wing and Plate Condition After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 40 cm up from the leading edge stagnation point.

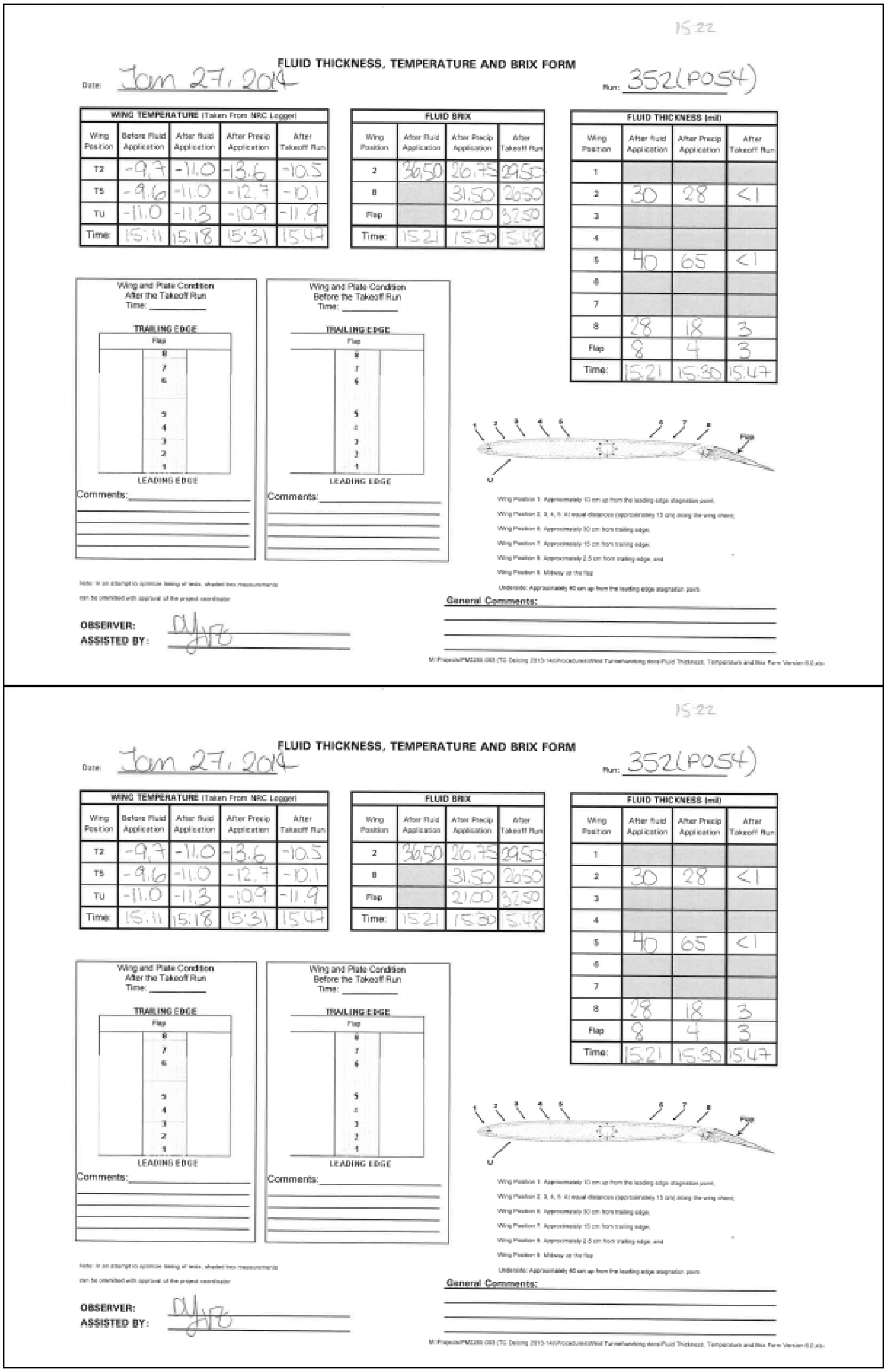
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY
ASSISTED BY: VB

H:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 8.0.xls

Figure C38: Test # 351



15:22

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 352(POS4)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.7	-11.0	-13.6	-10.5
T5	-9.6	-11.0	-12.7	-10.1
TU	-11.0	-11.3	-10.9	-11.9
Time:	15:11	15:18	15:31	15:47

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	36.50	26.75	29.50
8		31.50	26.50
Flap		21.00	32.50
Time:	15:21	15:30	15:48

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	30	28	<1
3			
4			
5	40	65	<1
6			
7			
8	28	18	3
Flap	8	4	3
Time:	15:21	15:30	15:47

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator.

General Comments: ____________

OBSERVER: ____________
ASSISTED BY: ____________

15:22

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27, 2014

Run: 352(POS4)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-9.7	-11.0	-13.6	-10.5
T5	-9.6	-11.0	-12.7	-10.1
TU	-11.0	-11.3	-10.9	-11.9
Time:	15:11	15:18	15:31	15:47

FLUID BRIX			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
2	36.50	26.75	29.50
8		31.50	26.50
Flap		21.00	32.50
Time:	15:21	15:30	15:48

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	30	28	<1
3			
4			
5	40	65	<1
6			
7			
8	28	18	3
Flap	8	4	3
Time:	15:21	15:30	15:47

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

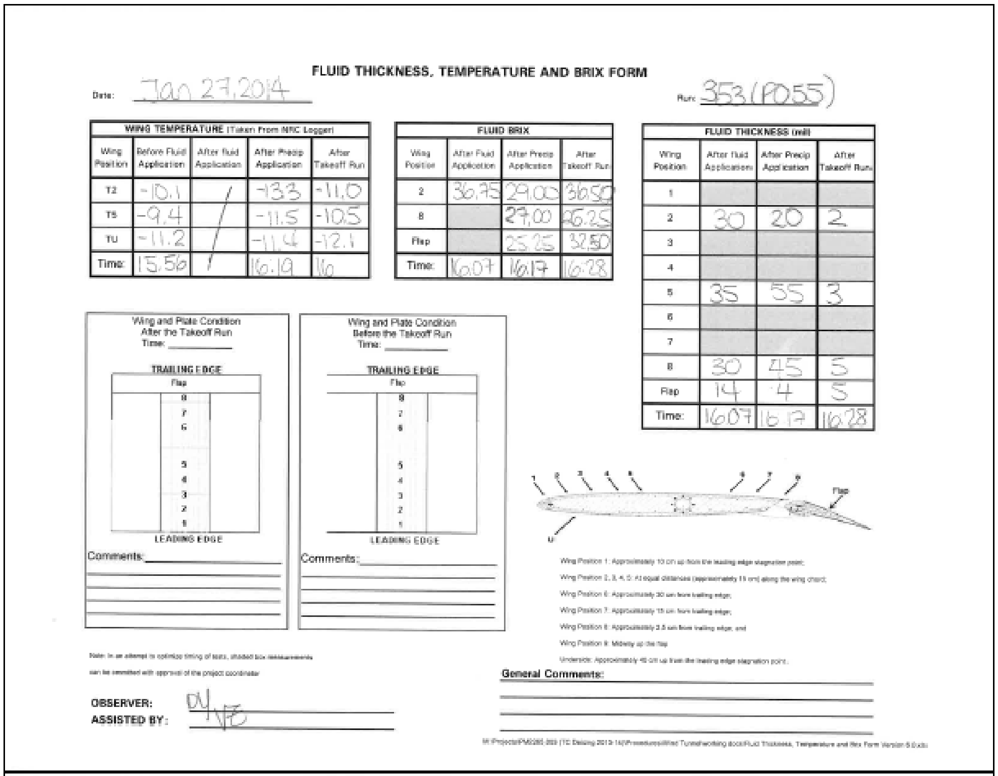
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator.

General Comments: ____________

OBSERVER: ____________
ASSISTED BY: ____________

Figure C39: Test # 352



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27,2014

Run: 353 (P055)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-10.1	/	-13.3	-11.0
T5	-9.4	/	-11.5	-10.5
TU	-11.2	/	-11.4	-12.1
Time:	15:56	/	16:19	16

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.75	29.00	36.50
8	▨	27.00	26.25
Flap	▨	25.25	32.50
Time:	16:07	16:17	16:28

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	20	2
3	▨	▨	▨
4	▨	▨	▨
5	35	55	3
6	▨	▨	▨
7	▨	▨	▨
8	30	45	5
Flap	14	4	5
Time:	1607	16 17	1628

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

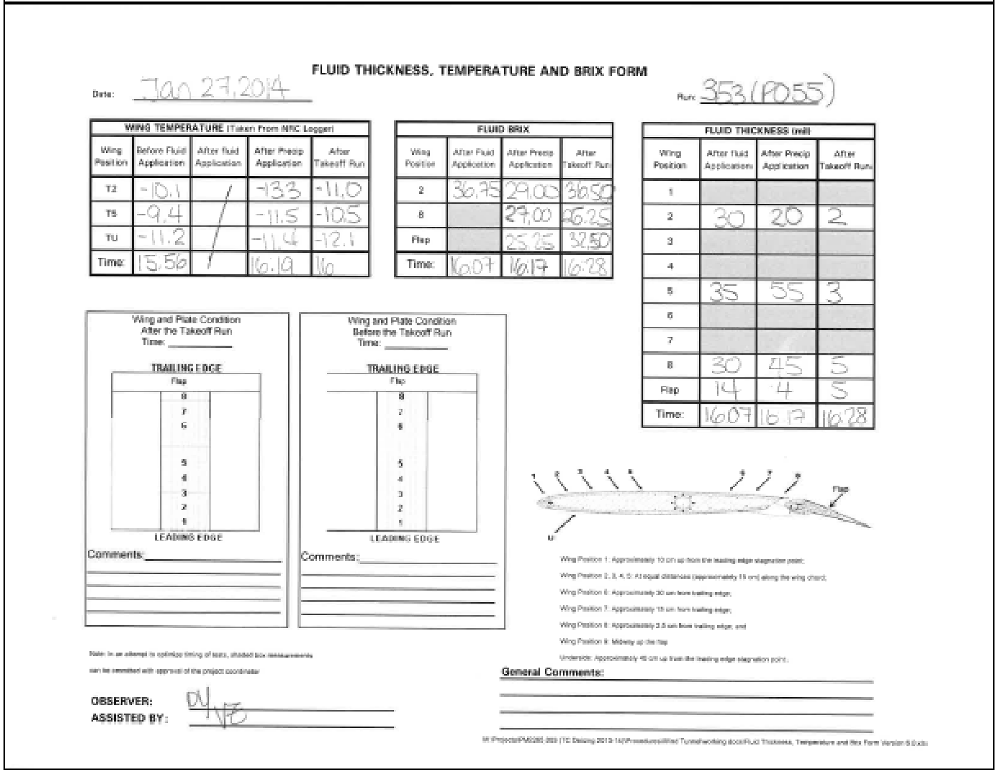
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 45 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: VB

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xlsx



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 27,2014

Run: 353 (P055)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	-10.1	/	-13.3	-11.0
T5	-9.4	/	-11.5	-10.5
TU	-11.2	/	-11.4	-12.1
Time:	15:56	/	16:19	16

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	36.75	29.00	36.50
8	▨	27.00	26.25
Flap	▨	25.25	32.50
Time:	16:07	16:17	16:28

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	20	2
3	▨	▨	▨
4	▨	▨	▨
5	35	55	3
6	▨	▨	▨
7	▨	▨	▨
8	30	45	5
Flap	14	4	5
Time:	1607	16 17	1628

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 45 cm up from the leading edge stagnation point.

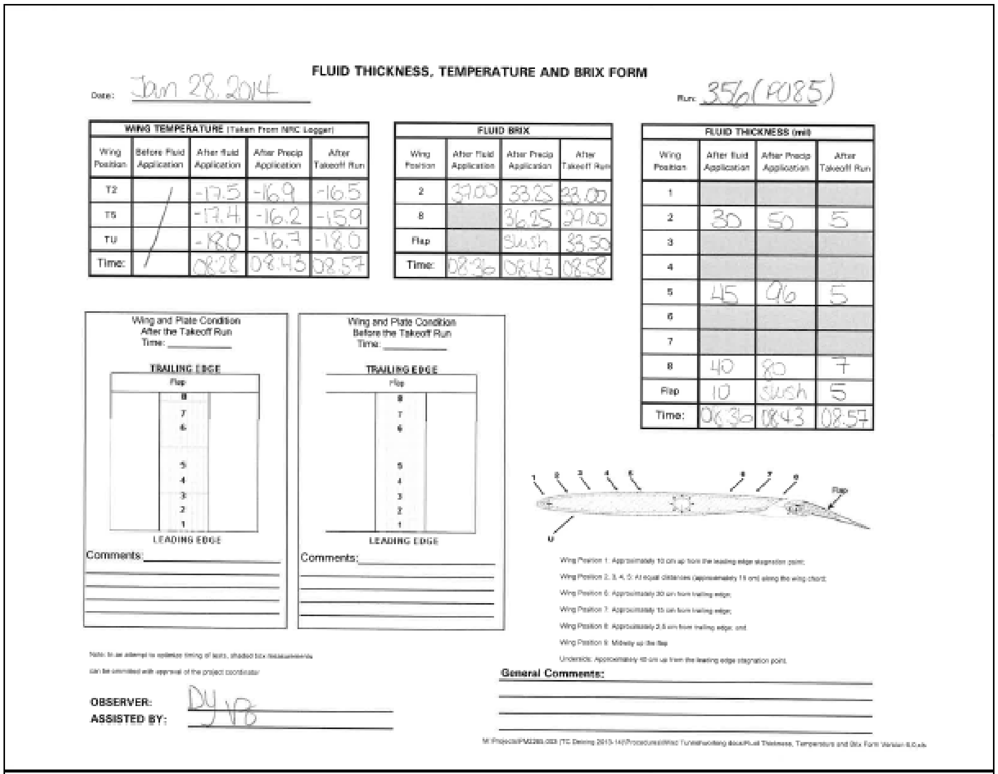
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: VB

General Comments: ____________

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xlsx

Figure C40: Test # 353



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28. 2014

Run: 356(P085)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-17.5	-16.9	-16.5
T5	/	-17.4	-16.2	-15.9
TU	/	-18.0	-16.7	-18.0
Time:	/	08:28	08:43	08:57

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	33.25	33.00
8	▨	36.25	29.00
Flap	▨	slush	33.50
Time:	08:36	08:43	08:58

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	50	5
3	▨	▨	▨
4	▨	▨	▨
5	45	96	5
6	▨	▨	▨
7	▨	▨	▨
8	40	80	7
Flap	10	slush	5
Time:	06:36	08:43	08:57

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 11 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

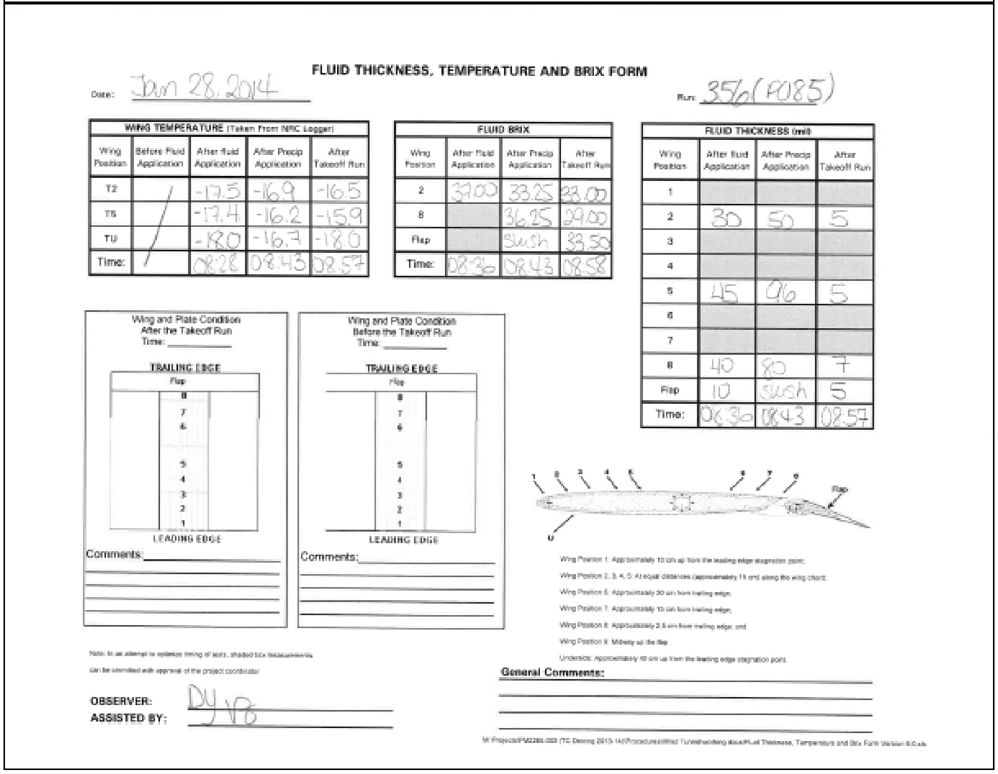
Wing Position 9: Midway up the flap

Underside: Approximately 10 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: VB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28. 2014

Run: 356(P085)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-17.5	-16.9	-16.5
T5	/	-17.4	-16.2	-15.9
TU	/	-18.0	-16.7	-18.0
Time:	/	08:28	08:43	08:57

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	33.25	33.00
8	▨	36.25	29.00
Flap	▨	slush	33.50
Time:	08:36	08:43	08:58

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	30	50	5
3	▨	▨	▨
4	▨	▨	▨
5	45	96	5
6	▨	▨	▨
7	▨	▨	▨
8	40	80	7
Flap	10	slush	5
Time:	06:36	08:43	08:57

Wing and Plate Condition
After the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 11 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

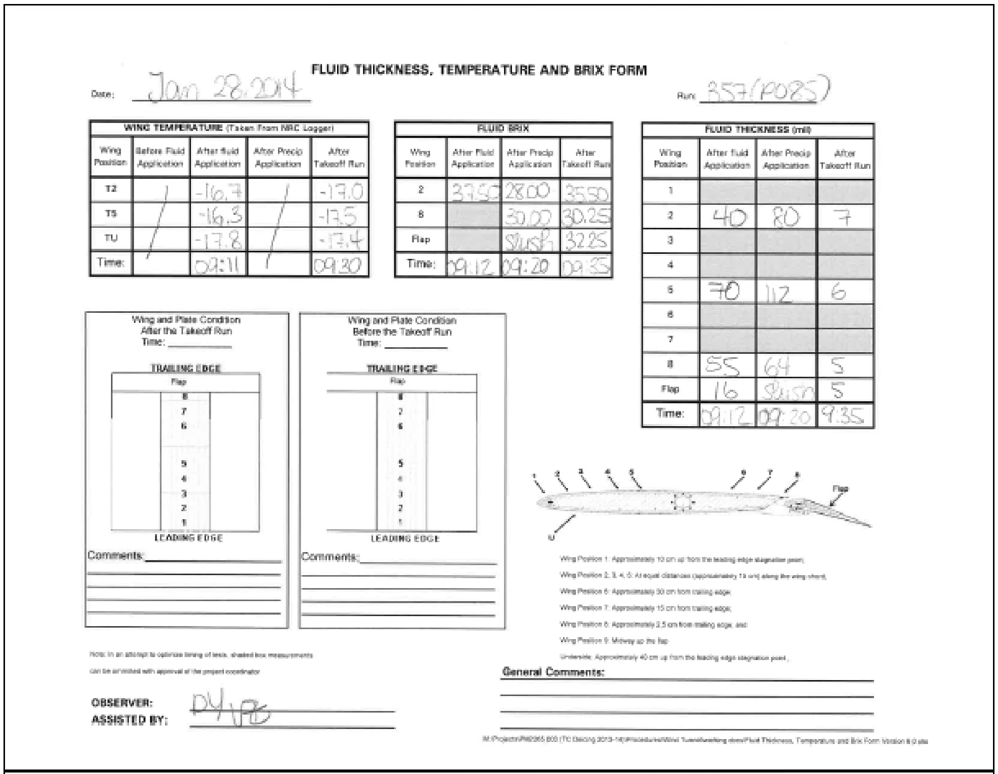
Underside: Approximately 10 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator

General Comments:

OBSERVER: DY
ASSISTED BY: VB

Figure C41: Test # 356



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28 2014

Run: 357 (P085)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-16.7	/	-17.0
TS	/	-16.3	/	-17.5
TU	/	-17.8	/	-17.4
Time:		09:11		09:30

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	28.00	35.50
8		30.00	30.25
Flap		Slush	32.25
Time:	09:12	09:20	09:35

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	40	80	7
3			
4			
5	70	112	6
6			
7			
8	55	64	5
Flap	16	Slush	5
Time:	09:12	09:20	9:35

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

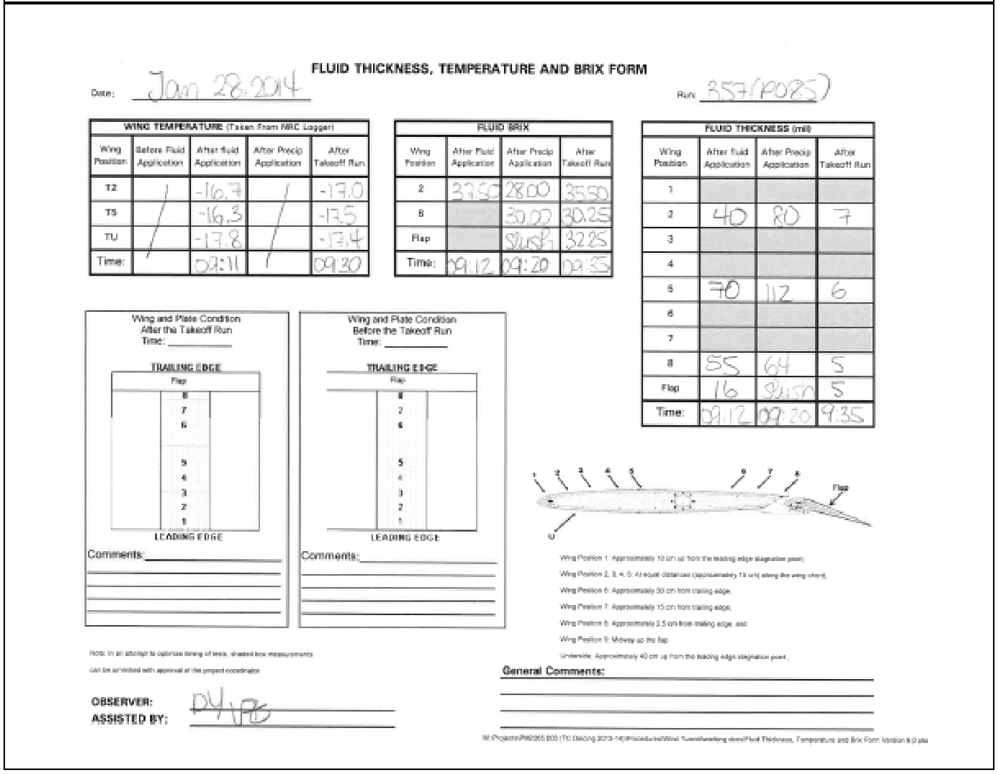
Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ________

OBSERVER: DY
ASSISTED BY: PD



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28 2014

Run: 357 (P085)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-16.7	/	-17.0
TS	/	-16.3	/	-17.5
TU	/	-17.8	/	-17.4
Time:		09:11		09:30

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	28.00	35.50
8		30.00	30.25
Flap		Slush	32.25
Time:	09:12	09:20	09:35

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	40	80	7
3			
4			
5	70	112	6
6			
7			
8	55	64	5
Flap	16	Slush	5
Time:	09:12	09:20	9:35

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

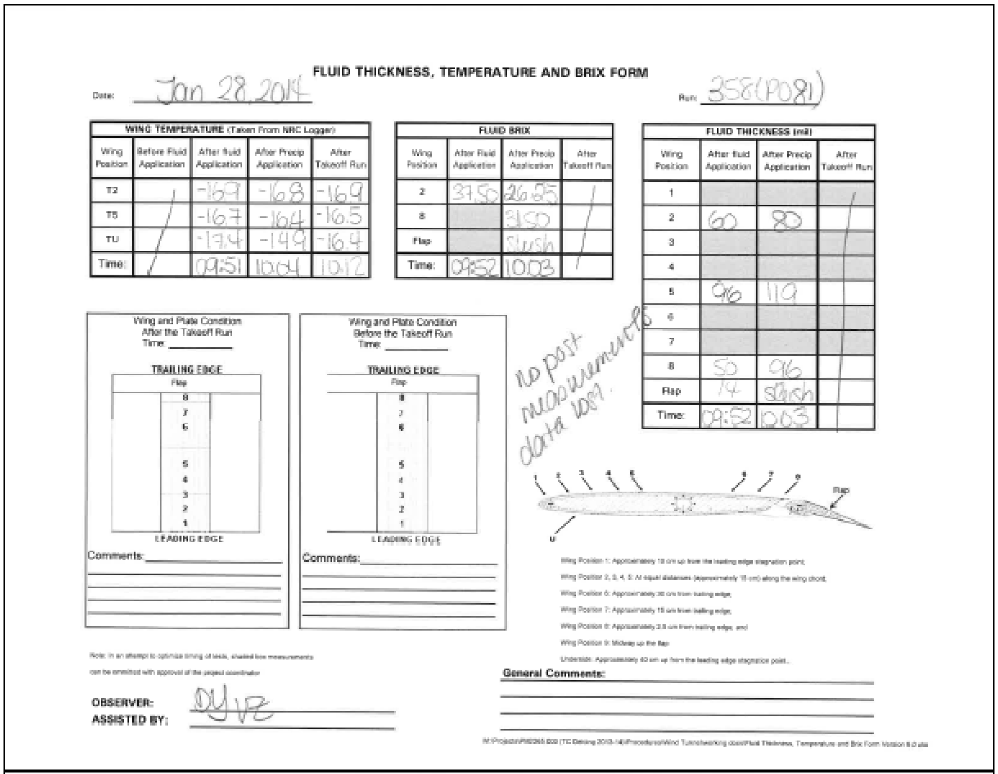
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ________

OBSERVER: DY
ASSISTED BY: PD

Figure C42: Test # 357



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 358(P081)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-16.9	-16.8	-16.9
T5	/	-16.7	-16.4	-16.5
TU	/	-17.4	-14.9	-16.4
Time:	/	09:51	10:04	10:12

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	26.25	/
8	▨	31.50	/
Flap	▨	Slush	/
Time:	09:52	10:03	/

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨ /
2	60	80	/
3	▨	▨	▨ /
4	▨	▨	▨ /
5	96	119	/
6	▨	▨	▨ /
7	▨	▨	▨ /
8	50	96	/
Flap	14	slush	/
Time:	09:52	10:03	/

no post measurements data log.

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

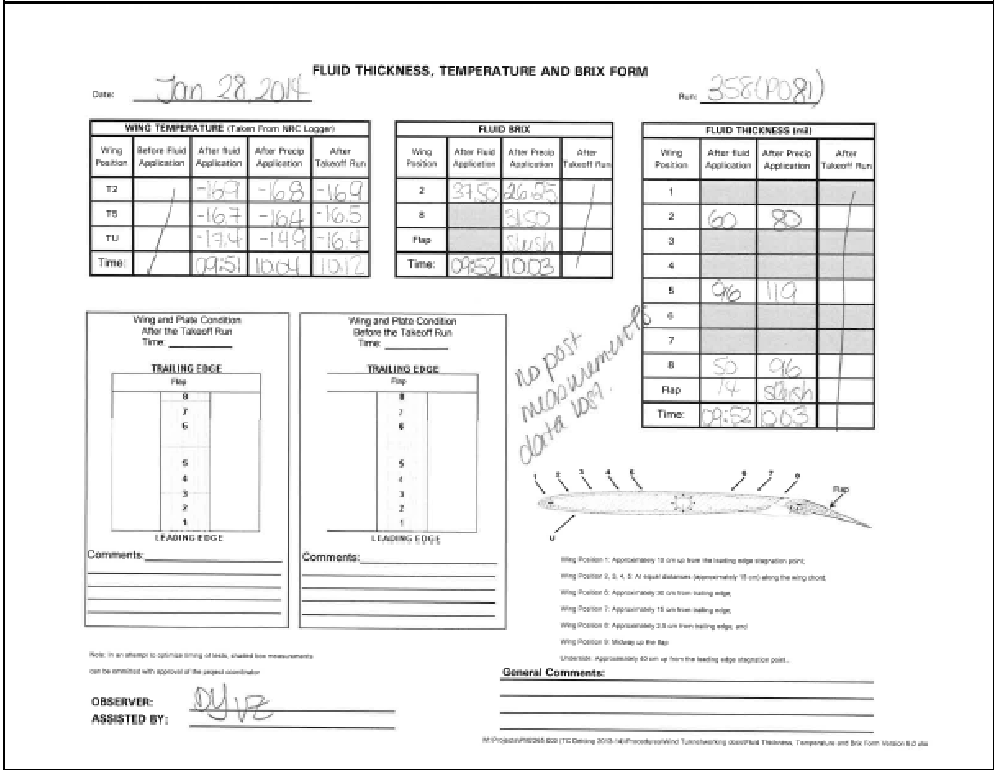
Comments: ________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap;
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator.

General Comments: ________

OBSERVER: DY VZ
ASSISTED BY: ________



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 358(P081)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-16.9	-16.8	-16.9
T5	/	-16.7	-16.4	-16.5
TU	/	-17.4	-14.9	-16.4
Time:	/	09:51	10:04	10:12

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	26.25	/
8	▨	31.50	/
Flap	▨	Slush	/
Time:	09:52	10:03	/

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨ /
2	60	80	/
3	▨	▨	▨ /
4	▨	▨	▨ /
5	96	119	/
6	▨	▨	▨ /
7	▨	▨	▨ /
8	50	96	/
Flap	14	slush	/
Time:	09:52	10:03	/

no post measurements data log.

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ________

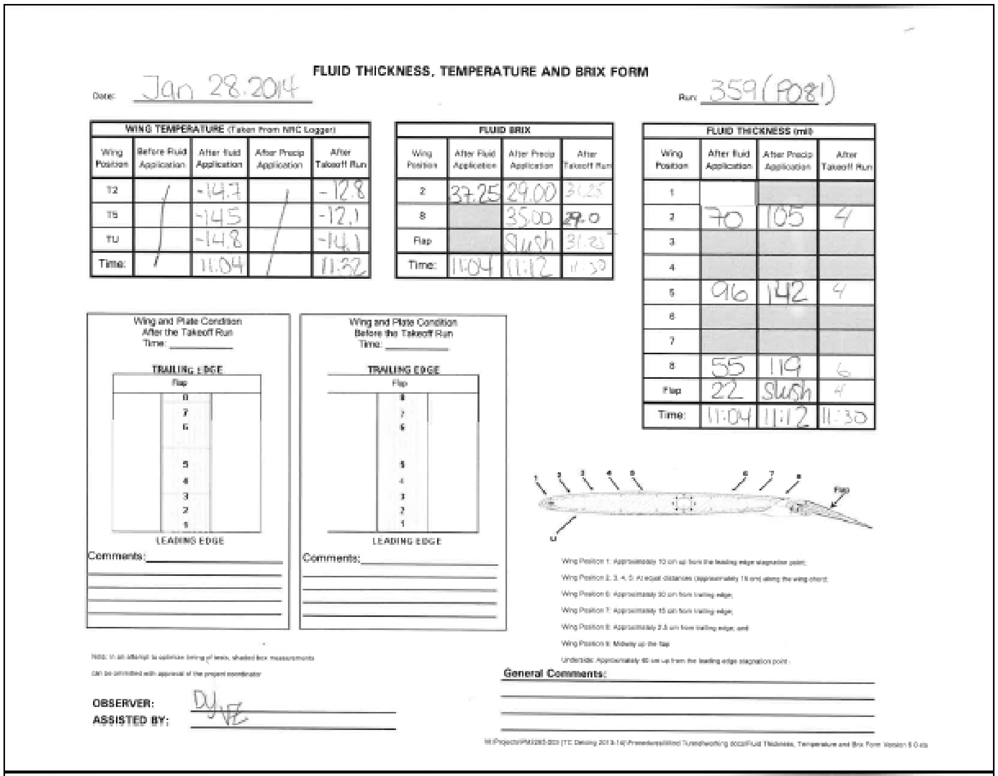
Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 30 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap;
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be ommitted with approval of the project coordinator.

General Comments: ________

OBSERVER: DY VZ
ASSISTED BY: ________

Figure C43: Test # 358



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28.2014

Run: 359(P081)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-14.7		-12.8
T5		-14.5		-12.1
TU		-14.8		-14.1
Time:		11:04		11:32

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.25	29.00	31.25
8		35.00	29.0
Flap		Slush	31.25
Time:	11:04	11:12	11:30

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	70	105	4
3			
4			
5	96	142	4
6			
7			
8	55	119	6
Flap	22	Slush	4
Time:	11:04	11:12	11:30

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

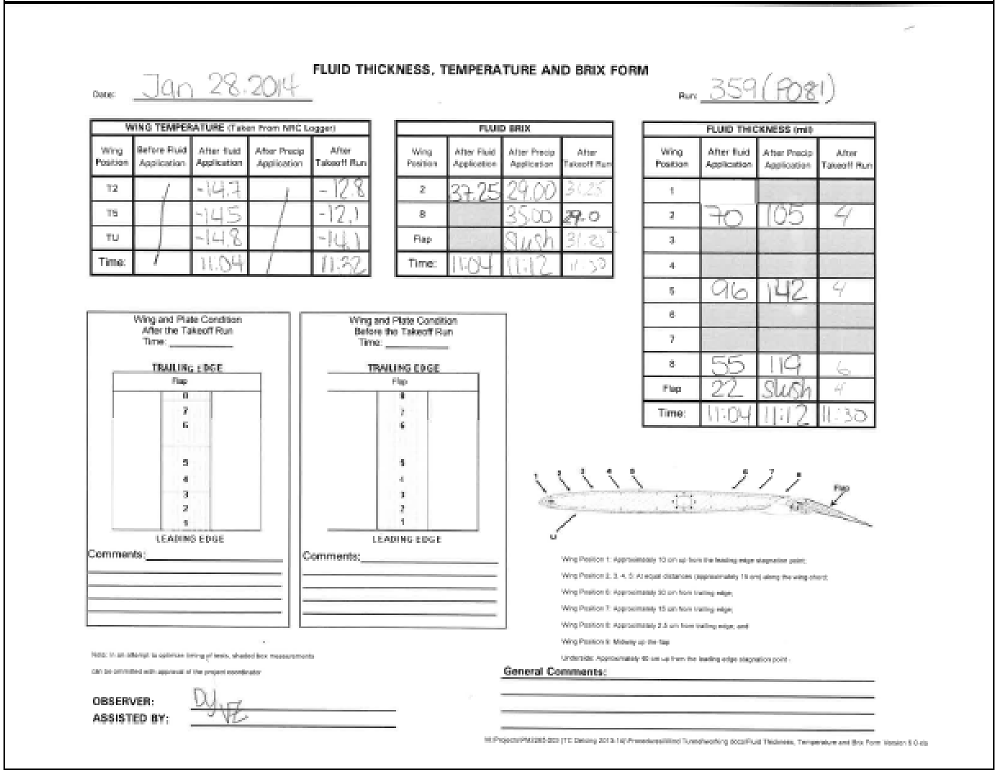
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: VZ

General Comments:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28.2014

Run: 359(P081)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2		-14.7		-12.8
T5		-14.5		-12.1
TU		-14.8		-14.1
Time:		11:04		11:32

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.25	29.00	31.25
8		35.00	29.0
Flap		Slush	31.25
Time:	11:04	11:12	11:30

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	70	105	4
3			
4			
5	96	142	4
6			
7			
8	55	119	6
Flap	22	Slush	4
Time:	11:04	11:12	11:30

Wing and Plate Condition
After the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing and Plate Condition
Before the Takeoff Run
Time: ________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

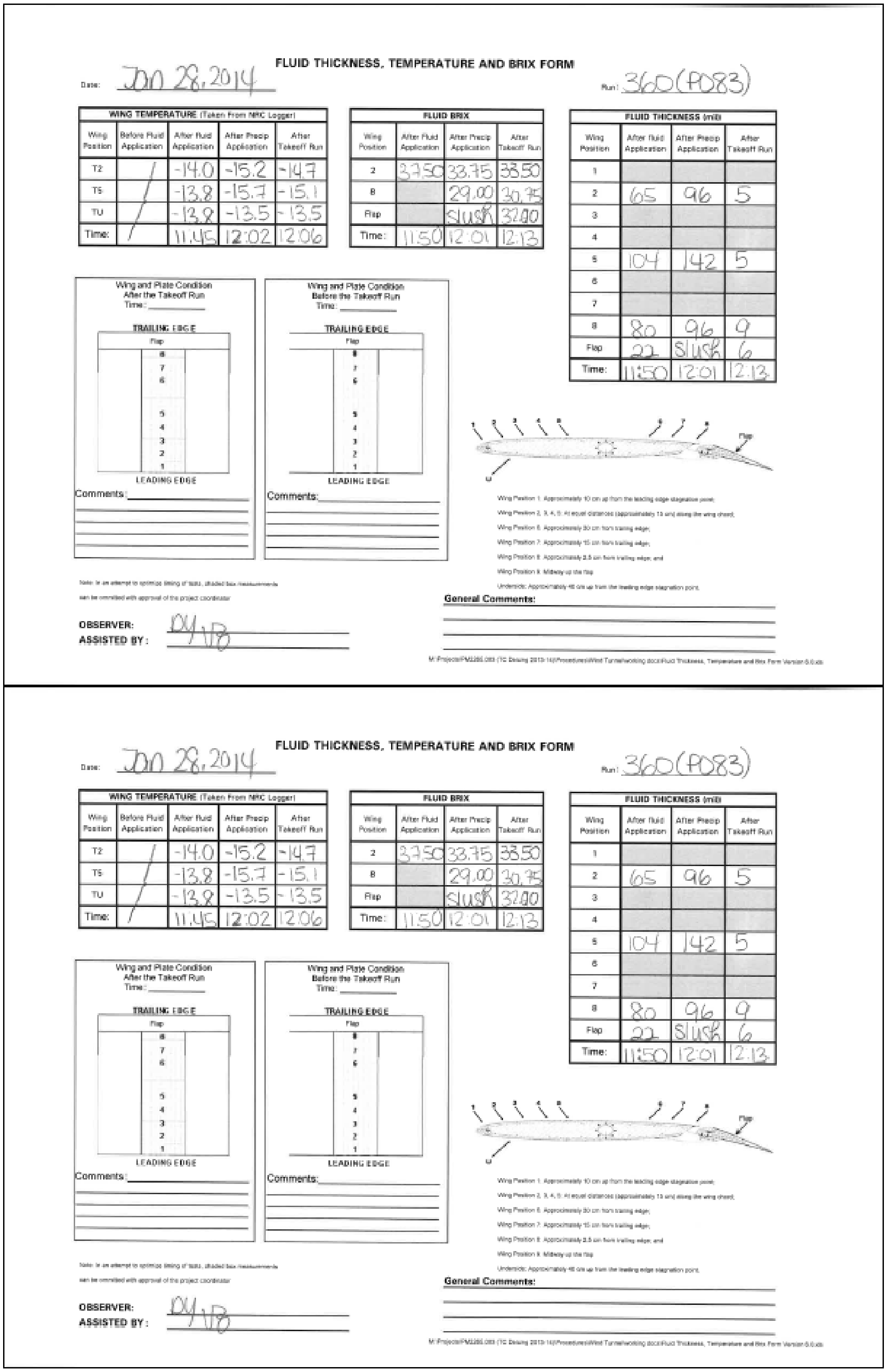
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DY
ASSISTED BY: VZ

General Comments:

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 5.0.xls

Figure C44: Test # 359



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 360(P083)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	/	-14.0	-15.2	-14.7
T5	/	-13.8	-15.7	-15.1
TU	/	-13.8	-13.5	-13.5
Time:	/	11:45	12:02	12:06

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	33.75	33.50
8		29.00	30.75
Flap		slush	32.00
Time:	11:50	12:01	12:13

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1			
2	65	96	5
3			
4			
5	104	142	5
6			
7			
8	80	96	9
Flap	22	slush	6
Time:	11:50	12:01	12:13

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY, VB
ASSISTED BY: ______

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 360(P083)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	/	-14.0	-15.2	-14.7
T5	/	-13.8	-15.7	-15.1
TU	/	-13.8	-13.5	-13.5
Time:	/	11:45	12:02	12:06

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	33.75	33.50
8		29.00	30.75
Flap		slush	32.00
Time:	11:50	12:01	12:13

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1			
2	65	96	5
3			
4			
5	104	142	5
6			
7			
8	80	96	9
Flap	22	slush	6
Time:	11:50	12:01	12:13

Wing and Plate Condition
After the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing and Plate Condition
Before the Takeoff Run
Time: ______

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ______

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

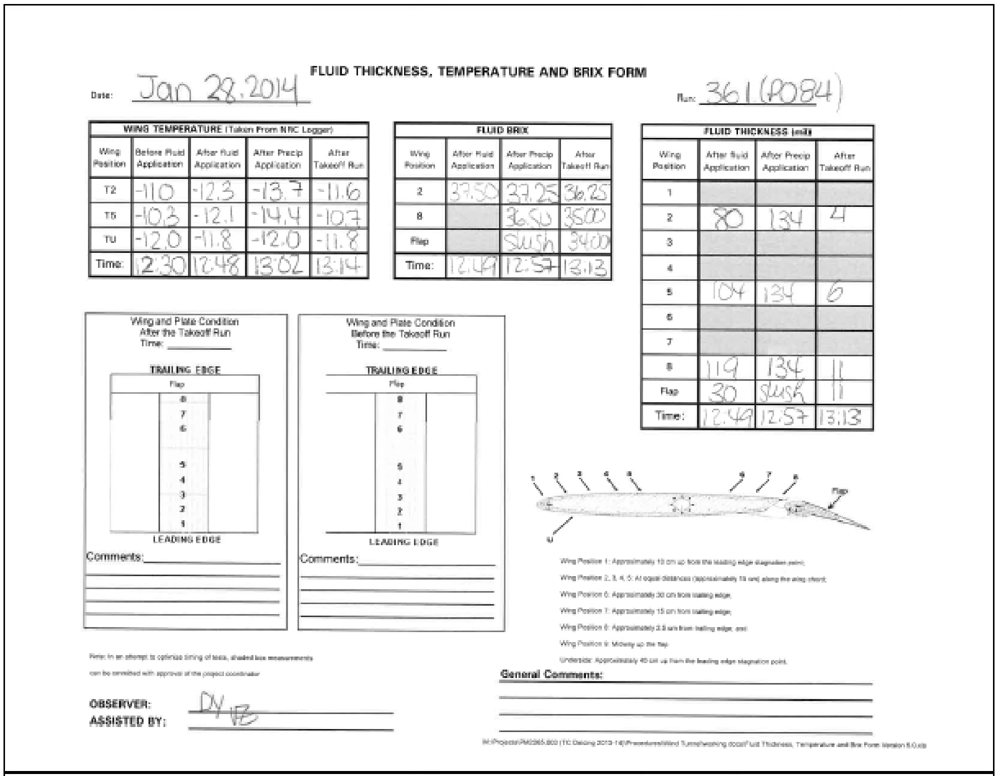
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ______

OBSERVER: DY, VB
ASSISTED BY: ______

Figure C45: Test #360



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28.2014

Run: 361 (P084)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	-11.0	-12.3	-13.7	-11.6
T5	-10.3	-12.1	-14.4	-10.7
TU	-12.0	-11.8	-12.0	-11.8
Time:	12:30	12:48	13:02	13:14

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	37.25	36.25
8	▨	36.50	35.00
Flap	▨	Slush	34.00
Time:	12:49	12:57	13:13

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	134	4
3	▨	▨	▨
4	▨	▨	▨
5	104	134	6
6	▨	▨	▨
7	▨	▨	▨
8	119	134	11
Flap	30	slush	11
Time:	12:49	12:57	13:13

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

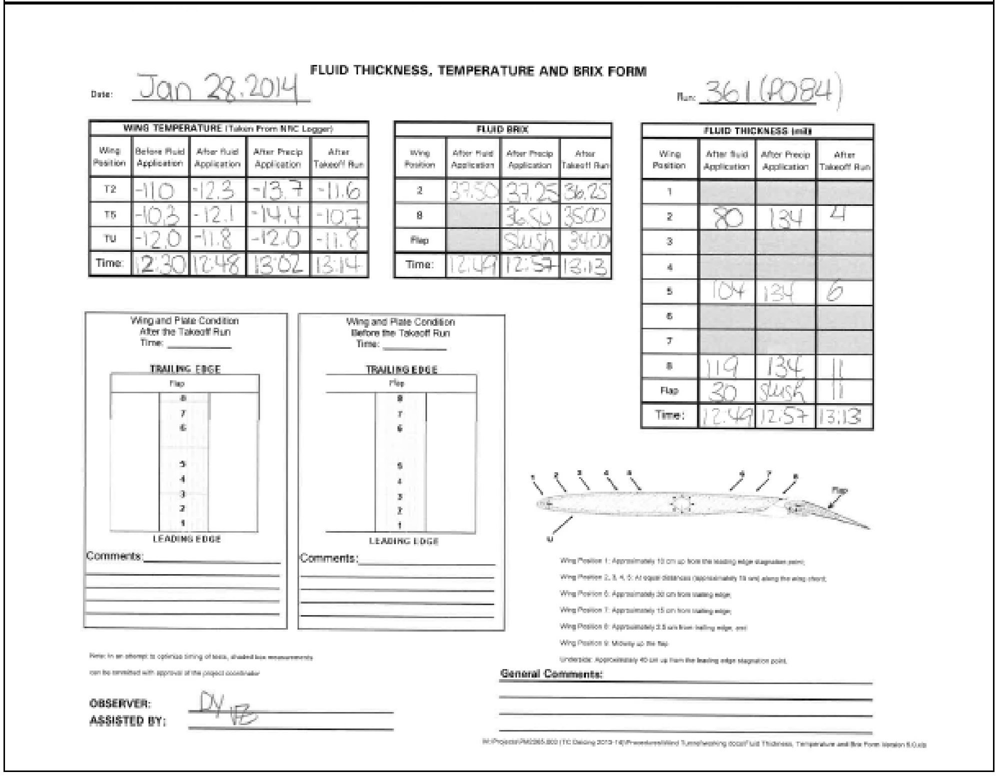
Underside: Approximately 45 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DV

ASSISTED BY: VB



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28.2014

Run: 361 (P084)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	-11.0	-12.3	-13.7	-11.6
T5	-10.3	-12.1	-14.4	-10.7
TU	-12.0	-11.8	-12.0	-11.8
Time:	12:30	12:48	13:02	13:14

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.50	37.25	36.25
8	▨	36.50	35.00
Flap	▨	Slush	34.00
Time:	12:49	12:57	13:13

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1	▨	▨	▨
2	80	134	4
3	▨	▨	▨
4	▨	▨	▨
5	104	134	6
6	▨	▨	▨
7	▨	▨	▨
8	119	134	11
Flap	30	slush	11
Time:	12:49	12:57	13:13

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 15 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap.

Underside: Approximately 45 cm up from the leading edge stagnation point.

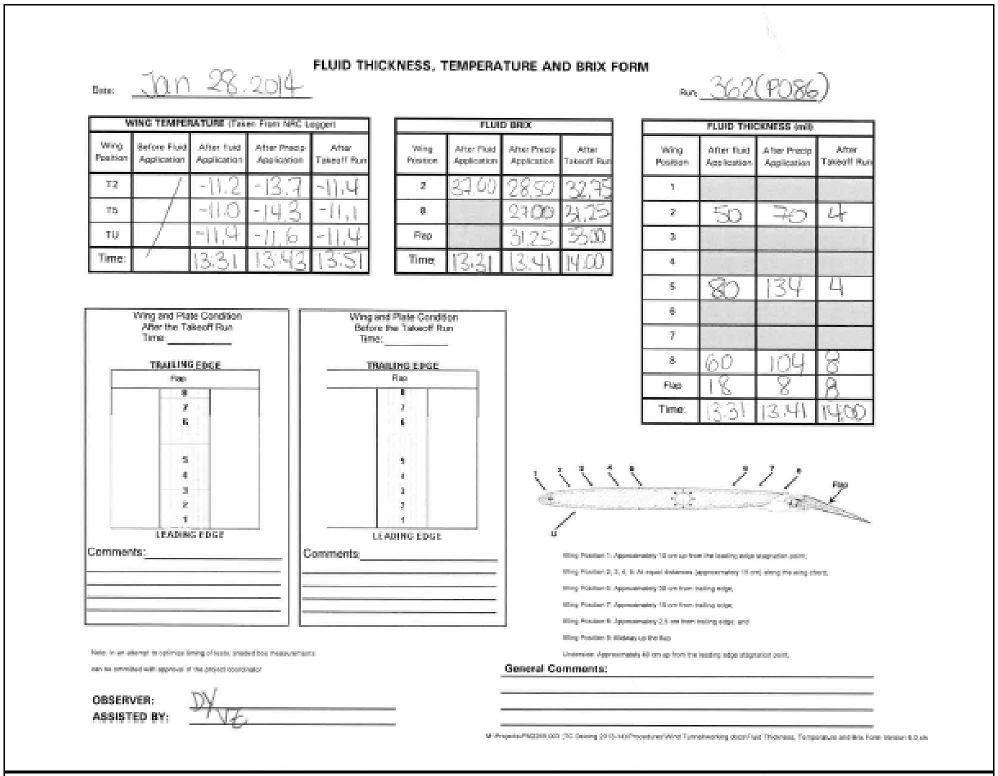
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ___________

OBSERVER: DV

ASSISTED BY: VB

Figure C46: Test # 361



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28.2014

Run: 362(P086)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-11.2	-13.7	-11.4
T5	/	-11.0	-14.3	-11.1
TU	/	-11.4	-11.6	-11.4
Time:	/	13:31	13:43	13:51

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	28.50	32.75
8		27.00	31.25
Flap		31.25	33.00
Time	13:31	13:41	14:00

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	50	70	4
3			
4			
5	80	134	4
6			
7			
8	60	104	8
Flap	18	8	8
Time:	13:31	13:41	14:00

Wing and Plate Condition
After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

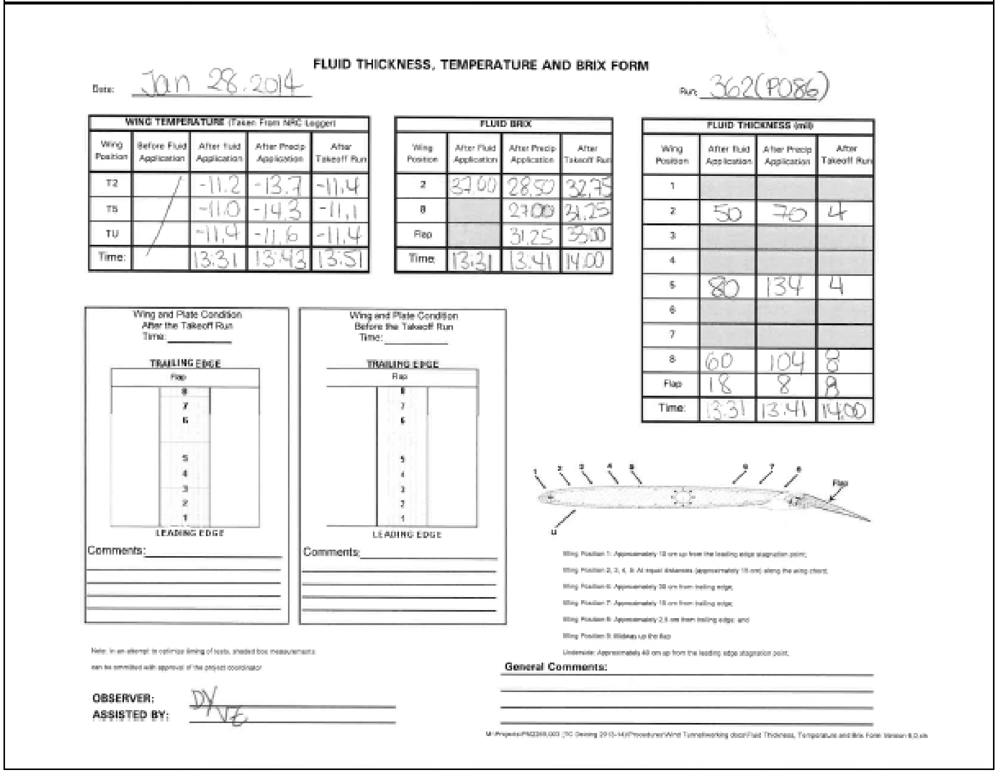
Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY

ASSISTED BY: VE

M:\Projects\PM2265.003 (TC Deicing 2013-14)\Procedures\Wind Tunnel\working docs\Fluid Thickness, Temperature and Brix Form Version 6.0.xls



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28.2014

Run: 362(P086)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	-11.2	-13.7	-11.4
T5	/	-11.0	-14.3	-11.1
TU	/	-11.4	-11.6	-11.4
Time:	/	13:31	13:43	13:51

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	37.00	28.50	32.75
8		27.00	31.25
Flap		31.25	33.00
Time	13:31	13:41	14:00

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1			
2	50	70	4
3			
4			
5	80	134	4
6			
7			
8	60	104	8
Flap	18	8	8
Time:	13:31	13:41	14:00

Wing and Plate Condition
After the Takeoff Run
Time: ____________

Comments: ____________

Wing and Plate Condition
Before the Takeoff Run
Time: ____________

Comments: ____________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments: ____________

OBSERVER: DY

ASSISTED BY: VE

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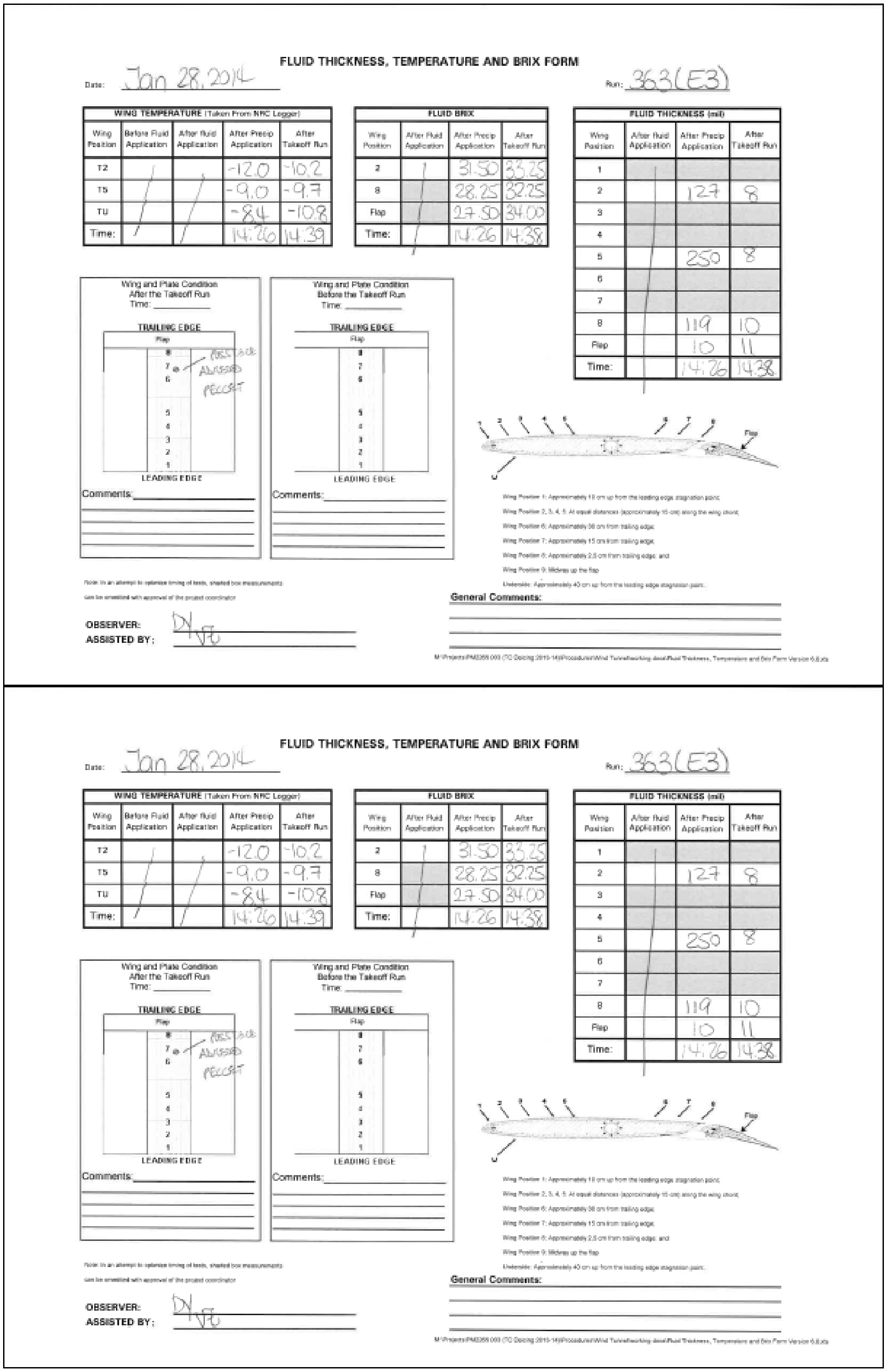
Figure C47: Test # 362



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 363(E3)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	/	-12.0	-10.2
T5	/	/	-9.0	-9.7
TU	/	/	-8.4	-10.8
Time:	/	/	14:26	14:39

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	31.50	33.25
8	/	28.25	32.25
Flap	/	27.50	34.00
Time:	/	14:26	14:38

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2	/	127	8
3	/		
4	/		
5	/	250	8
6	/		
7	/		
8	/	119	10
Flap	/	10	11
Time:	/	14:26	14:38

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7 ● [illegible] ABSORBED PELLET
6
5
4
3
2
1
LEADING EDGE

Comments:___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 56 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:___________

OBSERVER: DN
ASSISTED BY: VFG

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FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 363(E3)

WING TEMPERATURE (Taken From NRC Logger)				
Wing Position	Before Fluid Application	After fluid Application	After Precip Application	After Takeoff Run
T2	/	/	-12.0	-10.2
T5	/	/	-9.0	-9.7
TU	/	/	-8.4	-10.8
Time:	/	/	14:26	14:39

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	31.50	33.25
8	/	28.25	32.25
Flap	/	27.50	34.00
Time:	/	14:26	14:38

FLUID THICKNESS (mil)			
Wing Position	After fluid Application	After Precip Application	After Takeoff Run
1	/		
2	/	127	8
3	/		
4	/		
5	/	250	8
6	/		
7	/		
8	/	119	10
Flap	/	10	11
Time:	/	14:26	14:38

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7 ● [illegible] ABSORBED PELLET
6
5
4
3
2
1
LEADING EDGE

Comments:___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments:___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point;
Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;
Wing Position 6: Approximately 56 cm from trailing edge;
Wing Position 7: Approximately 15 cm from trailing edge;
Wing Position 8: Approximately 2.5 cm from trailing edge; and
Wing Position 9: Midway up the flap
Underside: Approximately 40 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

General Comments:___________

OBSERVER: DN
ASSISTED BY: VFG

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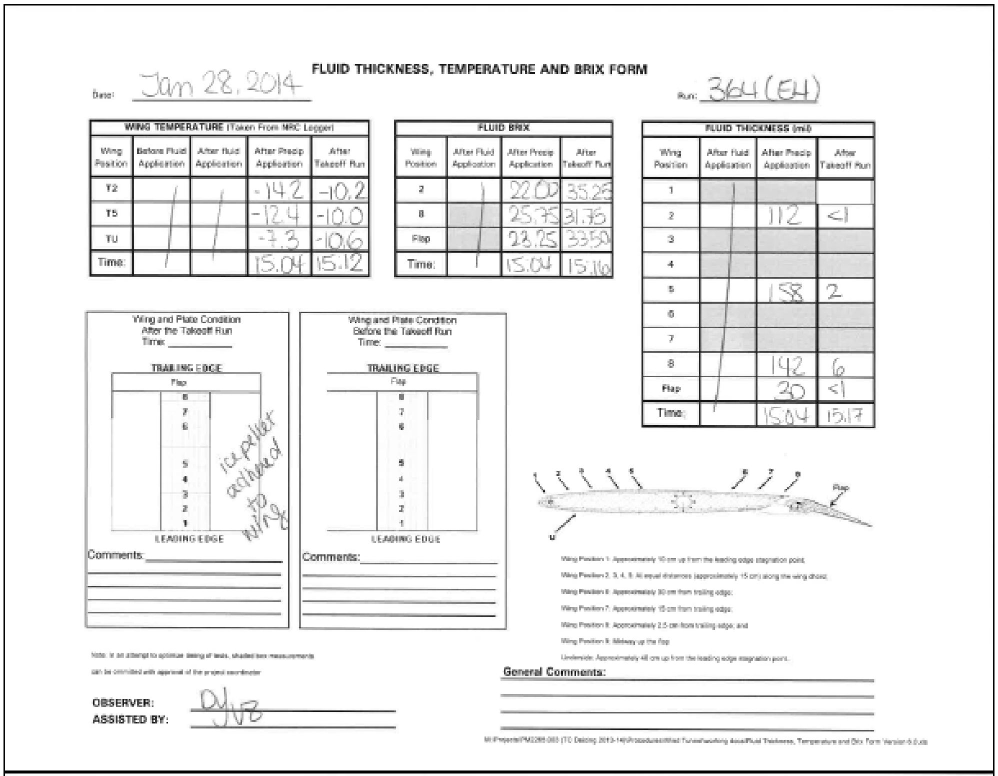
Figure C48: Test # 363



FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 364 (EH)

WING TEMPERATURE (Taken From MRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	/	/	-14.2	-10.2
T5			-12.4	-10.0
TU			-7.3	-10.6
Time:			15.04	15.12

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	22.00	35.25
8		25.75	31.75
Flap		23.25	3350
Time:		15.04	15:16

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1	/		
2		112	<1
3			
4			
5		158	2
6			
7			
8		142	6
Flap		30	<1
Time:		15.04	15.17

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

ice pellet adhered to wing

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point.

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 48 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DJ

ASSISTED BY: JVB

General Comments: ___________

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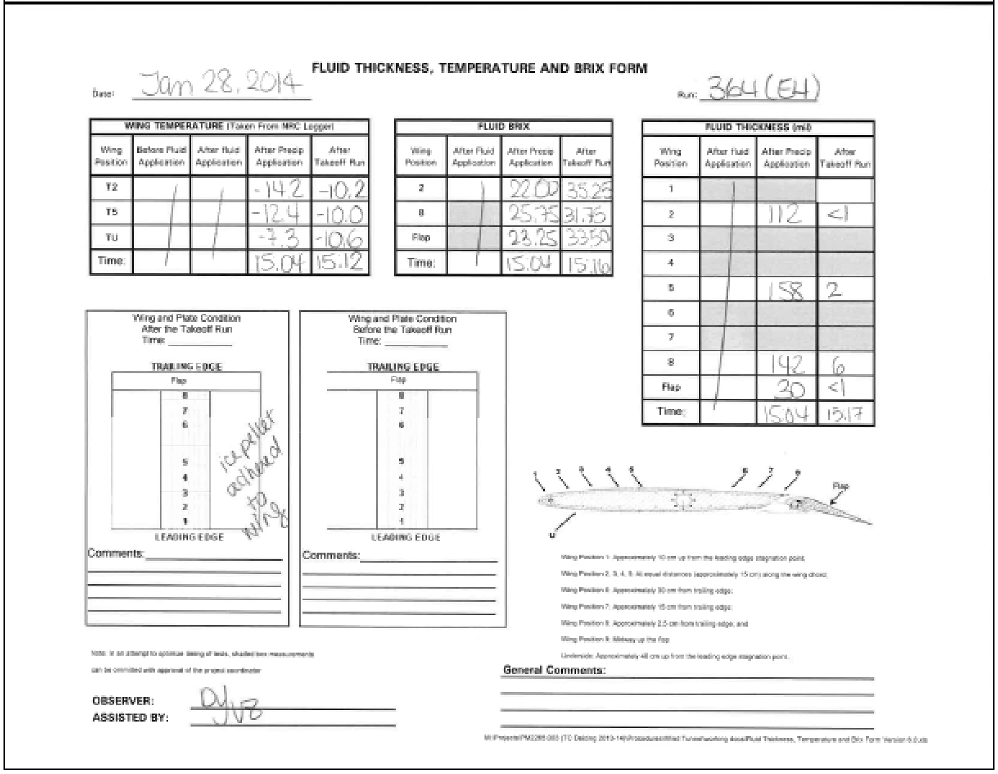

FLUID THICKNESS, TEMPERATURE AND BRIX FORM

Date: Jan 28, 2014

Run: 364 (EH)

WING TEMPERATURE (Taken From MRC Logger)				
Wing Position	Before Fluid Application	After Fluid Application	After Precip Application	After Takeoff Run
T2	/	/	-14.2	-10.2
T5			-12.4	-10.0
TU			-7.3	-10.6
Time:			15.04	15.12

FLUID BRIX			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
2	/	22.00	35.25
8		25.75	31.75
Flap		23.25	3350
Time:		15.04	15:16

FLUID THICKNESS (mil)			
Wing Position	After Fluid Application	After Precip Application	After Takeoff Run
1	/		
2		112	<1
3			
4			
5		158	2
6			
7			
8		142	6
Flap		30	<1
Time:		15.04	15.17

Wing and Plate Condition
After the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

ice pellet adhered to wing

Comments: ___________

Wing and Plate Condition
Before the Takeoff Run
Time: ___________

TRAILING EDGE
Flap
8
7
6
5
4
3
2
1
LEADING EDGE

Comments: ___________

Wing Position 1: Approximately 10 cm up from the leading edge stagnation point.

Wing Position 2, 3, 4, 5: At equal distances (approximately 15 cm) along the wing chord;

Wing Position 6: Approximately 30 cm from trailing edge;

Wing Position 7: Approximately 15 cm from trailing edge;

Wing Position 8: Approximately 2.5 cm from trailing edge; and

Wing Position 9: Midway up the flap

Underside: Approximately 48 cm up from the leading edge stagnation point.

Note: In an attempt to optimize timing of tests, shaded box measurements can be omitted with approval of the project coordinator

OBSERVER: DJ

ASSISTED BY: JVB

General Comments: ___________

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Figure C49: Test # 364

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