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Final Version 1.0
November 2017

AIRCRAFT GROUND ICING GENERAL RESEARCH ACTIVITIES DURING THE 2016-17 WINTER

Prepared for the
Transportation Development Centre
In cooperation with
Transport Canada Civil Aviation
and the
Federal Aviation Administration
William J. Hughes Technical Center

APS Aviation Inc.

TP 15374E

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November 2017
by: APS Aviation Inc.

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PREFACE

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

- To develop holdover time data for all newly-qualified de/anti-icing fluids and update and maintain the website for the holdover time guidelines;
- To evaluate fluid holdover times for snow at very cold temperatures close to -25°C;
- To conduct heavy snow research to determine the highest usable precipitation rate (HUPR) for which operations are permitted;
- To evaluate the effects of deploying flaps/slats, prior to takeoff, on fluid protection times;
- To conduct general and exploratory de/anti-icing research;
- To update the regression coefficient report with the newly-qualified de/anti-icing fluids; and
- To update the source documents used by Transport Canada and the Federal Aviation Administration for the maintenance and publication of the holdover time guidance material.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2016-17 are documented in four reports. The titles of the reports are as follows:

- TP 15372E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter;
- TP 15373E Regression Coefficients and Equations Used to Develop the Winter 2017-18 Aircraft Ground Deicing Holdover Time Tables;
- TP 15374E Aircraft Ground Icing General Research Activities During the 2016-17 Winter; and
- TP 15375E Testing of Endurance Times on Extended Flaps and Slats (2016-17).

This report, TP 15374E, has the following objective:

- To document the exploratory research and general activities carried out during the winter of 2016-17.

PROGRAM ACKNOWLEDGEMENTS

This multi-year research program has been funded by Transport Canada with support from the Federal Aviation Administration, William J. Hughes Technical Center, Atlantic City, NJ. This program could not have been accomplished without the participation of many organizations. APS would therefore like to thank the Transportation Development Centre of Transport Canada, the Federal Aviation Administration, National Research Council Canada, and supporting members of the SAE International G-12 Aircraft Ground De-Icing Committee.

APS would also like to acknowledge the dedication of the research team, whose performance was crucial to the acquisition of hard data. This includes the following people: Brandon Auclair, Steven Baker, Stephanie Bendickson, Benjamin Bernier, Chloë Bernier, Chris D'Avirro, John D’Avirro, Ben Falvo, Michael Hawdur, Gabriel Maatouk, Philip Murphy, Dany Posteraro, Marco Ruggi, Saba Tariq, David Youssef, and Nondas Zoitakis.

Special thanks are extended to Antoine Lacroix, Howard Posluns, Yvan Chabot, 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.

REPORT ACKNOWLEDGEMENTS

APS would like to acknowledge the following people for their significant contribution to this report: Stephanie Bendickson for *Development of Holdover Times for Heavy Snow,* Chloe Bernier for *Publication of Holdover Time Guidance Materials*, Saba Tariq for *Technical Review and Publication of Historical Reports*, Stephanie Bendickson for *Update of SAE Documents ARP5485, ARP5945, ARP5718 and ARP6207*, and David Youssef for *Presentations, Fluid Manufacturer Reports and Test Procedures for 2016-17*.

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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 (TDC). 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 (FAA).

16. Abstract

This report documents the general activities completed by APS related to aircraft ground deicing research in the winter of 2016-17. The activities documented in this report were carried out in addition to the main research projects completed in the winter of 2016-17, which are documented in separate reports. The five activities described in this report are listed below:

1) Development of Holdover Times for Heavy Snow;
2) Publication of Holdover Time Guidance Materials;
3) Technical Review and Publication of Historical Reports;
4) Update SAE Documents ARP5485, ARP5945, ARP5718, and ARP6207; and
5) Presentations, Fluid Manufacturer Reports and Test Procedures for 2016-17.

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

Plusieurs rapports de recherche sur les essais de technologies de dégivrage et d'antigivrage au cours d'hivers précédents ont été produits pour le compte de Transports Canada. Ils sont disponibles au Centre de développement des transports (CDT). Plusieurs rapports ont été produits dans le cadre du programme de recherche de cet hiver. Leur objet est exposé à la préface. Les travaux décrits dans le présent rapport ont été en partie coparrainés par la Federal Aviation Administration (FAA).

16. Résumé

Le présent rapport documente les activités de nature générale effectués par APS au cours de l'hiver 2016-2017, liés à la recherche sur le dégivrage d'aéronefs au sol. Les activités documentées dans le présent rapport ont été accomplies en plus des principaux projets de recherche de l'hiver 2016-2017, qui sont documentés dans des rapports séparés. Les cinq activités décrites dans ce rapport sont énumérées ci-dessous :

1) Élaboration de durées d'efficacités dans la neige abondante;
2) Publication de documents d'orientation sur les durées d'efficacité;
3) Examen technique et publication de rapports historiques;
4) Actualisation des documents SAE ARP5485, ARP5945, ARP5718 et ARP6207; et
5) Présentations, rapports aux fabricants de liquides et procédures d'essais pour 2016-2017.

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EXECUTIVE SUMMARY

This report documents the exploratory research and general activities completed in the winter of 2016-17 by APS Aviation Inc. (APS) on behalf of the Transportation Development Centre (TDC) of Transport Canada (TC) and the Federal Aviation Administration (FAA). This work is part of the TC/FAA aircraft ground deicing research project. The major activities of the research project are documented in separate reports; this report documents five activities that were carried out in addition to the main research projects in the winter of 2016-17.

Development of Holdover Times for Heavy Snow (Section 2)

Over the last three winters, APS has undertaken work in support of the development of holdover times for heavy snow. The culmination of this three-year research effort is data and analysis which enables the publication of heavy snow holdover times for most Type II, Type III and Type IV fluids. Additionally, limitations on the use of specific fluids in heavy snow have been determined and published for liquid water equivalent based systems, and limitations on the use of specific fluids in light and very light snow have been refined.

Publication of Holdover Time Guidance Materials (Section 3)

APS developed and implemented a website for the official TC holdover time guidelines in 2003 to eliminate the safety risks associated with discrepancies occurring as a result of holdover time information being published in multiple locations. Since then, APS has updated the website annually to reflect changes made to the guidelines. The website was updated with the 2017-18 holdover time guidelines and regression information in August 2017. A revision to the guidelines was issued on October 12, 2017, which communicates supplemental holdover times for snow in the temperature band below -3 to -8°C for select Type II and IV 100/0 fluids.

Technical Review and Publication of Historical Reports (Section 4)

APS has been involved in writing and publishing 194 reports on behalf of TC since 1992. At the request of TC and FAA, APS undertook the task to process and publish the draft reports backlogged in the system. At the beginning of this project, 124 reports were identified as non-published; APS performed technical and editorial reviews on 16 reports in the Final Draft 1.0 stage and published them as Final Version 1.0 in October 2017. Following the discussion that took place with TC and FAA in 2017, it is projected that 20 reports will be targeted for publication in 2017-18.

Update of SAE Documents ARP5485, ARP5945, ARP5718 and ARP6207 (Section 5)

APS has supported the development of SAE aerospace standards related to ground deicing for many years. In the winter of 2016-17, APS drafted updates to the existing SAE aerospace recommended practice (ARP) documents ARP5485, ARP5945, and ARP5718, and created a first draft of corresponding document ARP6207. APS worked with the SAE G-12 Holdover Time Committee (HOT) to achieve consensus on the proposed changes to the documents. The result of these efforts is final documents, which have approval of the SAE G-12 HOT Committee. It is expected the documents will be published by SAE in late 2017.

Presentations, Fluid Manufacturer Reports and Test Procedures for 2016-17 (Section 6)

A number of presentations, fluid manufacturer reports and test procedures were produced by APS for the winter 2016-17 test program. An account of these materials is included in this report.

SOMMAIRE

Le présent rapport documente les recherches exploratoires et les activités de nature générale accomplies au cours de l'hiver 2016-2017 par APS Aviation Inc. (APS), pour le compte du Centre de développement des transports (CDT) de Transports Canada (TC) et la Federal Aviation Administration (FAA). Ces travaux font partie du projet de recherche de TC et de la FAA sur le dégivrage d'aéronefs au sol. Les principales activités du projet de recherche sont documentées dans des rapports distincts; le présent rapport documente cinq activités accomplies en plus des principaux projets de recherche de l'hiver 2016-2017.

Élaboration de durées d'efficacités dans la neige abondante (section 2)

Au cours des trois derniers hivers, APS a entrepris des travaux en appui à l'élaboration de durées d'efficacité dans la neige abondante. Cet effort de recherche sur trois ans s'est soldé par une analyse et des données qui permettent la publication de durées d'efficacité dans la neige abondante pour la plupart des liquides de Types II, III et IV. De plus, des limites ont été établies et publiées sur l'utilisation dans la neige abondante de liquides spécifiques pour les systèmes équivalents à eau liquide; les limites sur l'utilisation de liquides spécifiques dans la neige légère et très légère ont également été ajustées.

Publication de documents d'orientation sur les durées d'efficacité (section 3)

En 2003, APS a élaboré et mis en place un site Web contenant les lignes directrices de TC sur les durées d'efficacité, afin d'éliminer les risques liés à la sécurité associés à la possibilité de divergences lorsque l'information sur les durées d'efficacité est publiée à plusieurs endroits. Depuis lors, APS a actualisé annuellement le site Web pour refléter les changements aux lignes directrices. En août 2017, le site Web a été actualisé aux lignes directrices sur les durées d'efficacité et à l'information de régression pour 2017-2018. Une révision aux lignes directrices a été publiée le 12 octobre 2017, pour transmettre les durées d'efficacité applicables à la neige dans la plage de températures sous -3 à -8°C, pour certains liquides 100/0 de Types II et IV.

Examen technique et publication de rapports historiques (section 4)

Depuis 1992, APS a été impliquée dans la rédaction et la publication de 194 rapports pour le compte de TC. À la demande de TC et de la FAA, APS a entrepris le traitement et la publication de projets de rapports accumulés dans le système. Au début du projet, 126 rapports ont été identifiés comme non publiés; APS a effectué les

examens techniques et éditoriaux de 16 rapports à l'étape de projet final 1.0 et a publié leur version finale 1.0 en octobre 2017. Suite à des discussions avec TC et la FAA en 2017, il est prévu de publier 20 rapports en 2017-2018.

Actualisation des documents SAE ARP5485, ARP5945, ARP5718 et ARP6207 (section 5)

Depuis plusieurs années, APS a collaboré au développement de normes aérospatiales SAE liées au dégivrage au sol. Au cours de l'hiver 2016-2017, APS a rédigé des mises à jour aux documents *Aerospace recommended practice* (ARP) de la SAE ARP5485, ARP5945 et ARP5718, de même que la première version du document connexe ARP6207. APS a collaboré au comité G-12 de la SAE sur les durées d'efficacité (HOT) en vue d'atteindre un consensus sur les changements proposés à la documentation. Ces efforts ont mené à la documentation finale, qui a reçu l'approbation du comité G-12 de la SAE sur les durées d'efficacité. La SAE prévoit sa publication pour la fin de 2017.

Présentations, rapports aux fabricants de liquides et procédures d'essais pour 2016-2017 (section 6)

APS a produit un certain nombre de présentations, de rapports aux fabricants de liquides et de procédures d'essais pour le programme d'essais de l'hiver 2016-2017. Le présent rapport contient une description de cette documentation.

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GLOSSARY

A4A	Airlines for America
APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
FAA	Federal Aviation Administration
HOT	Holdover Time
HUPR	Highest Usable Precipitation Rate
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
LUPR	Lowest Usable Precipitation Rate
LWE	Liquid Water Equivalent
MSC	Meteorological Service of Canada
NRC	National Research Council Canada
SCOUIC	Standing Committee on Operations Under Icing Conditions
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. Prior to the 1990s, aircraft ground deicing had not been extensively researched. As a result of this need for advancement, the aircraft ground icing research program was developed with the aim of overcoming this lack of knowledge.

Since the early 1990s, the Transportation Development Centre (TDC), Transport Canada (TC) has managed and conducted de/anti-icing related tests at various sites in Canada; it has also coordinated worldwide testing and evaluation of evolving technologies related to de/anti-icing operations with the co-operation of the US Federal Aviation Administration (FAA), the National Research Council (NRC), Meteorological Service of Canada (MSC), several major airlines, and deicing fluid manufacturers. There is still limited understanding of some aspects of the hazard and what further can be done to reduce remaining risks posed by the operation of aircraft in winter precipitation conditions. TDC is continuing its research, development, and testing and evaluation program with support from the FAA.

Under contract to the TDC, APS Aviation Inc. (APS) undertook a research program to further advance aircraft ground de/anti-icing research, technology, and information.

1.1 Activities Completed in 2016-17

The general activities and smaller research projects completed in 2016-17 are documented in this report. Each activity is detailed in a separate section as follows (section number in brackets):

a) Development of Holdover Times for Heavy Snow (Section 2);

b) Publication of Holdover Time Guidance Materials (Section 3);

c) Technical Review and Publication of Historical Reports (Section 4);

d) Update of SAE Documents ARP5485, ARP5945, ARP5718 and ARP6207 (Section 5); and

e) Presentations, Fluid Manufacturer Reports and Test Procedures for 2016-17 (Section 6).

The sections of the TC work statement relevant to all of these projects can be found in Appendix A.

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2. DEVELOPMENT OF HOLDOVER TIMES FOR HEAVY SNOW

This section documents the work carried out by APS Aviation Inc. (APS) in support of the development of holdover times for heavy snow. This project has been carried out over the winters of 2014-15, 2015-16 and 2016-17. In the winter of 2016-17, work focused on verifying the validity of endurance time data at precipitation rates corresponding to heavy snow and identifying corresponding limitations to its use.

It should be noted that the scope of this project was limited to the development of holdover times. The project does not consider operational issues related to heavy snow, such as engine operation limitations, airport operational capacity issues, and weather reporting limitations (frequency/accuracy).

2.1 Background

Snow is one of the most important conditions for which holdover times are published, as it is the weather condition under which the majority of all aircraft ground de/anti-icing operations are conducted. Holdover times are currently published for very light, light and moderate snow; they are not published for heavy snow.

Without holdover times, operations in heavy snow are very difficult, as takeoff can only be achieved by completing a pre-takeoff contamination check and taking off within 5 minutes (in Canada there are additional restrictions, i.e. this procedure cannot be used with Type I fluid or when holdover times are less than 20 minutes). Anecdotal reports indicate that many operators do not operate in heavy snow due to the difficulty of this procedure and because it is often impractical to carry out. As a result, heavy snow has a significant impact on operations. This led to operators making a request to regulators to investigate the possibility of providing holdover times for heavy snow.

In the winter of 2014-15, APS was tasked by Transport Canada (TC) and the Federal Aviation Administration (FAA) to complete a number of activities related to heavy snow holdover times. These tasks were completed over the winters of 2014-15, 2015-16 and 2016-17.

2.2 Previous Work

The heavy snow project was started in the winter of 2014-15 and continued in the winters of 2015-16 and 2016-17.

2.2.1 Previous Work: Winter 2014-15

In the winter of 2014-15, work was completed to determine which activities would be required to provide holdover times for heavy snow. Five activities were identified as follows:

1. Determine an upper rate limit for heavy snow;
2. Determine visibilities corresponding to the upper rate limit for heavy snow;
3. Collect fluid-specific endurance time data;
4. Verify the validity of regression curves at rates above 25 g/dm²/h; and
5. Collect snow machine data at very cold temperatures.

The first two activities were completed in the winter of 2014-15. Conclusions were made on each activity.

1. <u>Determine Upper Rate Limit for Heavy Snow</u>: It was determined 50 g/dm²/h is an appropriate upper rate limit for heavy snow. This conclusion was supported by a frequency analysis of meteorological data and an examination of existing endurance time data for commercial de/anti-icing fluids.
2. <u>Determine Visibilities Corresponding to Upper Rate Limit for Heavy Snow</u>: It was concluded that sufficient data exists to determine visibilities corresponding to the upper rate limit for heavy snow (50 g/dm²/h). These can be used to populate the visibility tables. Preliminary values were proposed; further detailed inspection by TC and the FAA would be required to finalize these values.

Activity #3 (collect fluid-specific endurance time data) was also considered in 2014-15. It was observed that fluid-specific endurance time data already exists for all Type II, III and IV fluids, with the exception of fluids that do not have fluid-specific holdover time tables. However, it was observed the completion of activity #4 (verify validity of regression curves at heavy snow rates) could determine that the existing data is not sufficient. It was therefore concluded further work on activity #3 may be required in the future.

The work completed in the winter of 2014-15 is documented in detail in the TC report, TP 15323E, *Aircraft Ground Icing Research General Activities During the 2014-15 Winter* (1).

2.2.2 Previous Work: Winter 2015-16

In the winter of 2015-16, work began on the fourth heavy snow activity: verifying the validity of the endurance time data sets. A methodology was developed to assess the validity of endurance time data at precipitation rates of 25-50 g/dm²/h. It was based on the methodology previously established to assess the validity of endurance time data at light precipitation rates. The approach is a weighted three-factor analysis. The factors are:

1. Number of heavy snow data points;
2. Number of data points above set rate; and
3. Heavy snow data scatter.

The analysis methodology was applied to the existing endurance time data sets (separate data sets exist for each fluid brand and each of its dilutions for which holdover times are published; most fluid brands have three data sets). The analysis concluded that insufficient data existed for several data sets.

As a result, the focus of the heavy snow project in 2015-16 was the collection of heavy snow data with fluids for which sufficient heavy snow data did not exist. This turned out to be a challenging task for several reasons.

1. Obtaining fluid samples was a challenge as the viscosities of the samples had to be very close to the published lowest on-wing viscosity (LOWV) values. Some manufacturers were not able or chose not to provide the requested samples.
2. Collecting data was challenging as heavy snow is infrequent, hard to forecast, and often of short duration.
3. Data analysis was complex and the analysis had to be completed numerous times: before, during and after data collection.
4. In some cases, the collected data did not appear to correlate with historical data; further work was required to understand the underlying cause(s).

As a result of some of these challenges, the work was extended into the winter of 2016-17.

The work completed in the winter of 2015-16 is summarized in the TC report, TP 15340E, *Aircraft Ground Icing General Research Activities During the 2015-16 Winter* (2). Data and analysis details not included in TP 15340E (2) are provided in this report, as they have been combined with the data collected and analysed in the winter of 2016-17.

2.3 Objective

The objective of the heavy snow project for the winter of 2016-17 was to complete the activities required to provide holdover times for heavy snow. These activities, identified in the winter of 2014-15, are detailed in Subsection 2.2.1.

Table 2.1 shows the status of each heavy snow activity prior to the winter of 2016-17. The 2016-17 objective was achieved by completing the work required to complete these activities.

Table 2.1: Status of Heavy Snow Activities Prior to Winter 2016-17

Heavy Snow Activity	Work Completed	Work Outstanding
1. Determine an upper rate limit for heavy snow	• Activity completed in 2014-15	• None
2. Determine visibilities corresponding to the upper rate limit for heavy snow	• Activity completed in 2014-15	• None
3. Collect fluid-specific endurance time data	• Initial observations made in 2014-15 • Supplemental heavy snow data collected in 2015-16	• Collect additional supplemental data: - Heavy snow data - All rate data (select fluids) • Complete a conformance analysis to confirm supplemental data correlates with historical data
4. Verify the validity of regression curves at rates above 25 g/dm²/h	• Initial HUPR analysis methodology developed in 2015-16	• Refine HUPR analysis methodology • Apply this methodology to Type II, III and IV data sets (include both historical and supplemental data) • Use results to identify fluid-specific limitations on the use of endurance time data in heavy snow • Analyse historical Type I fluid data sets
5. Collect snow machine data at very cold temperatures	• No work completed	• Collect artificial snow data at very cold temperatures at 50 g/dm²/h

2.4 Report Format

The work completed on the heavy snow project in the winter of 2016-17 is documented in detail in the subsections that follow. The work is presented by heavy snow activity; separate subsections are provided for each heavy snow activity for which work was completed.

- Subsection 2.5: Collect fluid-specific endurance time data
- Subsection 2.6: Verify validity of regression curves at rates above 25 g/dm²/h
- Subsection 2.7: Collect snow machine data at very cold temperatures

Subsections on conclusions (Subsection 2.8) and recommendations (Subsection 2.9) follow.

2.5 Collection of Supplemental Fluid-Specific Endurance Time Data

Supplemental data were collected to complement the existing historical endurance time data sets. Data were collected with Type II, III and IV fluids on an as needed basis, as described below.

2.5.1 Fluid Samples

Lowest on-wing viscosity samples of fluids for which sufficient heavy snow data did not exist were collected. In some cases, samples were rejected as viscosities were not determined to be sufficiently close to the published LOWV. In some cases, manufacturers did not provide the requested samples. Samples were collected in both winter 2015-16 and 2016-17.

2.5.2 Data Collection

Data were collected over the winters of 2015-16 and 2016-17. The objective was to collect data points in heavy snow (precipitation rates > 25 g/dm²/h) at a variety of temperatures. Data collection was challenging as heavy snow is not a frequently occurring event and typically, when it does occur, it is of short duration.

In some cases, preliminary data collected did not appear to conform with historical data. In these cases, supplemental data were collected at lower precipitation rates (< 25 g/dm²/h) to confirm and assess the nature of the discrepancies observed with the heavy snow data.

A log of endurance time data collected for this project is provided in Table 2.2.

Table 2.2: Log of Tests Conducted for Heavy Snow Project

Test No.	Date	Fluid Name	Fluid Dilution	Precipitation Rate (g/dm²/h)	Fail Time (min)	Temp (°C)
1	29-Dec-15	Cryotech Polar Guard Advance	100/0	35.5	17.0	-11.5
2	29-Dec-15	Cryotech Polar Guard Advance	75/25	35.6	16.6	-11.5
4	29-Dec-15	Dow EG106	100/0	34.1	35.9	-11.4
5	29-Dec-15	ABAX ECOWING AD-49	100/0	34.9	22.4	-11.4
6	29-Dec-15	ABAX ECOWING AD-49	75/25	35.0	20.5	-11.4
7	29-Dec-15	ABAX ECOWING 26	100/0	33.3	26.3	-11.4
8	29-Dec-15	ABAX ECOWING 26	75/25	35.1	18.7	-11.4
9	29-Dec-15	Clariant Max Flight SNEG	100/0	33.1	25.4	-11.4
11	29-Dec-15	Newave FCY-2 Bio+	100/0	33.1	19.3	-11.3
13	29-Dec-15	Newave FCY 9311	100/0	33.1	21.0	-11.3
14	29-Dec-15	Cryotech Polar Guard Advance	100/0	28.7	30.0	-8.1
15	29-Dec-15	Cryotech Polar Guard Advance	75/25	28.7	25.9	-8.1
16	29-Dec-15	Clariant Max Flight 04	100/0	27.8	45.4	-8.1
17	29-Dec-15	Dow EG106	100/0	28.4	29.2	-8.1
18	29-Dec-15	ABAX ECOWING 26	100/0	28.1	24.2	-8.1
19	29-Dec-15	ABAX ECOWING 26	75/25	30.9	8.8	-8.1
20	29-Dec-15	ABAX ECOWING AD-49	100/0	28.1	35.0	-8.1
21	29-Dec-15	ABAX ECOWING AD-49	75/25	28.0	26.6	-8.1
22	16-Feb-16	Aviation Shaanxi Cleanwing II	100/0	32.4	57.9	-6.3
23	16-Feb-16	Aviation Shaanxi Cleanwing II	75/25	32.2	51.7	-6.3
24	16-Feb-16	ABAX ECOWING AD-49	100/0	32.3	57.0	-6.3
25	16-Feb-16	ABAX ECOWING AD-49	75/25	31.4	39.9	-6.4
26	16-Feb-16	Cryotech Polar Guard Advance	100/0	31.9	48.5	-6.3
27	16-Feb-16	Cryotech Polar Guard Advance	75/25	31.2	38.9	-6.4
28	16-Feb-16	Dow EG106	100/0	31.7	48.0	-6.3
29	16-Feb-16	Clariant Max Flight 04	100/0	32.5	65.2	-6.2
30	16-Feb-16	Newave FCY-2 Bio+	100/0	29.4	30.2	-6.4
31	16-Feb-16	Clariant Max Flight SNEG	100/0	31.1	44.3	-6.3
32	16-Feb-16	ABAX ECOWING 26	100/0	30.5	37.3	-6.3
33	16-Feb-16	ABAX ECOWING 26	75/25	34.6	13.8	-6.0
34	16-Feb-16	LNT P250	75/25	37.1	35.5	-5.9
35	16-Feb-16	Newave FCY 9311	100/0	36.7	44.2	-5.8
36	24-Feb-16	Aviation Shaanxi Cleanwing II	50/50	22.6	25.6	-1.2
37	24-Feb-16	ABAX ECOWING AD-49	50/50	21.8	17.3	-1.2
38	24-Feb-16	Aviation Shaanxi Cleanwing II	100/0	23.2	40.8	-1.2
39	24-Feb-16	ABAX ECOWING AD-49	100/0	21.9	102.1	-1.1
40	24-Feb-16	Cryotech Polar Guard Advance	100/0	24.3	66.7	-1.2

Table 2.2: Log of Tests Conducted for Heavy Snow Project (cont'd)

Test No.	Date	Fluid Name	Fluid Dilution	Precipitation Rate (g/dm²/h)	Fail Time (min)	Temp (°C)
41	24-Feb-16	Aviation Shaanxi Cleanwing II	75/25	23.1	30.1	-1.2
42	24-Feb-16	ABAX ECOWING AD-49	75/25	18.1	66.5	-1.1
43	24-Feb-16	Cryotech Polar Guard Advance	50/50	21.5	17.3	-1.1
44	24-Feb-16	ABAX ECOWING 26	50/50	23.0	9.8	-1.1
45	24-Feb-16	Cryotech Polar Guard Advance	75/25	17.5	58.6	-1.1
46	24-Feb-16	Dow EG106	100/0	18.5	75.1	-1.1
47	24-Feb-16	Clariant LAUNCH PLUS	50/50	17.4	35.0	-1.1
48	24-Mar-16	Aviation Shaanxi Cleanwing II	50/50	11.3	16.3	-6.6
49	24-Mar-16	ABAX ECOWING AD-49	50/50	11.0	16.8	-6.6
50	24-Mar-16	ABAX ECOWING AD-49	75/25	10.1	65.0	-6.6
51	24-Mar-16	Aviation Shaanxi Cleanwing II	75/25	10.8	38.0	-6.6
52	24-Mar-16	Cryotech Polar Guard Advance	100/0	11.0	88.6	-6.6
53	24-Mar-16	ABAX ECOWING AD-49	100/0	37.5	23.1	-6.4
54	24-Mar-16	Aviation Shaanxi Cleanwing II	100/0	33.7	15.5	-6.4
55	24-Mar-16	Cryotech Polar Guard Advance	50/50	25.0	5.8	-6.4
56	24-Mar-16	ABAX ECOWING 26	50/50	25.1	5.8	-6.4
57	24-Mar-16	Dow EG106	100/0	39.9	24.3	-6.4
58	24-Mar-16	Aviation Shaanxi Cleanwing II	50/50	29.0	8.3	-6.4
59	24-Mar-16	ABAX ECOWING AD-49	50/50	29.1	8.0	-6.4
60	24-Mar-16	Cryotech Polar Guard Advance	75/25	36.8	16.8	-6.4
61	24-Mar-16	ABAX ECOWING 26	100/0	38.6	18.2	-6.4
62	24-Mar-16	ABAX ECOWING 26	75/25	33.6	9.9	-6.4
63	24-Mar-16	Newave FCY-2 Bio+	100/0	46.9	12.0	-6.4
64	24-Mar-16	Newave FCY 9311	100/0	48.1	16.3	-6.4
65	24-Mar-16	Clariant Max Flight SNEG	100/0	47.0	19.6	-6.4
66	24-Mar-16	Clariant Max Flight 04	100/0	45.3	25.9	-6.4
68	24-Mar-16	ABAX ECOWING AD-49	50/50	43.6	7.7	-6.4
69	24-Mar-16	Aviation Shaanxi Cleanwing II	50/50	43.6	6.3	-6.4
70	24-Mar-16	Dow EG106	100/0	44.3	23.0	-6.3
71	24-Mar-16	ABAX ECOWING 26	50/50	43.2	4.3	-6.4
72	24-Mar-16	Clariant Max Flight 04	100/0	31.5	45.3	-6.1
73	24-Mar-16	ABAX ECOWING AD-49	100/0	31.4	45.1	-6.1
74	24-Mar-16	Cryotech Polar Guard Advance	50/50	42.6	3.8	-6.4
75	24-Mar-16	Aviation Shaanxi Cleanwing II	100/0	47.3	15.4	-6.1
76	24-Mar-16	ABAX ECOWING AD-49	75/25	36.1	27.9	-6.1
77	24-Mar-16	Cryotech Polar Guard Advance	75/25	33.9	31.3	-6.1
78	24-Mar-16	Newave FCY 9311	100/0	30.0	38.9	-6.1
79	24-Mar-16	Cryotech Polar Guard Advance	100/0	29.5	40.2	-6.1

Table 2.2: Log of Tests Conducted for Heavy Snow Project (cont'd)

Test No.	Date	Fluid Name	Fluid Dilution	Precipitation Rate (g/dm²/h)	Fail Time (min)	Temp (°C)
80	24-Mar-16	Aviation Shaanxi Cleanwing II	75/25	46.6	11.5	-6.1
81	24-Mar-16	Clariant Launch Plus	50/50	46.5	7.4	-6.1
82	24-Mar-16	Clariant Max Flight SNEG	100/0	36.7	29.3	-6.1
83	24-Mar-16	Newave FCY-2 Bio+	100/0	19.6	38.8	-5.9
84	24-Mar-16	ABAX ECOWING 26	100/0	19.4	42.0	-5.9
85	24-Mar-16	ABAX ECOWING 26	75/25	20.2	19.8	-6.1
13	29-Dec-16	ABAX ECOWING 26	50/50	43.1	3.8	-2.6
11	29-Dec-16	ABAX ECOWING 26	50/50	37.6	4.1	-2.6
98	12-Feb-17	ABAX ECOWING 26	50/50	31.8	5.6	-3.4
48	24-Jan-17	ABAX ECOWING 26	50/50	45.5	2.9	-3.5
91	12-Feb-17	ABAX ECOWING 26	50/50	23.2	6.7	-3.5
84	12-Feb-17	ABAX ECOWING 26	50/50	47.5	2.8	-4.3
79	12-Feb-17	ABAX ECOWING 26	50/50	37.1	4.0	-4.4
10	29-Dec-16	ABAX ECOWING 26	75/25	37.6	9.9	-2.6
97	12-Feb-17	ABAX ECOWING 26	75/25	31.6	15.3	-3.4
90	12-Feb-17	ABAX ECOWING 26	75/25	20.6	20.2	-3.4
47	24-Jan-17	ABAX ECOWING 26	75/25	45.8	11.6	-3.5
83	12-Feb-17	ABAX ECOWING 26	75/25	48.0	8.7	-3.6
76	12-Feb-17	ABAX ECOWING 26	75/25	35.4	11.9	-4.4
73	12-Feb-17	ABAX ECOWING 26	75/25	22.4	18.7	-7.2
116	14-Mar-17	ABAX ECOWING 26	75/25	45.2	7.3	-7.9
109	14-Mar-17	ABAX ECOWING 26	75/25	31.4	12.8	-8.0
121	14-Mar-17	ABAX ECOWING 26	75/25	37.8	7.3	-8.1
22	3-Jan-17	ABAX/Dow AD-49	100/0	19.1	125.5	0.2
25	4-Jan-17	ABAX/Dow AD-49	100/0	16.3	134.7	-0.4
26	4-Jan-17	ABAX/Dow AD-49	100/0	14.4	115.0	-0.7
14	29-Dec-16	ABAX/Dow AD-49	100/0	7.6	150.9	-1.2
28	10-Jan-17	ABAX/Dow AD-49	100/0	5.8	201.5	-2.0
5	29-Dec-16	ABAX/Dow AD-49	100/0	41.7	30.4	-2.3
1	29-Dec-16	ABAX/Dow AD-49	100/0	16.0	81.0	-3.2
93	12-Feb-17	ABAX/Dow AD-49	100/0	28.2	52.1	-3.4
86	12-Feb-17	ABAX/Dow AD-49	100/0	27.8	52.1	-3.5
42	24-Jan-17	ABAX/Dow AD-49	100/0	39.6	46.2	-3.5
100	14-Feb-17	ABAX/Dow AD-49	100/0	6.0	165.0	-3.5
38	18-Jan-17	ABAX/Dow AD-49	100/0	7.3	186.9	-3.9
36	18-Jan-17	ABAX/Dow AD-49	100/0	4.6	199.6	-4.2
77	12-Feb-17	ABAX/Dow AD-49	100/0	35.5	32.9	-4.3
35	18-Jan-17	ABAX/Dow AD-49	100/0	5.4	215.1	-4.7

Table 2.2: Log of Tests Conducted for Heavy Snow Project (cont'd)

Test No.	Date	Fluid Name	Fluid Dilution	Precipitation Rate (g/dm²/h)	Fail Time (min)	Temp (°C)
32	17-Jan-17	ABAX/Dow AD-49	100/0	8.2	164.2	-5.2
69	12-Feb-17	ABAX/Dow AD-49	100/0	19.5	71.4	-6.5
117	14-Mar-17	ABAX/Dow AD-49	100/0	45.9	31.3	-7.8
110	14-Mar-17	ABAX/Dow AD-49	100/0	33.1	44.5	-8.0
122	14-Mar-17	ABAX/Dow AD-49	100/0	38.0	25.9	-8.3
112	14-Mar-17	ABAX/Dow AD-49	100/0	36.9	37.3	-8.3
65	12-Feb-17	ABAX/Dow AD-49	100/0	18.4	55.2	-8.9
105	14-Mar-17	ABAX/Dow AD-49	100/0	14.2	87.6	-9.0
18	31-Dec-16	ABAX/Dow AD-49	100/0	8.9	109.1	-9.5
61	12-Feb-17	ABAX/Dow AD-49	100/0	18.8	45.3	-9.8
20	31-Dec-16	ABAX/Dow AD-49	100/0	8.6	118.6	-10.1
51	1-Feb-17	ABAX/Dow AD-49	100/0	2.7	133.7	-13.3
23	3-Jan-17	ABAX/Dow AD-49	75/25	18.5	75.7	0.2
24	4-Jan-17	ABAX/Dow AD-49	75/25	19.9	74.8	0.0
27	4-Jan-17	ABAX/Dow AD-49	75/25	11.0	119.9	-1.0
15	29-Dec-16	ABAX/Dow AD-49	75/25	8.3	110.6	-1.3
29	10-Jan-17	ABAX/Dow AD-49	75/25	5.9	163.5	-2.3
6	29-Dec-16	ABAX/Dow AD-49	75/25	40.3	21.3	-2.5
2	29-Dec-16	ABAX/Dow AD-49	75/25	12.6	69.7	-3.3
94	12-Feb-17	ABAX/Dow AD-49	75/25	27.7	39.3	-3.4
43	24-Jan-17	ABAX/Dow AD-49	75/25	41.8	39.2	-3.5
87	12-Feb-17	ABAX/Dow AD-49	75/25	32.9	34.4	-3.5
39	18-Jan-17	ABAX/Dow AD-49	75/25	11.5	81.0	-3.6
101	14-Feb-17	ABAX/Dow AD-49	75/25	7.0	113.9	-3.8
37	18-Jan-17	ABAX/Dow AD-49	75/25	4.2	182.4	-4.2
78	12-Feb-17	ABAX/Dow AD-49	75/25	35.7	27.3	-4.4
34	18-Jan-17	ABAX/Dow AD-49	75/25	7.3	112.2	-5.1
33	17-Jan-17	ABAX/Dow AD-49	75/25	6.8	127.3	-5.2
70	12-Feb-17	ABAX/Dow AD-49	75/25	21.9	42.2	-6.8
118	14-Mar-17	ABAX/Dow AD-49	75/25	46.3	17.9	-7.9
111	14-Mar-17	ABAX/Dow AD-49	75/25	33.5	38.5	-8.0
123	14-Mar-17	ABAX/Dow AD-49	75/25	38.6	17.4	-8.3
113	14-Mar-17	ABAX/Dow AD-49	75/25	31.9	27.9	-8.3
66	12-Feb-17	ABAX/Dow AD-49	75/25	18.2	46.8	-8.9
106	14-Mar-17	ABAX/Dow AD-49	75/25	13.9	82.9	-9.0
19	31-Dec-16	ABAX/Dow AD-49	75/25	8.8	106.7	-9.5
62	12-Feb-17	ABAX/Dow AD-49	75/25	18.8	39.9	-9.8
21	31-Dec-16	ABAX/Dow AD-49	75/25	8.4	113.1	-10.1

Table 2.2: Log of Tests Conducted for Heavy Snow Project (cont'd)

Test No.	Date	Fluid Name	Fluid Dilution	Precipitation Rate (g/dm²/h)	Fail Time (min)	Temp (°C)
52	1-Feb-17	ABAX/Dow AD-49	75/25	2.5	230.6	-13.1
7	29-Dec-16	Cryotech Polar Guard Advance	100/0	24.6	84.1	-2.0
3	29-Dec-16	Cryotech Polar Guard Advance	100/0	16.5	79.1	-3.2
102	14-Feb-17	Cryotech Polar Guard Advance	100/0	6.0	221.4	-3.4
88	12-Feb-17	Cryotech Polar Guard Advance	100/0	17.8	91.3	-3.4
96	12-Feb-17	Cryotech Polar Guard Advance	100/0	25.1	95.5	-3.5
44	24-Jan-17	Cryotech Polar Guard Advance	100/0	31.5	78.3	-3.5
82	12-Feb-17	Cryotech Polar Guard Advance	100/0	48.3	16.2	-3.5
74	12-Feb-17	Cryotech Polar Guard Advance	100/0	35.3	34.5	-4.3
71	12-Feb-17	Cryotech Polar Guard Advance	100/0	19.2	92.0	-6.3
114	14-Mar-17	Cryotech Polar Guard Advance	100/0	45.0	59.6	-7.8
107	14-Mar-17	Cryotech Polar Guard Advance	100/0	30.5	77.6	-8.1
119	14-Mar-17	Cryotech Polar Guard Advance	100/0	35.1	53.3	-8.2
67	12-Feb-17	Cryotech Polar Guard Advance	100/0	18.5	56.4	-8.8
63	12-Feb-17	Cryotech Polar Guard Advance	100/0	18.9	47.1	-9.8
12	29-Dec-16	Cryotech Polar Guard Advance	50/50	41.5	4.5	-2.6
9	29-Dec-16	Cryotech Polar Guard Advance	50/50	39.9	4.6	-2.6
99	12-Feb-17	Cryotech Polar Guard Advance	50/50	31.9	8.5	-3.4
46	24-Jan-17	Cryotech Polar Guard Advance	50/50	42.8	4.7	-3.4
92	12-Feb-17	Cryotech Polar Guard Advance	50/50	21.7	10.5	-3.4
85	12-Feb-17	Cryotech Polar Guard Advance	50/50	50.9	3.6	-4.3
80	12-Feb-17	Cryotech Polar Guard Advance	50/50	37.8	5.8	-4.4
104	14-Feb-17	Cryotech Polar Guard Advance	50/50	10.6	13.4	-4.4
8	29-Dec-16	Cryotech Polar Guard Advance	75/25	41.0	26.8	-2.3
4	29-Dec-16	Cryotech Polar Guard Advance	75/25	14.1	72.6	-3.2
89	12-Feb-17	Cryotech Polar Guard Advance	75/25	17.7	63.3	-3.4
95	12-Feb-17	Cryotech Polar Guard Advance	75/25	28.1	48.6	-3.4
45	24-Jan-17	Cryotech Polar Guard Advance	75/25	40.4	41.0	-3.5
81	12-Feb-17	Cryotech Polar Guard Advance	75/25	48.0	14.8	-3.6
103	14-Feb-17	Cryotech Polar Guard Advance	75/25	6.0	156.3	-3.6
75	12-Feb-17	Cryotech Polar Guard Advance	75/25	35.4	29.0	-4.4
72	12-Feb-17	Cryotech Polar Guard Advance	75/25	21.9	40.6	-6.8
115	14-Mar-17	Cryotech Polar Guard Advance	75/25	46.5	15.9	-7.9
108	14-Mar-17	Cryotech Polar Guard Advance	75/25	31.0	27.0	-8.0
120	14-Mar-17	Cryotech Polar Guard Advance	75/25	38.6	16.8	-8.3
68	12-Feb-17	Cryotech Polar Guard Advance	75/25	18.3	44.7	-8.9
64	12-Feb-17	Cryotech Polar Guard Advance	75/25	18.7	33.2	-9.9

2.5.3 Conformance Analysis

A conformance analysis was completed to determine if the supplemental data collected in heavy snow conformed with the historical endurance time data. The conformance analysis was only completed with fluids for which supplemental data were collected.

The first step in the analysis was to calculate holdover times for "boundary" conditions. Boundary conditions are precipitation rate / temperature combinations used to calculate holdover time table values. The boundary conditions used in the conformance analysis are shown in Table 2.3. It should be noted that 50 g/dm²/h is not a boundary condition for which holdover times are currently published; however, the purpose of this project was to analyse the data for this precipitation rate (heavy snow) so it has been included. In addition, as fluid-specific data is not used to determine holdover times below -14°C, colder temperatures have been excluded.

Table 2.3: Boundary Conditions Used in Conformance Analysis

Fluid Type and Dilution	Precipitation Rates (g/dm²/h)	Temperatures (°C)
Type II/IV 100/0	3, 4, 10, 25, 50	-3, -14
Type II/IV 75/25	3, 4, 10, 25, 50	-3, -14
Type II/IV 50/50	3, 4, 10, 25, 50	-3
Type III 100/0	3, 4, 10, 25, 50	-3, -10
Type III 75/25	3, 4, 10, 25, 50	-3, -10
Type III 50/50	3, 4, 10, 25, 50	-3

The boundary condition holdover times were calculated from regression curves derived from two data sets:

1. Historical data only (this data produces the published holdover times); and
2. Combined data set of historical data and supplemental data. Supplemental data includes data collected for the heavy snow project (see Subsection 2.5.2), and data collected in 2012-13 for the light/very light snow project (documented in TC report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (3)).

The next step was to compare the boundary condition holdover times derived from the two data sets. Minor differences were considered acceptable; major changes were not. Changes were considered major if the holdover times calculated from the combined data regression curve were shorter than the holdover times calculated from the historical data regression curve by more than:

- 2 minutes (original holdover time $<$ 15 mins);
- 5 minutes (original holdover time 15 to 90 mins); or
- 10 minutes (original holdover time $>$ 90 mins).

The details of the analysis are shown in Table 2.4. In most cases no significant differences were observed between the holdover times calculated for the two data sets. However, there were several exceptions:

- Cryotech Polar Guard Advance (100/0, 75/25, 50/50);
- Cryotech Polar Guard II (100/0, 75/25, 50/50);
- ABAX / Dow AD-49 (100/0, 75/25);
- ABAX ECOWING 26 (75/25, 50/50); and
- Clariant Max Flight SNEG (100/0).

The data for these fluids was further examined. It was found that the discrepancies generally occurred as a result of fluids being submitted late in the season in the year they were originally tested. As a result, they lacked data at very low and/or very high precipitation rates. When data is “missing,” especially at the lower and/or upper ends of the precipitation rate and/or temperature ranges, the shapes of the regression curves are affected, typically at both “ends” (low and high rates) of the curves. This results in the data set providing potentially inaccurate holdover times in these conditions.

It was concluded from this analysis that the existing regression curves for the fluids identified above were not validated for use in heavy snow. The proposed solution was to recalculate all holdover times for these fluids using the combined data sets; this provides holdover times that are accurate for all precipitation rates including heavy snow. As a result of the recalculations, holdover times for heavier precipitation rates and in some cases lighter precipitation rates changed (due to the shapes of the curves changing at both ends of the curves).

Memos were prepared to document the details of the non-conforming data sets and to communicate them to TC and FAA. Copies of these memos are included in Appendix B.

TC and FAA subsequently had discussions with the affected fluid manufacturers. In the end, the proposed solutions were accepted by all parties and the proposed changes were incorporated into the TC and FAA Holdover Time Guidelines documents for the winter of 2017-18.

Table 2.4: Conformance Analysis Calculations

Fluid	Dil	Temp (°C)	ORIGINAL HOTS (at g/dm²/h)					NEW HOTS (at g/dm²/h)					CHANGE IN HOTS (at g/dm²/h)				
			50	25	10	4	3	50	25	10	4	3	50	25	10	4	3
Clariant LAUNCH	100/0	-3	45	65	105	170	200	44	65	110	185	220	-1	0	5	15	20
Clariant LAUNCH	75/25	-3	39	60	105	185	220	39	60	110	205	245	0	0	5	20	25
Clariant LAUNCH	50/50	-3	15	25	45	85	100	16	25	45	85	100	1	0	0	0	0
Clariant LAUNCH	100/0	-14	34	50	80	130	150	33	50	80	135	160	-1	0	0	5	10
Clariant LAUNCH	75/25	-14	31	45	85	145	175	30	50	90	160	195	-1	5	5	15	20
Clariant FLIGHT	75/25	-3	26	40	80	155	190	23	40	85	185	230	-3	0	5	30	40
Clariant FLIGHT	75/25	-14	13	20	40	80	100	12	20	45	95	120	-1	0	5	15	20
Kilfrost ABC-S Plus	100/0	-3	48	75	125	215	255	48	75	135	245	295	0	0	10	30	40
Kilfrost ABC-S Plus	75/25	-3	29	45	75	125	145	29	45	75	125	145	0	0	0	0	0
Kilfrost ABC-S Plus	100/0	-14	40	60	105	175	210	38	60	105	190	230	-2	0	0	15	20
Kilfrost ABC-S Plus	75/25	-14	24	35	60	105	120	24	35	60	100	120	0	0	0	-5	0
Aviation Shaanxi Cleanwing II	100/0	-3	18	30	55	100	120	19	30	55	100	120	1	0	0	0	0
Aviation Shaanxi Cleanwing II	75/25	-3	15	25	45	85	105	16	25	45	85	100	1	0	0	0	-5
Aviation Shaanxi Cleanwing II	50/50	-3	10	15	30	50	65	8	15	25	55	65	-2	0	-5	5	0
Aviation Shaanxi Cleanwing II	100/0	-14	18	30	55	100	120	18	30	50	95	110	0	0	-5	-5	-10
Aviation Shaanxi Cleanwing II	75/25	-14	15	25	45	85	105	16	25	45	80	100	1	0	0	-5	-5
Clariant Max Flight 04	100/0	-3	50	85	165	325	400	49	80	165	330	415	-1	-5	0	5	15
Clariant Max Flight 04	100/0	-14	21	35	70	140	170	20	35	70	140	175	-1	0	0	0	5
Clariant Max Flight SNEG	100/0	-3	44	65	100	165	190	35	55	100	180	220	-9	-10	0	15	30
Clariant Max Flight SNEG	100/0	-14	32	45	75	120	140	24	40	70	125	150	-8	-5	-5	5	10
Dow EG106	100/0	-3	22	40	80	165	210	27	45	85	165	205	5	5	5	0	-5
Dow EG106	100/0	-14	18	30	65	130	165	20	35	65	125	155	2	5	0	-5	-10
Newave FCY 9311	100/0	-3	21	35	70	140	175	23	40	70	135	165	2	5	0	-5	-10
Newave FCY 9311	100/0	-14	14	25	50	95	120	17	25	50	95	115	3	0	0	0	-5
Newave FCY-2 Bio+	100/0	-3	17	30	65	140	175	19	30	65	135	170	2	0	0	-5	-5
Newave FCY-2 Bio+	100/0	-14	7	15	30	60	75	9	15	30	60	75	2	0	0	0	0
Clariant LAUNCH PLUS	100/0	-3	30	55	125	280	365	30	55	125	275	355	0	0	0	-5	-10
Clariant LAUNCH PLUS	75/25	-3	25	50	115	275	360	25	50	115	270	350	0	0	0	-5	-10
Clariant LAUNCH PLUS	50/50	-3	11	20	45	95	120	10	20	40	95	120	-1	0	-5	0	0
Clariant LAUNCH PLUS	100/0	-14	20	40	85	195	250	20	40	85	190	240	0	0	0	-5	-10
Clariant LAUNCH PLUS	75/25	-14	16	30	75	175	230	17	30	75	175	230	1	0	0	0	0
ABAX Ecowing 26	100/0	-3	27	40	60	95	110	24	35	60	100	120	-3	-5	0	5	10
ABAX Ecowing 26	75/25	-3	18	25	45	80	95	13	20	40	80	100	-5	-5	-5	0	5
ABAX Ecowing 26	50/50	-3	7	10	20	40	50	4	7	20	40	50	-3	-3	0	0	0
ABAX Ecowing 26	100/0	-14	24	35	55	85	100	20	30	50	85	100	-4	-5	-5	0	0
ABAX Ecowing 26	75/25	-14	16	25	40	75	85	9	15	30	55	70	-7	-10	-10	-20	-15
ABAX/Dow AD-49	100/0	-3	51	70	110	170	195	36	60	115	220	270	-15	-10	5	50	75
ABAX/Dow AD-49	75/25	-3	73	85	100	120	130	26	45	95	195	245	-47	-40	-5	75	115
ABAX/Dow AD-49	50/50	-3	10	15	25	40	45	7	15	25	55	70	-3	0	0	15	25
ABAX/Dow AD-49	100/0	-14	51	70	110	170	195	24	40	75	145	180	-27	-30	-35	-25	-15
ABAX/Dow AD-49	75/25	-14	73	85	100	120	130	18	30	65	140	175	-55	-55	-35	20	45
Cryotech Polar Guard Advance	100/0	-3	62	80	110	155	170	43	65	115	195	235	-19	-15	5	40	65
Cryotech Polar Guard Advance	75/25	-3	29	45	80	145	175	23	40	85	180	230	-6	-5	5	35	55
Cryotech Polar Guard Advance	50/50	-3	10	15	35	80	100	5	10	25	70	95	-5	-5	-10	-10	-5
Cryotech Polar Guard Advance	100/0	-14	42	55	75	105	115	26	40	70	120	140	-16	-15	-5	15	25
Cryotech Polar Guard Advance	75/25	-14	21	35	60	105	125	15	25	55	120	150	-6	-10	-5	15	25

Note: 3-25 g values = rounded HOTs, 50 g values = ET rounded to nearest minute

Legend - Changes in HOTs shading	No difference or increase	Acceptable decrease	Unacceptable decrease

2.6 Verification of the Validity of Regression Curves

Several tasks were completed to verify the validity of the regression curves derived from endurance time data for use with heavy snow. These are documented in the following subsections.

2.6.1 Refinement of HUPR and LUPR Analysis Methodologies

An analysis methodology was developed early in the winter of 2015-16 to assess the validity of snow endurance time data sets at high rates of precipitation (see Subsection 2.2.2). This methodology was based on the approach developed in the winter of 2012-13 to assess the validity of snow endurance time data sets at low rates of precipitation. This work was used in the determination of light and very light snow holdover times and resulted in the publication of limitations on the use of this data in the form of lowest usable precipitation rates (LUPRs). The work is documented in the TC report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (3).

In 2016-17, significant effort went into refining this methodology to determine the most appropriate and accurate analysis methodology for determining the highest usable precipitation rates (HUPRs). Specifically, the factor weightings, data rating scores and minimum passing scores were modified. The collection of additional heavy snow data made this possible.

In addition, the LUPR analysis methodology was re-examined in conjunction with the HUPR analysis methodology. Several refinements were made to the LUPR analysis methodology as a result.

The final analysis approach for the determination of both HUPR and LUPR is a weighted three-factor analysis. Table 2.5 lists the three factors and their weightings. Table 2.6 shows the data rating score criteria.

The ratings are multiplied by the factor weighting to determine a final score for a specific precipitation rate. LUPR scores are calculated for each precipitation rate between 3 and 10 g/dm²/h. HUPR scores are calculated for 25 and 50 g/dm²/h and rates in multiples of 5 in between (25, 30, 35, 40, 45, 50). The scores are compared to the minimum acceptance score, which is 26. The LUPR is the lowest precipitation rate at which a data set has a passing score; the HUPR is the highest precipitation rate at which a data set has a passing score.

This analysis approach was drafted into the SAE standard ARP5718B, *Qualifications Required for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluid* (4). The document was balloted to the SAE G-12 Holdover Time Committee and passed. Therefore, this methodology has been accepted by the aircraft ground icing industry.

Table 2.5: Factors Used in LUPR/HUPR Calculations

Factor	Description – LUPR	Description – HUPR	Weight
1. Data Points with Precipitation Rates near the Precipitation Rate being Examined	Number of data points with precipitation rates ≤ 0.5 g/dm²/h above the precipitation rate being examined	Number of data points with precipitation rates ≥ 10 g/dm²/h below the precipitation rate being examined	30%
2. Data Points in High or Low Precipitation Rate Categories	Number of data points with precipitation rates ≤ 10 g/dm²/h	Number of data points with precipitation rates ≥ 20 g/dm²/h	50%
3. Negative Scatter of High or Low Precipitation Rate Data Points	Difference between endurance time predicted by regression curve and measured endurance time calculated as a percentage Scatter is set to 0% for data points with positive scatter (i.e. predicted endurance time < measured endurance time) Average scatter is calculated for all data points ≤ 10 g/dm²/h	Difference between endurance time predicted by regression curve and measured endurance time calculated as a percentage Scatter is set to 0% for data points with positive scatter (i.e. predicted endurance time < measured endurance time) Average scatter is calculated for all data points ≥ 25 g/dm²/h	20%

Table 2.6: LUPR/HUPR Factor Ratings

Factor #1: Data Points with Precipitation Rates near the Precipitation Rate being Examined		
Rating	**LUPR**	**HUPR**
Rating = 40	≥3 data points ≤ precipitation rate +0.5	≥2 data points ≥ precipitation rate -10
Rating = 30	2 data points ≤ precipitation rate +0.5	1 data points ≥ precipitation rate -10
Rating = 20	1 data point ≤ precipitation rate +0.5	n/a
Rating = 10	n/a	n/a
Rating = 0	0 data points ≤ precipitation rate +0.5	0 data points ≥ precipitation rate -10
Factor #2: Data Points at High or Low Precipitation Rate Categories		
Rating	**LUPR**	**HUPR**
Rating = 40	≥8 data points ≤10 g/dm²/h	≥5 data points >20 g/dm²/h
Rating = 30	6-7 data points ≤10 g/dm²/h	4 data points >20 g/dm²/h
Rating = 20	4-5 data points ≤10 g/dm²/h	3 data points >20 g/dm²/h
Rating = 10	2-3 data points ≤10 g/dm²/h	2 data points >20 g/dm²/h
Rating = 0	<2 data points ≤10 g/dm²/h	<2 data points >20 g/dm²/h
Factor #3: Negative Scatter of High or Low Precipitation Rate Data Points		
Rating	**LUPR**	**HUPR**
Rating = 40	≥-10%	≥-10%
Rating = 30	-11 to -15%	-11 to -15%
Rating = 20	-16 to -20%	-16 to -20%
Rating = 10	n/a	n/a
Rating = 0	<-20%	<-20%

2.6.2 Application of LUPR/HUPR Analysis Methodology to Determine LUPR/HUPRs

The final HUPR and LUPR analysis methodologies were applied to all Type II, Type III and Type IV fluid-specific endurance time data sets. The data sets consisted of the following data:

1. Historic endurance time testing data collected the year(s) the fluid originally underwent endurance time testing;
2. (If applicable) Supplemental endurance time data collected in the winters of 2015-16 and 2016-17 in support of heavy snow holdover times (see Subsection 2.5.2); and
3. (If applicable) Supplemental light and very light snow endurance time data collected in the winter of 2012-13 in support of light and very light snow holdover times (documented in TC report, TP 15228E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter* (3)).

Table 2.7 and Table 2.8 provide the statistics and calculations used to determine the HUPR and LUPR values, respectively, for all Type II, Type III and Type IV fluids in the 2017-18 TC and FAA holdover time guidelines. The HUPR/LUPR values are shown in the last column of each table. HUPR/LUPR values that fall below or above the maximum/minimum possible values are shaded pink. These values represent a limitation on the use of the fluid at high and low rates of precipitation.

This data should be interpreted with caution. The next subsections provide important related information on the data, calculations, applicability and supporting files.

2.6.2.1 Note on Supplemental Data

As indicated above, supplemental data were not collected for all fluids. It was only collected if needed for the related project and if the fluid manufacturer was willing and able to provide the needed sample(s).

2.6.2.2 Calculation of Negative Scatter Score for Fluids with Non-Conforming Data

In the cases of data sets with non-conforming data (see Subsection 2.5.3), the revised regression coefficients (those derived from the combined historic and supplemental data sets) were used to calculate the negative scatter score. The original regression coefficients were used to calculate the negative scatter score for all other data sets.

2.6.2.3 Identification of Data Sets with Supplemental Data and/or Revised Regressions

The third column in Table 2.7 and Table 2.8 indicates whether supplemental (extra) data were collected for the data set (yes or no). It also indicates if the original or revised (new) regression was used in the calculations. See Subsection 2.6.2.2 above for related information.

2.6.2.4 Temperature Applicability of HUPR and LUPR Values

It should be noted that the HUPR and LUPR values in these tables is applicable only to the temperature range for which the endurance time data is used to derive holdover times:

- -14°C and above for Type II and Type IV 100/0 and 75/25 fluids;
- -25°C and above for Type III 100/0 fluids;
- -10°C and above for Type III 75/25 fluids; and
- -3°C and above for Type II, Type III and Type IV 50/50 fluids.

Determination of LUPR and HUPR values for other temperature ranges was not part of this project. Determination of these values is documented in the TC report, TP 15373E, *Regression Coefficients and Equations Used to Develop the Winter 2017-18 Aircraft Ground Deicing Holdover Time Tables* (5).

2.6.2.5 Note on Supporting Data Files

Multiple final data files exist for each fluid analysed as part of this project. Each file includes endurance time data, regression analysis, and HUPR/LUPR statistics, calculations, and scores. Up to three files may exist for each fluid.

1. <u>Original Data Only, Original Regression</u>: exists for all fluids. Provides final HUPR/LUPR and regression information for fluids without supplemental data. Provides baseline holdover time values for conformance analysis.
2. <u>Original Data + Supplemental Data, Original Regression</u>: exists for fluids for which supplemental data were collected. Provides final HUPR/LUPR and regression information for fluids with supplemental conforming data.
3. <u>Original Data + Supplemental Data, New Regression</u>: exists for fluids for which supplemental data were collected. Provides final HUPR/LUPR and regression information for fluids with supplemental non-conforming data. Provides comparative holdover times values for conformance analysis.

Table 2.7: Calculations to Determine HUPRs for 2017-18 Type II, III and IV De/Anti-Icing Fluids

Fluid Brand	Fluid Dil.	Extra Data / Regression	Factor Data Statistics*								HUPR Score*						HUPR* (g)
			Data Points >20 g	Data Points ≥15 g	Data Points ≥20 g	Data Points ≥25 g	Data Points ≥30 g	Data Points ≥35 g	Data Points ≥40 g	Neg. Scatter >25 g	25 g	30 g	35 g	40 g	45 g	50 g	
ABAX ECOWING 26	100/0	yes / original	15	19	15	8	6	3	2	-18%	38	38	38	38	38	38	50
ABAX ECOWING 26	75/25	yes / new	17	23	17	12	10	6	3	-20%	36	36	36	36	36	36	50
ABAX ECOWING 26	50/50	yes / new	11	14	11	8	7	5	3	-16%	36	36	36	36	36	36	50
ABAX ECOWING AD-2	100/0	no / original	7	13	7	6	5	3	2	-12%	38	38	38	38	38	38	50
ABAX ECOWING AD-2	75/25	no / original	8	13	8	5	4	4	3	-12%	38	38	38	38	38	38	50
ABAX ECOWING AD-2	50/50	no / original	7	9	7	4	4	3	2	-18%	36	36	36	36	36	36	50
ABAX ECOWING AD-49	100/0	yes / new	9	17	9	9	7	6	2	-9%	40	40	40	40	40	40	50
ABAX ECOWING AD-49	75/25	yes / new	14	21	14	13	11	7	3	-11%	38	38	38	38	38	38	50
ABAX ECOWING AD-49	50/50	yes / original	5	7	5	3	2	2	2	-34%	32	32	32	32	32	32	50
AllClear AeroClear MAX	100/0	no / original	9	13	9	5	4	4	3	-3%	40	40	40	40	40	40	50
Aviation Shaanxi Cleanwing II	100/0	yes / original	5	7	5	4	4	2	2	-14%	38	38	38	38	38	38	50
Aviation Shaanxi Cleanwing II	75/25	yes / original	4	7	4	3	3	2	2	-12%	35	35	35	35	35	35	50
Aviation Shaanxi Cleanwing II	50/50	yes / original	5	11	5	4	3	3	3	-26%	32	32	32	32	32	32	50
Beijing Yadilite YD-102	100/0	no / original	4	5	4	3	2	1	1	-14%	35	35	35	35	30	30	50
Beijing Yadilite YD-102	75/25	no / original	7	9	7	4	3	2	2	-10%	38	38	38	38	38	38	50
Beijing Yadilite YD-102	50/50	no / original	4	6	4	3	2	2	1	-5%	37	37	37	37	37	32	50
CHEMCO ChemR EG IV	100/0	no / original	7	13	7	5	5	4	3	-13%	38	38	38	38	38	38	50
Clariant EG IV NORTH	100/0	no / original	11	16	11	8	4	3	1	-6%	40	40	40	40	40	35	50
Clariant Max Flight 04	100/0	yes / original	8	12	8	5	4	2	1	-9%	40	40	40	40	40	35	50
Clariant Max Flight AVIA	100/0	no / original	11	16	11	7	4	3	1	-6%	40	40	40	40	40	35	50
Clariant Max Flight SNEG	100/0	yes / new	10	14	10	7	5	2	1	-16%	36	36	36	36	36	31	50
Clariant Max Flight SNEG	75/25	no / original	6	11	6	3	2	1	1	-14%	38	38	38	38	33	33	50
Clariant Max Flight SNEG	50/50	yes / original	11	11	11	7	6	2	1	-12%	38	38	38	38	38	33	50
Clariant MP II FLIGHT	100/0	no / original	8	11	8	5	1	0	0	-8%	40	40	40	35	20	20	40
Clariant MP II FLIGHT	75/25	yes / original	9	12	9	5	1	0	0	-11%	38	38	38	33	18	18	40
Clariant MP II FLIGHT	50/50	no / original	4	8	4	4	1	0	0	0%	37	37	37	32	17	17	40
Clariant MP II FLIGHT PLUS	100/0	no / original	5	9	5	2	1	1	1	0%	40	40	40	35	35	35	50
Clariant MP II FLIGHT PLUS	75/25	no / original	7	10	7	3	1	1	1	-26%	32	32	32	27	27	27	50
Clariant MP II FLIGHT PLUS	50/50	no / original	6	9	7	2	1	0	0	0%	40	40	40	35	20	20	40
Clariant MP III 2031 ECO	100/0	no / original	4	6	4	4	3	2	2	0%	37	37	37	37	37	37	50
Clariant MP III 2031 ECO	75/25	no / original	4	5	4	3	3	2	2	0%	37	37	37	37	37	37	50
Clariant MP III 2031 ECO	50/50	no / original	4	6	4	4	4	3	3	-4%	37	37	37	37	37	37	50
Clariant MP IV LAUNCH	100/0	yes / original	12	13	12	12	10	8	8	-6%	40	40	40	40	40	40	50
Clariant MP IV LAUNCH	75/25	yes / original	17	17	17	15	11	11	11	-11%	38	38	38	38	38	38	50
Clariant MP IV LAUNCH	50/50	yes / original	9	9	9	8	8	7	5	-6%	40	40	40	40	40	40	50

* g/dm²/h is abbreviated as "g" in this table

Table 2.7: Calculations to Determine HUPRs for 2017-18 Type II, III and IV De/Anti-Icing Fluids (cont'd)

Fluid Brand	Fluid Dil.	Extra Data / Regression	Factor Data Statistics*								HUPR Score*						HUPR* (g)
			Data Points >20 g	Data Points ≥15 g	Data Points ≥20 g	Data Points ≥25 g	Data Points ≥30 g	Data Points ≥35 g	Data Points ≥40 g	Neg. Scatter >25 g	25 g	30 g	35 g	40 g	45 g	50 g	
Clariant MP IV LAUNCH PLUS	100/0	yes / original	5	6	6	3	3	3	3	0%	40	40	40	40	40	40	50
Clariant MP IV LAUNCH PLUS	75/25	yes / original	6	8	6	5	4	4	3	0%	40	40	40	40	40	40	50
Clariant MP IV LAUNCH PLUS	50/50	yes / original	6	8	6	5	4	3	2	-13%	38	38	38	38	38	38	50
Cryotech Polar Guard Advance	100/0	yes / new	13	24	13	11	8	5	2	-17%	36	36	36	36	36	36	50
Cryotech Polar Guard Advance	75/25	yes / new	15	26	15	13	11	8	4	-11%	38	38	38	38	38	38	50
Cryotech Polar Guard Advance	50/50	yes / new	14	18	15	11	9	8	5	-10%	40	40	40	40	40	40	50
Cryotech Polar Guard II	100/0	yes / new	13	24	13	11	8	5	2	-17%	36	36	36	36	36	36	50
Cryotech Polar Guard II	75/25	yes / new	15	26	15	13	11	8	4	-11%	38	38	38	38	38	38	50
Cryotech Polar Guard II	50/50	yes / new	14	18	15	11	9	8	5	-10%	40	40	40	40	40	40	50
Deicing Solutions ECO-SHIELD	100/0	no / original	4	8	4	2	2	1	1	-4%	37	37	37	37	32	32	50
Dow Endurance EG106	100/0	yes / original	8	10	8	7	5	2	1	-3%	40	40	40	40	40	35	50
Dow FlightGuard AD-49	100/0	yes / new	9	17	9	9	7	6	2	-9%	40	40	40	40	40	40	50
Dow FlightGuard AD-49	75/25	yes / new	14	21	14	13	11	7	3	-11%	38	38	38	38	38	38	50
Dow FlightGuard AD-49	50/50	yes / original	5	7	5	3	2	2	2	-34%	32	32	32	32	32	32	50
Kilfrost ABC-Ice Clear II	100/0	no / original	8	10	8	7	5	5	4	-9%	40	40	40	40	40	40	50
Kilfrost ABC-Ice Clear II	75/25	no / original	6	11	6	5	4	4	4	-9%	40	40	40	40	40	40	50
Kilfrost ABC-Ice Clear II	50/50	no / original	7	9	7	6	3	3	2	-20%	36	36	36	36	36	36	50
Kilfrost ABC-K Plus	100/0	no / original	5	7	5	5	5	4	1	-15%	38	38	38	38	38	33	50
Kilfrost ABC-K Plus	75/25	no / original	8	9	8	6	5	3	3	-3%	40	40	40	40	40	40	50
Kilfrost ABC-K Plus	50/50	no / original	2	5	2	0	0	0	0	n/a	23	23	3	3	3	3	25
Kilfrost ABC-S Plus	100/0	yes / original	13	13	13	11	10	10	9	-7%	40	40	40	40	40	40	50
Kilfrost ABC-S Plus	75/25	yes / original	13	14	13	12	12	12	10	-7%	40	40	40	40	40	40	50
Kilfrost ABC-S Plus	50/50	no / original	7	7	7	7	7	6	4	-2%	40	40	40	40	40	40	50
LNT Solutions E450	100/0	no / original	6	9	6	5	4	3	2	-11%	38	38	38	38	38	38	50
Newave FCY 9311	100/0	yes / original	10	12	10	7	6	3	1	-6%	40	40	40	40	40	35	50
Newave FCY-2	100/0	no / original	11	13	11	9	7	7	4	-8%	40	40	40	40	40	40	50
Newave FCY-2	75/25	no / original	12	15	12	11	9	9	7	-4%	40	40	40	40	40	40	50
Newave FCY-2	50/50	no / original	8	8	8	8	8	7	4	-5%	40	40	40	40	40	40	50
Newave FCY-2 Bio+	100/0	yes / original	6	10	6	6	4	2	2	-6%	40	40	40	40	40	40	50
Newave FCY-2 Bio+	75/25	no / original	4	7	4	3	1	1	1	-4%	37	37	37	32	32	32	50
Newave FCY-2 Bio+	50/50	no / original	6	9	6	5	3	2	1	-10%	40	40	40	40	40	35	50
Oksayd Defrost ECO 4	100/0	no / original	5	11	5	4	3	2	1	-8%	40	40	40	40	40	35	50
Shaanxi Cleansurface IV	100/0	no / original	11	14	11	4	3	2	1	-12%	38	38	38	38	38	33	50
Shaanxi Cleansurface IV	75/25	no / original	12	16	12	7	3	2	2	-10%	38	38	38	38	38	38	50
Shaanxi Cleansurface IV	50/50	no / original	5	9	5	2	1	1	1	-17%	36	36	36	31	31	31	50

* g/dm²/h is abbreviated as "g" in this table

Table 2.8: Calculations to Determine LUPRs for 2017-18 Type II, III and IV De/Anti-Icing Fluids

Fluid Brand	Fluid Dil.	Extra Data / Regression	Factor Data Statistics*									LUPR Score*							LUPR* (g)
			Data Points ≤10.0 g	Data Points ≤9.5 g	Data Points ≤8.5 g	Data Points ≤7.5 g	Data Points ≤6.5 g	Data Points ≤5.5 g	Data Points ≤4.5 g	Data Points ≤3.5 g	Neg. Scatter 0-10 g	9 g	8 g	7 g	6 g	5 g	4 g	3 g	
ABAX ECOWING 26	100/0	yes / original	14	14	12	12	12	11	11	8	-7%	40	40	40	40	40	40	40	3
ABAX ECOWING 26	75/25	yes / new	10	10	8	8	6	5	4	2	-16%	36	36	36	36	36	36	31	3
ABAX ECOWING 26	50/50	yes / new	14	14	12	9	7	6	5	4	-12%	38	38	38	38	38	38	38	3
ABAX ECOWING AD-2	100/0	no / original	19	18	18	16	14	11	6	4	-6%	40	40	40	40	40	40	40	3
ABAX ECOWING AD-2	75/25	no / original	18	18	17	15	14	10	5	3	-6%	40	40	40	40	40	40	40	3
ABAX ECOWING AD-2	50/50	no / original	12	11	11	9	9	8	6	3	-8%	40	40	40	40	40	40	40	3
ABAX ECOWING AD-49	100/0	yes / new	22	21	18	16	12	10	6	3	-7%	40	40	40	40	40	40	40	3
ABAX ECOWING AD-49	75/25	yes / new	21	19	18	15	11	10	8	4	-13%	38	38	38	38	38	38	38	3
ABAX ECOWING AD-49	50/50	yes / original	7	7	6	5	5	5	3	2	-4%	37	37	37	37	37	37	32	3
AllClear AeroClear MAX	100/0	no / original	43	43	41	38	34	29	21	13	-7%	40	40	40	40	40	40	40	3
Aviation Shaanxi Cleanwing II	100/0	yes / original	9	8	7	7	7	5	2	1	-2%	40	40	40	40	40	35	30	3
Aviation Shaanxi Cleanwing II	75/25	yes / original	9	9	7	7	7	5	3	1	-5%	40	40	40	40	40	40	30	3
Aviation Shaanxi Cleanwing II	50/50	yes / original	2	2	2	2	1	1	1	0	-5%	26	26	26	21	21	21	11	7
Beijing Yadilite YD-102	100/0	no / original	27	27	22	21	20	18	15	13	-11%	38	38	38	38	38	38	38	3
Beijing Yadilite YD-102	75/25	no / original	26	26	23	21	21	17	15	11	-11%	38	38	38	38	38	38	38	3
Beijing Yadilite YD-102	50/50	no / original	11	11	9	6	6	5	4	2	-14%	38	38	38	38	38	38	33	3
CHEMCO ChemR EG IV	100/0	no / original	13	12	12	10	7	7	2	1	-8%	40	40	40	40	40	35	30	3
Clariant EG IV NORTH	100/0	no / original	15	15	15	14	13	10	5	3	-6%	40	40	40	40	40	40	40	3
Clariant Max Flight 04	100/0	yes / original	12	12	11	11	9	7	7	5	-9%	40	40	40	40	40	40	40	3
Clariant Max Flight AVIA	100/0	no / original	17	17	17	17	15	10	6	4	-8%	40	40	40	40	40	40	40	3
Clariant Max Flight SNEG	100/0	yes / new	11	11	10	10	10	8	3	3	-10%	38	38	38	38	38	38	38	3
Clariant Max Flight SNEG	75/25	no / original	12	12	11	11	11	9	4	2	-10%	40	40	40	40	40	40	35	3
Clariant Max Flight SNEG	50/50	yes / original	6	6	6	6	4	4	3	2	-9%	37	37	37	37	37	37	32	3
Clariant MP II FLIGHT	100/0	no / original	8	7	5	5	4	2	1	1	-5%	40	40	40	40	35	30	30	3
Clariant MP II FLIGHT	75/25	yes / original	15	12	10	9	7	4	4	1	-4%	40	40	40	40	40	40	30	3
Clariant MP II FLIGHT	50/50	no / original	5	5	4	4	4	4	3	2	-2%	34	34	34	34	34	34	29	3
Clariant MP II FLIGHT PLUS	100/0	no / original	10	10	8	8	6	3	1	0	-10%	40	40	40	40	40	30	20	4
Clariant MP II FLIGHT PLUS	75/25	no / original	13	12	11	11	10	7	4	2	-12%	38	38	38	38	38	38	33	3
Clariant MP II FLIGHT PLUS	50/50	no / original	7	7	6	6	4	3	2	0	-8%	37	37	37	37	37	32	17	4
Clariant MP III 2031 ECO	100/0	no / original	15	15	14	14	11	7	7	4	-6%	40	40	40	40	40	40	40	3
Clariant MP III 2031 ECO	75/25	no / original	13	13	12	10	8	8	6	5	-5%	40	40	40	40	40	40	40	3
Clariant MP III 2031 ECO	50/50	no / original	7	7	6	6	5	5	5	4	-13%	35	35	35	35	35	35	35	3
Clariant MP IV LAUNCH	100/0	yes / original	8	8	7	4	4	4	4	2	-10%	38	38	38	38	38	38	33	3
Clariant MP IV LAUNCH	75/25	yes / original	7	7	5	5	4	4	2	1	-6%	37	37	37	37	37	32	27	3
Clariant MP IV LAUNCH	50/50	yes / original	4	4	3	2	2	2	2	2	-2%	34	34	29	29	29	29	29	3

* g/dm²/h is abbreviated as "g" in this table

Table 2.8: Calculations to Determine LUPRs for 2017-18 Type II, III and IV De/Anti-Icing Fluids (cont'd)

Fluid Brand	Fluid Dil.	Extra Data / Regression	Factor Data Statistics*									LUPR Score*							LUPR* (g)
			Data Points ≤10.0 g	Data Points ≤9.5 g	Data Points ≤8.5 g	Data Points ≤7.5 g	Data Points ≤6.5 g	Data Points ≤5.5 g	Data Points ≤4.5 g	Data Points ≤3.5 g	Neg. Scatter 0-10 g	9 g	8 g	7 g	6 g	5 g	4 g	3 g	
Clariant MP IV LAUNCH PLUS	100/0	yes / original	10	9	8	8	7	5	3	2	-7%	40	40	40	40	40	40	35	3
Clariant MP IV LAUNCH PLUS	75/25	yes / original	9	9	8	7	6	5	4	2	-7%	40	40	40	40	40	40	35	3
Clariant MP IV LAUNCH PLUS	50/50	yes / original	6	5	5	5	5	5	4	3	-4%	37	37	37	37	37	37	37	3
Cryotech Polar Guard Advance	100/0	yes / new	15	14	11	8	7	6	6	3	-12%	38	38	38	38	38	38	38	3
Cryotech Polar Guard Advance	75/25	yes / new	13	12	11	9	9	7	7	2	-12%	38	38	38	38	38	38	33	3
Cryotech Polar Guard Advance	50/50	yes / new	6	6	6	6	6	5	5	1	-10%	37	37	37	37	37	37	27	3
Cryotech Polar Guard II	100/0	yes / new	15	14	11	8	7	6	6	3	-12%	38	38	38	38	38	38	38	3
Cryotech Polar Guard II	75/25	yes / new	13	12	11	9	9	7	7	2	-12%	38	38	38	38	38	38	33	3
Cryotech Polar Guard II	50/50	yes / new	6	6	6	6	6	5	5	1	-10%	37	37	37	37	37	37	27	3
Deicing Solutions ECO-SHIELD	100/0	no / original	14	14	12	10	9	7	6	3	-17%	36	36	36	36	36	36	36	3
Dow Endurance EG106	100/0	yes / original	8	7	6	5	5	3	3	2	-3%	40	40	40	40	40	40	35	3
Dow FlightGuard AD-49	100/0	yes / new	22	21	18	16	12	10	6	3	-7%	40	40	40	40	40	40	40	3
Dow FlightGuard AD-49	75/25	yes / new	21	19	18	15	11	10	8	4	-13%	38	38	38	38	38	38	38	3
Dow FlightGuard AD-49	50/50	yes / original	7	7	6	5	5	5	3	2	-4%	37	37	37	37	37	37	32	3
Kilfrost ABC-Ice Clear II	100/0	no / original	8	7	7	5	4	3	2	2	-6%	40	40	40	40	40	35	35	3
Kilfrost ABC-Ice Clear II	75/25	no / original	9	9	7	7	5	3	2	2	-8%	40	40	40	40	40	35	35	3
Kilfrost ABC-Ice Clear II	50/50	no / original	6	5	5	4	4	4	4	4	-9%	37	37	37	37	37	37	37	3
Kilfrost ABC-K Plus	100/0	no / original	16	15	15	13	10	5	2	1	-8%	40	40	40	40	40	35	30	3
Kilfrost ABC-K Plus	75/25	no / original	15	14	13	11	8	6	4	0	-6%	40	40	40	40	40	40	20	4
Kilfrost ABC-K Plus	50/50	no / original	18	18	13	12	10	8	6	2	-5%	40	40	40	40	40	40	35	3
Kilfrost ABC-S Plus	100/0	yes / original	9	7	5	3	3	2	1	1	-5%	40	40	40	40	35	30	30	3
Kilfrost ABC-S Plus	75/25	yes / original	8	8	8	5	5	4	2	2	-9%	40	40	40	40	40	35	35	3
Kilfrost ABC-S Plus	50/50	no / original	3	2	2	2	2	2	2	2	-1%	26	26	26	26	26	26	26	3
LNT Solutions E450	100/0	no / original	16	16	16	16	15	15	15	10	-12%	38	38	38	38	38	38	38	3
Newave FCY 9311	100/0	yes / original	12	11	11	9	9	6	3	2	-5%	40	40	40	40	40	40	35	3
Newave FCY-2	100/0	no / original	6	6	5	4	4	2	2	2	-11%	35	35	35	35	30	30	30	3
Newave FCY-2	75/25	no / original	6	5	5	4	4	4	4	3	-16%	33	33	33	33	33	33	33	3
Newave FCY-2	50/50	no / original	3	3	3	3	3	3	3	3	-5%	31	31	31	31	31	31	31	3
Newave FCY-2 Bio+	100/0	yes / original	20	19	19	16	15	12	10	8	-5%	40	40	40	40	40	40	40	3
Newave FCY-2 Bio+	75/25	no / original	17	17	16	14	13	11	10	8	-9%	40	40	40	40	40	40	40	3
Newave FCY-2 Bio+	50/50	no / original	10	10	9	7	7	6	4	2	-5%	40	40	40	40	40	40	35	3
Oksayd Defrost ECO 4	100/0	no / original	13	13	13	13	9	7	5	2	-4%	40	40	40	40	40	40	35	3
Shaanxi Cleansurface IV	100/0	no / original	14	14	14	13	12	9	5	4	-6%	40	40	40	40	40	40	40	3
Shaanxi Cleansurface IV	75/25	no / original	13	13	13	12	11	8	5	3	-9%	40	40	40	40	40	40	40	3
Shaanxi Cleansurface IV	50/50	no / original	6	6	6	6	5	4	4	3	-7%	37	37	37	37	37	37	37	3

* g/dm²/h is abbreviated as "g" in this table

2.6.2.6 Minimum HUPR Values for Existing Fluids

Published holdover times have always been considered valid at precipitation rates up to 25 g/dm²/h. Therefore, existing fluids are considered to have an HUPR of at least 25 g/dm²/h. This is noteworthy as the calculations shown in Table 2.7 indicate that Kilfrost ABC-K Plus 50/50 dilution should have an HUPR below 25 g/dm²/h, but the HUPR is shown as 25 g/dm²/h. This situation occurred as the fluid required additional data to support a higher HUPR but the manufacturer did not provide a fluid sample.

2.6.3 Significance of LUPR and HUPR Values

LUPR and HUPR values represent the lowest (LUPR) and highest (HUPR) precipitation rates at which the regression information for an endurance time data set can be used to safely calculate holdover times. This is significant for two applications.

2.6.3.1 Publication of Holdover Times

For publication of holdover times, specific LUPR and HUPR values must be achieved to safely publish holdover times. As mentioned at the beginning of this chapter, holdover times are currently published for very light, light and moderate snow, with the exception of some Type II fluids for which holdover times are only published for moderate snow. This encompasses the precipitation rate range 3 to 25 g/dm²/h. Therefore, to safely publish holdover times for the current holdover time tables, the LUPR and HUPR for the associated endurance time data set must be 3 g/dm²/h (or lower) and 25 g/dm²/h (or higher), respectively.

In order to publish holdover times for heavy snow (assuming the new upper rate limit for heavy snow is accepted – see Subsection 2.2.1), an HUPR of 50 g/dm²/h must be achieved. As shown in Table 2.7, the majority of existing de/anti-icing fluids do have an HUPR of 50 g/dm²/h; therefore, it would be possible to publish holdover times for heavy snow for the majority of fluids.

2.6.3.2 Limitations on Regression Information for Liquid Water Equivalent Systems

For liquid water equivalent (LWE) based systems, the LUPR and HUPR values associated with a data set represent the lowest (LUPR) and highest (HUPR) precipitation rates that the system can use. If a precipitation rate below the LUPR is measured by an LWE system, it can not use that rate; it must use the LUPR to calculate a holdover time. If a precipitation rate above the HUPR is measured by an LWE system, it can not provide a holdover time.

As a result of this project, HUPRs for Type II, III and IV fluids were published for the first time for the winter of 2017-18. In previous winters, HUPRs did not exist and

LWE systems were able to calculate and provide holdover times based on inputs of up to 50 g/dm²/h (this remains the case for Type I fluids). It should be noted that when TC and FAA first put regulatory approval processes in place for LWE based systems, the endurance time data were examined from a broader perspective. Regulators concluded 50 g/dm²/h was an appropriate upper limit. It was only when the data were examined in greater detail as part of the heavy snow project that the need for HUPRs emerged. (This issue was one of many for which regulators had to find solutions to enable the use of LWE based systems.)

2.6.4 Examination of Type I Fluid Data

Type I fluids do not have fluid-specific data or fluid-specific holdover times. Type I holdover times are instead derived from data sets comprised of data collected with a variety of fluids. There are two Type I fluid snow data sets: composite surfaces and aluminum surfaces.

The historical Type I fluid natural snow data set is shown in Figure 2.1 (aluminum surfaces) and Figure 2.2 (composite surfaces). The data is plotted by temperature. In addition to data from the historical data sets, data collected in very cold snow conditions in the winter of 2014-15 is plotted (see purple circles). The very cold snow data were predominantly collected in light snow.

The Type I fluid natural snow data sets were examined to determine the validity of the data at heavy snow rates of precipitation (25-50 g/dm²/h). The analysis methodology described in Subsection 2.6.1 was used to examine the data. The analysis determined that the HUPR for both data sets is 50 g/dm²/h.

The analysis indicates that the Type I fluid endurance time data has been validated for use in heavy snow. However, it should be noted that very limited data exists at colder temperatures. In the aluminum historical data set, the coldest data point is at -15°C; in the composite historical data set, the coldest data point is at -13°C. In addition, the aluminum historical data set has very limited data below -3°C in heavy snow. As a result, related regression curves at high precipitation rates and very low temperatures yield lower confidence in holdover times than in other conditions.

It is not recommended that a limitation be put on the use of Type I data in snow, i.e. HUPRs for Type I fluids should not be published. However, it is recommended that:

1. Further work be considered, including an effort to collect data with Type I fluids at very high rates and very low temperatures; and
2. TC and FAA should continue to limit the use of Type I fluids in heavy snow to 50 g/dm²/h through their related guidance documents (TC holdover time determination system exemption, FAA LWE advisory circular).

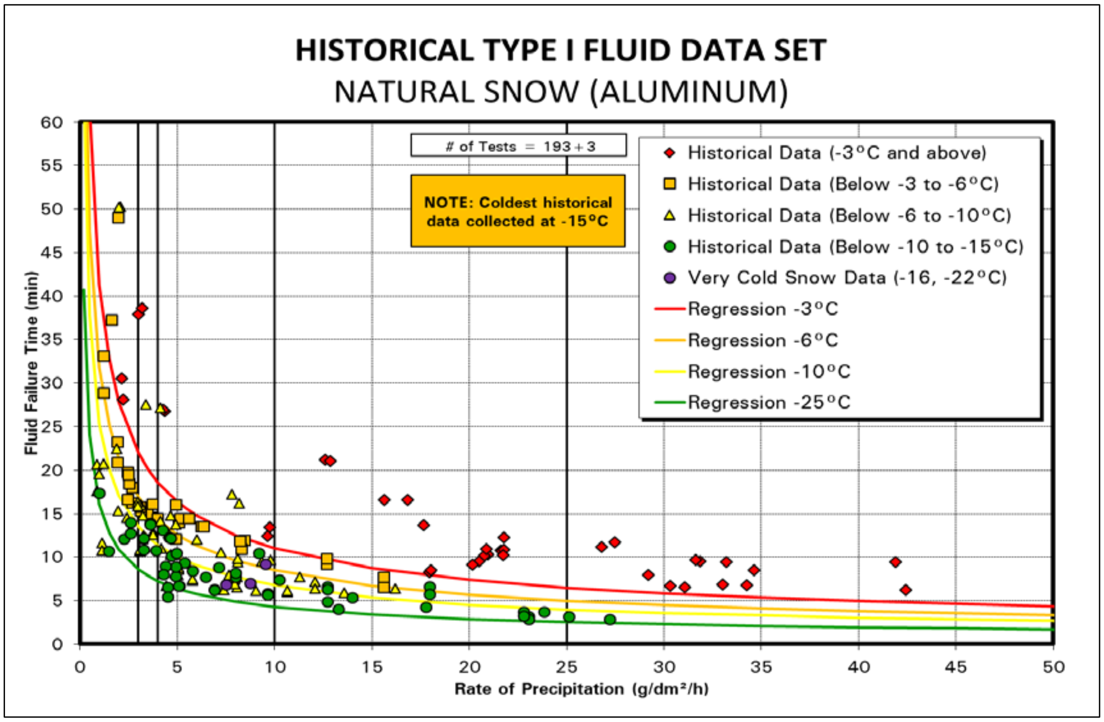

Figure 2.1: Historical Type I Fluid Natural Snow Aluminum Surface Data Set

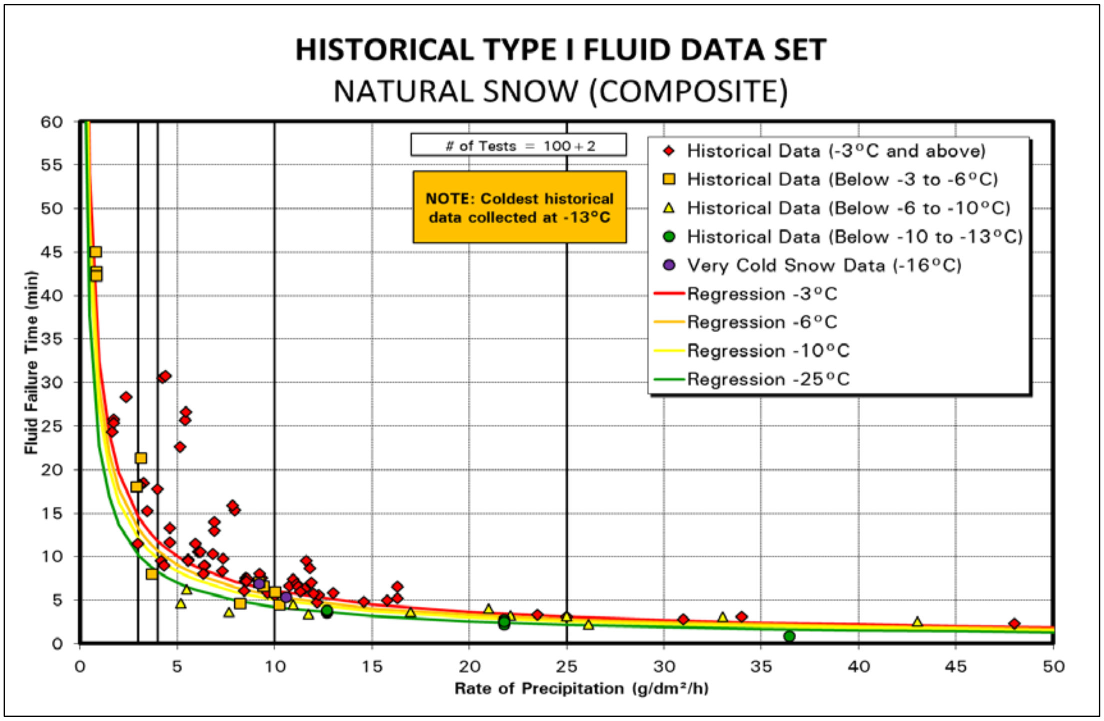

Figure 2.2: Historical Type I Fluid Natural Snow Composite Surface Data Set

2.7 Collection of Artificial Heavy Snow Data at Very Cold Temperatures

The fifth activity identified as a requirement to publish holdover times for heavy snow was artificial snow data at very cold temperatures. This requirement was identified in the winter of 2014-15 (see Subsection 2.2.1), as snow holdover times for Type II and Type IV fluids at temperatures below -14°C were, at that time, generic (not fluid-specific) and developed based on artificial snow data.

This changed in the winter of 2016-17, when a project was undertaken to develop fluid-specific holdover times for snow for Type II and Type IV fluids below -14°C. Participation in this project was optional for fluid manufacturers. The result of the project was fluid-specific holdover times for some fluids (based on fluid-specific natural snow data collected in 2016-17) and modified generic holdover times for all other fluids (based on the existing artificial snow data and the newly collected natural snow data with participating fluids).

Artificial snow data were collected in the winter of 2016-17 as part of both the heavy snow project and the very cold snow project. Artificial snow data were also collected in the winter of 2015-16 as part of the heavy snow project. The 2015-16 data were collected at temperatures of -14°C and above; the 2016-17 data were collected at -18°C and -25°C. A summary of the data points collected is shown in Table 2.9.

Table 2.9: Artificial Snow Data Points Collected in Heavy Snow

Winter	Type II	Type IV	All
2015-16	6	9	15
2016-17	4	9	13
All	**10**	**18**	**28**

Initial analysis of the artificial snow data for the very cold snow project indicated differences between artificial and natural snow data points collected in similar conditions. An analytical approach for interpreting this relationship has not yet been determined. As a result, this data can not yet be used to determine holdover times for heavy snow at very cold temperatures.

2.8 Conclusions

The work completed on the heavy snow project over the winters of 2015-16 and 2016-17 resulted in several conclusions.

1. Analysis and, in some cases, the collection of additional endurance time data determined the majority of fluid-specific Type II, III and IV fluid endurance time data sets can be used without modification to determine holdover times for heavy snow (precipitation rates up to 50 g/dm²/h).

2. Some fluid-specific endurance time data sets required the addition of supplemental data to obtain data sets that can safely be used to determine holdover times for heavy snow (precipitation rates up to 50 g/dm²/h). These data sets were used to determine updated holdover times for these fluids at all precipitation rates. These fluids are:
   - Cryotech Polar Guard Advance (100/0, 75/25, 50/50);
   - Cryotech Polar Guard II (100/0, 75/25, 50/50);
   - ABAX / Dow AD-49 (100/0, 75/25);
   - ABAX ECOWING 26 (75/25, 50/50); and
   - Clariant Max Flight SNEG (100/0).

3. Some fluid-specific endurance time data sets require additional data to determine if they can be used to determine holdover times for heavy snow (precipitation rates up to 50 g/dm²/h). This data was not collected as the fluid manufacturers did not provide samples for testing. For these fluids, a highest usable precipitation rate (HUPR) was determined. This rate is the highest rate for which holdover times can safely be derived from the fluid's endurance time data. The HUPR restricts use of these fluids in heavy snow to precipitation rates at or below the HUPR. These fluids are:
   - Clariant Safewing MP II FLIGHT (100/0, 75/25, 50/50);
   - Clariant Safewing MP II FLIGHT PLUS (50/50); and
   - Kilfrost ABC-K Plus (50/50).

4. Preliminary analysis with the historical Type I data sets indicates the data has generally been validated for use in heavy snow. However, there are some limitations to this conclusion, as limited data exists in heavy snow and colder temperatures.

5. Heavy snow data was collected with an artificial snow machine at very cold temperatures. This data has not yet been analysed as a result of inconsistencies with snow machine data that have recently emerged. It may be analysed in future when these inconsistencies are better understood.

As a result of this work:

1. Heavy snow holdover times can now theoretically be provided for all Type II, III and IV fluids, with the exception of those with HUPRs below 50 g/dm²/h (identified in item #3 above);

2. Limitations on the use of Type II, III and IV fluid regression information in heavy snow have been put in place for LWE based systems – these limitations are published as a table of HUPRs in the TC and FAA Regression Information publications; and

3. Minor changes were made to the previously published LUPR values as a result of minor modifications to the LUPR analysis methodology; these changes were published by updating the existing table of LUPRs in the TC and FAA Regression Information publications.

2.9 Recommendations

It is recommended that:

1. LUPRs and HUPRs be calculated for all new Type II, III and IV de/anti-icing fluids that are submitted for endurance time testing and testing should not be considered complete until sufficient data is collected to support an LUPR of 3 g/dm²/h and an HUPR of 50 g/dm²/h;

2. New fluids submitted for endurance time testing must be submitted early in the season to ensure sufficient data can be collected at all rates encompassed in the range 3 to 50 g/dm²/h; and

3. TC and FAA consider publishing holdover times for heavy snow for all Type II, III and IV fluids with HUPRs of 50 g/dm²/h.

It is also recommended that consideration be given to the following:

1. Further work to examine the limitations of the existing Type I fluid endurance time data in heavy snow at very cold temperatures; and

2. Additional analysis with the data collected with Type II, III and IV fluids in artificial snow.

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3. PUBLICATION OF HOLDOVER TIME GUIDANCE MATERIALS

This section describes the work APS Aviation Inc. (APS) completed in the winter of 2016-17 in support of Transport Canada (TC) and the Federal Aviation Administration (FAA) holdover time guidance materials.

3.1 Background

The development and use of holdover time (HOT) guidelines has represented an important contribution to the enhancement of flight safety in winter aircraft operations. In the years since their introduction, the HOT guidelines and related guidance materials have become a standard and essential part of winter operations. APS plays a significant role in the preparation and management of these documents.

3.2 APS Contribution to HOT Guidance Materials

Over the years, APS has supported TC and the FAA in the development and management of the HOT guidelines documents. APS completes the following tasks in support of the HOT guidance materials on an annual basis:

a) Develops fluid-specific HOT and regression tables for new Type II, III and IV anti-icing fluids which undergo endurance time testing;

b) Requests, collects and reviews information provided by fluid manufacturers related to fluid qualification dates and lowest operational use temperatures (LOUTs) – this results in updates being made to the list of fluids in the HOT guidelines;

c) Recommends changes to the HOT guidance materials as a result of new research findings;

d) Maintains an ongoing list of potential future changes to the HOT guidance materials, schedules and runs meetings to review and discuss these changes with TC/FAA, and implements changes as required;

e) Drafts HOT guidelines and HOT regression information documents on an annual basis including TC English, TC French and FAA versions;

f) Provides support for the update of the FAA N8900 series document;

g) Restructures guidance material to make it accessible for people with disabilities;

h) Updates the TC HOT guidelines website on an annual basis (or more frequently if updates to the HOT guidelines are more frequent); and

i) Hosts the TC HOT guidelines website and monitors and maintains it on an annual basis.

3.3 Winter 2017-18 Holdover Time Guidance Materials

In August 2017, the 2017-18 HOT Guidelines and Regression Information documents were finalized. The changes made to the documents are summarized in the documents themselves and are described in detail in two TC reports:

1. **Holdover Time Guidelines:** TP 15372E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter* (6); and
2. **Holdover Time Regression Information:** TP 15373E, *Regression Coefficients and Equations Used to Develop the Winter 2017-18 Aircraft Ground Deicing Holdover Time Tables* (5).

The titles of the 2017-18 documents are listed in Table 3.1. Final drafts of the FAA documents were provided to the FAA publications department. The TC documents were published on the TC HOT guidelines website (see Subsection 3.4) on August 9, 2017.

As intended, the FAA finalized and published its N8900 series notice along with the other HOT guidance materials, on August 11, 2017.

Table 3.1: 2016-17 HOT Guidance Documents

HOT Guidelines	1. Transport Canada Holdover Time (HOT) Guidelines Winter 2017-2018
	2. Guide de Transports Canada sur les durées d'efficacité Hiver 2017-2018
	3. FAA Holdover Time Guidelines Winter 2017-2018
Regression Information	4. Transport Canada HOT Guidelines Regression Information Winter 2017-2018
	5. Transports Canada Guide des durées d'efficacité Information de régression Hiver 2017-2018
	6. FAA Holdover Time Regression Information Winter 2017-2018

3.3.1 Document Revisions

Supplemental holdover times for snow in the temperature band below -3 to -8°C for select 100/0 fluids were published on October 12, 2017 in the form of a revision to the 2017-18 HOT Guidelines. Only fluids for which manufacturers paid a participation fee were given the supplemental HOTs in the form of a data table in an appendix of the HOT Guidelines. The HOTs published for temperatures below -3 to -14°C continued to apply for all fluids that did not choose to participate.

3.4 TC HOT Guidelines Website

In the summer of 2003, TC asked APS to develop and maintain a website for the TC HOT guidelines to serve as the single source location for HOT information. This was done to eliminate the safety risks associated with publishing information in multiple locations, which can result in information discrepancies.

The website was first made available when the 2003-04 HOT guidelines were published in July 2003, and has been updated regularly since that time (typically once per year). The website is published in English and French, primarily for Canadian operators, although the information is made public for others to use.

The website is now used extensively by industry to access the HOT guidelines documents. Table 3.2 provides information on usage of the website from October 8, 2008 to August 9, 2017.

Table 3.2: Summary of Traffic on TC HOT Website (10/8/2008 - 8/9/2017)

Hits		**Page Views**		**Visitors**	
Total Hits	997,447	Total Page Views	268,551	Total Visitors	119,593
Visitor Hits	851,254	Average Page Views per Day	82	Average Visitors per Day	36
Spider Hits	146,193	Average Page Views per Visitor	2.25	Total Unique IPs	55,793
Average Hits per Day	307				
Average Hits per Visitor	7.12				

3.5 Future Responsibilities

APS will continue contributing to the development of the TC and FAA HOT guidance materials in the winter of 2017-18. Specifically, APS will continue carrying out the tasks listed in Subsection 3.2.

In regards to the TC HOT Guidelines website, APS will ensure the website is operational, in terms of Internet availability, for a one-year period. In the summer of 2018, APS intends to update the website with the new HOT guidelines and regression information documents.

4. TECHNICAL REVIEW AND PUBLICATION OF HISTORICAL REPORTS

This section describes the process APS Aviation Inc. (APS) uses to publish the technical reports it prepares for Transport Canada (TC) and the Federal Aviation Administration (FAA), details the status of the technical review of reports currently in the publication process and provides guidance for publishing historical reports in the future.

4.1 Background

As of November 1, 2016, APS has prepared over 187 reports on aircraft ground icing research and development on behalf of TC and the FAA. Of these 187 reports, 124 reports have not been published (most are currently at the Final Draft 1.0 phase). This backlog is attributed to limited resources and shifting priorities within Transport Development Canada (TDC) and the FAA.

4.2 Objective

To remedy this backlog, APS was tasked by TC and FAA to develop a prioritized list of unpublished reports, accelerate these reports through the publication process and release them as Final Version 1.0. The objective of this project for winter 2016-17 was to complete these tasks for 12 reports (targets for subsequent years will be determined at the completion of each year).

The objective was achieved by utilising the following measures:

- Coordinate and outsource technical review of reports with technical experts;
- Perform technical reviews (to be done by technical experts) and make necessary updates to prepare reports for final editing and publishing; and
- Provide a status of progress within the monthly progress reports.

4.3 Publication Process and Delivery of Technical Reports

APS produces reports annually for the de/anti-icing research program on behalf of TC and FAA by utilising a detailed report management process that it has developed and continuously updated. Figure 4.1 displays the report timeline that offers a global view of the entire process; it includes all the phases with their respective milestones, and detailed tasks that are involved in taking a report from initiation to publication. The report management timeline is comprised of seven phases. The first three phases are internal to APS and labelled Internal Phase 1, 2 and 3, respectively. The following four phases are related to publication of a report and are labelled Publication Phase 1, 2, 3 and 4, respectively. Reports typically undergo these phases prior to delivery of Final Version 1.0.

For the year 2016-17, APS surpassed the goal of 12 reports and published 16 reports, as shown in Table 4.1. These reports were published and delivered to TC and FAA as Final Version 1.0 in 2016-17.

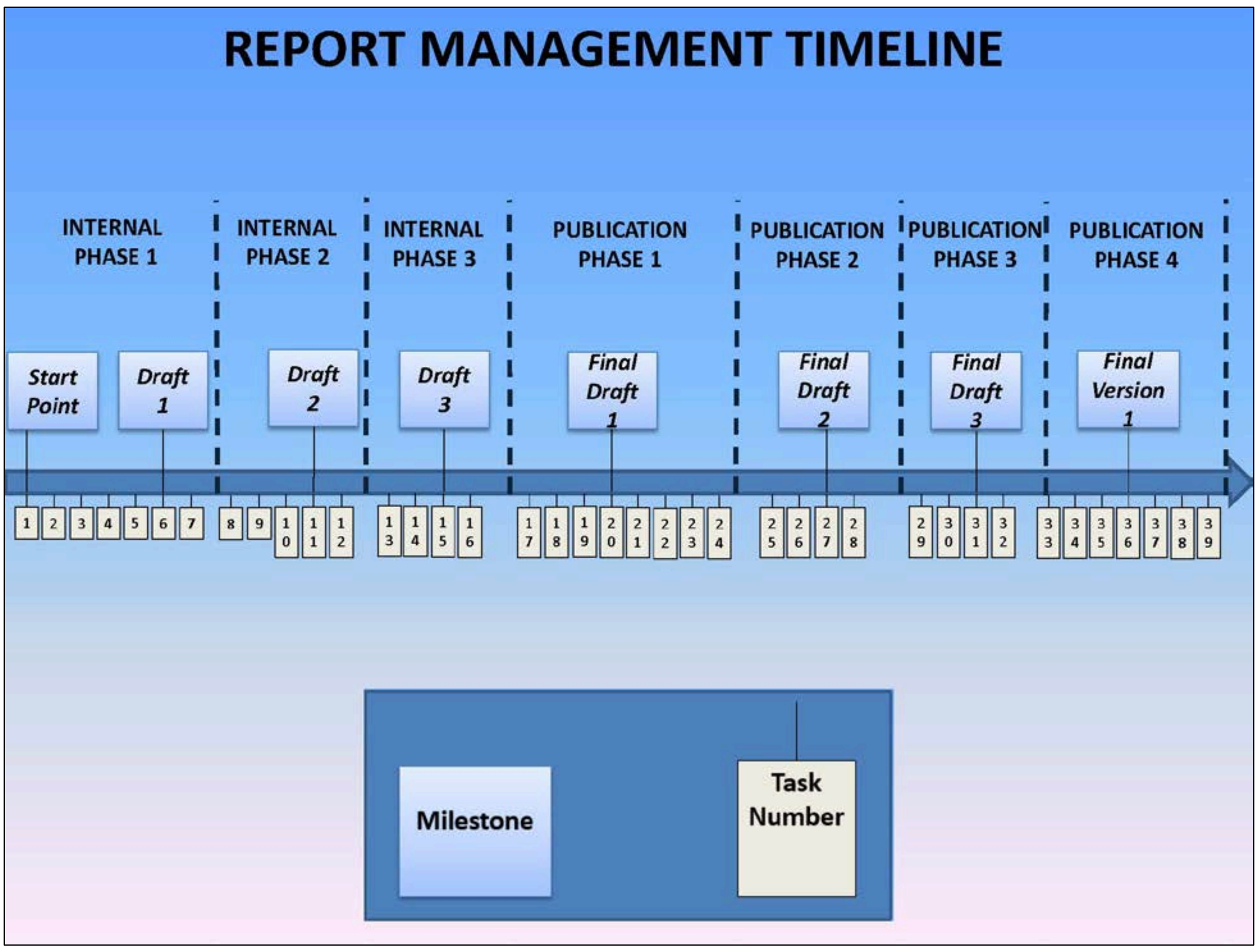

Figure 4.1: Report Management Timeline

Table 4.1: List of Technical Reports to be Published (2016-17)

No.	TP Number	Report Title	Category	Priority	Latest Version	Publication Date
1	TP 15323E	Aircraft Ground Icing Research General Activities During the 2014-15 Winter	General and Exploratory	1	Final Version 1.0	March 2017
2	TP 15275E	Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates Volume 1 of 4 (Summary Report)	Ice Phobic	2	Final Version 1.0	July 2017
	TP 15275E	Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates Volume 2 of 4 (Year 1 of 3: 2011-12 Testing Report)	Ice Phobic	2	Final Version 1.0	July 2017
	TP 15275E	Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates Volume 3 of 4 (Year 2 of 3: 2012-13 Testing Report)	Ice Phobic	2	Final Version 1.0	July 2017
	TP 15275E	Investigation of Ice Phobic Technologies to Reduce Aircraft Icing in Northern and Cold Climates Volume 4 of 4 (Year 3 of 3: 2013-14 Testing Report)	Ice Phobic	2	Final Version 1.0	July 2017
3	TP 13993E	Impact of Winter Weather on Holdover Time Table Format (1995-2002)	Readac	3	Final Version 1.0	November 2017
4	TP 14146E	Winter Weather Impact on Holdover Time Table Format (1995-2003)	Readac	3	Final Version 1.0	November 2017
5	TP 14375E	Winter Weather Impact on Holdover Time Table Format (1995-2004)	Readac	3	Final Version 1.0	November 2017
6	TP 14444E	Winter Weather Impact on Holdover Time Table Format (1995-2005)	Readac	3	Final Version 1.0	November 2017
7	TP 14715E	Winter Weather Impact on Holdover Time Table Format (1995-2006)	Readac	3	Final Version 1.0	November 2017
8	TP 14777E	Winter Weather Impact on Holdover Time Table Format (1995-2007)	Readac	3	Final Version 1.0	November 2017
9	TP 14870E	Winter Weather Impact on Holdover Time Table Format (1995-2008)	Readac	3	Final Version 1.0	November 2017
10	TP 14934E	Winter Weather Impact on Holdover Time Table Format (1995-2009)	Readac	3	Final Version 1.0	November 2017
11	TP 15051E	Winter Weather Impact on Holdover Time Table Format (1995-2010)	Readac	3	Final Version 1.0	November 2017
12	TP 15157E	Winter Weather Impact on Holdover Time Table Format (1995-2011)	Readac	3	Final Version 1.0	November 2017
13	TP 15201E	Winter Weather Impact on Holdover Time Table Format (1995-2012)	Readac	3	Final Version 1.0	November 2017
14	TP 15227E	Winter Weather Impact on Holdover Time Table Format (1995-2013)	Readac	3	Final Version 1.0	November 2017
15	TP 15268E	Winter Weather Impact on Holdover Time Table Format (1995-2014)	Readac	3	Final Version 1.0	November 2017
16	TP 15320E	Winter Weather Impact on Holdover Time Table Format (1995-2015)	Readac	3	Final Version 1.0	November 2017

4.3.1 Overall Publication Status of Technical Reports

The overall status of the reports as of November 1, 2016 was as follows:

- Published reports: 63;
- Non-published reports: 124; and
- Total reports: 187.

During 2016-17, the following activities took place:

- Five reports from the 2015-16 research year were delivered to TC/FAA as Final Draft 1.0;
- One non-classified (confidential) report from the 2015-16 research year reached the Final Draft 1.0 stage;
- One report from the 2014-15 research year was delivered to TC/FAA as Final Draft 1.0;
- Two reports from the 2015-16 research year were delivered to TC/FAA as Final Version 1.0; and
- As stated in Subsection 4.3, 16 reports from the older years were delivered to TC/FAA as Final Version 1.0.

Therefore, the overall status of the reports as of November 30, 2017 was as follows:

- Published reports: 81;
- Non-published reports: 113; and
- Total reports: 194.

In addition, APS is currently working on 4 reports for the winter 2016-17 research activities; these are not included in the totals as of November 30, 2017.

Assuming that APS will publish 20 reports per year (4 current year reports, and 16 old reports), it will take approximately 7 years to clear the backlog.

4.4 Conclusions

APS has been involved in writing and publishing technical reports on behalf of TC and FAA since 1992 and has produced a total of 194 reports. Due to limited TC and FAA resources, 124 reports were still outstanding and APS was tasked with developing a prioritized list of unpublished reports that needed to be reviewed and published. For the year 2016-17, APS published 16 reports, which were delivered to TC and FAA as Final Version 1.0 in November 2017.

4.5 Recommendations

During the project planning phase (summer 2017), APS, TC and FAA discussed increasing the number of historical technical reports to be published for the year 2017-18 to 20. Since APS has taken a more active role in completing this project, it is recommended that proper resources be dedicated to publishing these reports on a yearly basis. It should also be noted that APS has contracted technical and copy editors, as well as part-time junior research assistants, to fulfil publication requirements. APS remains heavily involved in all phases of report publication.

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5. UPDATE OF SAE DOCUMENTS ARP5485, ARP5945, ARP5718 AND ARP6207

This section documents the work carried out by APS Aviation Inc. (APS) in support of the updates made to SAE aerospace recommended practice (ARP) documents ARP5485, ARP5945, ARP5718 and ARP6207. This work was carried out over the winter of 2016-17.

5.1 Background

APS has supported the development of SAE aerospace standards related to ground deicing since the inception of the aircraft ground icing research program in the early 1990s. APS has been instrumental in the development of standards related to test protocols for endurance time testing. These include the following aerospace recommended practice documents:

1. ARP5485: Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids SAE Type II, III, and IV; and

2. ARP5945: Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids SAE Type I.

APS has also contributed to the development of the standards related to the qualification of de/anti-icing fluids. These include:

1. ARP5718: Qualifications Required for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids; and

2. ARP6207: Qualifications Required for SAE Type I Aircraft Deicing/Anti-Icing Fluids.

APS personnel were nominated sponsors of these documents several years ago. However, until the winter of 2016-17, resources were not available to update the standards.

5.2 Objective

In the winter of 2016-17, Transport Canada (TC) and Federal Aviation Administration (FAA) tasked APS to work on SAE standards ARP5485, ARP5945, ARP5718 and ARP6207. The specific objective of the project was to bring these standards up to date with current industry and regulatory practices.

5.3 Tasks

ARP5485, ARP5945 and ARP5718 are existing standards; ARP6207 is a new standard that is the Type I fluid equivalent to ARP5718.

For the existing standards (ARP5485, ARP5945 and ARP5718), the following tasks were completed to achieve the objective:

- Researching and drafting changes;
- Presenting the changes to the SAE G-12 Holdover Time (HOT) Committee;
- Balloting the draft documents;
- Finding resolutions/compromises to conflicts;
- Re-balloting the documents as necessary; and
- Working with SAE committee representative and SAE content management team to finalize documents.

For the new standard (ARP6207), the following tasks were completed to achieve the objective:

- Researching content and creating an initial draft document;
- Presenting the initial draft document to the SAE G-12 Holdover Time (HOT) Committee;
- Balloting the draft document;
- Finding resolutions/compromises to conflicts;
- Re-balloting the document as necessary; and
- Working with SAE committee representative and SAE content management team to finalize documents.

The primary changes made to the documents, as well as the first ballot results, conflicts, and resolutions, are detailed in the related presentations given to the SAE G-12 HOT Committee at the May 2017 meeting in Athens, Greece. These presentations are documented in Section 6.

5.4 Achievements and Next Steps

At the time of writing of this report, all documents had undergone a second Committee level ballot. These ballots passed without any technical disapprovals or comments. Therefore, the SAE G-12 HOT Committee has approved the final APS prepared versions of SAE documents ARP5485, ARP5945, ARP5718 and ARP6207.

It should be noted that the SAE content management team has since updated these documents, and the next step is for them to be balloted to the SAE Aerospace Council. This is expected to take place in the fall of 2017, with publication of the documents to follow soon after.

5.5 Conclusions

Significant effort went into updating ARP5485, ARP5945 and ARP5718, and creating ARP6207 in the winter of 2016-17. The result of these efforts is production of the final documents, which have approval of the SAE G-12 HOT Committee.

5.6 Recommendations

It is recommended that resources be dedicated to updating these standards every two years. This timeframe should suffice in keeping documents current, and the management process and required resources manageable.

It should be noted that the endurance time testing standards were updated to reflect current industry, regulatory, and practical testing requirements. Further changes are recommended to improve the test protocols. These should be considered for the next update of the documents.

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6. PRESENTATIONS, FLUID MANUFACTURER REPORTS AND TEST PROCEDURES FOR 2016-17

This section contains an account of the test procedures, presentations and fluid manufacturer reports prepared by APS Aviation Inc. (APS) in the winter of 2016-17.

6.1 Presentations

SAE G-12 Committees hold several meetings each year. During these and other meetings, APS presents the findings of work that has been completed during the year. Most of the research presented at these meetings is also eventually documented in various reports.

In 2016-17, APS gave presentations at the following meetings:

1) SAE G-12 Holdover Time Committee, Montreal, Canada, October 2016;
2) SAE G-12 Holdover Time Committee, Athens, Greece, May 2017;
3) Airlines for America (A4A) Ground Deicing Forum, Washington, USA, June 2017; and
4) Standing Committee on Operations Under Icing Conditions (SCOUIC), Calgary, Canada, October 2017.

The presentations given by APS at each of these meetings are listed in the following subsections. A copy of each presentation listed is contained in Appendix C.

6.1.1 SAE G-12 Holdover Time Committee Meeting, Montreal, Canada, October 2016

Three presentations were prepared for the SAE G-12 Holdover Time Committee meeting held in Montreal, Canada in October 2016:

1) HOT Guidelines Fall 2016 Update;
2) Possible Changes to Type II-IV Generic HOT Tables; and
3) Fluid Application Tables, One Step vs. Two Step, and Reconceptualization.

6.1.2 SAE G-12 Holdover Time Committee Meeting, Athens, Greece, May 2017

Nine presentations were prepared for the SAE G-12 Holdover Time Committee meeting held in Athens, Greece in May 2017:

1) ARP5485 and ARP5945 Update;
2) ARP5718 Update;
3) Development of ARP6207: Process to Commercialize Type I Fluids;
4) Winter 2016-17 Endurance Time Testing Results;
5) Effect of Deployed Flaps and Slats on De/Anti-Icing Fluid HOTs;
6) Research to Develop Highest Usable Precipitation Rates (HUPRs) and HOTs for Heavy Snow;
7) Changes to HOT Guidelines for Winter 2017-18 (prepared by APS and presented by Yvan Chabot-Transport Canada, and Charles Enders-Federal Aviation Administration);
8) Impact of Type IV Fluids not Being Qualified as Type II Fluids; and
9) Holdover Times for Very Cold Snow.

6.1.3 A4A Ground Deicing Forum, Washington, USA, June 2017

One presentation was prepared for the A4A Ground Deicing Forum held in Washington, USA in June 2017:

1) Changes to HOT Guidelines for Winter 2017-18.

6.1.4 Standing Committee on Operations Under Icing Conditions, Calgary, Canada, October 2017

Two presentations were prepared for the Standing Committee on Operations Under Icing Conditions (SCOUIC) meeting held in Calgary, Canada in October 2017:

1) Changes to HOT Guidance for Winter 2017-18; and
2) Ground Icing Research Program Projects and Initiatives.

6.2 Fluid Manufacturer Reports

As part of the holdover time research program, several fluids are tested for holdover performance each year. The data from fluids that are commercialized is published in in the related Transport Canada report, TP 15372E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter* (6), while the non-commercialized fluid reports are maintained by the fluid manufacturers for research purposes.

6.2.1 Holdover Time Testing Reports

Five reports were prepared to document holdover time testing conducted in the winter of 2016-17. Copies of these reports were provided to the fluid manufacturers and to the Transport Canada and Federal Aviation Administration project managers.

Four of the reports are for commercialized fluids; these reports can be found in the appendices of the Transport Canada report, TP 15372E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter* (6). The last report was for an experimental fluid.

The five reports are:

1) Type II: ABAX ECOWING AD-2;
2) Type III: AllClear AeroClear MAX (Batch # ACM111116-8000 PT);
3) Type IV: CHEMCO ChemR EG IV;
4) Type IV: Oksayd Defrost ECO 4; and
5) One non-commercialized experimental fluid.

A companion document outlining the methodologies used in endurance time testing of Type II, III and IV fluid was also prepared and provided to the manufacturers.

6.2.2 Very Cold Snow Holdover Time Testing Reports

Seven reports were prepared to document fluid-specific very cold snow holdover time testing conducted in the winter of 2016-17. Copies of these reports were provided to the fluid manufacturers and to the Transport Canada and Federal Aviation Administration project managers. They are also provided as appendices to the Transport Canada report, TP 15372E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter* (6).

The seven reports are:

1) Type II: Clariant Safewing MP II Flight;
2) Type III: AllClear AeroClear MAX (Batch # ACM111116-8000 PT);
3) Type IV: Clariant Safewing MP IV Launch;
4) Type IV: Clariant Safewing MP IV Launch Plus;
5) Type IV: DOW Chemical UCAR™ Endurance EG106;
6) Type IV: LNT Solutions E450; and
7) Type II/IV: Cryotech Polar Guard II/Cryotech Polar Guard Advance.

6.3 Test Procedures

Several procedures were developed to guide and support the research team in conducting tests in the winter of 2016-17. It should be noted that some procedures used in the winter of 2016-17 were developed in previous years. Table 6.1 provides the list of the procedures. The procedures have been included as appendices to the winter 2016-17 reports; the specific reports are listed in the last column of Table 6.1.

Table 6.1: List of Procedures 2016-17

Program Element #	ID#	Contract Program Element	Name of Procedure	Latest Version Details	Report
1	1.1	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	Procedure: TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING	Version 1.0, Jan 15, 2004	HOT
1	1.2	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	Procedure: TEST REQUIREMENTS FOR NATURAL PRECIPITATION FLAT PLATE TESTING	Version 1.0, Dec 23, 2004	HOT
1	1.3	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	Procedure: DETERMINATION OF ENDURANCE TIMES OF TYPE I FLUIDS UNDER NATURAL SNOW PRECIPITATION AT DORVAL	Version 1.0, Dec 14, 2007	HOT
1	1.4	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	Procedure: ENDURANCE TIME TEST REQUIREMENTS FOR SIMULATED SNOW FLAT PLATE TESTING WITH TYPE I, II, III AND IV FLUIDS	Final Version 1.2, January 23, 2008	HOT
1	1.5	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	Procedure: ENDURANCE TIME TESTING IN FROST WITH TYPE I, II, III AND IV FLUIDS	Version 1.0, Nov 13, 2003 + Addendum Jan 4, 2013	HOT
1	1.6	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	Addendum to Procedure: ENDURANCE TIME TESTING IN FROST WITH TYPE I, II, III AND IV FLUIDS Validation of Frost HOTs with New Fluids	Final Version 1.0, Jan 4, 2013	HOT
1	1.7	ENDURANCE TIME TESTING FOR MAINTENANCE AND PUBLICATION OF HOT GUIDANCE MATERIAL	OVERALL PROGRAM OF TESTS AT NRC, MARCH/APRIL 2017	Final Version 1.0, March 24, 2017	HOT
2	2.1	EVALUATION OF ENDURANCE TIMES ON DEPLOYED FLAPS AND SLATS	Procedure: FLAPS AND SLATS RESEARCH - COMPARATIVE AIRFOIL TESTING	Final Version 1.0, December 15, 2016	FLAPS
17	17.1	ENDURANCE TIME TESTING IN SNOW CONDITIONS AT VERY COLD TEMPERATURES TO VALIDATE HOTS AT -25°C	Procedure: NATURAL SNOW TESTING AT VERY COLD TEMPERATURES	Final Version 1.0, January 3, 2017	HOT
17	17.2	ENDURANCE TIME TESTING IN SNOW CONDITIONS AT VERY COLD TEMPERATURES TO VALIDATE HOTS AT -25°C	Procedure: ARTIFICIAL SNOW TESTING AT VERY COLD TEMPERATURES	Final Version 1.0, March 13, 2017	HOT

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1. Asnytska, Y., Bendickson, S., Bernier, B., Bernier, C., D'Avirro, J., Ruggi, M., Youssef, D., *Aircraft Ground Icing Research General Activities During the 2014-15 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, February 2016, TP 15323E, 244.

2. Bendickson, S., Bernier, B., Bernier, C., Ruggi, M., Youssef, D., *Aircraft Ground Icing General Research Activities During the 2015-16 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, January 2017, TP 15340E, XX (to be published).

3. Bendickson, S., *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2012-13 Winter,* APS Aviation Inc., Transportation Development Centre, Montreal, March 2014, TP 15228E, XX (to be published).

4. SAE International Aerospace Recommended Practice 5718B, *Qualifications Required for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluid*, December 2017.

5. Bendickson, S., *Regression Coefficients and Equations Used to Develop the Winter 2017-18 Aircraft Ground Deicing Holdover Time Tables*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2017, TP 15373E, XX (to be published).

6. Bendickson, S., *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, January 2018, TP 15372E, 70.

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APPENDIX A

TRANSPORTATION DEVELOPMENT CENTRE
WORK STATEMENT EXCERPT
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2016-17

TRANSPORTATION DEVELOPMENT CENTRE
WORK STATEMENT EXCERPT
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2016-17

4.3 Exploratory Research and Standards - Priority 1

Note: This program element includes research activities that will be pursued on an exploratory and ad-hoc basis, including the preparation of standards that may be developed based on the results of research accomplished. The purpose of this activity is to allow for ad-hoc participation at meetings and preliminary testing, the need for which arise from current industry issues. These activities may include, but are not limited to:

a) Support activities of SAE G-12 Aerodynamics Workgroup;

b) Support activities of Ice Detection Workgroup;

c) Support the rewrite of TP14052 through attendance of all meeting and consultations and providing additional technical support as needed;

d) Participate in discussion or meetings related to Ice Phobic coatings research (i.e. SAE G8/G9);

e) Provide support for further development of SAE aircraft ground deicing standards and review updates to these standards that are balloted by SAE;

f) Advance use of tablets for electronic flight bags;

g) Evaluate runway deicer fluid performance;

h) Review the usage of infrared heat with Type I and Type II/IV fluids;

i) Investigate the dispersion of fluids on airport surfaces;

j) Evaluate the limitations of hot water deicing;

k) Investigate the feasibility of infrared system development for northern climates;

l) Participate in discussion or meetings related to the visibility table harmonization;

m) Support research into use of LWE systems with existing HOT tables;

n) Evaluate endurance times for indoor warm soaked anti-icing applications (hangar);

o) Evaluate the effects of manual snow removal method and effects on aerodynamics;

p) Participate in fluid requalification working group (WSET, AERO, and HOT testing);

q) Investigate replacement of reefer trailer;

r) Conduct research at the request of the TC Research Officer to address imminent industry dance or to investigate safety concerns;

s) Investigation into non-glycol (acetate based) Type I compatibility with Type II/IV fluids;

t) HOTs on aircraft Radome and use as a representative surface;

u) Development of lookup table for association of METAR report to specific holdover time table cells; and

v) Investigation into effect of elevation on radiative cooling during the taxi phase (Frost at LOUT).

4.5 Continued Heavy Snow Endurance Time Research to Develop HUPRs for All Data Sets - Priority 2

a) Acquire necessary fluid samples for testing of problematic fluids;

b) Conduct viscosity tests with new fluid samples;

c) Conduct outdoor testing to collect HOT data in snow at heavy rates of precipitation (>25 g/dm²/h). Conduct indoor snow testing to supplement the outdoor data only if required;

d) Analyze the data collected using the HUPR analytical approach to determine HUPRs and heavy snow ETs for all data sets;

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

f) Incorporate HUPRs into the regression information publications.

4.7 Update Source Documents for Maintenance and Publication of HOT Guidance Material - Priority 1

a) Maintain a log of proposed changes to the HOT guidelines;

b) In consultation with the regulators, review long-lead issues during the winter months and recommend changes that should be made for the following season;

c) Coordinate, plan and lead discussions between TC and FAA to resolve outstanding issues, further harmonize guidance materials, and find appropriate ways to incorporate new guidance into the HOT guidance documents;

d) Update the TC and FAA HOT guidance documents (HOT Guidelines, Regression Information, N8900 series notice) with data/guidance from new testing and research, new information collected, changes made to SAE standards, and input from users;

e) Post the 2016-17 TC HOT guidelines documents online and post updates (not budgeted) that may be needed in special circumstances; and

f) Ensure the TC HOT guidelines website is operational, in terms of internet availability, for a one-year period.

4.9 Provision for Support Services and Other Activities - Priority 1

a) Provide support services to assist with program coordination, reviewing, packaging and formatting reports.

4.12 Technical Review, Approval, and Publishing of Technical Reports (12 Reports per Year) – Priority 2

a) Develop prioritized list of unpublished APS reports to be reviewed and published;

b) Coordinate and outsource technical review of reports with technical experts;

c) Perform technical review (to be done by technical experts), and make necessary updates to the reports to prepare the document for final editing and publishing. The target is to complete this for 12 reports per year; and

d) Provide a status of the progress within the monthly progress reports.

4.13 Update SAE Research Protocol Documents ARP5485, ARP5945, ARP5718 and ARP6207 - Priority 2

a) Further develop, advance and ballot, as required, SAE ARP 5485;

b) Further develop, advance and ballot, as required, SAE ARP 5945;

c) Further develop, advance and ballot, as required, SAE ARP 5718;

d) Develop and ballot SAE ARP 6207 (this document will be the Type I equivalent to ARP 5718);

e) Prepare necessary presentation material for SAE G-12 committee meetings; and

f) Report on progress.

4.14 Infrastructure for TC/FAA Aircraft Ground Icing Research Program - Priority 1

4.14.1 Infrastructure for FAA/TC Guideline Development

This program element does not include the actual endurance time testing of newly submitted fluids; the description of the fluid endurance time testing has been included in a previous section of this document and will be funded by the fluid manufacturers.

Fluid Management

a) Receive and catalogue fluids;

b) Verify viscosity of newly received fluids and, at the request of TC/FAA, verify viscosity of fluids in inventory intended for testing use; and

c) Maintain log of fluid inventory and viscosity information.

Preparation and Setup for Natural and Artificial Snow Testing

g) Prepare the P.E.T. test site at Trudeau International Airport (YUL) for conducting tests;

h) Upgrade test site infrastructure (i.e.: trailer, shed, snowmachine) to ensure personnel safety and adhere to environmental guidelines;

i) Prepare an updated procedure for testing fluids outdoors during snow events;

j) Prepare an updated procedure for testing fluids with the snowmaker, as required;

k) Evaluate current methods for measuring snowfall intensity or holdover times;

l) Develop improved, more efficient methods to measure snowfall intensity or holdover times, if appropriate; and

m) Update and maintain iPad based HOT testing data form.

Preparation and Setup for Simulated Precipitation Testing at NRC

a) Prepare a general top-level plan to coordinate all simulated precipitation required by the research program. Testing will be conducted at the NRC Climatic Environment Facility (CEF) in U89 at Uplands, Ottawa;

Note: The NRC facility costs associated with testing at U89 are not included in this task and are dealt with directly with TC through a M.O.U. agreement with NRC;

b) Coordinate scheduling and test plans with NRC CEF personnel;

c) Prepare a test procedure for the conduct of endurance time tests in simulated precipitation at the NRC CEF;

d) Conduct calibration to attain appropriate test conditions for each weather condition represented in the holdover time tables;

e) As the cost for this activity is highly weighted on calibration of precipitation rates, evaluate and, if possible, develop an improved, more efficient method to measure intensity of precipitation; and

f) Update and maintain the NRC Rate Calculation software.

General Activities

a) Analyze individual fluid HOT data to develop generic Type II and Type IV HOTs;

b) Maintain data to ensure continuity;

c) Present material and data at SAE G-12 meeting; and

d) Prepare report.

4.14.2 Infrastructure for FAA/TC Research and Development - Priority 1

This program element does not include the actual research and development testing; the description of these program elements has been included in other sections of this document and has been budgeted separately.

Fluid Management

a) Receive and catalogue fluids;

b) Verify viscosity of newly received fluids and, at the request of TC/FAA, verify viscosity of fluids in inventory intended for testing use; and

c) Maintain log of fluid inventory and viscosity information.

Preparation and Setup for Natural and Artificial Snow Testing at Trudeau International Airport

a) Prepare the P.E.T. test site at Trudeau International Airport (YUL) for conducting tests;

b) Upgrade test site infrastructure (i.e.: trailer, shed, snowmachine) to ensure personnel safety and adhere to environmental guidelines;

c) Prepare an updated procedures for testing fluids outdoors during snow events;

d) Evaluate current methods for measuring snowfall intensity or holdover times; and

e) Develop improved, more efficient methods to measure snowfall intensity or holdover times, if appropriate.

Preparation and Setup for Simulated Precipitation Testing at NRC

a) Prepare a general top-level plan to coordinate all simulated precipitation required by the research program. Testing will be conducted at the NRC Climatic Environment Facility (CEF) in U89 at Uplands, Ottawa;

Note: The NRC facility costs associated with testing at U89 are not included in this task and are dealt with directly with TC through a M.O.U. agreement with NRC;

b) Coordinate scheduling and test plans with NRC CEF personnel;

c) Prepare a test procedure for the conduct of endurance time tests in simulated precipitation at the NRC CEF;

d) Conduct calibration to attain appropriate test conditions for each weather condition represented in the holdover time tables; and

e) As the cost for this activity is highly weighted on calibration of precipitation rates, evaluate and, if possible, develop an improved, more efficient method to measure intensity of precipitation.

APPENDIX B

MEMOS ON FLUIDS WITH NON-CONFORMING HEAVY SNOW DATA

ABAX ECOWING 26

Memo

TO:	Antoine Lacroix, Transport Canada Warren Underwood, FAA	**CC:**	Yvan Chabot, Transport Canada Chuck Enders, FAA
FROM:	Stephanie Bendickson, APS Aviation John D'Avirro, APS Aviation	**DATE:**	April 11, 2017

RE: **Determination of Highest Usable Precipitation Rates (HUPR) and Appropriate Holdover Times for Heavy Snow for ABAX Ecowing 26**

Background: Project

Transport Canada and the FAA contracted APS to conduct research to determine appropriate highest usable precipitation rates (HUPRs) in snow and appropriate holdover times for heavy snow for Type II, III, and IV fluids over the winters of 2015-16 and 2016-17. This project included analysis of original endurance time data, collection of fluid samples, collection of endurance time data with these samples, and final analysis of historic and new data.

Background: ABAX Ecowing 26

ABAX Ecowing 26 was originally submitted for endurance time testing in the winter of 2000-01.

In the winter of 2012-13, APS undertook a project to determine holdover times for light and very light snow for select Type II/IV fluids. The original Ecowing 26 snow endurance time data sets were examined. The 100/0 and 50/50 data sets were found to have sufficient data to determine light and very light snow holdover times, but the 75/25 data set was found to be lacking data at low precipitation rates. Supplemental data was collected that winter with the 75/25 fluid at low precipitation rates. Adjusted regression curves were used to provide HOTs for light and very light snow as the supplemental data did not support the existing regression curves.

Data and Analysis: ABAX Ecowing 26

In the winter of 2015-16, the original Ecowing 26 snow endurance time data was re-examined in the context of heavy snow. It was found the data set lacked data at precipitation rates above 25 g/dm²/h (heavy snow).

- ABAX subsequently submitted samples of the 100/0, 75/25 and 50/50 dilutions for supplemental data collection in 2015-16. The viscosities of the 75/25 and 50/50 dilutions were found to be inappropriate for testing. The viscosity of the 100/0 sample was appropriate.
- Data collected with the 100/0 sample in heavy snow in the winter of 2015-16 lined up with the regression curves derived from the original endurance time testing. The data confirmed the original curves are appropriate to provide HOTs to the maximum HUPR of 50 g/dm²/h.
- Additional 75/25 and 50/50 samples were provided by ABAX for testing in the winter of 2016-17. The viscosities were found to be appropriate. Data collected with the 75/25 and 50/50 samples in heavy snow in the winter of 2016-17 was somewhat below / shorter than the regression curve derived from the original endurance time testing. This indicates shorter endurance times at higher precipitation rates.

Figures 1 to 3 show the original snow endurance time data sets and regression curves. Figures 4 to 6 show the original data plus the additional data collected over the winters of 2015-16 and 2016-17. Data collected at low precipitation rates in the winter of 2012-13 as part of the project to determine HOTs for light and very light snow is also plotted on the 75/25 chart. The regression curves shown in Figures 4to 6 are derived from the combined data sets.

Explanation

When new fluids are submitted for holdover time testing, they are tested in the natural snow weather conditions that occur at the APS Montreal-Trudeau Airport test site that winter. Conditions and storms vary from winter to winter. In the case of Ecowing 26, very limited data was collected in heavy snow.

When data is "missing," especially at low/high precipitation rates and/or temperatures, the shapes of the regression curves are affected. In the case of Ecowing 26 75/25 and 50/50 case, the curves (and subsequently the related holdover times) were artificially high at higher precipitation rates.

Separately, the data collected with Ecowing 26 75/25 in the winter of 2012-13 indicated an issue with the original regression curves at low precipitation rates.

Conclusion and Recommendation

The testing conducted with Ecowing 26 100/0 in 2015-16 validated the appropriateness of the original regression curves at high rates of precipitation. The research supports an HUPR of 50 g/dm²/h.

The testing conducted with Ecowing 26 75/25 and 50/50 in 2016-17 indicates the original snow endurance time data collected is insufficient to provide appropriate holdover times above the precipitation rates encompassed by moderate snow. Our analysis shows the currently published snow holdover times for Ecowing 26 75/25 and 50/50 at higher precipitation rates are likely too high and that an HUPR beyond 25 g/dm²/h is not appropriate.

We therefore recommend that the Ecowing 26 75/25 and 50/50 holdover times be modified for the winter of 2017-18. The modified holdover times should be derived from the combined data set of the original HOT testing data and the data collected in 2016-17. For the 75/25 dilution, the data collected in 2012-13 should also be included. The recommended holdover times are shown in Table 1 (FAA format) and Table 2 (TC format).

If these changes are made, the recommended HUPRs for Ecowing 26 100/0, 75/25 and 50/50 will be 50 g/dm²/h – the highest possible value.

Special Consideration

ABAX has advised APS that this fluid will not be on the market as of 2017-18. If the fluid is not expected to be used, the recommended changes to holdover times may not be required if the HUPR is limited to 25 g/dm²/h. However, consideration should be given to fluid already delivered to users and its possible existence in inventory and potential use in 2017-18.

Note

Comprehensive verification of the data and corresponding holdover times presented herein is ongoing. This verification will be completed prior to publication of the 2017-18 holdover time guidelines. You will be advised should the verification result in changes to any of the information contained herein.

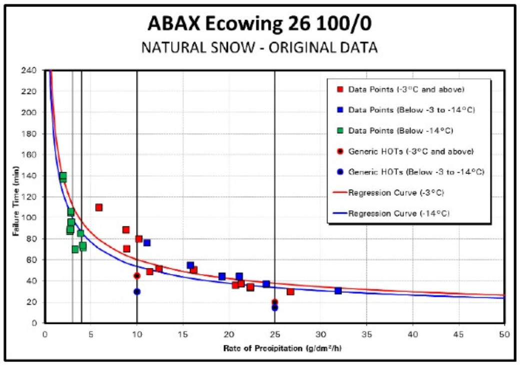

Figure 1: 100/0 Original Data

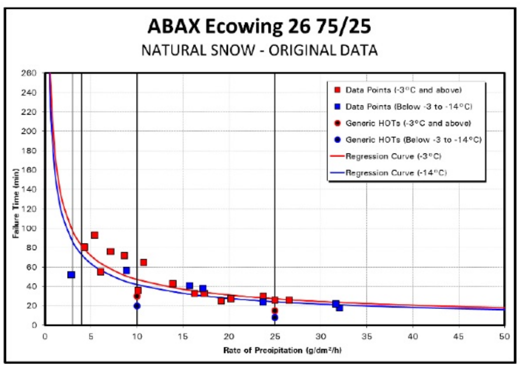

Figure 2: 75/25 Original Data

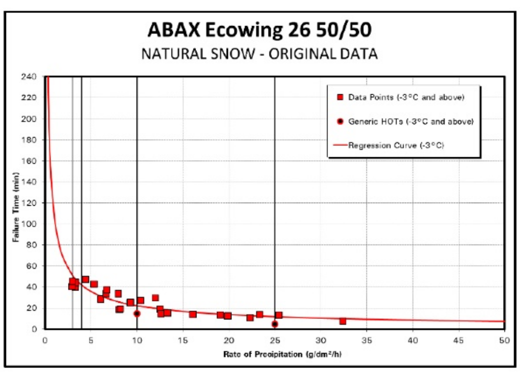

Figure 3: 50/50 Original Data

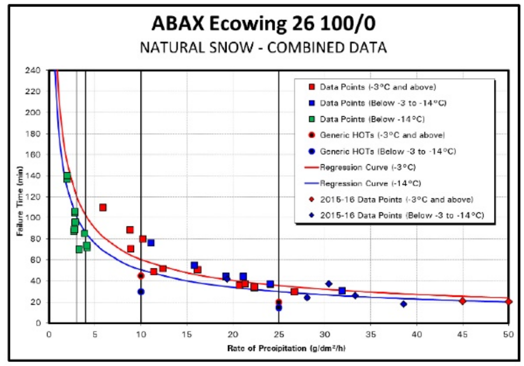

Figure 4: 100/0 Combined Data

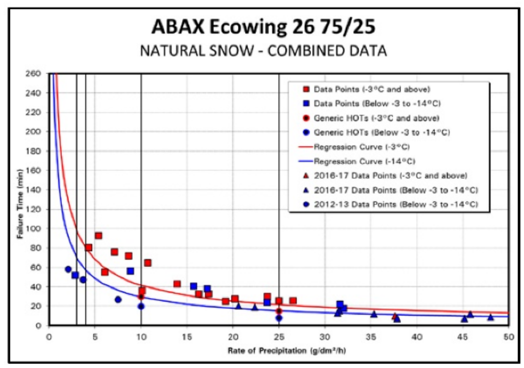

Figure 5: 75/25 Combined Data

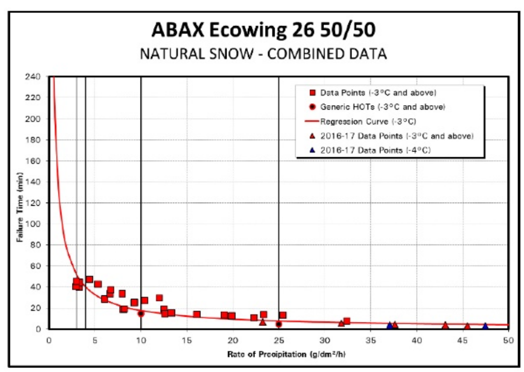

Figure 6: 50/50 Combined Data

TABLE 1: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
ABAX ECOWING 26
(FAA FORMAT)

Outside Air Temperature		Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Moderate	Light	Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:25-2:35	0:40-1:00	1:00-1:35	1:35-1:50	0:50-1:35	0:40-0:50	0:25-0:45	
		75/25	1:05-1:55	~~0:25-0:45~~ 0:20-0:40	~~0:45-1:15~~ 0:40-1:20	~~1:15-1:25~~ 1:20-1:40	0:45-1:05	0:25-0:35	0:25-0:45	
		50/50	0:30-0:45	~~0:10-0:20~~ 0:07-0:20	0:20-0:40	0:40-0:50	0:15-0:25	0:08-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:45-2:15	0:35-0:55	0:55-1:25	1:25-1:40	0:30-1:10	0:15-0:35		
		75/25	0:35-1:15	~~0:25-0:40~~ 0:15-0:30	~~0:40-0:55~~ 0:30-0:55	~~0:55-1:05~~ 0:55-1:10	0:20-0:50	0:15-0:25		
below -14 to -25	below 7 to -13	100/0	0:25-0:45	GENERIC	GENERIC	GENERIC				

Decreases in red
Increases in blue

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TABLE 2: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
ABAX ECOWING 26
(TRANSPORT CANADA FORMAT)

Outside Air Temperature		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Moderate	Light	Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:25 – 2:35	0:40 – 1:00	1:00 – 1:35	1:35	0:50 – 1:35	0:40 – 0:50	0:20 – 1:25	
		75/25	1:05 – 1:55	~~0:25 – 0:45~~ 0:20 – 0:40	~~0:45 – 1:15~~ 0:40 – 1:20	~~1:15~~ 1:20	0:45 – 1:05	0:25 – 0:35	0:10 – 1:00	
		50/50	0:30 – 0:45	~~0:10~~ – 0:20 0:07 – 0:20	0:20 – 0:40	0:40	0:15 – 0:25	0:08 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:45 – 2:15	0:35 – 0:55	0:55 – 1:25	1:25	0:30 – 1:10	0:15 – 0:35		
		75/25	0:35 – 1:15	~~0:25 – 0:40~~ 0:15 – 0:30	~~0:40~~ – 0:55 0:30 – 0:55	0:55	0:20 – 0:50	0:15 – 0:25		
below -14 to -25	below 7 to -13	100/0	0:25 – 0:45	GENERIC	GENERIC	GENERIC				

Decreases in red
Increases in blue

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ABAX ECOWING AD-49 / DOW UCAR FLIGHTGUARD AD-49

Memo

TO:	Antoine Lacroix, Transport Canada Warren Underwood, FAA	**CC:**	Yvan Chabot, Transport Canada Chuck Enders, FAA
FROM:	Stephanie Bendickson, APS Aviation John D'Avirro, APS Aviation	**DATE:**	April 11, 2017
RE:	**Determination of Highest Usable Precipitation Rates (HUPR) and Appropriate Holdover Times for Heavy Snow for ABAX Ecowing AD-49 and Dow UCAR FlightGuard AD-49**		

Background: Project

Transport Canada and the FAA contracted APS to conduct research to determine appropriate highest usable precipitation rates (HUPRs) in snow and appropriate holdover times for heavy snow for Type II, III, and IV fluids over the winters of 2015-16 and 2016-17. This project included analysis of original endurance time data, collection of fluid samples, collection of endurance time data with these samples, and final analysis of historic and new data.

Background: ABAX Ecowing AD-49 / Dow UCAR FlightGuard AD-49

ABAX Ecowing AD-49, which is also marketed under the brand name Dow UCAR FlightGuard AD-49, was submitted late in the season the year it was tested (2008-09). As a result of its late submission and of weather conditions in Montreal that winter, the endurance time collected was somewhat limited. Nevertheless, it was found sufficient to provide holdover times for moderate snow (the only snowfall intensity for which HOTs were provided at that time).

In the winter of 2012-13, APS undertook a project to determine holdover times for light and very light snow for select Type II/IV fluids. The original AD-49 snow endurance time data set was examined and found to be lacking data at low precipitation rates. Supplemental data was collected at low precipitation rates. It was found to meet or exceed the HOTs predicted by the existing regression curves.

Data and Analysis: ABAX Ecowing AD-49 / Dow UCAR FlightGuard AD-49

In the winter of 2015-16, the original AD-49 snow endurance time data was re-examined in the context of heavy snow. It was found the data set lacked data at precipitation rates above 25 g/dm²/h (heavy snow). It was also noted that the coldest temperature at which data was collected with the 100/0 and 75/25 fluids was -9°C; ideally data is collected to -14°C.

- ABAX subsequently submitted samples of the 100/0, 75/25 and 50/50 dilutions for supplemental data collection in 2015-16. The viscosity of the 100/0 sample was found to be below the LOWV. The data collected with this sample was not used. The viscosities of the 75/25 and 50/50 samples were appropriate.
- Data collected in the winter of 2015-16 with the 75/25 sample did not line up with the regression curve derived from the original endurance time testing. The data indicated shorter endurance times at higher precipitation rates and lower temperatures. Data collected in the winter of 2015-16 with the 50/50 sample lined up with the original data regression curve and confirmed the appropriateness of the existing holdover times and regression coefficients for higher precipitation rates.
- Additional 100/0 and 75/25 samples were provided for further testing in the winter of 2016-17. These samples were provided by Dow. The viscosities were found to be appropriate. Data collected with the 75/25 sample confirmed the results observed in 2015-16; the data indicated shorter endurance times at higher precipitation rates and lower temperatures. Similarly, the data collected with the 100/0 sample indicated shorter endurance times at higher precipitation rates and lower temperatures.

Figures 1 to 3 show the original snow endurance time data sets and regression curves. Figures 4 to 6 show the original data plus the additional data collected over the winters of 2015-16 and 2016-17. Data collected at low precipitation rates in the winter of 2012-13 as part of the project to determine HOTs for light and very light snow is also plotted on the charts. The regression curves shown in Figures 4 to 6 are derived from the combined data sets.

Explanation

When new fluids are submitted for holdover time testing, they are tested in the natural snow weather conditions that occur at the APS Montreal-Trudeau Airport test site that winter. Conditions and storms vary from winter to winter. In the case of AD-49, no data was collected in heavy snow and no data was collected below -9°C.

When data is "missing," especially at low/high precipitation rates and/or temperatures, the shapes of the regression curves are affected. In the case of AD-49 100/0 and 75/25, the curves (and subsequently the related holdover times) were artificially high at higher precipitation rates due to the lack of data in this area.

Conclusion and Recommendation

It seems the original snow endurance time data collected with AD-49 was insufficient to provide holdover times above the precipitation rates encompassed by moderate snow.

Our analysis shows the currently published snow holdover times for AD-49 100/0 and 75/25 at higher precipitation rates are likely too high. In addition, data collected with these fluids at lower precipitation supports longer holdover times for lighter rates. We therefore recommend that the holdover times for AD-49 100/0 and 75/25 be modified for the winter of 2017-18. The modified holdover times should be derived from the combined data set of the original HOT testing data, the data collected in 2015-16, the data collected in 2016-17, and the data collected in 2012-13. The recommended holdover times are shown in Table 1 (FAA format) and Table 2 (TC format).

If these changes are made, the recommended HUPRs will be 50 g/dm²/h – the highest possible value.

Note

Comprehensive verification of the data and corresponding holdover times presented herein is ongoing. This verification will be completed prior to publication of the 2017-18 holdover time guidelines. You will be advised should the verification result in changes to any of the information contained herein.

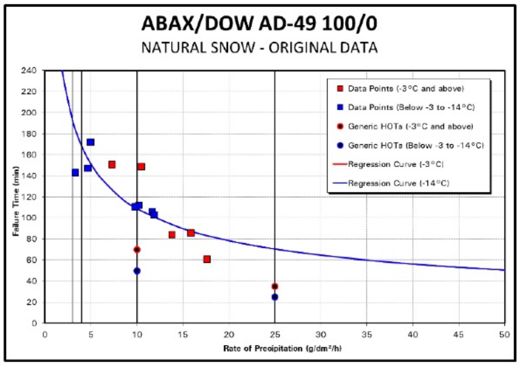

Figure 1: 100/0 Original Data

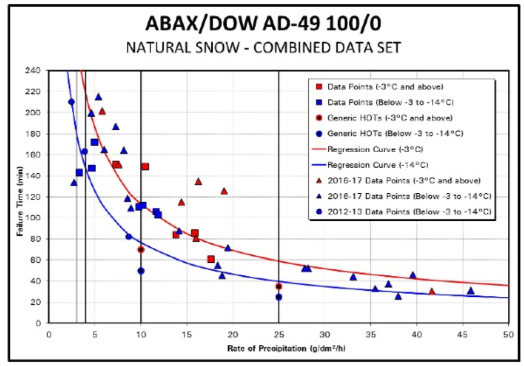

Figure 4: 100/0 Combined Data

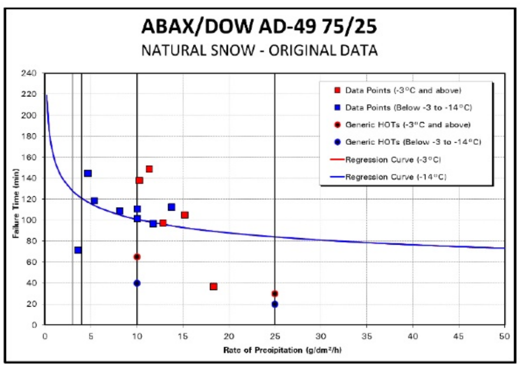

Figure 2: 75/25 Original Data

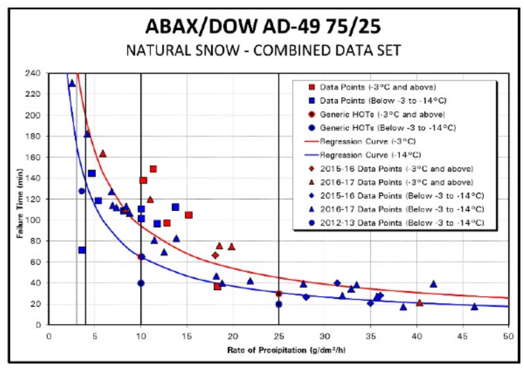

Figure 5: 75/25 Combined Data

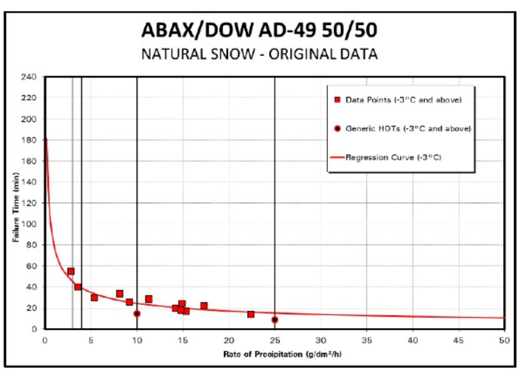

Figure 3: 50/50 Original Data

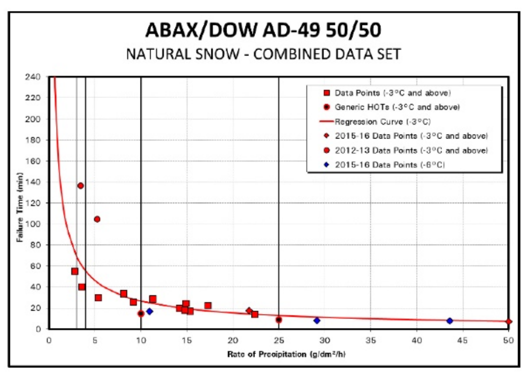

Figure 6: 50/50 Combined Data

TABLE 1: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
ABAX ECOWING AD-49 AND DOW UCAR FLIGHTGUARD AD-49
(FAA FORMAT)

Outside Air Temperature		Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Moderate	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	3:20-4:00	~~1:10-1:50~~ 1:00-1:55	~~1:50-2:50~~ 1:55-3:00	~~2:50-3:00~~ 3:00-3:00	1:25-2:00	1:00-1:25	0:10-1:55	
		75/25	2:25-4:00	~~1:20-1:40~~ 0:45-1:35	~~1:40-2:05~~ 1:35-3:00	~~2:05-2:15~~ 3:00-3:00	1:55-2:00	0:50-1:30	0:10-1:40	
		50/50	0:25-0:50	0:15-0:25	0:25-0:40	0:40-0:45	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	~~1:10-1:50~~ 0:40-1:15	~~1:50-2:50~~ 1:15-2:25	~~2:50-3:00~~ 2:25-3:00	0:25-1:257	0:20-0:257		
		75/25	0:30-1:10	~~1:20-1:40~~ 0:30-1:05	~~1:40-2:05~~ 1:05-2:15	~~2:05-2:15~~ 2:15-2:55	0:15-1:057	0:15-0:257		
below -14 to -26	below 7 to -14.8	100/0	0:25-0:40	GENERIC	GENERIC	GENERIC				

Decreases in red
Increases in blue

*Note: FAA cap on snow holdover times is 3 hours

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TABLE 2: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
ABAX ECOWING AD-49 AND DOW UCAR FLIGHTGUARD AD-49
(TRANSPORT CANADA FORMAT)

Outside Air Temperature		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Moderate	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	3:20 – 4:00	~~1:10 – 1:50~~ 1:00 – 1:55	~~1:50~~ – 2:00 1:55 – 2:00	2:00	1:25 – 2:00	1:00 – 1:25	0:10 – 1:55	
		75/25	2:25 – 4:00	~~1:20 – 1:40~~ 0:45 – 1:35	~~1:40~~ – 2:00 1:35 – 2:00	2:00	1:55 – 2:00	0:50 – 1:30	0:10 – 1:40	
		50/50	0:25 – 0:50	0:15 – 0:25	0:25 – 0:40	0:40	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	~~1:10 – 1:50~~ 0:40 – 1:15	~~1:50~~ – 2:00 1:15 – 2:00	2:00	0:25 – 1:25	0:20 – 0:25		
		75/25	0:30 – 1:10	~~1:20 – 1:40~~ 0:30 – 1:05	~~1:40~~ – 2:00 1:05 – 2:00	2:00	0:15 – 1:05	0:15 – 0:25		
below -14 to -26	below 7 to -14.8	100/0	0:25 – 0:40	GENERIC	GENERIC	GENERIC				

Decreases in red
Increases in blue

*Note: Transport Canada cap on snow holdover times is 2 hours

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CRYOTECH POLAR GUARD II / CRYOTECH POLAR GUARD ADVANCE

Memo

TO:	Antoine Lacroix, Transport Canada Warren Underwood, FAA	**CC:**	Yvan Chabot, Transport Canada Chuck Enders, FAA
FROM:	Stephanie Bendickson, APS Aviation John D'Avirro, APS Aviation	**DATE:**	April 11, 2017

RE: **Determination of Highest Usable Precipitation Rates (HUPR) and Appropriate Holdover Times for Heavy Snow for Cryotech Polar Guard Advance and Cryotech Polar Guard II**

Background: Project

Transport Canada and the FAA contracted APS to conduct research to determine appropriate highest usable precipitation rates (HUPRs) in snow and appropriate holdover times for heavy snow for Type II, III, and IV fluids over the winters of 2015-16 and 2016-17. This project included analysis of original endurance time data, collection of fluid samples, collection of endurance time data with these samples, and final analysis of historic and new data.

Background: Cryotech Polar Guard Advance and Polar Guard II

Cryotech Polar Guard Advance is a Type IV fluid that was submitted for endurance time testing late in the winter of 2010-11 (February 2011). The Polar Guard Advance formulation is also marketed as a Type II fluid under the brand name Polar Guard II.

Data and Analysis: Cryotech Polar Guard Advance

Analysis of the Polar Guard Advance original snow endurance time data set indicated a lack of data at precipitation rates above 25 g/dm²/h (heavy snow). Cryotech subsequently submitted samples of the neat, 75/25 and 50/50 dilutions for supplemental testing in the fall of 2015.

Data collected in heavy snow in the winter of 2015-16 did not line up with the regression curves derived from the original endurance time data set. The data indicated shorter endurance times at higher precipitation rates. A second set of samples was provided by Cryotech for testing in the winter of 2016-17. This was done as it was thought the way the 2015-16 samples were prepared impacted the fluid's performance. However, this turned out not to be the case as the data collected in the winter of 2016-17 confirmed the results observed in 2015-16.

Figures 1 to 3 show the original Polar Guard Advance snow endurance time data sets and regression curves. Figures 4 to 6 show the original data plus the supplemental data collected over the winters of 2015-16 and 2016-17. Data collected at low precipitation rates in the winter of 2012-13 as part of a project to determine holdover times for light and very light snow is also plotted on the charts. The regression curves shown in Figures 4-6 are derived from the combined data sets. There are differences, some significant, between these curves and the original curves. Note the curves determine holdover times; therefore, differences in curves means differences in holdover times.

Explanation

When new fluids are submitted for holdover time testing, they are tested in the natural snow weather conditions that occur at the APS Montreal-Trudeau Airport test site that winter. Conditions and storms vary from winter to winter. In the case of Polar Guard Advance, no heavy snow data was collected. This is likely partially a result of the weather conditions in Montreal that winter and of the late submission of the fluid in the winter. When data is "missing," especially at low/high precipitation rates and/or temperatures, the shapes of the regression curves are affected. In this case, the missing data led to curves (and subsequently the related holdover times) that were artificially high at higher precipitation rates.

Conclusion and Recommendation

Our analysis shows the currently published snow holdover times for Polar Guard Advance and Polar Guard II at higher precipitation rates are likely too high. In addition, data collected at lower precipitation supports longer holdover times at lighter rates. We recommend that the holdover times for these fluids be modified for the winter of 2017-18. The modified HOTs should be derived from all data collected to date with this fluid: the original HOT testing data, the heavy snow data collected in 2015-16 and 2016-17, and the light snow data collected in 2012-13. The recommended holdover times are shown in Table 1 (FAA format) and Table 2 (TC format).

If these changes are made, the recommended HUPRs will be 50 $g/dm^2/h$ – the highest possible value.

Note

Comprehensive verification of the data and corresponding holdover times presented herein is ongoing. This verification will be completed prior to publication of the 2017-18 holdover time guidelines. You will be advised should the verification result in changes to any of the information contained herein.

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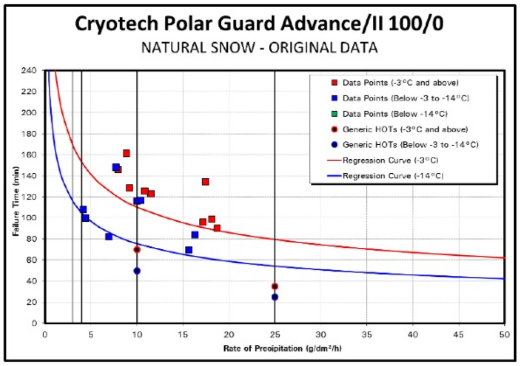

Figure 1: 100/0 Original Data

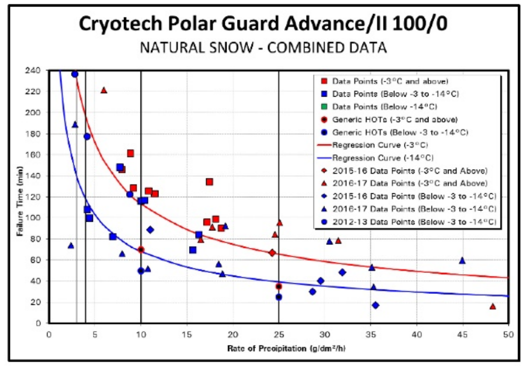

Figure 4: 100/0 Combined Data

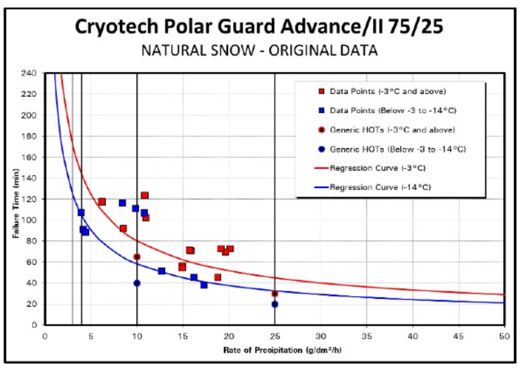

Figure 2: 75/25 Original Data

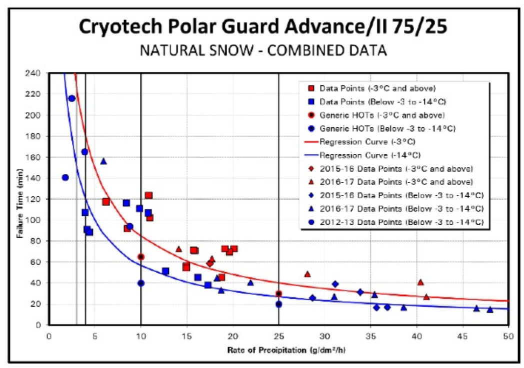

Figure 5: 75/25 Combined Data

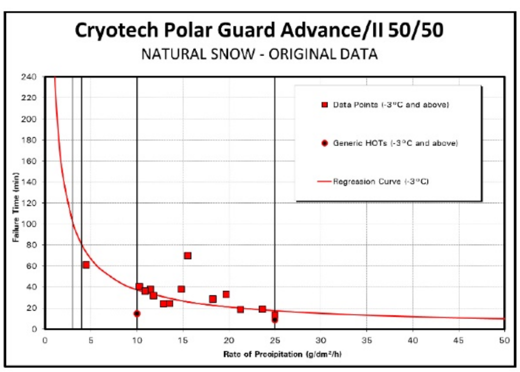

Figure 3: 50/50 Original Data

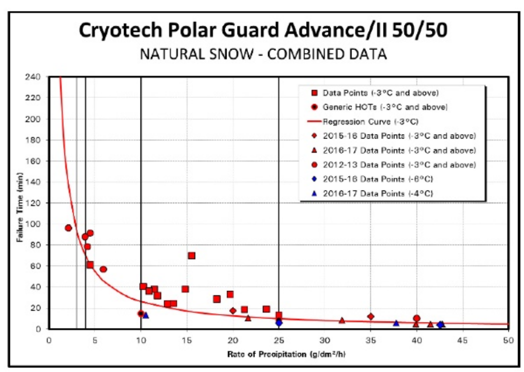

Figure 6: 50/50 Combined Data

TABLE 1: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
CRYOTECH POLAR GUARD® ADVANCE AND POLAR GUARD® II
(FAA FORMAT)

Outside Air Temperature		Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets* Moderate	Snow, Snow Grains or Snow Pellets* Light	Snow, Snow Grains or Snow Pellets* Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	2:50-4:00	~~1:20-1:50~~ 1:05-1:55	~~1:50-2:35~~ 1:55-3:00	~~2:35-2:50~~ 3:00-3:00	1:35-2:00	1:15-1:30	0:15-2:00	
		75/25	2:30-4:00	~~0:45-1:20~~ 0:40-1:25	~~1:20-2:25~~ 1:25-3:00	~~2:25-2:55~~ 3:00-3:00	1:40-2:00	0:40-1:10	0:09-1:40	
		50/50	0:50-1:25	~~0:15-0:35~~ 0:10-0:25	~~0:35-1:20~~ 0:25-1:10	~~1:20-1:45~~ 1:10-1:35	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	~~0:55-1:15~~ 0:40-1:10	~~1:15-1:45~~ 1:10-2:00	~~1:45-1:55~~ 2:00-2:20	0:35-1:35	0:35-0:45		
		75/25	0:40-1:30	~~0:35-1:00~~ 0:25-0:55	~~1:00-1:45~~ 0:55-2:00	~~1:45-2:05~~ 2:00-2:30	0:25-1:05	0:35-0:45		
Below -14 to -30.5	Below 7 to -22.9	100/0	0:25-0:50	TBD	TBD	TBD				

Decreases in red
Increases in blue

*Note: FAA cap on snow holdover times is 3 hours

Page 4 of 5

TABLE 2: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
CRYOTECH POLAR GUARD® ADVANCE AND POLAR GUARD® II
(TRANSPORT CANADA FORMAT)

Outside Air Temperature		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets* Moderate	Snow, Snow Grains or Snow Pellets* Light	Snow, Snow Grains or Snow Pellets* Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	2:50 – 4:00	~~1:20 – 1:50~~ 1:05 – 1:55	~~1:50~~ – 2:00 1:55 – 2:00	2:00	1:35 – 2:00	1:15 – 1:30	0:15 – 2:00	
		75/25	2:30 – 4:00	~~0:45 – 1:20~~ 0:40 – 1:25	~~1:20~~ – 2:00 1:25 – 2:00	2:00	1:40 – 2:00	0:40 – 1:10	0:09 – 1:40	
		50/50	0:50 – 1:25	~~0:15 – 0:35~~ 0:10 – 0:25	~~0:35 – 1:20~~ 0:25 – 1:10	~~1:20~~ 1:10	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	~~0:55 – 1:15~~ 0:40 – 1:10	~~1:15 – 1:45~~ 1:10 – 2:00	~~1:45~~ 2:00	0:35 – 1:35	0:35 – 0:45		
		75/25	0:40 – 1:30	~~0:35 – 1:00~~ 0:25 – 0:55	~~1:00 – 1:45~~ 0:55 – 2:00	~~1:45~~ 2:00	0:25 – 1:05	0:35 – 0:45		
below -14 to -30.5	below 7 to -22.9	100/0	0:25 – 0:50	TBD	TBD	TBD				

Decreases in red
Increases in blue

*Note: Transport Canada cap on snow holdover times is 2 hours

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CLARIANT MAX FLIGHT SNEG

Memo

TO:	Antoine Lacroix, Transport Canada Warren Underwood, FAA	**CC:**	Yvan Chabot, Transport Canada Chuck Enders, FAA
FROM:	Stephanie Bendickson, APS Aviation John D'Avirro, APS Aviation	**DATE:**	April 11, 2017
RE:	**Determination of Highest Usable Precipitation Rates (HUPR) and Appropriate Holdover Times for Heavy Snow for Clariant Max Flight SNEG**		

Background: Project

Transport Canada and the FAA contracted APS to conduct research to determine appropriate highest usable precipitation rates (HUPRs) in snow and appropriate holdover times for heavy snow for Type II, III, and IV fluids over the winters of 2015-16 and 2016-17. This project included analysis of original endurance time data, collection of fluid samples, collection of endurance time data with these samples, and final analysis of historic and new data.

Data and Analysis: Clariant Max Flight SNEG

Analysis of the original snow endurance time data for Clariant Max Flight SNEG indicated a lack of data at precipitation rates above 25 g/dm²/h (heavy snow) for the 100/0 dilution. The 75/25 and 50/50 dilutions were found to have sufficient data. APS had Max Flight SNEG 100/0 fluid on hand, which was leftover from the original endurance time testing conducted with the fluid the year prior.

Data was collected in heavy snow with this sample in the winter of 2015-16. The data did not line up with the regression curves derived from the original Max Flight SNEG 100/0 endurance time data set. The data indicated shorter endurance times at higher precipitation rates.

Figure 1 shows the original snow endurance time data set and related regression curves. Figure 2 shows the original data plus the additional data collected in 2015-16. The regression curves shown in Figure 2 are derived from the combined data set.

Conclusion and Recommendation

Our analysis validated the appropriateness of the original regression curves for Max Flight SNEG 75/25 and 50/50 at high rates of precipitation. The research supports an HUPR of 50 g/dm²/h for these fluids.

The testing conducted with Max Flight SNEG 100/0 indicates the original snow endurance time data collected is insufficient to provide appropriate holdover times above the precipitation rates encompassed by moderate snow. Our analysis shows the currently published snow holdover times for Max Flight SNEG 100/0 at higher precipitation rates are likely too high.

We therefore recommend that the Max Flight SNEG 100/0 holdover times be modified for the winter of 2017-18. The modified holdover times should be derived from the combined data set of the original HOT testing data and the data collected in heavy snow in 2015-16. The recommended holdover times are shown in Table 1 (FAA format) and Table 2 (TC format). If these changes are made, the recommended HUPR for Max Flight SNEG 100/0 will be 50 g/dm²/h – the highest possible value.

Note

Comprehensive verification of the data and corresponding holdover times presented herein is ongoing. This verification will be completed prior to publication of the 2017-18 holdover time guidelines. You will be advised should the verification result in changes to any of the information contained herein.

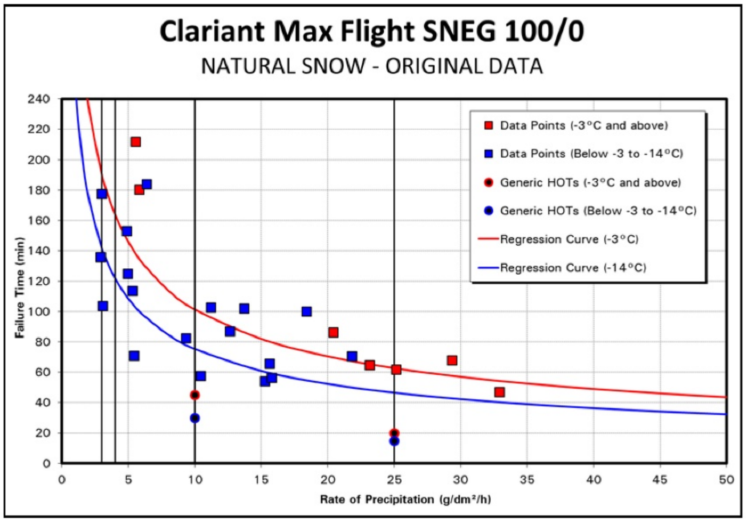

Figure 1: 100/0 Original Data

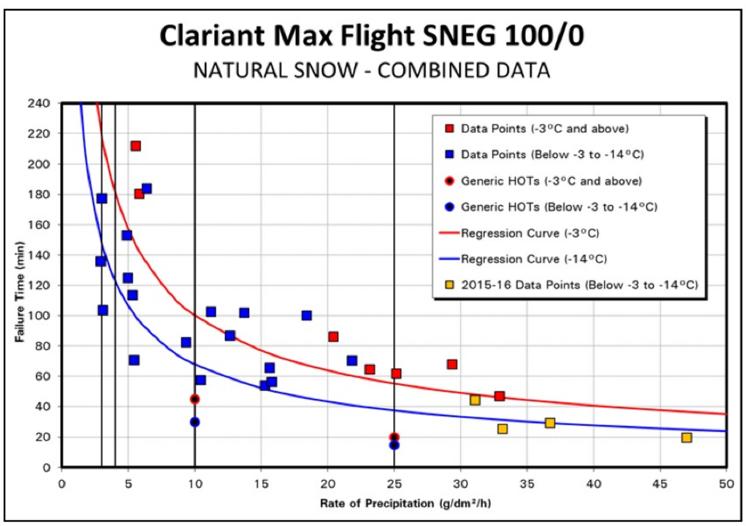

Figure 2: 100/0 Combined Data

TABLE 1: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
CLARIANT MAX FLIGHT SNEG
(FAA FORMAT)

Outside Air Temperature		Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets* Moderate	Snow, Snow Grains or Snow Pellets* Light	Snow, Snow Grains or Snow Pellets* Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	2:25-4:00	~~1:05-1:40~~ 0:55-1:40	~~1:40-2:45~~ 1:40-3:00	~~2:45-3:00~~ 3:00-3:00	2:00-2:00	0:50-1:40	0:20-1:30	
		75/25	4:00-4:00	0:55-1:30	1:30-2:25	2:25-2:50	1:30-2:00	1:05-1:20	0:15-1:45	
		50/50	1:30-3:30	0:20-0:45	0:45-1:45	1:45-2:20	0:35-1:10	0:15-0:30		
below -3 to -14	below 27 to 7	100/0	0:45-2:20	~~0:45-1:15~~ 0:40-1:10	~~1:15-2:00~~ 1:10-2:05	~~2:00-2:20~~ 2:05-2:30	0:30-1:25	0:25-0:40	CAUTION: No holdover time guidelines exist	
		75/25	0:30-1:25	0:40-1:00	1:00-1:40	1:40-2:00	0:20-1:05	0:20-0:40		
below -14 to -29	below 7 to -20.2	100/0	0:20-0:50	GENERIC	GENERIC	GENERIC				

Decreases in red
Increases in blue

*Note: FAA cap on snow holdover times is 3 hours

Page 3 of 4

TABLE 2: RECOMMENDED CHANGES TO HOLDOVER TIMES FOR
CLARIANT MAX FLIGHT SNEG
(TRANSPORT CANADA FORMAT)

Outside Air Temperature		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets* Moderate	Snow, Snow Grains or Snow Pellets* Light	Snow, Snow Grains or Snow Pellets* Very Light	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	2:25 – 4:00	~~1:05~~ – 1:40 0:55 – 1:40	1:40 – 2:00	2:00	2:00 – 2:00	0:50 – 1:40	0:20 – 1:30	
		75/25	4:00 – 4:00	0:55 – 1:30	1:30 – 2:00	2:00	1:30 – 2:00	1:05 – 1:20	0:15 – 1:45	
		50/50	1:30 – 3:30	0:20 – 0:45	0:45 – 1:45	1:45	0:35 – 1:10	0:15 – 0:30		
below -3 to -14	below 27 to 7	100/0	0:45 – 2:20	~~0:45 – 1:15~~ 0:40 – 1:10	~~1:15~~ – 2:00 1:10 – 2:00	2:00	0:30 – 1:25	0:25 – 0:40	CAUTION: No holdover time guidelines exist	
		75/25	0:30 – 1:25	0:40 – 1:00	1:00 – 1:40	1:40	0:20 – 1:05	0:20 – 0:40		
below -14 to -29	below 7 to -20.2	100/0	0:20 – 0:50	GENERIC	GENERIC	GENERIC				

Decreases in red
Increases in blue

*Note: Transport Canada cap on snow holdover times is 2 hours

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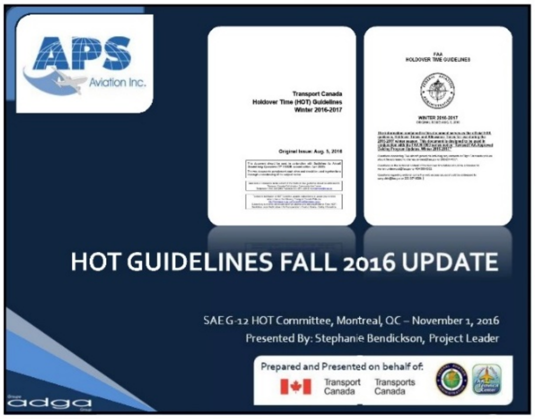
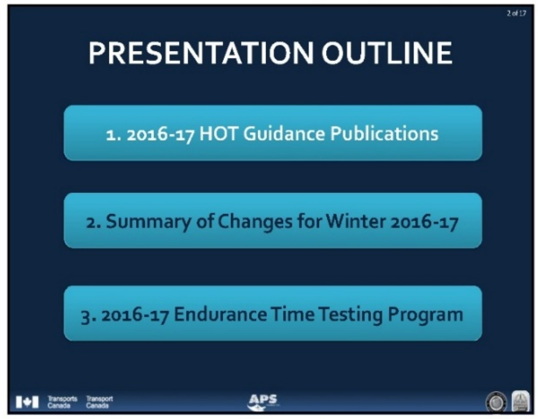
APPENDIX C

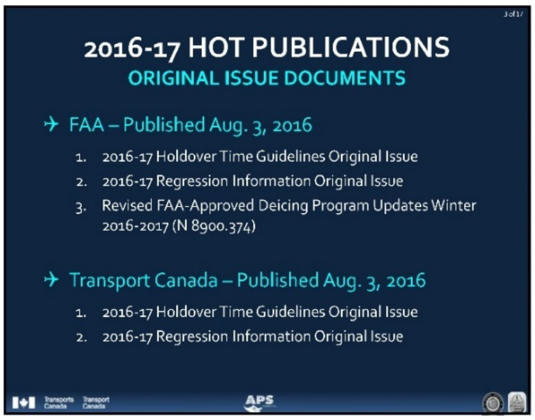
PRESENTATIONS AT VARIOUS MEETINGS

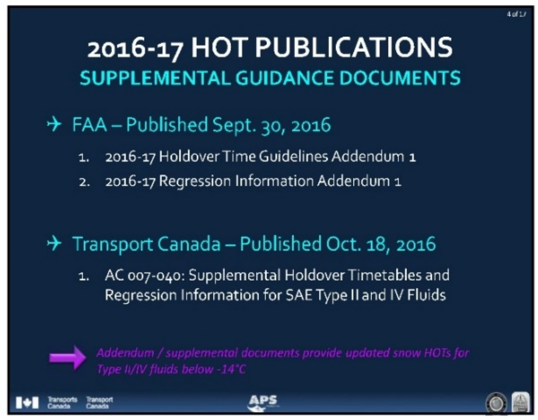
SAE G-12 HOT COMMITTEE, MONTREAL, CANADA

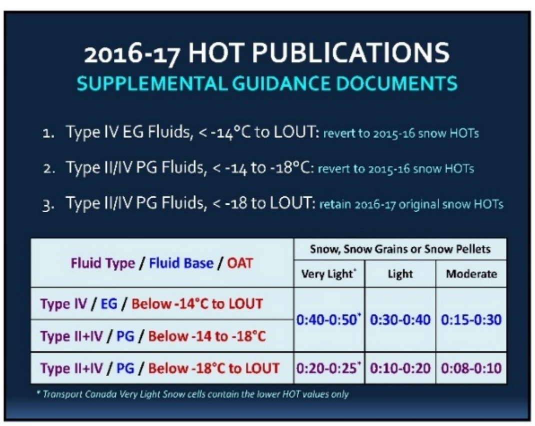
PRESENTATION:
HOT GUIDELINES FALL 2016 UPDATE


APS
Aviation Inc.
Transport Canada
Holdover Time (HOT) Guidelines
Winter 2016-2017
Original Issue: Aug. 5, 2016
FAA
HOLDOVER TIME GUIDELINES
WINTER 2016-2017
HOT GUIDELINES FALL 2016 UPDATE
SAE G-12 HOT Committee, Montreal, QC – November 1, 2016
Presented By: Stephanie Bendickson, Project Leader
Prepared and Presented on behalf of:
Transport Canada
Transports Canada
adga


2 of 17
PRESENTATION OUTLINE
1. 2016-17 HOT Guidance Publications
2. Summary of Changes for Winter 2016-17
3. 2016-17 Endurance Time Testing Program
Transports Canada
Transport Canada
APS

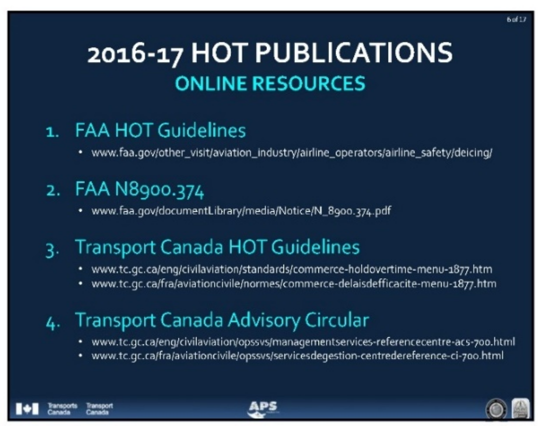

3 of 17
2016-17 HOT PUBLICATIONS
ORIGINAL ISSUE DOCUMENTS
FAA – Published Aug. 3, 2016
1. 2016-17 Holdover Time Guidelines Original Issue
2. 2016-17 Regression Information Original Issue
3. Revised FAA-Approved Deicing Program Updates Winter 2016-2017 (N 8900.374)
Transport Canada – Published Aug. 3, 2016
1. 2016-17 Holdover Time Guidelines Original Issue
2. 2016-17 Regression Information Original Issue
Transports Canada
Transport Canada
APS

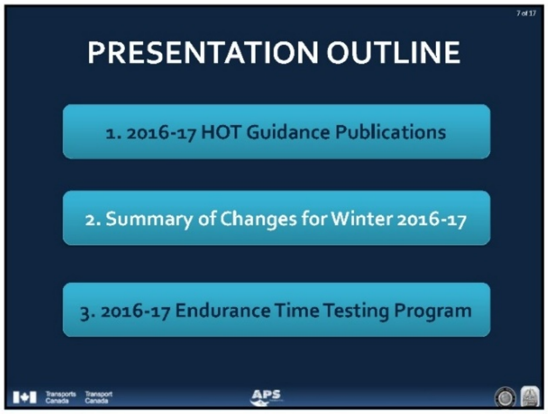

4 of 17
2016-17 HOT PUBLICATIONS
SUPPLEMENTAL GUIDANCE DOCUMENTS
FAA – Published Sept. 30, 2016
1. 2016-17 Holdover Time Guidelines Addendum 1
2. 2016-17 Regression Information Addendum 1
Transport Canada – Published Oct. 18, 2016
1. AC 007-040: Supplemental Holdover Timetables and Regression Information for SAE Type II and IV Fluids
Addendum / supplemental documents provide updated snow HOTs for Type II/IV fluids below -14°C
Transports Canada
Transport Canada
APS

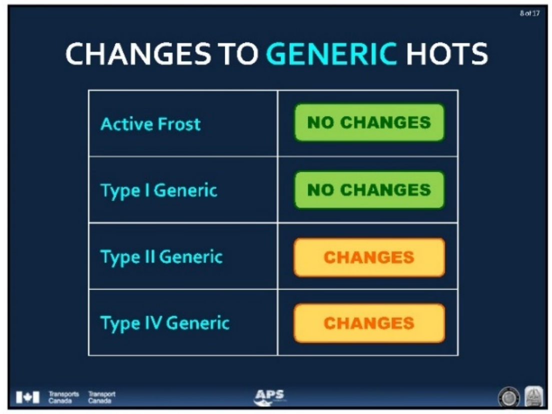

2016-17 HOT PUBLICATIONS
SUPPLEMENTAL GUIDANCE DOCUMENTS
1. Type IV EG Fluids, < -14°C to LOUT: revert to 2015-16 snow HOTs
2. Type II/IV PG Fluids, < -14 to -18°C: revert to 2015-16 snow HOTs
3. Type II/IV PG Fluids, < -18 to LOUT: retain 2016-17 original snow HOTs

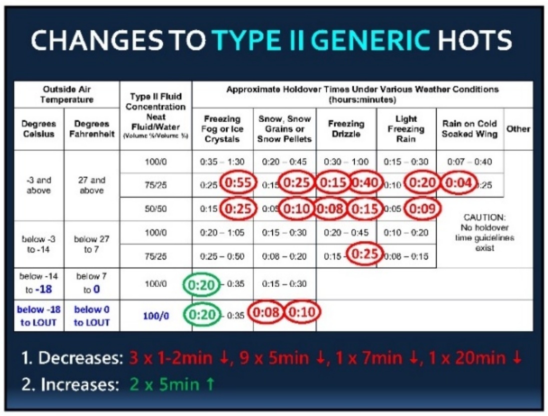
Fluid Type / Fluid Base / OAT	Snow, Snow Grains or Snow Pellets		
	Very Light*	Light	Moderate
Type IV / EG / Below -14°C to LOUT Type II+IV / PG / Below -14 to -18°C	0:40-0:50*	0:30-0:40	0:15-0:30
Type II+IV / PG / Below -18°C to LOUT	0:20-0:25*	0:10-0:20	0:08-0:10

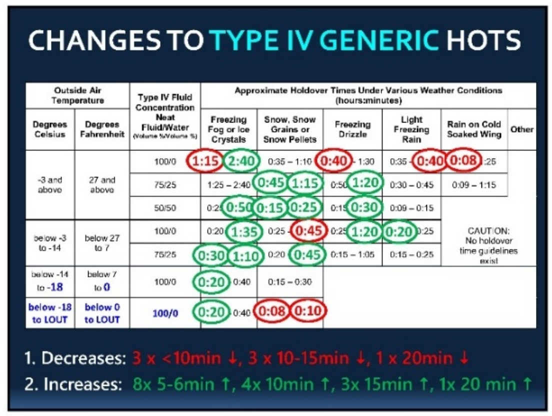
* Transport Canada Very Light Snow cells contain the lower HOT values only

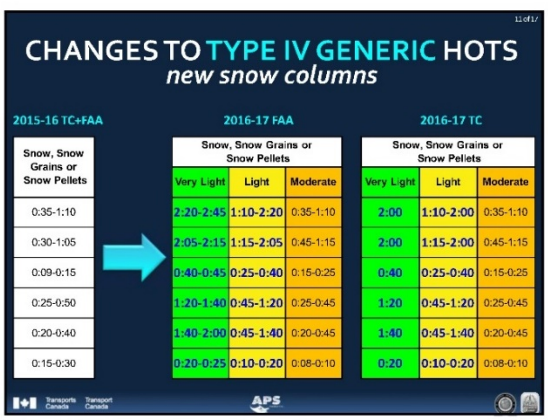

6 of 17
2016-17 HOT PUBLICATIONS
ONLINE RESOURCES
1. FAA HOT Guidelines
• www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/
2. FAA N8900.374
• www.faa.gov/documentLibrary/media/Notice/N_8900.374.pdf
3. Transport Canada HOT Guidelines
• www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm
• www.tc.gc.ca/fra/aviationcivile/normes/commerce-delaisdefficacite-menu-1877.htm
4. Transport Canada Advisory Circular
• www.tc.gc.ca/eng/civilaviation/opssvs/managementservices-referencecentre-acs-700.html
• www.tc.gc.ca/fra/aviationcivile/opssvs/servicesdegestion-centredereference-ci-700.html
Transports Canada
Transport Canada
APS


7 of 17
PRESENTATION OUTLINE
1. 2016-17 HOT Guidance Publications
2. Summary of Changes for Winter 2016-17
3. 2016-17 Endurance Time Testing Program
Transports Canada Transport Canada
APS


8 of 17
CHANGES TO GENERIC HOTS
Active Frost
NO CHANGES
Type I Generic
NO CHANGES
Type II Generic
CHANGES
Type IV Generic
CHANGES
Transports Canada Transport Canada
APS


CHANGES TO TYPE II GENERIC HOTS
Outside Air Temperature
Degrees Celsius
Degrees Fahrenheit
Type II 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
Light Freezing Rain
Rain on Cold Soaked Wing
Other
-3 and above
27 and above
100/0
0:35 – 1:30
0:20 – 0:45
0:30 – 1:00
0:15 – 0:30
0:07 – 0:40
75/25
0:25
0:55
0:15
0:25
0:15
0:40
0:10
0:20
0:04
:25
50/50
0:15
0:25
0:05
0:10
0:08
0:15
0:05
0:09
below -3 to -14
below 27 to 7
100/0
0:20 – 1:05
0:15 – 0:30
0:20 – 0:45
0:10 – 0:20
75/25
0:25 – 0:50
0:08 – 0:20
0:15
0:25
0:08 – 0:15
CAUTION: No holdover time guidelines exist
below -14 to -18
below 7 to 0
100/0
0:20
0:35
0:15 – 0:30
below -18 to LOUT
below 0 to LOUT
100/0
0:20
0:35
0:08
0:10
1. Decreases: 3 x 1-2min ↓, 9 x 5min ↓, 1 x 7min ↓, 1 x 20min ↓
2. Increases: 2 x 5min ↑


CHANGES TO TYPE IV GENERIC HOTS
Outside Air Temperature
Degrees Celsius
Degrees Fahrenheit
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
Light Freezing Rain
Rain on Cold Soaked Wing
Other
-3 and above
27 and above
100/0
1:15
2:40
0:35 – 1:10
0:40
1:30
0:35
0:40
0:08
:25
75/25
1:25 – 2:40
0:45
1:15
0:50
1:20
0:30 – 0:45
0:09 – 1:15
50/50
0:2
0:50
0:15
0:25
0:15
0:30
0:09 – 0:15
below -3 to -14
below 27 to 7
100/0
0:20
1:35
0:25
0:45
0:25
1:20
0:20
0:25
75/25
0:30
1:10
0:20
0:45
0:15 – 1:05
0:15 – 0:25
CAUTION: No holdover time guidelines exist
below -14 to -18
below 7 to 0
100/0
0:20
0:40
0:15 – 0:30
below -18 to LOUT
below 0 to LOUT
100/0
0:20
0:40
0:08
0:10
1. Decreases: 3 x <10min ↓, 3 x 10-15min ↓, 1 x 20min ↓
2. Increases: 8x 5-6min ↑, 4x 10min ↑, 3x 15min ↑, 1x 20 min ↑


11 of 17
CHANGES TO TYPE IV GENERIC HOTS
new snow columns
2015-16 TC+FAA
Snow, Snow Grains or Snow Pellets
0:35-1:10
0:30-1:05
0:09-0:15
0:25-0:50
0:20-0:40
0:15-0:30
2016-17 FAA
Snow, Snow Grains or Snow Pellets
Very Light
Light
Moderate
2:20-2:45
1:10-2:20
0:35-1:10
2:05-2:15
1:15-2:05
0:45-1:15
0:40-0:45
0:25-0:40
0:15-0:25
1:20-1:40
0:45-1:20
0:25-0:45
1:40-2:00
0:45-1:40
0:20-0:45
0:20-0:25
0:10-0:20
0:08-0:10
2016-17 TC
Snow, Snow Grains or Snow Pellets
Very Light
Light
Moderate
2:00
1:10-2:00
0:35-1:10
2:00
1:15-2:00
0:45-1:15
0:40
0:25-0:40
0:15-0:25
1:20
0:45-1:20
0:25-0:45
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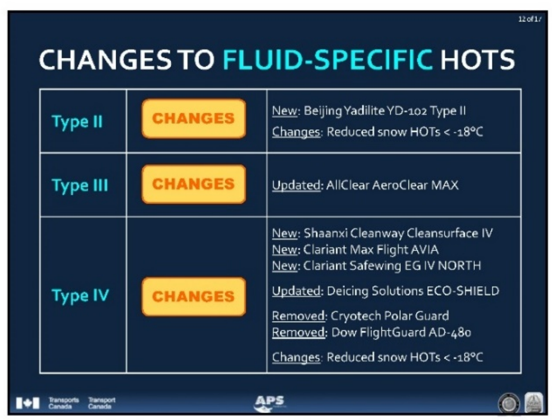
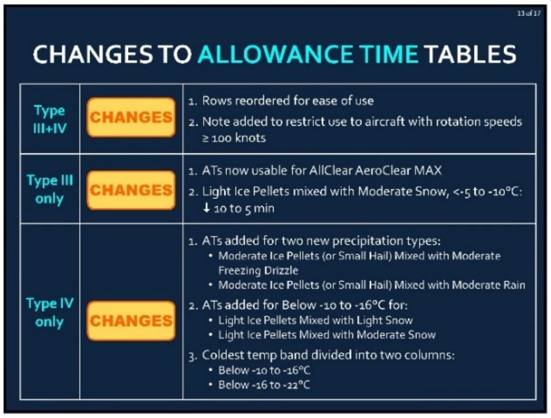
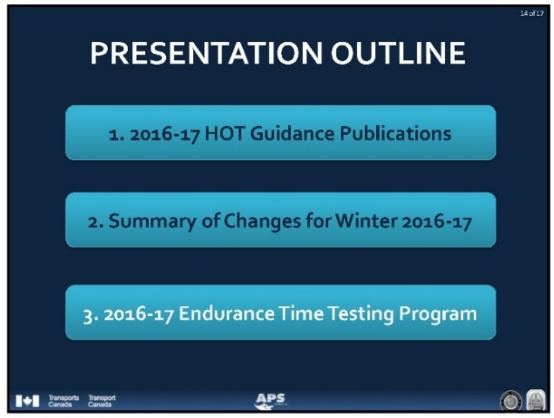
0:08-0:10
Transports Canada Transport Canada
APS


12 of 17
CHANGES TO FLUID-SPECIFIC HOTS
Type II
CHANGES
New: Beijing Yadilite YD-102 Type II
Changes: Reduced snow HOTs < -18°C
Type III
CHANGES
Updated: AllClear AeroClear MAX
Type IV
CHANGES
New: Shaanxi Cleanway Cleansurface IV
New: Clariant Max Flight AVIA
New: Clariant Safewing EG IV NORTH
Updated: Deicing Solutions ECO-SHIELD
Removed: Cryotech Polar Guard
Removed: Dow FlightGuard AD-480
Changes: Reduced snow HOTs < -18°C
Transports Canada Transport Canada
APS


13 of 17
CHANGES TO ALLOWANCE TIME TABLES
Type III+IV
CHANGES
1. Rows reordered for ease of use
2. Note added to restrict use to aircraft with rotation speeds ≥ 100 knots
Type III only
CHANGES
1. ATs now usable for AllClear AeroClear MAX
2. Light Ice Pellets mixed with Moderate Snow, <-5 to -10°C: ↓ 10 to 5 min
Type IV only
CHANGES
1. ATs added for two new precipitation types:
• Moderate Ice Pellets (or Small Hail) Mixed with Moderate Freezing Drizzle
• Moderate Ice Pellets (or Small Hail) Mixed with Moderate Rain
2. ATs added for Below -10 to -16°C for:
• Light Ice Pellets Mixed with Light Snow
• Light Ice Pellets Mixed with Moderate Snow
3. Coldest temp band divided into two columns:
• Below -10 to -16°C
• Below -16 to -22°C


14 of 17
PRESENTATION OUTLINE
1. 2016-17 HOT Guidance Publications
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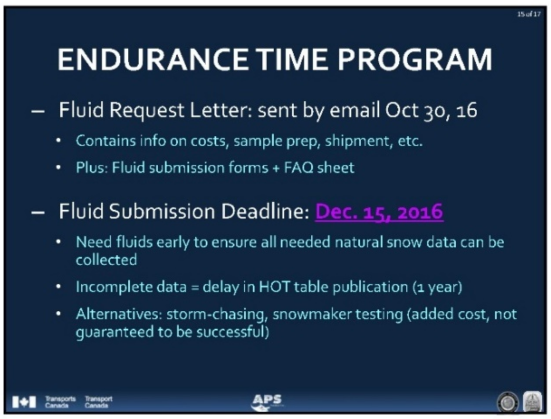
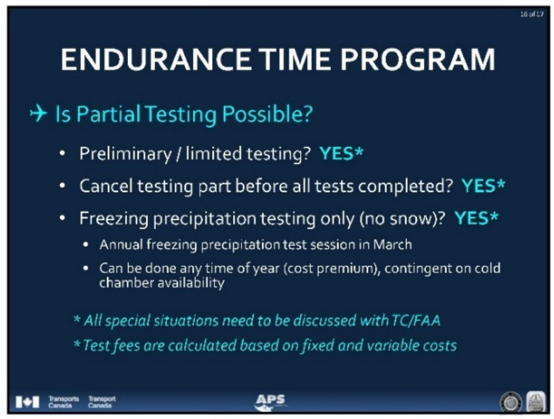
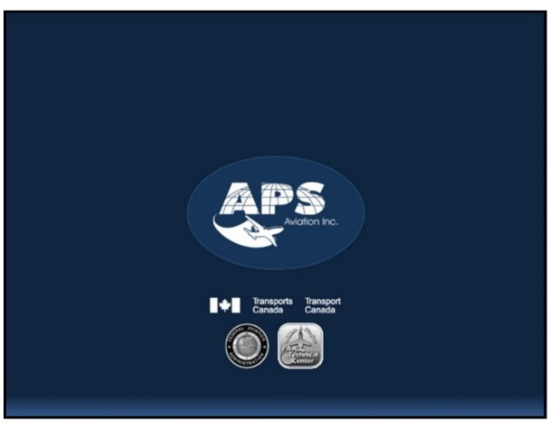
APS


15 of 17
ENDURANCE TIME PROGRAM
– Fluid Request Letter: sent by email Oct 30, 16
• Contains info on costs, sample prep, shipment, etc.
• Plus: Fluid submission forms + FAQ sheet
– Fluid Submission Deadline: Dec. 15, 2016
• Need fluids early to ensure all needed natural snow data can be collected
• Incomplete data = delay in HOT table publication (1 year)
• Alternatives: storm-chasing, snowmaker testing (added cost, not guaranteed to be successful)
APS


16 of 17
ENDURANCE TIME PROGRAM
Is Partial Testing Possible?
• Preliminary / limited testing? YES*
• Cancel testing part before all tests completed? YES*
• Freezing precipitation testing only (no snow)? YES*
• Annual freezing precipitation test session in March
• Can be done any time of year (cost premium), contingent on cold chamber availability
* All special situations need to be discussed with TC/FAA
* Test fees are calculated based on fixed and variable costs
APS


APS
Aviation Inc.
Transports Canada
Transport Canada

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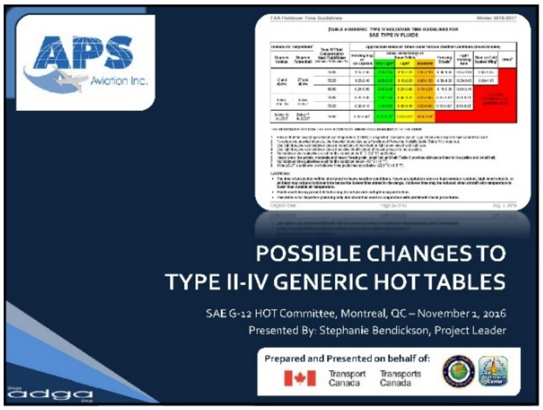
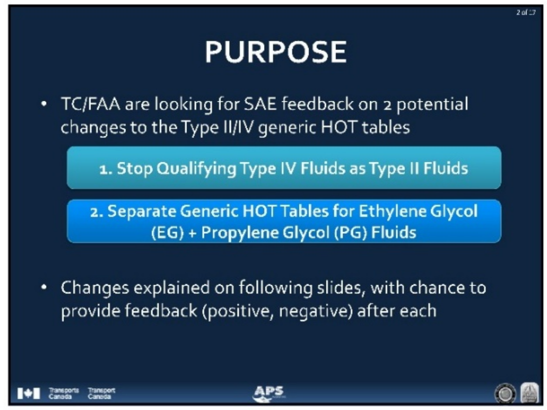
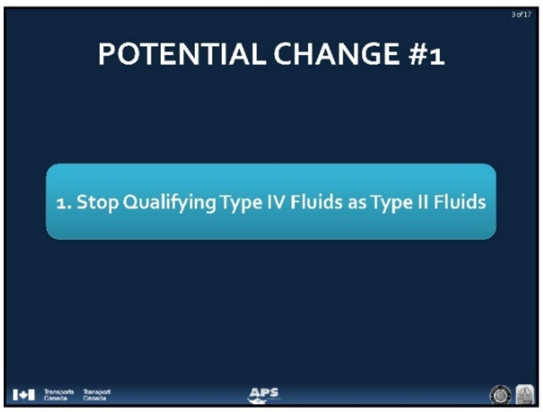
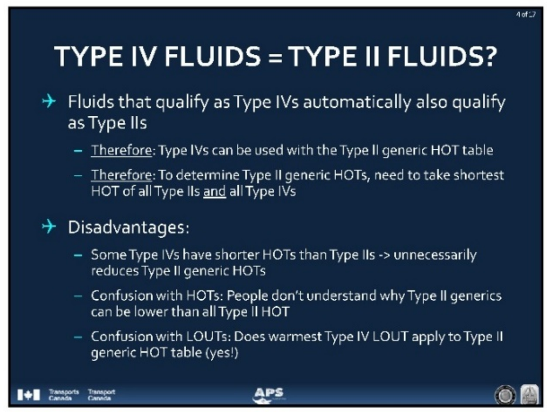
SAE G-12 HOT COMMITTEE, MONTREAL, CANADA

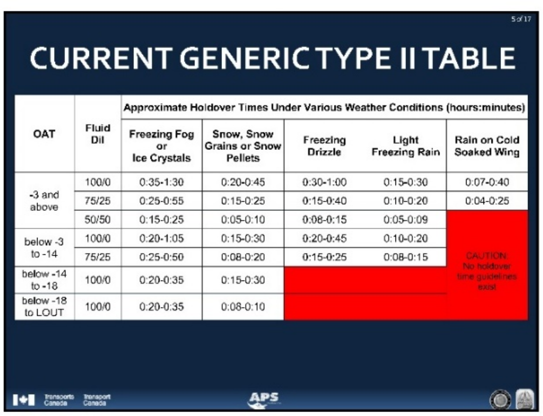
PRESENTATION:
POSSIBLE CHANGES TO TYPE II-IV GENERIC HOT TABLES



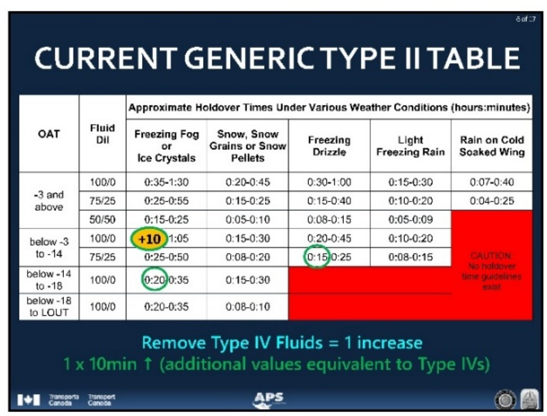




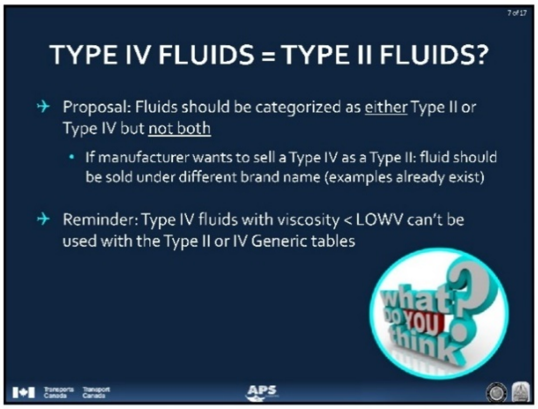


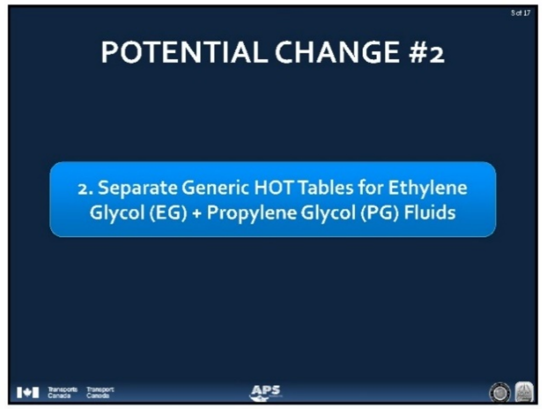


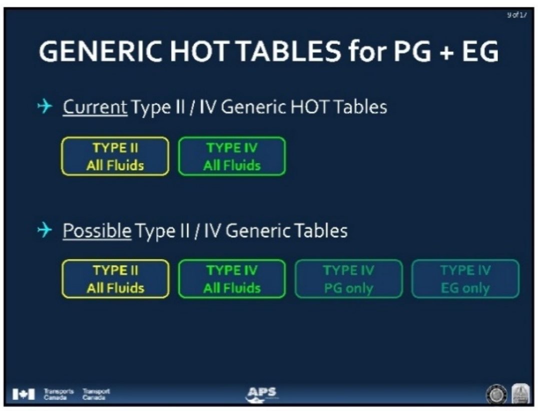
OAT	Fluid Dil	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)				
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
-3 and above	100/0	0:35-1:30	0:20-0:45	0:30-1:00	0:15-0:30	0:07-0:40
	75/25	0:25-0:55	0:15-0:25	0:15-0:40	0:10-0:20	0:04-0:25
	50/50	0:15-0:25	0:05-0:10	0:08-0:15	0:05-0:09	CAUTION: No holdover time guidelines exist
below -3 to -14	100/0	0:20-1:05	0:15-0:30	0:20-0:45	0:10-0:20	
	75/25	0:25-0:50	0:08-0:20	0:15-0:25	0:08-0:15	
below -14 to -18	100/0	0:20-0:35	0:15-0:30			
below -18 to LOUT	100/0	0:20-0:35	0:08-0:10			

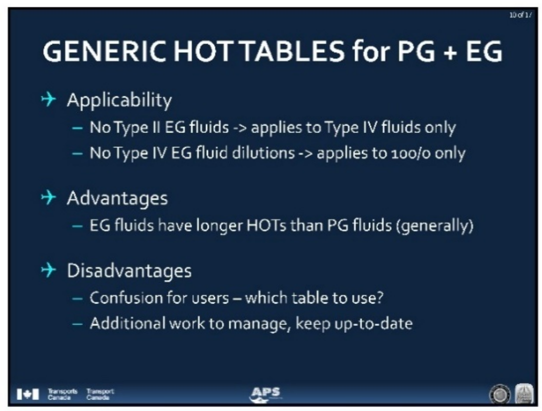


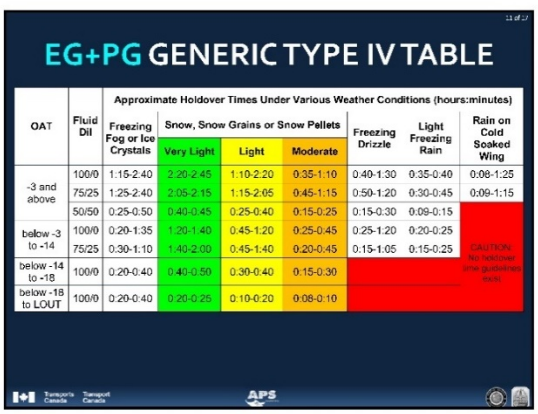
OAT	Fluid Dil	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)				
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
-3 and above	100/0	0:35-1:30	0:20-0:45	0:30-1:00	0:15-0:30	0:07-0:40
	75/25	0:25-0:55	0:15-0:25	0:15-0:40	0:10-0:20	0:04-0:25
	50/50	0:15-0:25	0:05-0:10	0:08-0:15	0:05-0:09	CAUTION: No holdover time guidelines exist
below -3 to -14	100/0	+10 1:05	0:15-0:30	0:20-0:45	0:10-0:20	
	75/25	0:25-0:50	0:08-0:20	0:15-0:25	0:08-0:15	
below -14 to -18	100/0	0:20-0:35	0:15-0:30			
below -18 to LOUT	100/0	0:20-0:35	0:08-0:10			



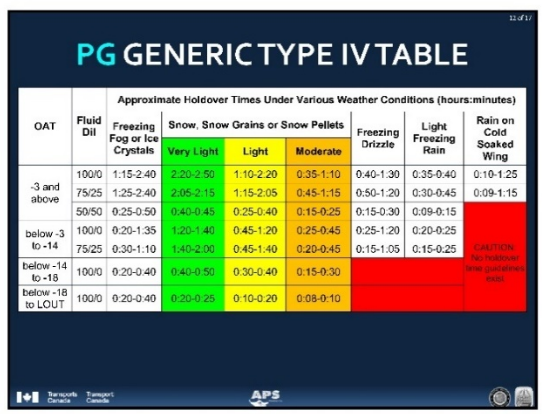




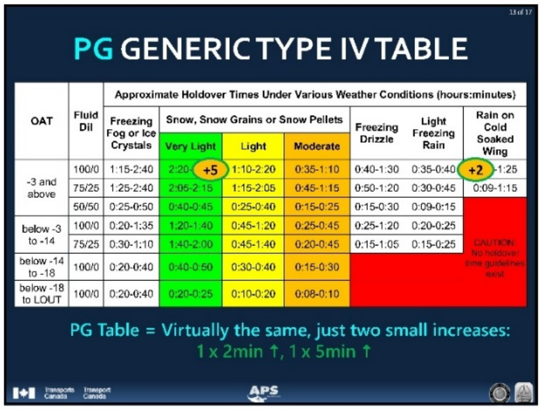


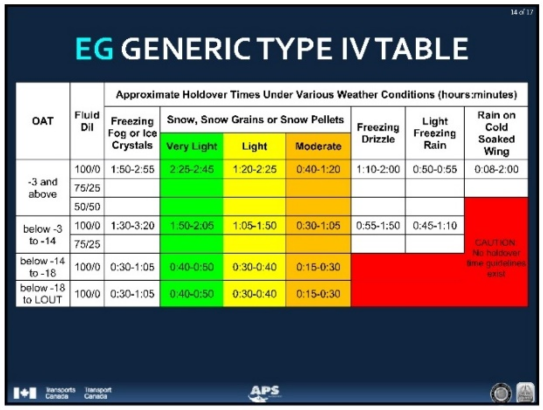


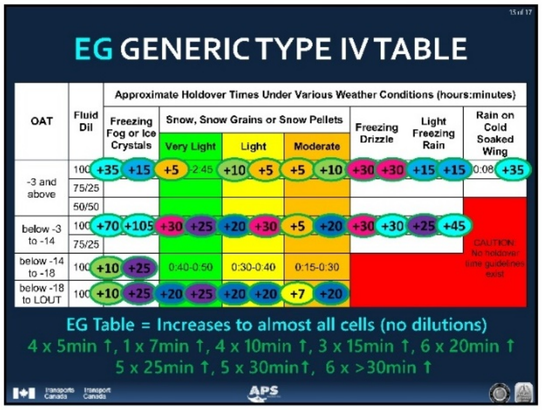
OAT	Fluid Dil	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
			Very Light	Light	Moderate			
-3 and above	100/0	1:15-2:40	2:20-2:45	1:10-2:20	0:35-1:10	0:40-1:30	0:35-0:40	0:08-1:25
	75/25	1:25-2:40	2:05-2:15	1:15-2:05	0:45-1:15	0:50-1:20	0:30-0:45	0:09-1:15
	50/50	0:25-0:50	0:40-0:45	0:25-0:40	0:15-0:25	0:15-0:30	0:09-0:15	CAUTION: No holdover time guidelines exist
below -3 to -14	100/0	0:20-1:35	1:20-1:40	0:45-1:20	0:25-0:45	0:25-1:20	0:20-0:25	
	75/25	0:30-1:10	1:40-2:00	0:45-1:40	0:20-0:45	0:15-1:05	0:15-0:25	
below -14 to -18	100/0	0:20-0:40	0:40-0:50	0:30-0:40	0:15-0:30			
below -18 to LOUT	100/0	0:20-0:40	0:20-0:25	0:10-0:20	0:08-0:10			

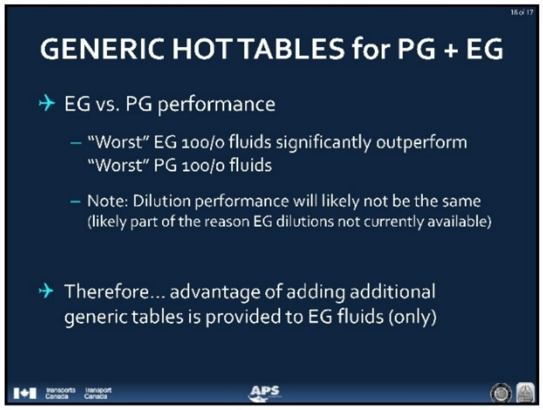


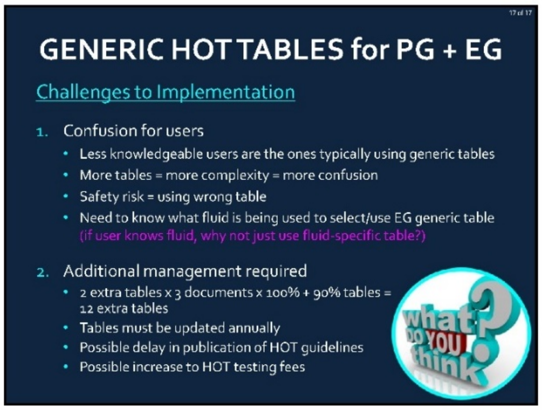
OAT	Fluid Dil	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)						
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
			Very Light	Light	Moderate			
-3 and above	100/0	1:15-2:40	2:20-2:50	1:10-2:20	0:35-1:10	0:40-1:30	0:35-0:40	0:10-1:25
	75/25	1:25-2:40	2:05-2:15	1:15-2:05	0:45-1:15	0:50-1:20	0:30-0:45	0:09-1:15
	50/50	0:25-0:50	0:40-0:45	0:25-0:40	0:15-0:25	0:15-0:30	0:09-0:15	CAUTION: No holdover time guidelines exist
below -3 to -14	100/0	0:20-1:35	1:20-1:40	0:45-1:20	0:25-0:45	0:25-1:20	0:20-0:25	
	75/25	0:30-1:10	1:40-2:00	0:45-1:40	0:20-0:45	0:15-1:05	0:15-0:25	
below -14 to -18	100/0	0:20-0:40	0:40-0:50	0:30-0:40	0:15-0:30			
below -18 to LOUT	100/0	0:20-0:40	0:20-0:25	0:10-0:20	0:08-0:10			


13 of 17
PG GENERIC TYPE IV TABLE
OAT | Fluid Dil | Approximate Holdover Times Under Various Weather Conditions (hours:minutes)
Freezing Fog or Ice Crystals | Snow, Snow Grains or Snow Pellets: Very Light | Light | Moderate | Freezing Drizzle | Light Freezing Rain | Rain on Cold Soaked Wing
-3 and above | 100/0 | 1:15-2:40 | 2:20- +5 | 1:10-2:20 | 0:35-1:10 | 0:40-1:30 | 0:35-0:40 | +2 -1:25
75/25 | 1:25-2:40 | 2:05-2:15 | 1:15-2:05 | 0:45-1:15 | 0:50-1:20 | 0:30-0:45 | 0:09-1:15
50/50 | 0:25-0:50 | 0:40-0:45 | 0:25-0:40 | 0:15-0:25 | 0:15-0:30 | 0:09-0:15
below -3 to -14 | 100/0 | 0:20-1:35 | 1:20-1:40 | 0:45-1:20 | 0:25-0:45 | 0:25-1:20 | 0:20-0:25
75/25 | 0:30-1:10 | 1:40-2:00 | 0:45-1:40 | 0:20-0:45 | 0:15-1:05 | 0:15-0:25
below -14 to -18 | 100/0 | 0:20-0:40 | 0:40-0:50 | 0:30-0:40 | 0:15-0:30
below -18 to LOUT | 100/0 | 0:20-0:40 | 0:20-0:25 | 0:10-0:20 | 0:08-0:10
CAUTION: No holdover time guidelines exist
PG Table = Virtually the same, just two small increases:
1 x 2min ↑, 1 x 5min ↑
Transports Canada Transport Canada
APS


14 of 17
EG GENERIC TYPE IV TABLE
OAT | Fluid Dil | Approximate Holdover Times Under Various Weather Conditions (hours:minutes)
Freezing Fog or Ice Crystals | Snow, Snow Grains or Snow Pellets: Very Light | Light | Moderate | Freezing Drizzle | Light Freezing Rain | Rain on Cold Soaked Wing
-3 and above | 100/0 | 1:50-2:55 | 2:25-2:45 | 1:20-2:25 | 0:40-1:20 | 1:10-2:00 | 0:50-0:55 | 0:08-2:00
75/25
50/50
below -3 to -14 | 100/0 | 1:30-3:20 | 1:50-2:05 | 1:05-1:50 | 0:30-1:05 | 0:55-1:50 | 0:45-1:10
75/25
below -14 to -18 | 100/0 | 0:30-1:05 | 0:40-0:50 | 0:30-0:40 | 0:15-0:30
below -18 to LOUT | 100/0 | 0:30-1:05 | 0:40-0:50 | 0:30-0:40 | 0:15-0:30
CAUTION: No holdover time guidelines exist
Transports Canada Transport Canada
APS


15 of 17
EG GENERIC TYPE IV TABLE
OAT | Fluid Dil | Approximate Holdover Times Under Various Weather Conditions (hours:minutes)
Freezing Fog or Ice Crystals | Snow, Snow Grains or Snow Pellets: Very Light | Light | Moderate | Freezing Drizzle | Light Freezing Rain | Rain on Cold Soaked Wing
-3 and above | 100 | +35 +15 | +5 -2:45 | +10 +5 | +5 +10 | +30 +30 | +15 +15 | 0:08 +35
75/25
50/50
below -3 to -14 | 100 | +70 +105 | +30 +25 | +20 +30 | +5 +20 | +30 +30 | +25 +45
75/25
below -14 to -18 | 100 | +10 +25 | 0:40-0:50 | 0:30-0:40 | 0:15-0:30
below -18 to LOUT | 100 | +10 +25 | +20 +25 | +20 +20 | +7 +20
CAUTION: No holdover time guidelines exist
EG Table = Increases to almost all cells (no dilutions)
4 x 5min ↑, 1 x 7min ↑, 4 x 10min ↑, 3 x 15min ↑, 6 x 20min ↑
5 x 25min ↑, 5 x 30min↑, 6 x >30min ↑
Transports Canada Transport Canada
APS


16 of 17
GENERIC HOT TABLES for PG + EG
EG vs. PG performance
– "Worst" EG 100/0 fluids significantly outperform "Worst" PG 100/0 fluids
– Note: Dilution performance will likely not be the same
(likely part of the reason EG dilutions not currently available)
Therefore… advantage of adding additional generic tables is provided to EG fluids (only)
Transports Canada Transport Canada
APS


17 of 17
GENERIC HOT TABLES for PG + EG
Challenges to Implementation
1. Confusion for users
• Less knowledgeable users are the ones typically using generic tables
• More tables = more complexity = more confusion
• Safety risk = using wrong table
• Need to know what fluid is being used to select/use EG generic table
(if user knows fluid, why not just use fluid-specific table?)
2. Additional management required
• 2 extra tables x 3 documents x 100% + 90% tables = 12 extra tables
• Tables must be updated annually
• Possible delay in publication of HOT guidelines
• Possible increase to HOT testing fees
what do YOU think

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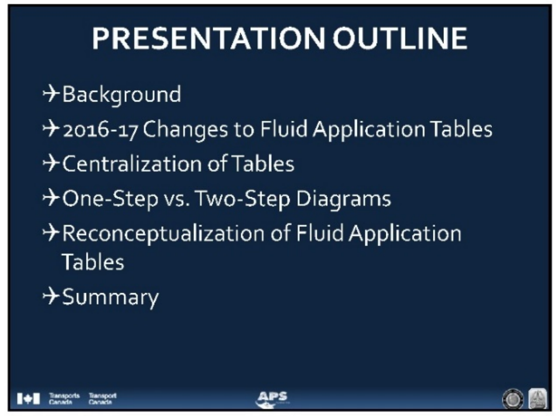
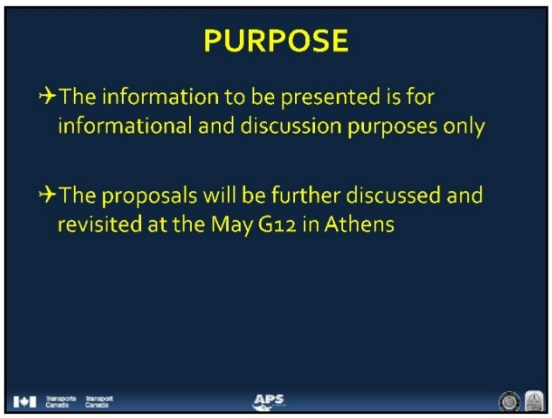
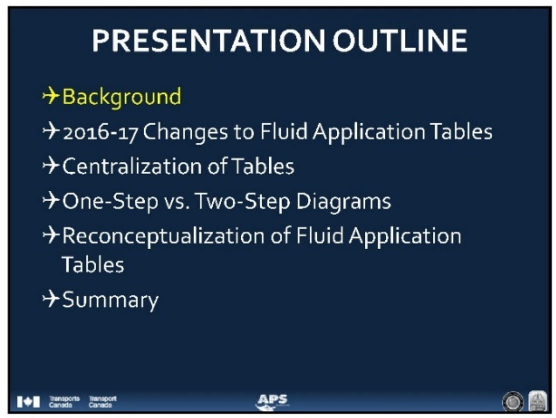
SAE G-12 HOT COMMITTEE, MONTREAL, CANADA

PRESENTATION:
FLUID APPLICATION TABLES, ONE STEP VS. TWO STEP,
& RECONCEPTUALIZATION


APS
Aviation Inc.
Fluid Application Tables,
One Step vs. Two Step, & Reconceptualization
SAE G12, Montreal, QC – November 1, 2016
Presented By: Marco Ruggi, Eng., M.B.A., Project Leader
Research conducted on behalf of:
Transport Canada
Transports Canada


PRESENTATION OUTLINE
Background
2016-17 Changes to Fluid Application Tables
Centralization of Tables
One-Step vs. Two-Step Diagrams
Reconceptualization of Fluid Application Tables
Summary


PURPOSE
The information to be presented is for informational and discussion purposes only
The proposals will be further discussed and revisited at the May G12 in Athens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2016-17 Changes to Fluid Application Tables
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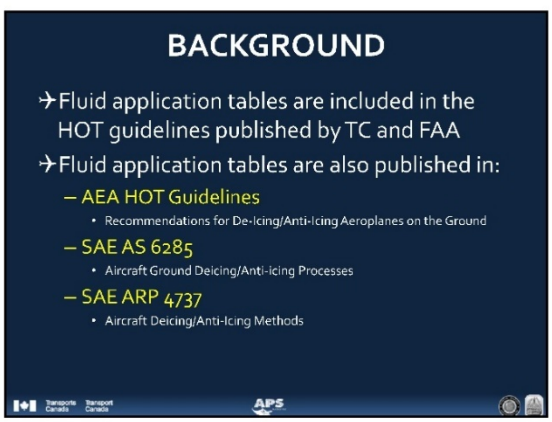
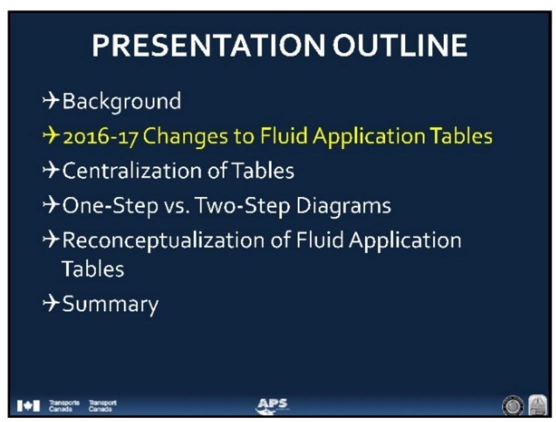

BACKGROUND
Fluid application tables are included in the HOT guidelines published by TC and FAA
Fluid application tables are also published in:
– AEA HOT Guidelines
• Recommendations for De-Icing/Anti-Icing Aeroplanes on the Ground
– SAE AS 6285
• Aircraft Ground Deicing/Anti-icing Processes
– SAE ARP 4737
• Aircraft Deicing/Anti-Icing Methods


PRESENTATION OUTLINE
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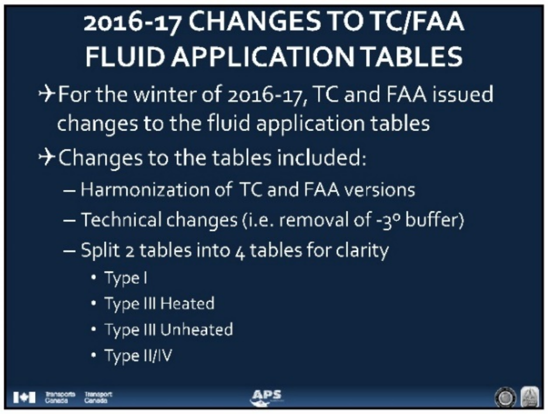
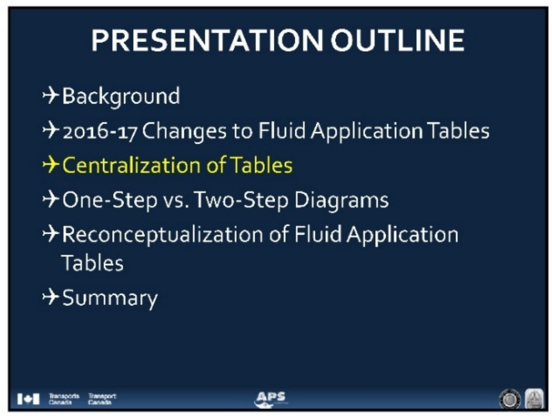

2016-17 CHANGES TO TC/FAA FLUID APPLICATION TABLES
For the winter of 2016-17, TC and FAA issued changes to the fluid application tables
Changes to the tables included:
– Harmonization of TC and FAA versions
– Technical changes (i.e. removal of -3° buffer)
– Split 2 tables into 4 tables for clarity
• Type I
• Type III Heated
• Type III Unheated
• Type II/IV
APS


Transports Canada
Transport Canada
2015-16
2016-17
APS


2015-16
2016-17
APS


PRESENTATION OUTLINE
Background
2016-17 Changes to Fluid Application Tables
Centralization of Tables
One-Step vs. Two-Step Diagrams
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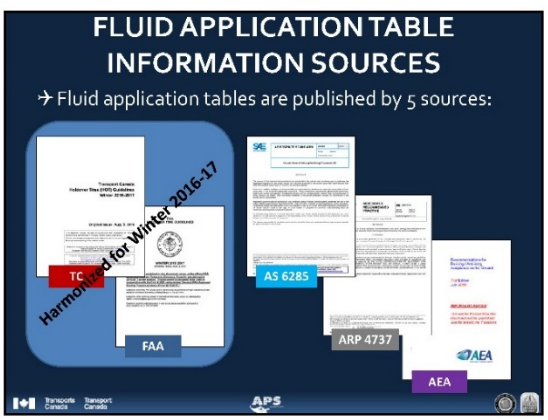
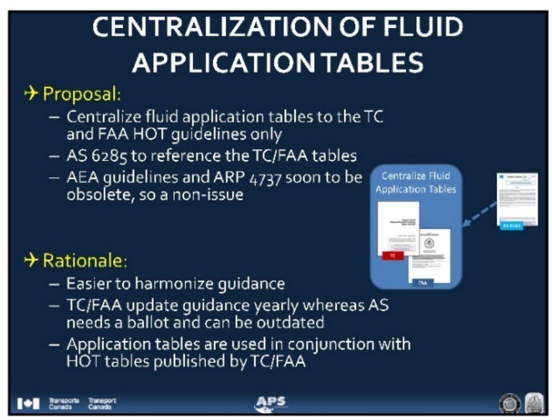
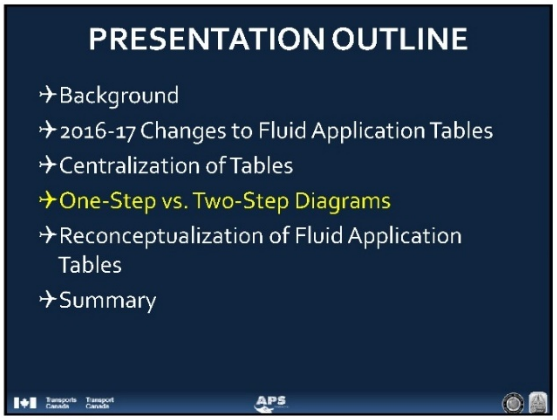
APS


FLUID APPLICATION TABLE INFORMATION SOURCES
Fluid application tables are published by 5 sources:
Harmonized for Winter 2016-17
TC
FAA
AS 6285
ARP 4737
AEA
APS


CENTRALIZATION OF FLUID APPLICATION TABLES
Proposal:
– Centralize fluid application tables to the TC and FAA HOT guidelines only
– AS 6285 to reference the TC/FAA tables
– AEA guidelines and ARP 4737 soon to be obsolete, so a non-issue
Centralize Fluid Application Tables
Rationale:
– Easier to harmonize guidance
– TC/FAA update guidance yearly whereas AS needs a ballot and can be outdated
– Application tables are used in conjunction with HOT tables published by TC/FAA
APS


PRESENTATION OUTLINE
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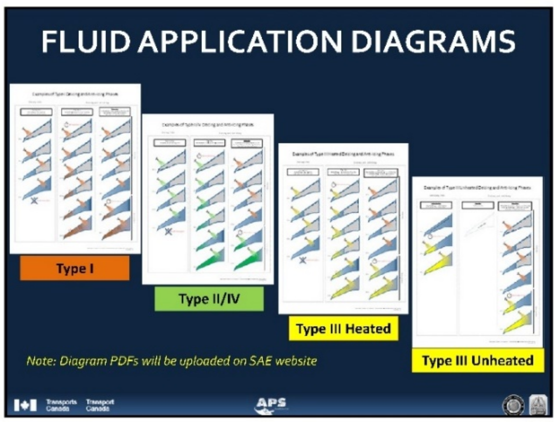
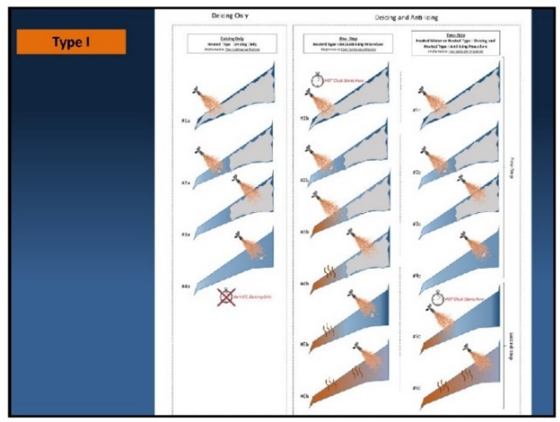
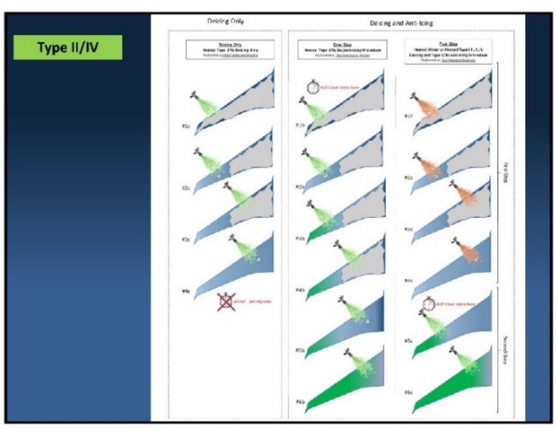
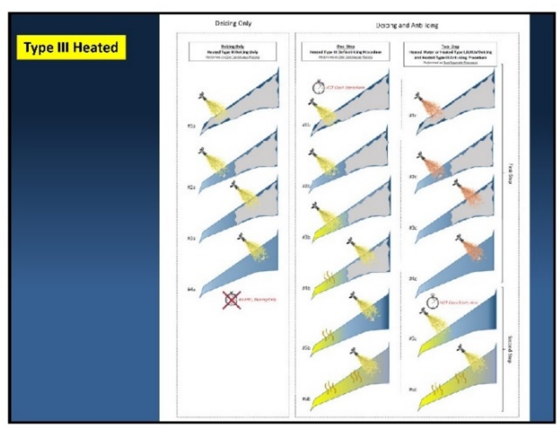
2016-17 Changes to Fluid Application Tables
Centralization of Tables
One-Step vs. Two-Step Diagrams
Reconceptualization of Fluid Application Tables
Summary
APS

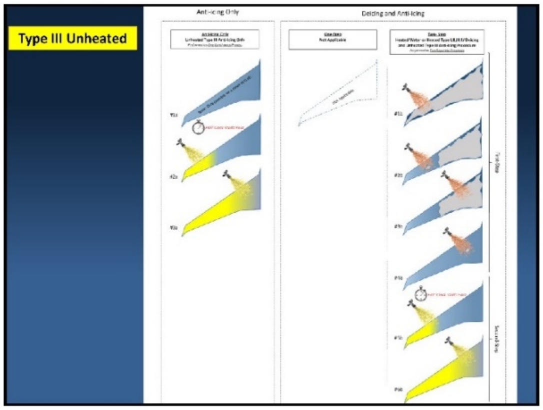

ONE-STEP vs. TWO-STEP DIAGRAMS
Diagrams were presented in Savannah to:
– Better describe one-step versus two-step
– Communicate importance of heat transfer
Based on industry feedback, diagrams were updated
– Now reflect the 4 fluid application tables in the TC and FAA guidelines
APS

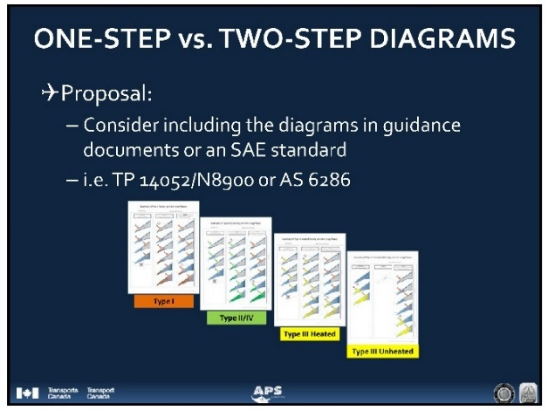

FLUID APPLICATION DIAGRAMS
Type I
Type II/IV
Type III Heated
Type III Unheated
Note: Diagram PDFs will be uploaded on SAE website
APS

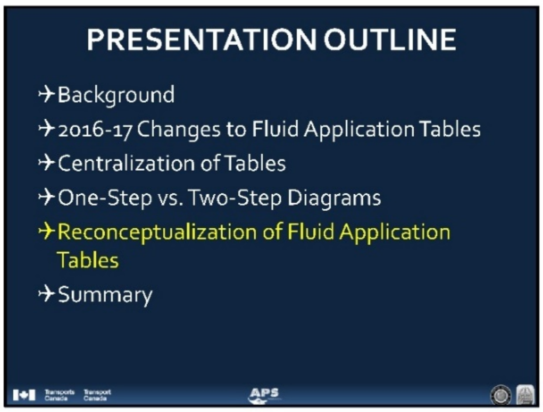

Type I
Deicing Only
Deicing and Anti-Icing

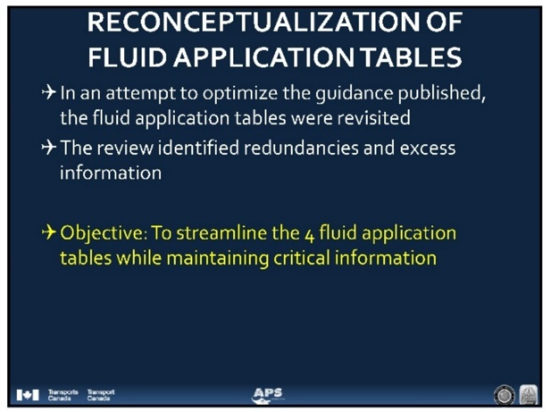

Type II/IV
Deicing Only
Deicing and Anti-Icing

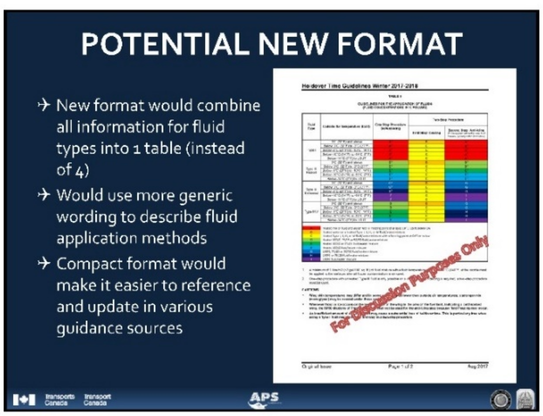

Type III Heated
Deicing Only
Deicing and Anti-Icing

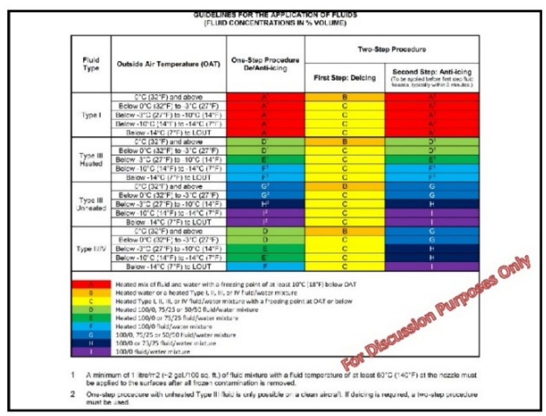












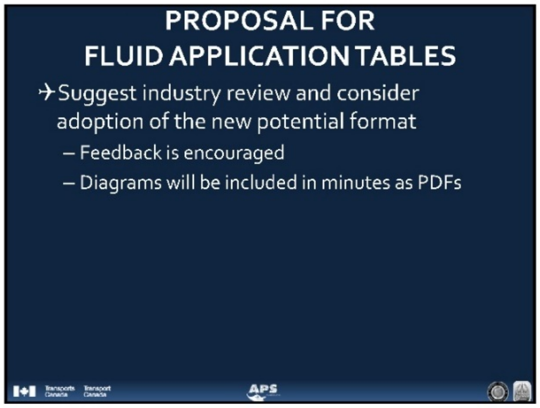
GUIDELINES FOR THE APPLICATION OF FLUIDS
(FLUID CONCENTRATIONS IN % VOLUME)

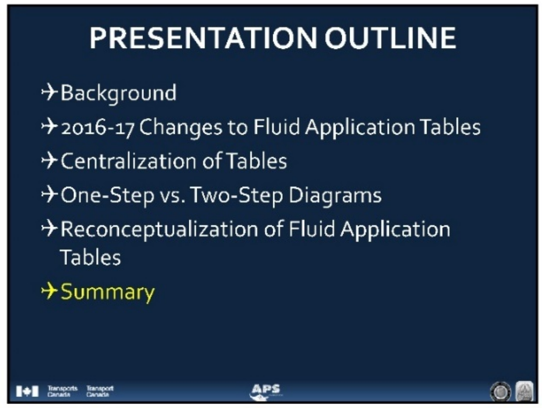
Fluid Type	Outside Air Temperature (OAT)	One-Step Procedure De/Anti-icing	Two-Step Procedure	
			First Step: Deicing	Second Step: Anti-icing (To be applied before first step fluid freezes, typically within 3 minutes.)
Type I	0°C (32°F) and above	A[1]	B	A[1]
	Below 0°C (32°F) to -3°C (27°F)	A[1]	C	A[1]
	Below -3°C (27°F) to -10°C (14°F)	A[1]	C	A[1]
	Below -10°C (14°F) to -14°C (7°F)	A[1]	C	A[1]
	Below -14°C (7°F) to LOUT	A[1]	C	A[1]
Type III Heated	0°C (32°F) and above	D[1]	B	D[1]
	Below 0°C (32°F) to -3°C (27°F)	D[1]	C	D[1]
	Below -3°C (27°F) to -10°C (14°F)	E[1]	C	E[1]
	Below -10°C (14°F) to -14°C (7°F)	F[1]	C	F[1]
	Below -14°C (7°F) to LOUT	F[1]	C	F[1]
Type III Unheated	0°C (32°F) and above	G[2]	B	G
	Below 0°C (32°F) to -3°C (27°F)	G[2]	C	G
	Below -3°C (27°F) to -10°C (14°F)	H[2]	C	H
	Below -10°C (14°F) to -14°C (7°F)	I[2]	C	I
	Below -14°C (7°F) to LOUT	I[2]	C	I
Type II/IV	0°C (32°F) and above	D	B	G
	Below 0°C (32°F) to -3°C (27°F)	D	C	G
	Below -3°C (27°F) to -10°C (14°F)	E	C	H
	Below -10°C (14°F) to -14°C (7°F)	E	C	H
	Below -14°C (7°F) to LOUT	F	C	I

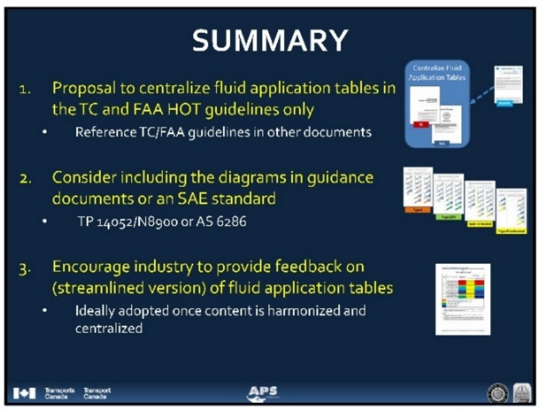
A	Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT
B	Heated water or a heated Type I, II, III, or IV fluid/water mixture
C	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below
D	Heated 100/0, 75/25 or 50/50 fluid/water mixture
E	Heated 100/0 or 75/25 fluid/water mixture
F	Heated 100/0 fluid/water mixture
G	100/0, 75/25 or 50/50 fluid/water mixture
H	100/0 or 75/25 fluid/water mixture
I	100/0 fluid/water mixture

1 A minimum of 1 litre/m2 (~2 gal./100 sq. ft.) of fluid mixture with a fluid temperature of at least 60°C (140°F) at the nozzle must be applied to the surfaces after all frozen contamination is removed.

2 One-step procedure with unheated Type III fluid is only possible on a clean aircraft. If deicing is required, a two-step procedure must be used.


PROPOSAL FOR
FLUID APPLICATION TABLES
Suggest industry review and consider adoption of the new potential format
– Feedback is encouraged
– Diagrams will be included in minutes as PDFs
APS


PRESENTATION OUTLINE
Background
2016-17 Changes to Fluid Application Tables
Centralization of Tables
One-Step vs. Two-Step Diagrams
Reconceptualization of Fluid Application Tables
Summary
APS


SUMMARY
1. Proposal to centralize fluid application tables in the TC and FAA HOT guidelines only
• Reference TC/FAA guidelines in other documents
2. Consider including the diagrams in guidance documents or an SAE standard
• TP 14052/N8900 or AS 6286
3. Encourage industry to provide feedback on (streamlined version) of fluid application tables
• Ideally adopted once content is harmonized and centralized
APS


APS
Questions?
mruggi@adga.ca

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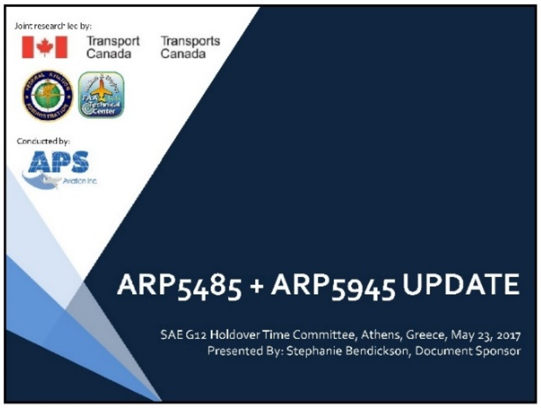
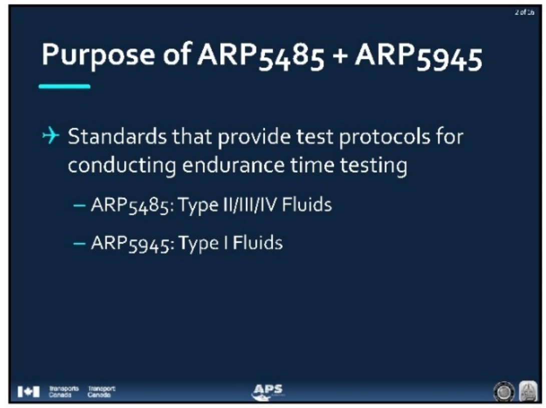
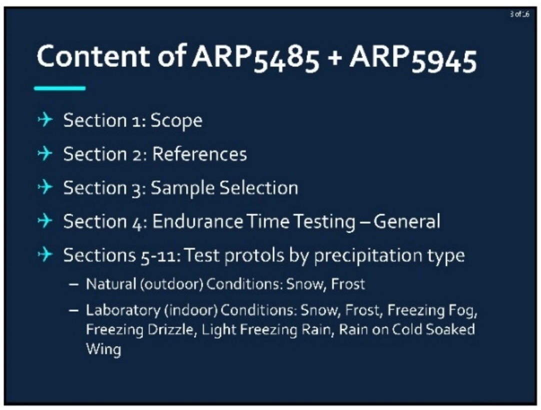
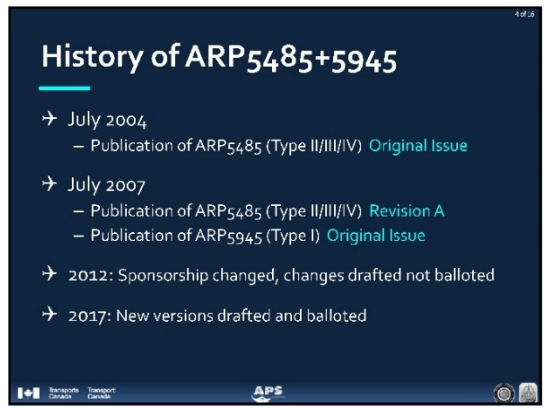
SAE G-12 HOLOVER TIME COMMITTEE, ATHENS, GREECE

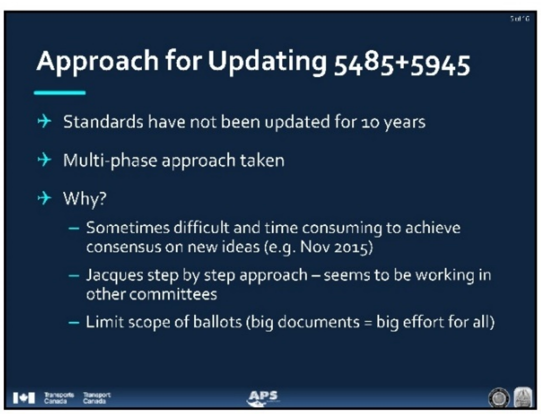
PRESENTATION:
ARP5485 + ARP5945 UPDATE

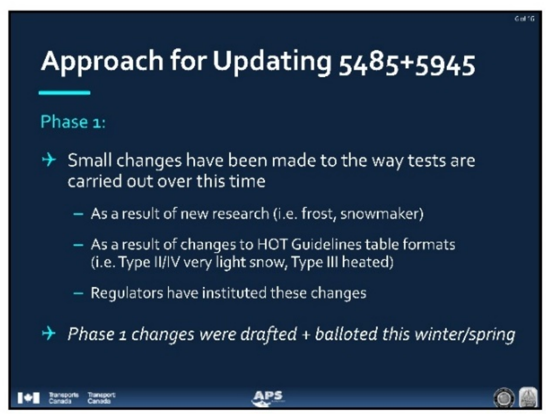

Joint research led by:
Transport Canada
Transports Canada
Conducted by:
APS
ARP5485 + ARP5945 UPDATE
SAE G12 Holdover Time Committee, Athens, Greece, May 23, 2017
Presented By: Stephanie Bendickson, Document Sponsor

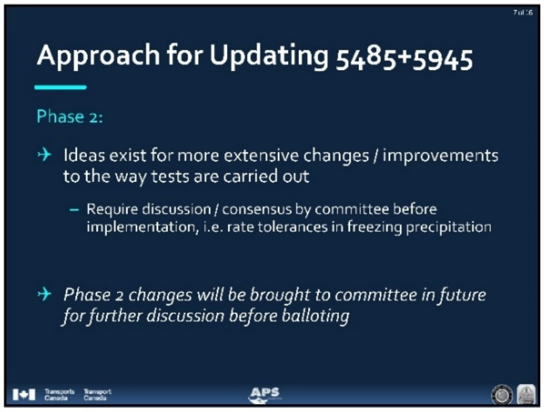

Purpose of ARP5485 + ARP5945
Standards that provide test protocols for conducting endurance time testing
– ARP5485: Type II/III/IV Fluids
– ARP5945: Type I Fluids

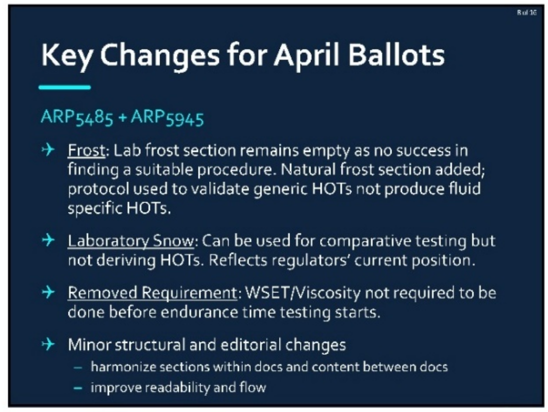

Content of ARP5485 + ARP5945
Section 1: Scope
Section 2: References
Section 3: Sample Selection
Section 4: Endurance Time Testing – General
Sections 5-11: Test protols by precipitation type
– Natural (outdoor) Conditions: Snow, Frost
– Laboratory (indoor) Conditions: Snow, Frost, Freezing Fog, Freezing Drizzle, Light Freezing Rain, Rain on Cold Soaked Wing

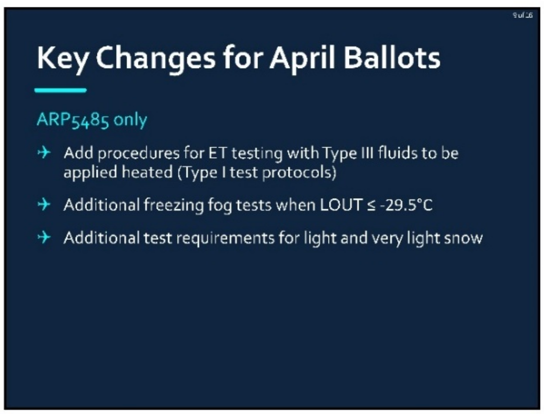

History of ARP5485+5945
July 2004
– Publication of ARP5485 (Type II/III/IV) Original Issue
July 2007
– Publication of ARP5485 (Type II/III/IV) Revision A
– Publication of ARP5945 (Type I) Original Issue
2012: Sponsorship changed, changes drafted not balloted
2017: New versions drafted and balloted

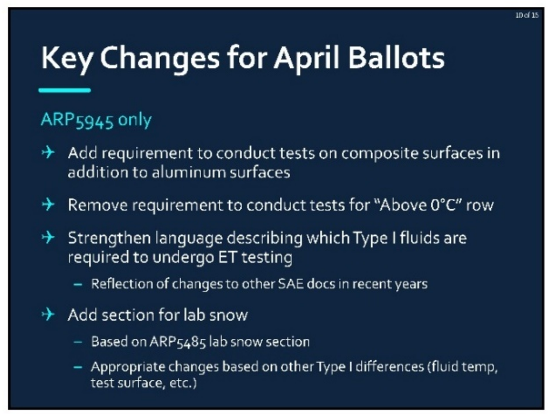

Approach for Updating 5485+5945
Standards have not been updated for 10 years
Multi-phase approach taken
Why?
– Sometimes difficult and time consuming to achieve consensus on new ideas (e.g. Nov 2015)
– Jacques step by step approach – seems to be working in other committees
– Limit scope of ballots (big documents = big effort for all)

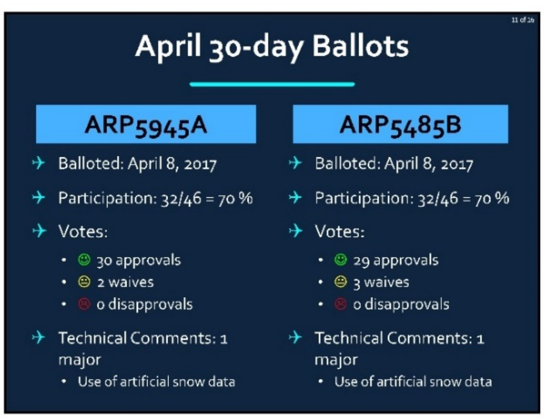

Approach for Updating 5485+5945
Phase 1:
Small changes have been made to the way tests are carried out over this time
– As a result of new research (i.e. frost, snowmaker)
– As a result of changes to HOT Guidelines table formats (i.e. Type II/IV very light snow, Type III heated)
– Regulators have instituted these changes
Phase 1 changes were drafted + balloted this winter/spring

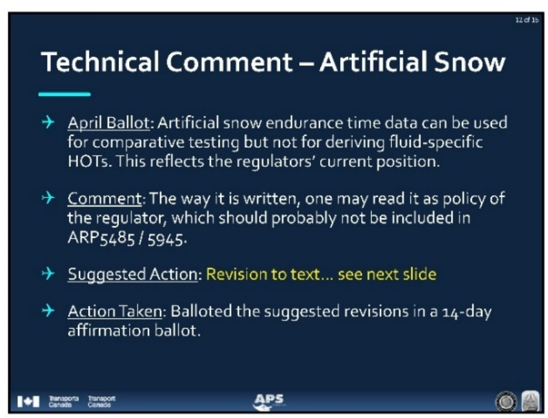

Approach for Updating 5485+5945
Phase 2:
Ideas exist for more extensive changes / improvements to the way tests are carried out
– Require discussion / consensus by committee before implementation, i.e. rate tolerances in freezing precipitation
Phase 2 changes will be brought to committee in future for further discussion before balloting
APS

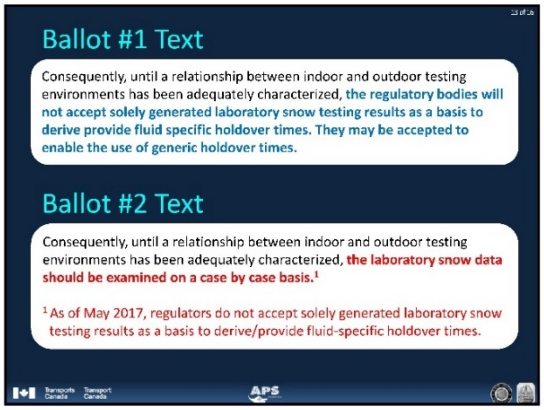

Key Changes for April Ballots
ARP5485 + ARP5945
Frost: Lab frost section remains empty as no success in finding a suitable procedure. Natural frost section added; protocol used to validate generic HOTs not produce fluid specific HOTs.
Laboratory Snow: Can be used for comparative testing but not deriving HOTs. Reflects regulators' current position.
Removed Requirement: WSET/Viscosity not required to be done before endurance time testing starts.
Minor structural and editorial changes
– harmonize sections within docs and content between docs
– improve readability and flow

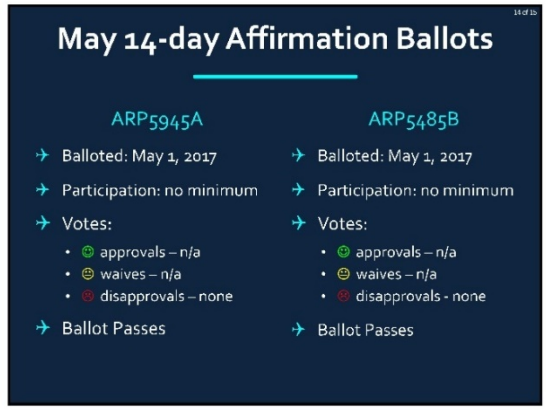

Key Changes for April Ballots
ARP5485 only
Add procedures for ET testing with Type III fluids to be applied heated (Type I test protocols)
Additional freezing fog tests when LOUT ≤ -29.5°C
Additional test requirements for light and very light snow


Key Changes for April Ballots
ARP5945 only
Add requirement to conduct tests on composite surfaces in addition to aluminum surfaces
Remove requirement to conduct tests for "Above 0°C" row
Strengthen language describing which Type I fluids are required to undergo ET testing
– Reflection of changes to other SAE docs in recent years
Add section for lab snow
– Based on ARP5485 lab snow section
– Appropriate changes based on other Type I differences (fluid temp, test surface, etc.)

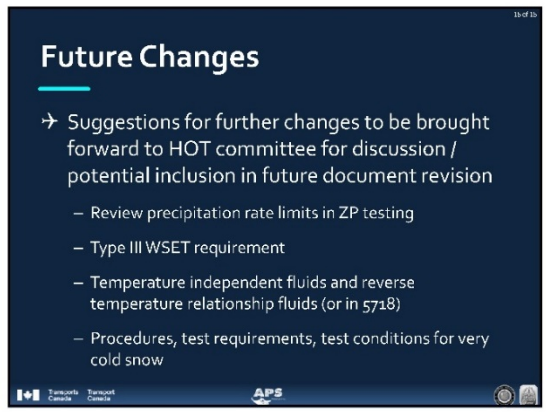

April 30-day Ballots
ARP5945A
Balloted: April 8, 2017
Participation: 32/46 = 70 %
Votes:
30 approvals
2 waives
0 disapprovals
Technical Comments: 1 major
Use of artificial snow data
ARP5485B
Balloted: April 8, 2017
Participation: 32/46 = 70 %
Votes:
29 approvals
3 waives
0 disapprovals
Technical Comments: 1 major
Use of artificial snow data


Technical Comment – Artificial Snow
April Ballot: Artificial snow endurance time data can be used for comparative testing but not for deriving fluid-specific HOTs. This reflects the regulators' current position.
Comment: The way it is written, one may read it as policy of the regulator, which should probably not be included in ARP5485 / 5945.
Suggested Action: Revision to text... see next slide
Action Taken: Balloted the suggested revisions in a 14-day affirmation ballot.
APS


Ballot #1 Text
Consequently, until a relationship between indoor and outdoor testing environments has been adequately characterized, the regulatory bodies will not accept solely generated laboratory snow testing results as a basis to derive provide fluid specific holdover times. They may be accepted to enable the use of generic holdover times.
Ballot #2 Text
Consequently, until a relationship between indoor and outdoor testing environments has been adequately characterized, the laboratory snow data should be examined on a case by case basis.1
1 As of May 2017, regulators do not accept solely generated laboratory snow testing results as a basis to derive/provide fluid-specific holdover times.
APS


May 14-day Affirmation Ballots
ARP5945A
Balloted: May 1, 2017
Participation: no minimum
Votes:
approvals – n/a
waives – n/a
disapprovals – none
Ballot Passes
ARP5485B
Balloted: May 1, 2017
Participation: no minimum
Votes:
approvals – n/a
waives – n/a
disapprovals - none
Ballot Passes


Path Forward
Update documents with 14-day ballot changes and editorial suggestions/changes
Submit documents for Aerospace Council Ballot
Expect ballots will pass and documents will be published
Note: Information on artificial / natural snow data correlation to be prepared for future meeting, as per committee request.


Future Changes
Suggestions for further changes to be brought forward to HOT committee for discussion / potential inclusion in future document revision
– Review precipitation rate limits in ZP testing
– Type III WSET requirement
– Temperature independent fluids and reverse temperature relationship fluids (or in 5718)
– Procedures, test requirements, test conditions for very cold snow
APS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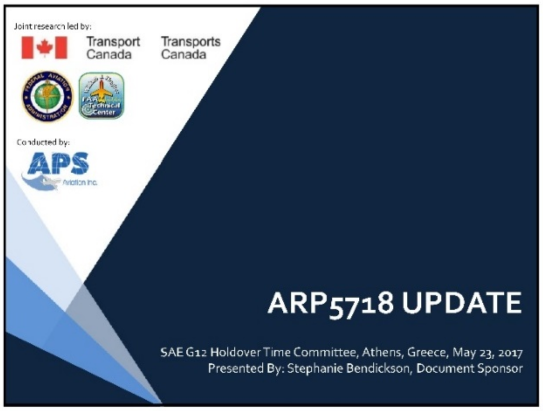
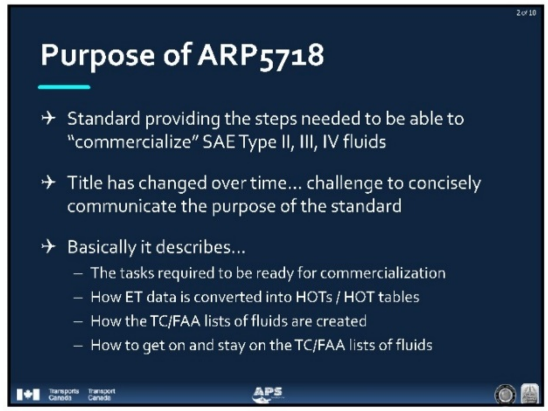
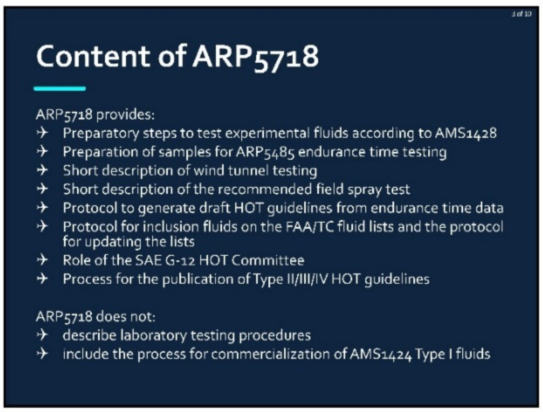
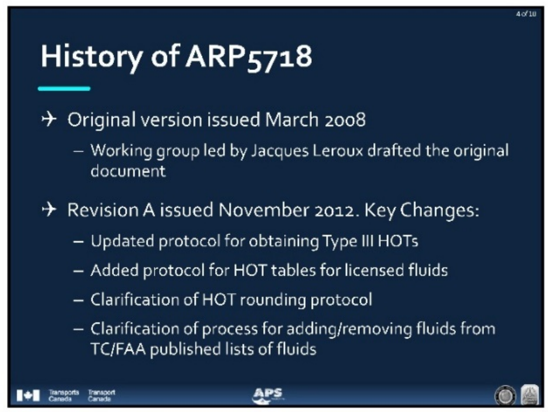
SAE G-12 HOLOVER TIME COMMITTEE, ATHENS, GREECE

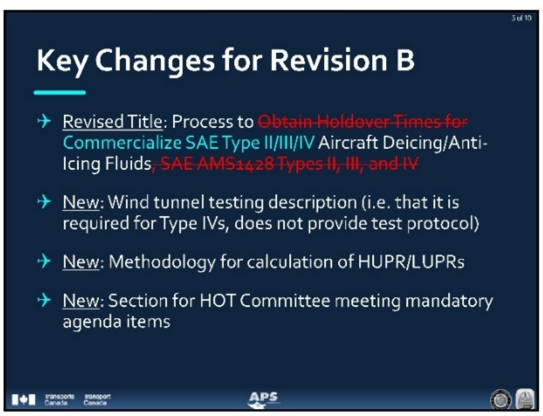
PRESENTATION:
ARP5718 UPDATE

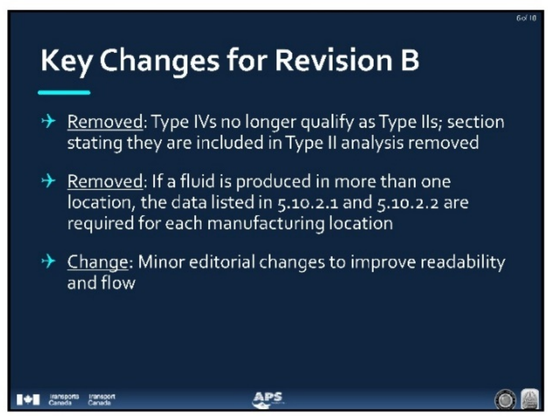

Joint research led by:
Transport Canada
Transports Canada
FAA Technical Center
Conducted by:
APS Aviation Inc.
ARP5718 UPDATE
SAE G12 Holdover Time Committee, Athens, Greece, May 23, 2017
Presented By: Stephanie Bendickson, Document Sponsor

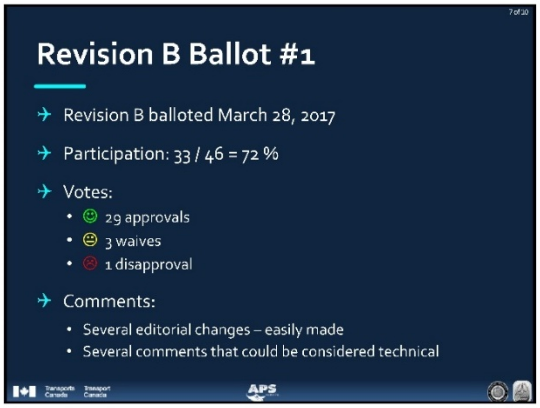

2 of 10
Purpose of ARP5718
Standard providing the steps needed to be able to "commercialize" SAE Type II, III, IV fluids
Title has changed over time… challenge to concisely communicate the purpose of the standard
Basically it describes…
– The tasks required to be ready for commercialization
– How ET data is converted into HOTs / HOT tables
– How the TC/FAA lists of fluids are created
– How to get on and stay on the TC/FAA lists of fluids

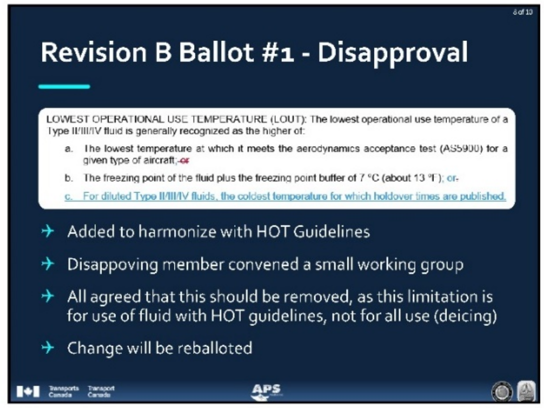

3 of 10
Content of ARP5718
ARP5718 provides:
Preparatory steps to test experimental fluids according to AMS1428
Preparation of samples for ARP5485 endurance time testing
Short description of wind tunnel testing
Short description of the recommended field spray test
Protocol to generate draft HOT guidelines from endurance time data
Protocol for inclusion fluids on the FAA/TC fluid lists and the protocol for updating the lists
Role of the SAE G-12 HOT Committee
Process for the publication of Type II/III/IV HOT guidelines
ARP5718 does not:
describe laboratory testing procedures
include the process for commercialization of AMS1424 Type I fluids

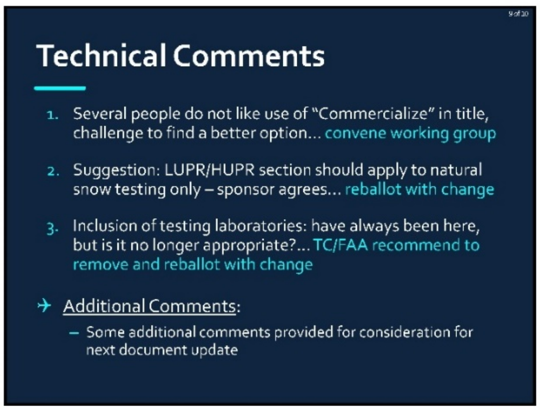

4 of 10
History of ARP5718
Original version issued March 2008
– Working group led by Jacques Leroux drafted the original document
Revision A issued November 2012. Key Changes:
– Updated protocol for obtaining Type III HOTs
– Added protocol for HOT tables for licensed fluids
– Clarification of HOT rounding protocol
– Clarification of process for adding/removing fluids from TC/FAA published lists of fluids

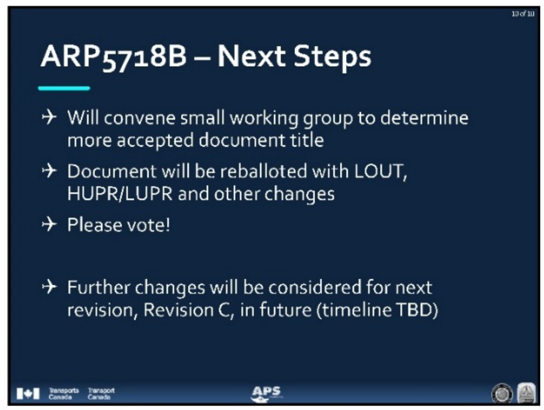

5 of 10
Key Changes for Revision B
Revised Title: Process to ~~Obtain Holdover Times for~~ Commercialize SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids~~, SAE AMS1428 Types II, III, and IV~~
New: Wind tunnel testing description (i.e. that it is required for Type IVs, does not provide test protocol)
New: Methodology for calculation of HUPR/LUPRs
New: Section for HOT Committee meeting mandatory agenda items


6 of 10
Key Changes for Revision B
Removed: Type IVs no longer qualify as Type IIs; section stating they are included in Type II analysis removed
Removed: If a fluid is produced in more than one location, the data listed in 5.10.2.1 and 5.10.2.2 are required for each manufacturing location
Change: Minor editorial changes to improve readability and flow


7 of 10
Revision B Ballot #1
Revision B balloted March 28, 2017
Participation: 33 / 46 = 72 %
Votes:
29 approvals
3 waives
1 disapproval
Comments:
Several editorial changes – easily made
Several comments that could be considered technical
APS


8 of 10
Revision B Ballot #1 - Disapproval
LOWEST OPERATIONAL USE TEMPERATURE (LOUT): The lowest operational use temperature of a Type II/III/IV fluid is generally recognized as the higher of:
a. The lowest temperature at which it meets the aerodynamics acceptance test (AS5900) for a given type of aircraft; or
b. The freezing point of the fluid plus the freezing point buffer of 7 °C (about 13 °F); or.
c. For diluted Type II/III/IV fluids, the coldest temperature for which holdover times are published.
Added to harmonize with HOT Guidelines
Disappoving member convened a small working group
All agreed that this should be removed, as this limitation is for use of fluid with HOT guidelines, not for all use (deicing)
Change will be reballoted
APS


9 of 10
Technical Comments
1. Several people do not like use of "Commercialize" in title, challenge to find a better option… convene working group
2. Suggestion: LUPR/HUPR section should apply to natural snow testing only – sponsor agrees… reballot with change
3. Inclusion of testing laboratories: have always been here, but is it no longer appropriate?… TC/FAA recommend to remove and reballot with change
Additional Comments:
– Some additional comments provided for consideration for next document update


10 of 10
ARP5718B – Next Steps
Will convene small working group to determine more accepted document title
Document will be reballoted with LOUT, HUPR/LUPR and other changes
Please vote!
Further changes will be considered for next revision, Revision C, in future (timeline TBD)
APS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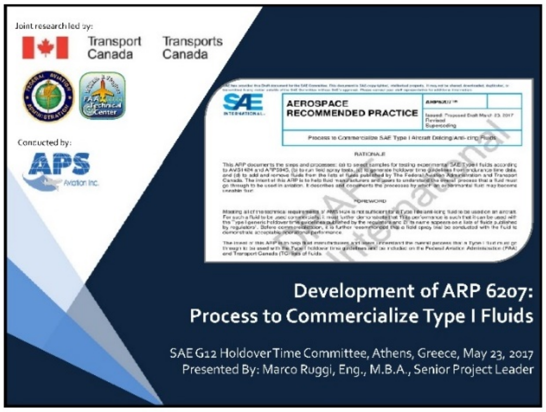
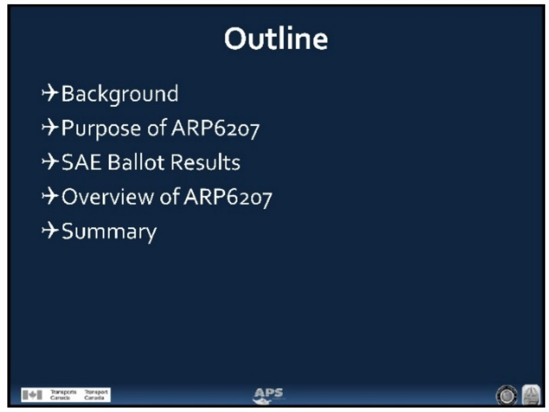
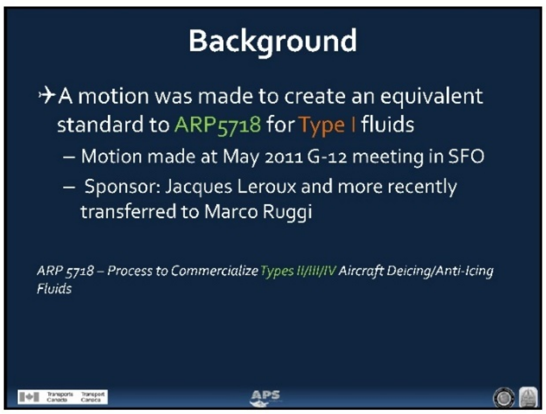
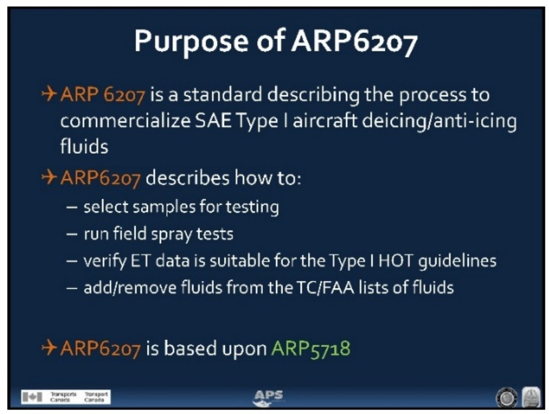
SAE G-12 HOLDOVER TIME COMMITTEE, ATHENS, GREECE

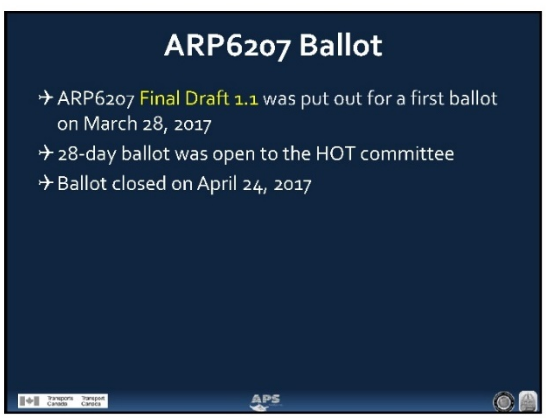
PRESENTATION:
DEVELOPMENT OF ARP6207: PROCESS TO COMMERCIALIZE TYPE I FLUIDS

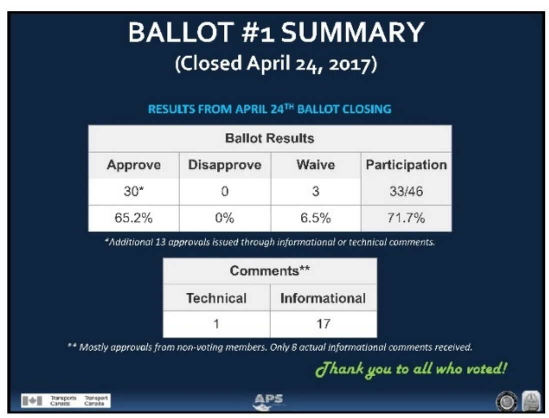

Joint research led by:
Transport Canada
Transports Canada
Conducted by:
APS Aviation Inc.
SAE INTERNATIONAL
AEROSPACE RECOMMENDED PRACTICE
Development of ARP 6207:
Process to Commercialize Type I Fluids
SAE G12 Holdover Time Committee, Athens, Greece, May 23, 2017
Presented By: Marco Ruggi, Eng., M.B.A., Senior Project Leader


Outline
Background
Purpose of ARP6207
SAE Ballot Results
Overview of ARP6207
Summary


Background
A motion was made to create an equivalent standard to ARP5718 for Type I fluids
– Motion made at May 2011 G-12 meeting in SFO
– Sponsor: Jacques Leroux and more recently transferred to Marco Ruggi
ARP 5718 – Process to Commercialize Types II/III/IV Aircraft Deicing/Anti-Icing Fluids


Purpose of ARP6207
ARP 6207 is a standard describing the process to commercialize SAE Type I aircraft deicing/anti-icing fluids
ARP6207 describes how to:
– select samples for testing
– run field spray tests
– verify ET data is suitable for the Type I HOT guidelines
– add/remove fluids from the TC/FAA lists of fluids
ARP6207 is based upon ARP5718


ARP6207 Ballot
ARP6207 Final Draft 1.1 was put out for a first ballot on March 28, 2017
28-day ballot was open to the HOT committee
Ballot closed on April 24, 2017

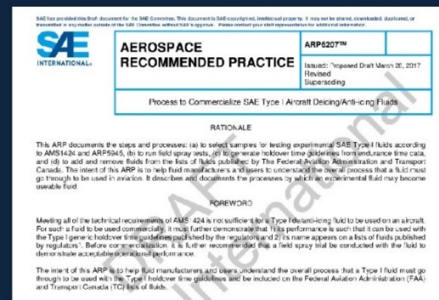

BALLOT #1 SUMMARY
(Closed April 24, 2017)
RESULTS FROM APRIL 24TH BALLOT CLOSING
Ballot Results
Approve | Disapprove | Waive | Participation
30* | 0 | 3 | 33/46
65.2% | 0% | 6.5% | 71.7%
*Additional 13 approvals issued through informational or technical comments.
Comments**
Technical | Informational
1 | 17
** Mostly approvals from non-voting members. Only 8 actual informational comments received.
Thank you to all who voted!

Technical and Informational Comments

- Eight committee members provided informational comments
  - mostly editorial comments
- Two main points identified:
  1. The use of the word "Commercialize" in title: maybe more of a process to qualify?... Discussions ongoing
  2. The identification of testing laboratories: exists in other standards, but maybe no longer appropriate?... TC/FAA recommend to remove and re-ballot with change

  Similar comments were made in the ARP 5718 ballot
- ARP 6207 will be updated and re-balloted

ARP6207



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SAE INTERNATIONAL

AEROSPACE RECOMMENDED PRACTICE	ARP6207™	
	Issued: Proposed Draft March 26, 2017 Revised Superseding	
Process to Commercialize SAE Type I Aircraft Deicing/Anti-icing Fluids		

RATIONALE

This ARP documents the steps and processes: (a) to select samples for testing experimental SAE Type I fluids according to AMS1424 and ARP5945, (b) to run field spray tests, (c) to generate holdover time guidelines from endurance time data, and (d) to add and remove fluids from the lists of fluids published by The Federal Aviation Administration and Transport Canada. The intent of this ARP is to help fluid manufacturers and users to understand the overall process that a fluid must go through to be used in aviation. It describes and documents the processes by which an experimental fluid may become useable fluid.

FOREWORD

Meeting all of the technical requirements of AMS1424 is not sufficient for a Type I de/anti-icing fluid to be used on an aircraft. For such a fluid to be used commercially, it must further demonstrate that 1) its performance is such that it can be used with the Type I generic holdover time guidelines published by the regulators and 2) its name appears on a lists of fluids published by regulators[1]. Before commercialization, it is further recommended that a field spray trial be conducted with the fluid to demonstrate acceptable operational performance.

The intent of this ARP is to help fluid manufacturers and users understand the overall process that a Type I fluid must go through to be used with the Type I holdover time guidelines and be included on the Federal Aviation Administration (FAA) and Transport Canada (TC) lists of fluids.

DRAFT SAE International

Overview of ARP 6207

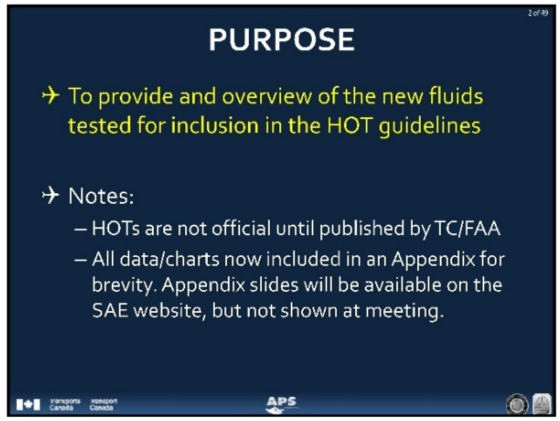
1. SCOPE
2. REFERENCES
3. LABORATORY TESTING AND SAMPLE SELECTION
4. FIELD SPRAY TESTING
5. PREPARATION OF DRAFT HOLDOVER TIME GUIDELINES AND FLUID LISTS
6. ROLE OF THE SAE G-12 AIRCRAFT DEICING FLUIDS COMMITTEE
7. ROLE OF THE SAE G-12 HOLDOVER TIME COMMITTEE
8. PUBLICATION OF HOLDOVER TIME GUIDELINES AND FLUID LISTS
9. TIMELINE

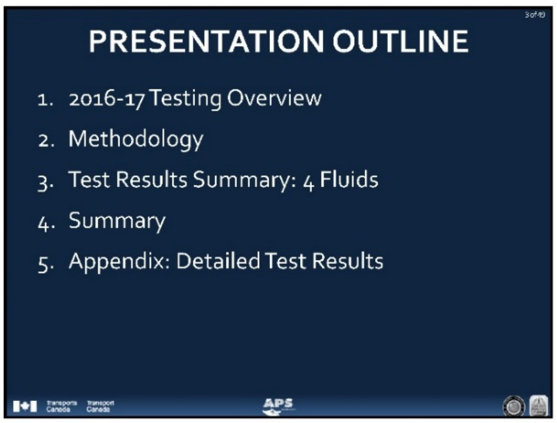
Summary

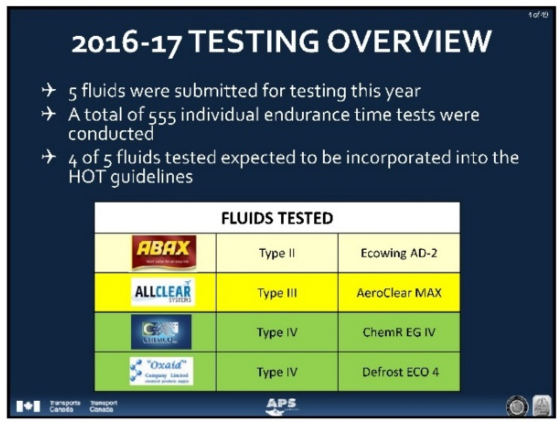
- ARP6207 ballot was generally well received
- A few minor comments will be addressed in the upcoming weeks, and a new version will be issued with track changes
- ARP6207 will go out for re-ballot
  - Stay tuned and please vote!

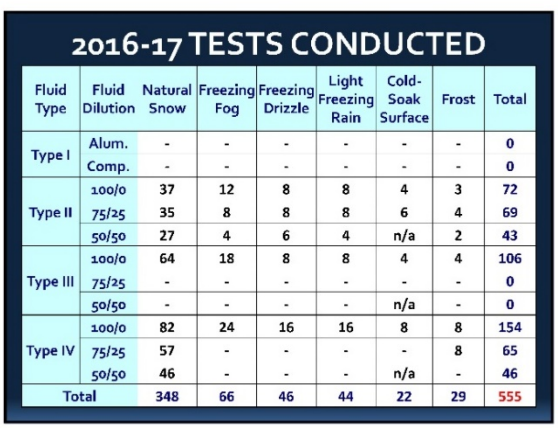
SAE G-12 HOT COMMITTEE, ATHENS, GREECE

PRESENTATION:
ENDURANCE TIME TESTING RESULTS



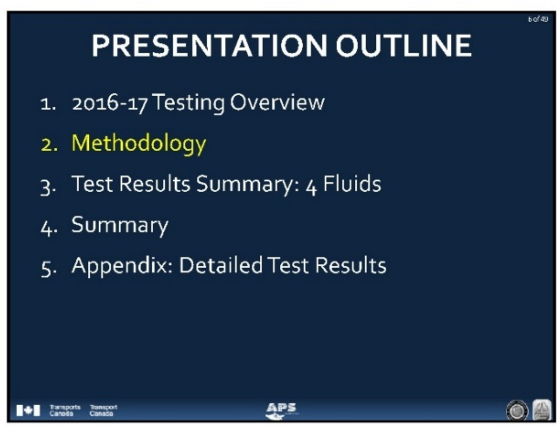


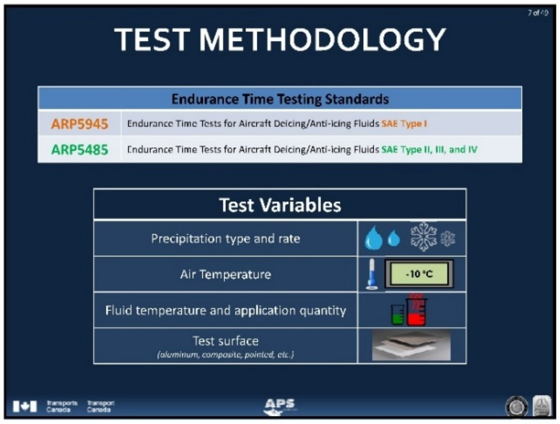


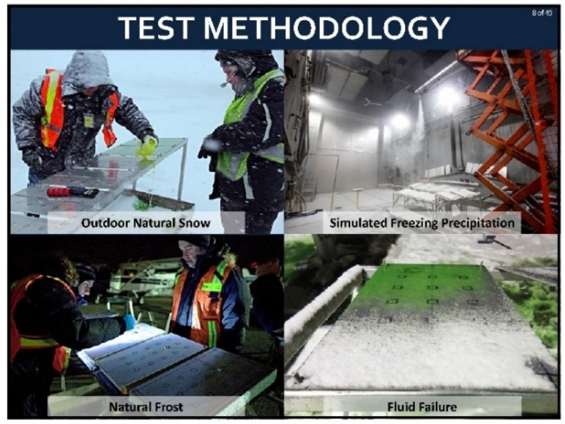


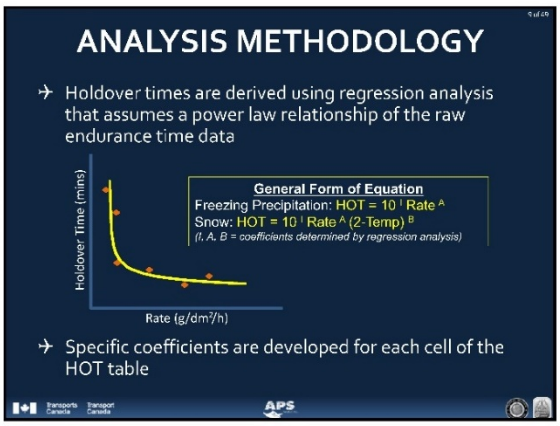
2016-17 TESTS CONDUCTED

Fluid Type	Fluid Dilution	Natural Snow	Freezing Fog	Freezing Drizzle	Light Freezing Rain	Cold-Soak Surface	Frost	Total
Type I	Alum.	-	-	-	-	-	-	0
	Comp.	-	-	-	-	-	-	0
Type II	100/0	37	12	8	8	4	3	72
	75/25	35	8	8	8	6	4	69
	50/50	27	4	6	4	n/a	2	43
Type III	100/0	64	18	8	8	4	4	106
	75/25	-	-	-	-	-	-	0
	50/50	-	-	-	-	n/a	-	0
Type IV	100/0	82	24	16	16	8	8	154
	75/25	57	-	-	-	-	8	65
	50/50	46	-	-	-	n/a	-	46
Total		348	66	46	44	22	29	555




7 of 49
TEST METHODOLOGY
Endurance Time Testing Standards
ARP5945 Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids SAE Type I
ARP5485 Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids SAE Type II, III, and IV
Test Variables
Precipitation type and rate
Air Temperature
-10 °C
Fluid temperature and application quantity
Test surface
(aluminum, composite, painted, etc.)
APS


8 of 49
TEST METHODOLOGY
Outdoor Natural Snow
Simulated Freezing Precipitation
Natural Frost
Fluid Failure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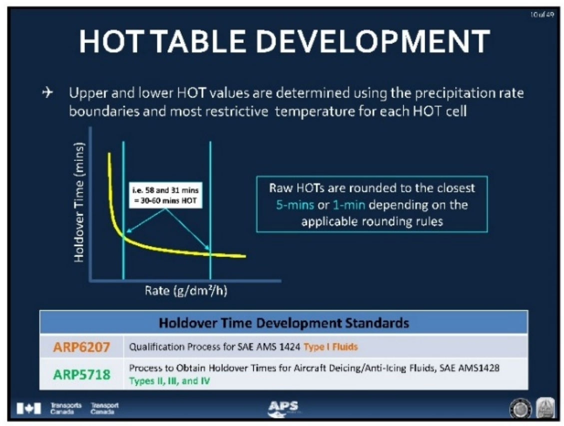
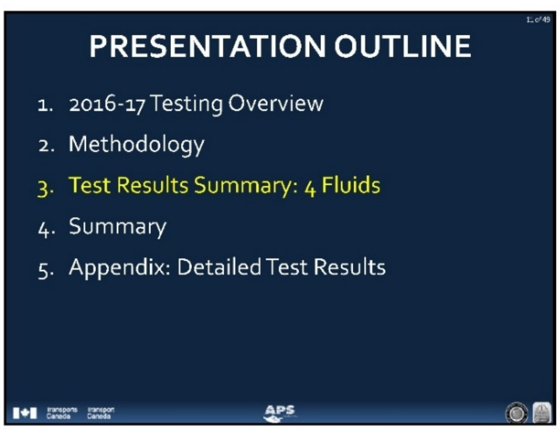
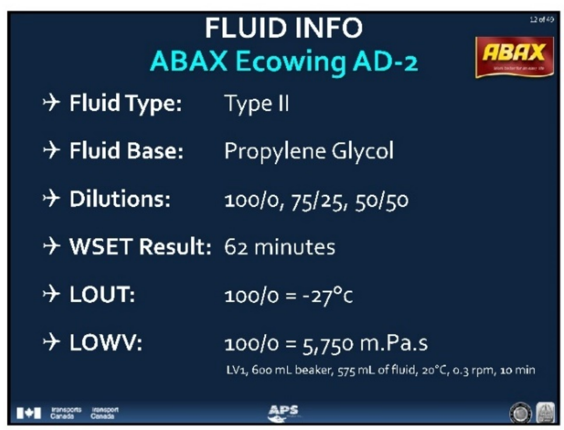
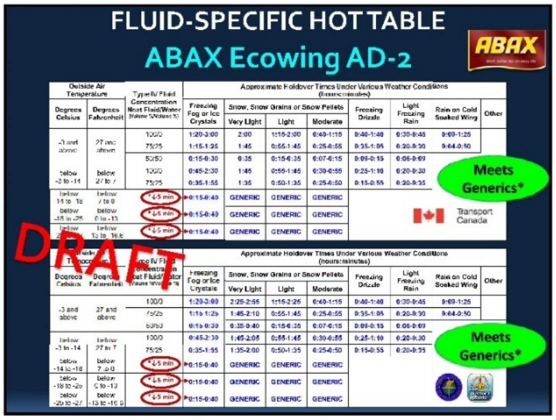
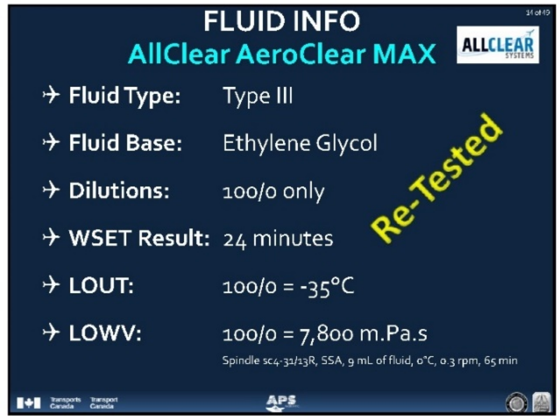
ANALYSIS METHODOLOGY
Holdover times are derived using regression analysis that assumes a power law relationship of the raw endurance time data
General Form of Equation
Freezing Precipitation: HOT = 10 I Rate A
Snow: HOT = 10 I Rate A (2-Temp) B
(I, A, B = coefficients determined by regression analysis)
Holdover Time (mins)
Rate (g/dm²/h)
Specific coefficients are developed for each cell of the HOT table
APS

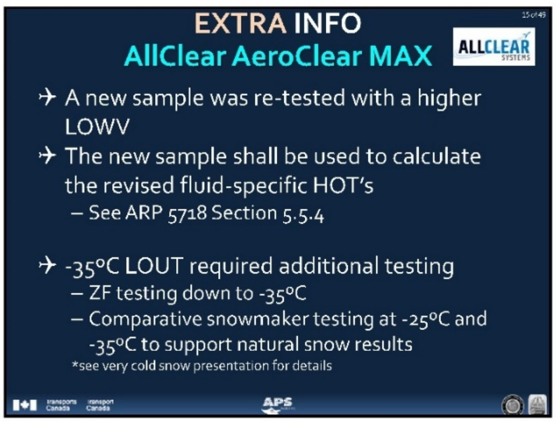

10 of 49
HOT TABLE DEVELOPMENT
Upper and lower HOT values are determined using the precipitation rate boundaries and most restrictive temperature for each HOT cell
Holdover Time (mins)
i.e. 58 and 31 mins = 30-60 mins HOT
Raw HOTs are rounded to the closest 5-mins or 1-min depending on the applicable rounding rules
Rate (g/dm²/h)
Holdover Time Development Standards
ARP6207 Qualification Process for SAE AMS 1424 Type I Fluids
ARP5718 Process to Obtain Holdover Times for Aircraft Deicing/Anti-Icing Fluids, SAE AMS1428 Types II, III, and IV
APS


11 of 49
PRESENTATION OUTLINE
1. 2016-17 Testing Overview
2. Methodology
3. Test Results Summary: 4 Fluids
4. Summary
5. Appendix: Detailed Test Results
APS


12 of 49
FLUID INFO
ABAX Ecowing AD-2
ABAX
Fluid Type: Type II
Fluid Base: Propylene Glycol
Dilutions: 100/0, 75/25, 50/50
WSET Result: 62 minutes
LOUT: 100/0 = -27°C
LOWV: 100/0 = 5,750 m.Pa.s
LV1, 600 mL beaker, 575 mL of fluid, 20°C, 0.3 rpm, 10 min
APS


FLUID-SPECIFIC HOT TABLE
ABAX Ecowing AD-2
ABAX
Approximate Holdover Times Under Various Weather Conditions (hours:minutes)
Outside Air Temperature | Degrees Celsius | Degrees Fahrenheit | Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %) | Freezing Fog or Ice Crystals | Snow, Snow Grains or Snow Pellets: Very Light | Light | Moderate | Freezing Drizzle | Light Freezing Rain | Rain on Cold Soaked Wing | Other
-3 and above | 27 and above | 100/0 | 1:20-3:00 | 2:00 | 1:15-2:00 | 0:40-1:15 | 0:40-1:40 | 0:30-0:45 | 0:09-1:25
75/25 | 1:15-1:25 | 1:45 | 0:55-1:45 | 0:25-0:55 | 0:35-1:05 | 0:20-0:30 | 0:04-0:50
50/50 | 0:15-0:30 | 0:35 | 0:15-0:35 | 0:07-0:15 | 0:09-0:15 | 0:06-0:09
below -3 to -14 | below 27 to 7 | 100/0 | 0:45-2:30 | 1:45 | 0:55-1:45 | 0:30-0:55 | 0:25-1:10 | 0:20-0:30
75/25 | 0:35-1:55 | 1:35 | 0:50-1:35 | 0:25-0:50 | 0:15-0:55 | 0:20-0:35
below -14 to -18 | below 7 to 0 | *↓5 min | 0:15-0:40 | GENERIC | GENERIC | GENERIC
below -18 to -25 | below 0 to -13 | *↓5 min | 0:15-0:40 | GENERIC | GENERIC | GENERIC
below | below -13 to -16.6 | *↓5 min | 0:15-0:40 | GENERIC | GENERIC | GENERIC
Meets Generics*
Transport Canada
DRAFT
-3 and above | 27 and above | 100/0 | 1:20-3:00 | 2:25-2:55 | 1:15-2:25 | 0:40-1:15 | 0:40-1:40 | 0:30-0:45 | 0:09-1:25
75/25 | 1:15-1:25 | 1:45-2:10 | 0:55-1:45 | 0:25-0:55 | 0:35-1:05 | 0:20-0:30 | 0:04-0:50
50/50 | 0:15-0:30 | 0:35-0:40 | 0:15-0:35 | 0:07-0:15 | 0:09-0:15 | 0:06-0:09
below -3 to -14 | below 27 to 7 | 100/0 | 0:45-2:30 | 1:45-2:05 | 0:55-1:45 | 0:30-0:55 | 0:25-1:10 | 0:20-0:30
75/25 | 0:35-1:55 | 1:35-2:00 | 0:50-1:35 | 0:25-0:50 | 0:15-0:55 | 0:20-0:35
below -14 to -18 | below 7 to 0 | *↓5 min | 0:15-0:40 | GENERIC | GENERIC | GENERIC
below -18 to -25 | below 0 to -13 | *↓5 min | 0:15-0:40 | GENERIC | GENERIC | GENERIC
below -25 to -27 | below -13 to -16.6 | *↓5 min | 0:15-0:40 | GENERIC | GENERIC | GENERIC
Meets Generics*


FLUID INFO
AllClear AeroClear MAX
ALLCLEAR SYSTEMS
Fluid Type: Type III
Fluid Base: Ethylene Glycol
Dilutions: 100/0 only
WSET Result: 24 minutes
LOUT: 100/0 = -35°C
LOWV: 100/0 = 7,800 m.Pa.s
Spindle sc4-31/13R, SSA, 9 mL of fluid, 0°C, 0.3 rpm, 65 min
Re-Tested
Transports Canada Transport Canada
APS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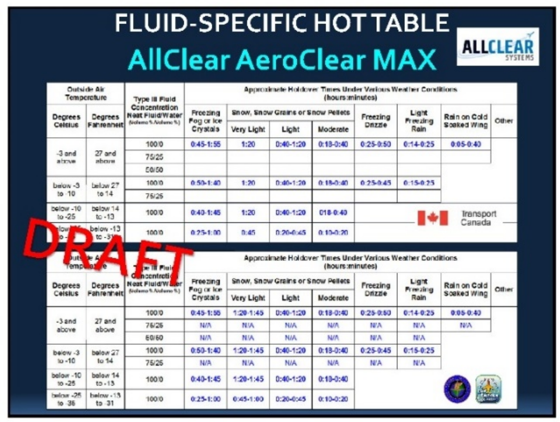
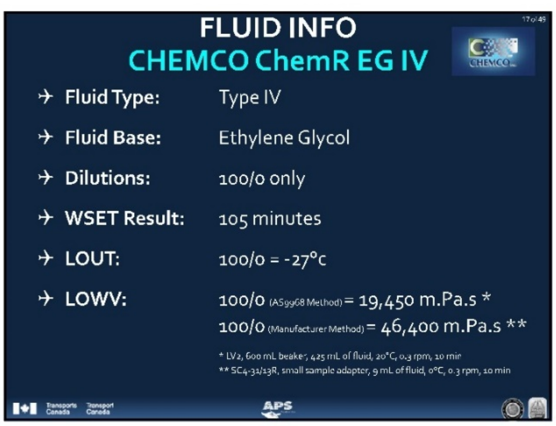
EXTRA INFO
AllClear AeroClear MAX
ALLCLEAR SYSTEMS
A new sample was re-tested with a higher LOWV
The new sample shall be used to calculate the revised fluid-specific HOT's
– See ARP 5718 Section 5.5.4
-35°C LOUT required additional testing
– ZF testing down to -35°C
– Comparative snowmaker testing at -25°C and -35°C to support natural snow results
*see very cold snow presentation for details
Transports Canada Transport Canada
APS


FLUID-SPECIFIC HOT TABLE
AllClear AeroClear MAX
ALLCLEAR SYSTEMS
Approximate Holdover Times Under Various Weather Conditions (hours:minutes)
Outside Air Temperature | Degrees Celsius | Degrees Fahrenheit | Type III Fluid Concentration Neat Fluid/Water (Volume %/Volume %) | Freezing Fog or Ice Crystals | Snow, Snow Grains or Snow Pellets: Very Light | Light | Moderate | Freezing Drizzle | Light Freezing Rain | Rain on Cold Soaked Wing | Other
-3 and above | 27 and above | 100/0 | 0:45-1:55 | 1:20 | 0:40-1:20 | 0:18-0:40 | 0:25-0:50 | 0:14-0:25 | 0:05-0:40
75/25
50/50
below -3 to -10 | below 27 to 14 | 100/0 | 0:50-1:40 | 1:20 | 0:40-1:20 | 0:18-0:40 | 0:25-0:45 | 0:15-0:25
75/25
below -10 to -25 | below 14 to -13 | 100/0 | 0:40-1:45 | 1:20 | 0:40-1:20 | 018-0:40
below -13 to -31 | 100/0 | 0:25-1:00 | 0:45 | 0:20-0:45 | 0:10-0:20
Transport Canada
DRAFT
-3 and above | 27 and above | 100/0 | 0:45-1:55 | 1:20-1:45 | 0:40-1:20 | 0:18-0:40 | 0:25-0:50 | 0:14-0:25 | 0:05-0:40
75/25 | N/A | N/A | N/A | N/A | N/A | N/A | N/A
50/50 | N/A | N/A | N/A | N/A | N/A | N/A
below -3 to -10 | below 27 to 14 | 100/0 | 0:50-1:40 | 1:20-1:45 | 0:40-1:20 | 0:18-0:40 | 0:25-0:45 | 0:15-0:25
75/25 | N/A | N/A | N/A | N/A | N/A | N/A
below -10 to -25 | below 14 to -13 | 100/0 | 0:40-1:45 | 1:20-1:45 | 0:40-1:20 | 0:18-0:40
below -25 to -35 | below -13 to -31 | 100/0 | 0:25-1:00 | 0:45-1:00 | 0:20-0:45 | 0:10-0:20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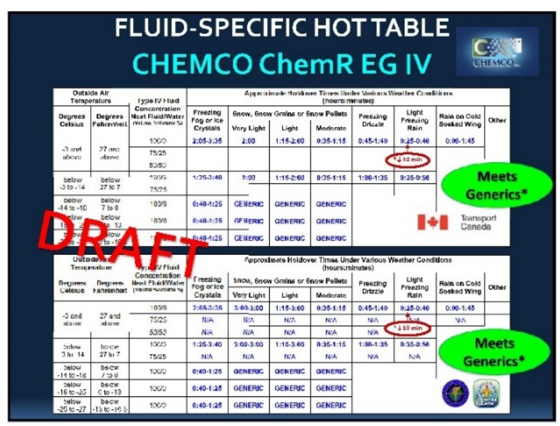
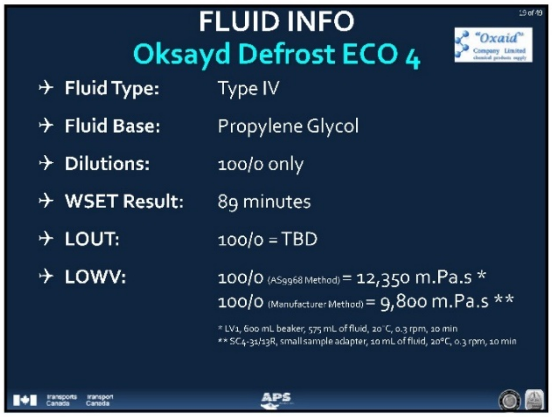
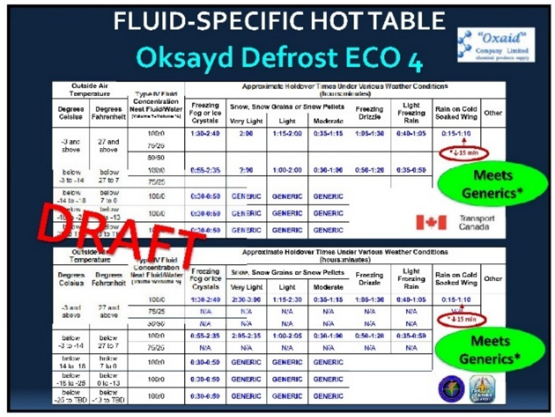
FLUID INFO
CHEMCO ChemR EG IV
CHEMCO
Fluid Type: Type IV
Fluid Base: Ethylene Glycol
Dilutions: 100/0 only
WSET Result: 105 minutes
LOUT: 100/0 = -27°c
LOWV: 100/0 (AS9968 Method) = 19,450 m.Pa.s *
100/0 (Manufacturer Method) = 46,400 m.Pa.s **
* LV2, 600 mL beaker, 425 mL of fluid, 20°C, 0.3 rpm, 10 min
** SC4-31/13R, small sample adapter, 9 mL of fluid, 0°C, 0.3 rpm, 10 min
Transports Canada Transport Canada
APS

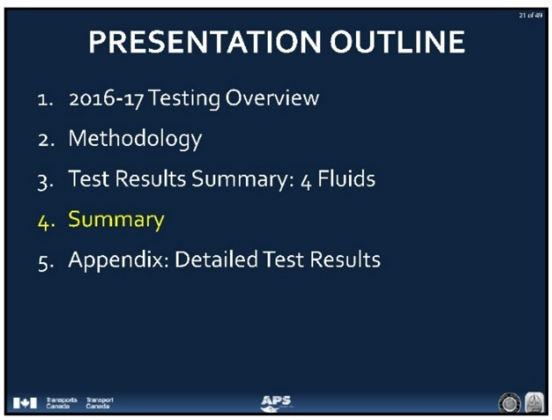

FLUID-SPECIFIC HOT TABLE
CHEMCO ChemR EG IV
CHEMCO
Approximate Holdover Times Under Various Weather Conditions (hours:minutes)
Outside Air Temperature | Degrees Celsius | Degrees Fahrenheit | Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %) | Freezing Fog or Ice Crystals | Snow, Snow Grains or Snow Pellets: Very Light | Light | Moderate | Freezing Drizzle | Light Freezing Rain | Rain on Cold Soaked Wing | Other
-3 and above | 27 and above | 100/0 | 2:05-3:35 | 2:00 | 1:15-2:00 | 0:35-1:15 | 0:45-1:40 | 0:25-0:40 | 0:06-1:45
75/25
50/50
*↓10 min
below -3 to -14 | below 27 to 7 | 100/0 | 1:25-3:40 | 2:00 | 1:15-2:00 | 0:35-1:15 | 1:00-1:35 | 0:35-0:50
75/25
below -14 to -18 | below 7 to 0 | 100/0 | 0:40-1:25 | GENERIC | GENERIC | GENERIC
100/0 | 0:40-1:25 | GENERIC | GENERIC | GENERIC
0:40-1:25 | GENERIC | GENERIC | GENERIC
Meets Generics*
Transport Canada
DRAFT
-3 and above | 27 and above | 100/0 | 2:05-3:35 | 3:00-3:00 | 1:15-3:00 | 0:35-1:15 | 0:45-1:40 | 0:25-0:40 | 0:06-1:45
75/25 | N/A | N/A | N/A | N/A | N/A | N/A | N/A
50/50 | N/A | N/A | N/A | N/A | N/A
*↓10 min
below -3 to -14 | below 27 to 7 | 100/0 | 1:25-3:40 | 3:00-3:00 | 1:15-3:00 | 0:35-1:15 | 1:00-1:35 | 0:35-0:50
75/25 | N/A | N/A | N/A | N/A | N/A | N/A
below -14 to -18 | below 7 to 0 | 100/0 | 0:40-1:25 | GENERIC | GENERIC | GENERIC
below -18 to -25 | below 0 to -13 | 100/0 | 0:40-1:25 | GENERIC | GENERIC | GENERIC
below -25 to -27 | below -13 to -16.6 | 100/0 | 0:40-1:25 | GENERIC | GENERIC | GENERIC
Meets Generics*

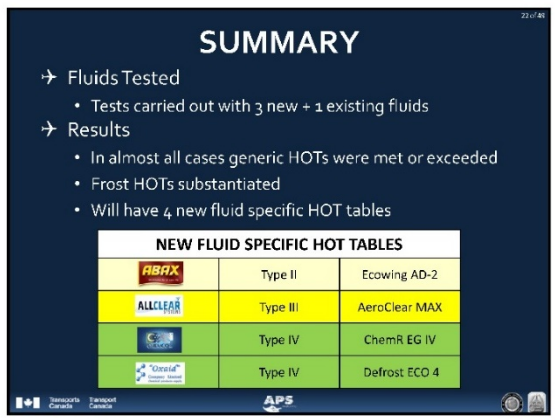




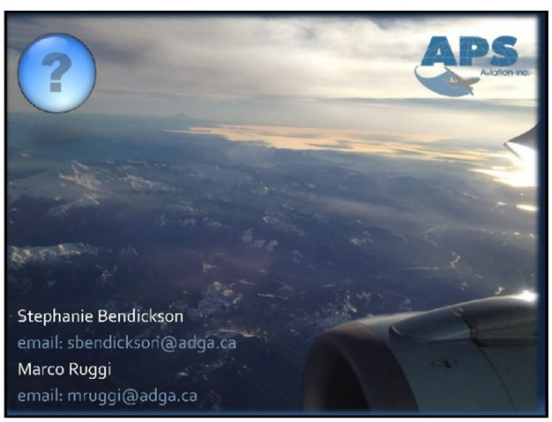
Outside Air Temperature		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Light	Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:30-2:40	2:00	1:15-2:00	0:35-1:15	1:05-1:30	0:40-1:05	0:15-1:10	
		75/25								
		50/50								
below -3 to -14	below 27 to 7	100/0	0:55-2:35	2:00	1:00-2:00	0:30-1:00	0:50-1:20	0:35-0:50		
		75/25								
below -14 to -18	below 7 to 0	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
below [illegible]	below [illegible] to -13	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
[illegible]	[illegible]	[illegible]	0:30-0:50	GENERIC	GENERIC	GENERIC				

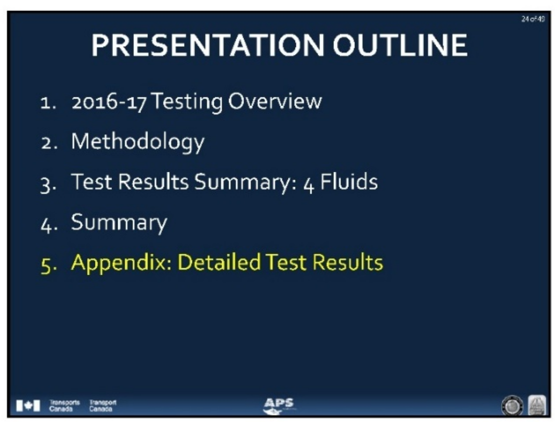
Outside Air Temperature		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Light	Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:30-2:40	2:30-3:00	1:15-2:30	0:35-1:15	1:05-1:30	0:40-1:05	0:15-1:10	
		75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
		50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -14	below 27 to 7	100/0	0:55-2:35	2:05-2:35	1:00-2:05	0:30-1:00	0:50-1:20	0:35-0:50		
		75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	below 7 to 0	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
below -18 to -25	below 0 to -13	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
below -25 to TBD	below -13 to TBD	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				

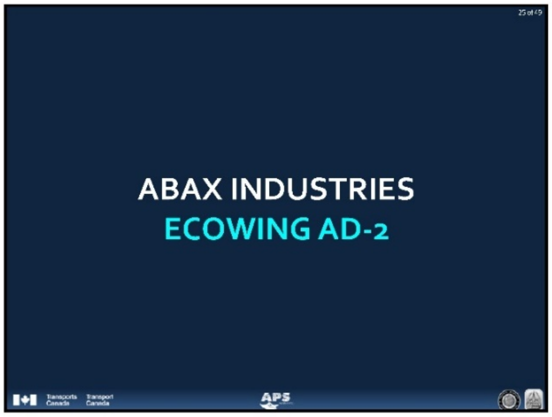


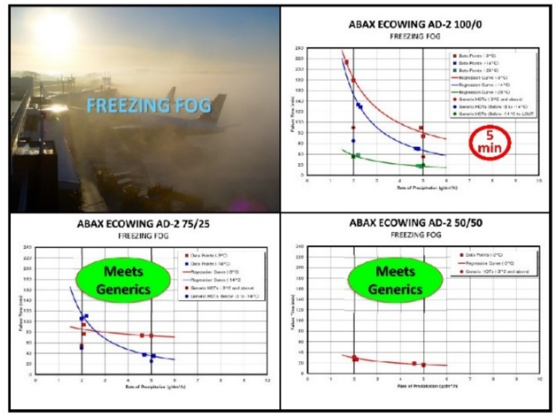


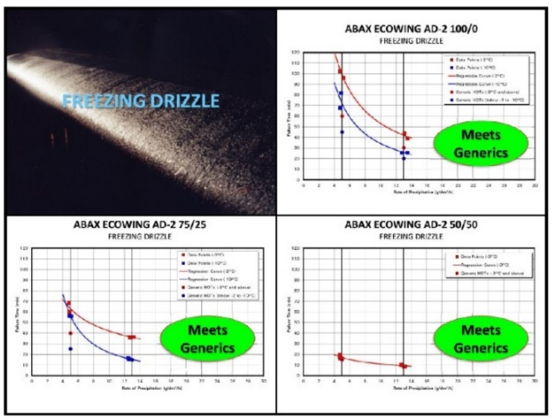
NEW FLUID SPECIFIC HOT TABLES		
ABAX	Type II	Ecowing AD-2
ALLCLEAR	Type III	AeroClear MAX
	Type IV	ChemR EG IV
"Oxaid"	Type IV	Defrost ECO 4

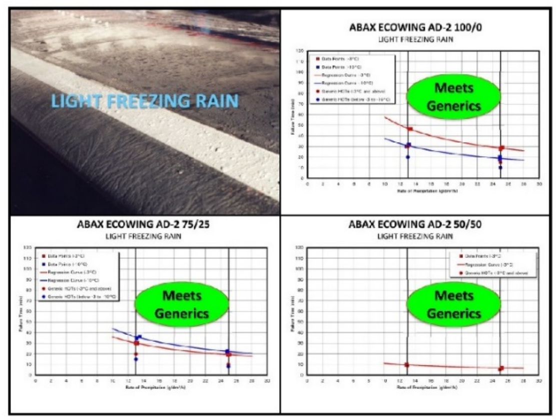


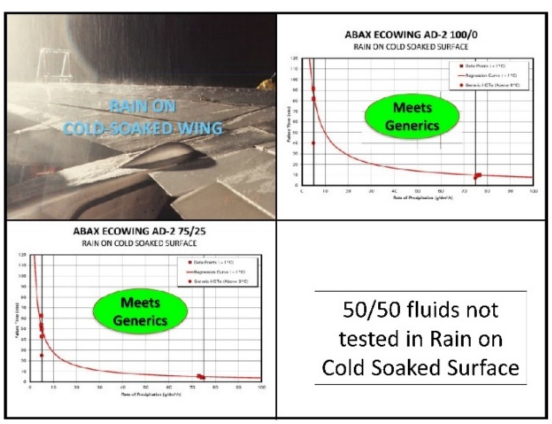


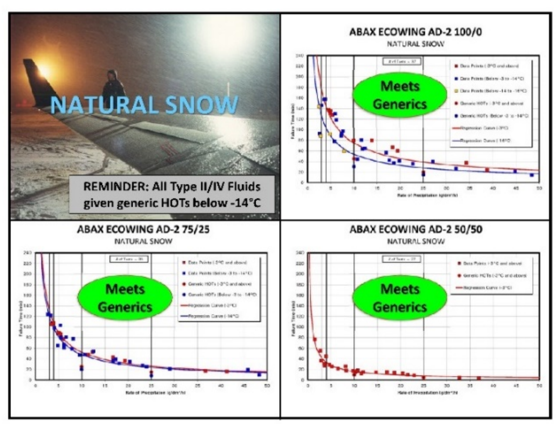

25 of 49
ABAX INDUSTRIES
ECOWING AD-2

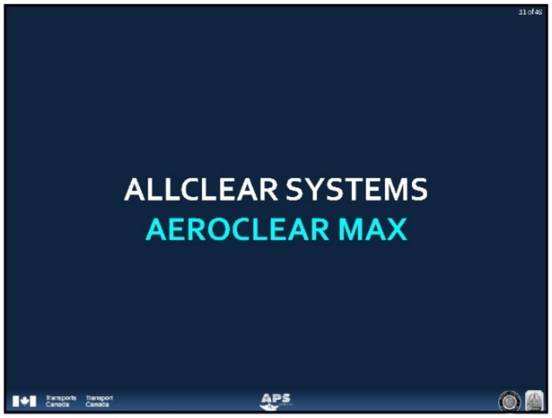

FREEZING FOG
ABAX ECOWING AD-2 100/0
FREEZING FOG
5 min
ABAX ECOWING AD-2 75/25
FREEZING FOG
Meets Generics
ABAX ECOWING AD-2 50/50
FREEZING FOG
Meets Generics


FREEZING DRIZZLE
ABAX ECOWING AD-2 100/0
FREEZING DRIZZLE
Meets Generics
ABAX ECOWING AD-2 75/25
FREEZING DRIZZLE
Meets Generics
ABAX ECOWING AD-2 50/50
FREEZING DRIZZLE
Meets Generics

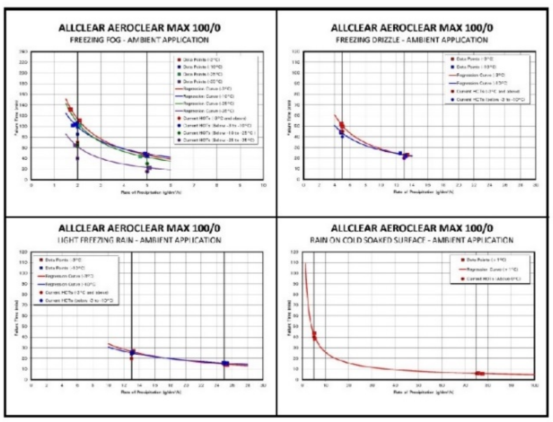

LIGHT FREEZING RAIN
ABAX ECOWING AD-2 100/0
LIGHT FREEZING RAIN
Meets Generics
ABAX ECOWING AD-2 75/25
LIGHT FREEZING RAIN
Meets Generics
ABAX ECOWING AD-2 50/50
LIGHT FREEZING RAIN
Meets Generics


RAIN ON COLD-SOAKED WING
ABAX ECOWING AD-2 100/0
RAIN ON COLD SOAKED SURFACE
Meets Generics
ABAX ECOWING AD-2 75/25
RAIN ON COLD SOAKED SURFACE
Meets Generics
50/50 fluids not tested in Rain on Cold Soaked Surface

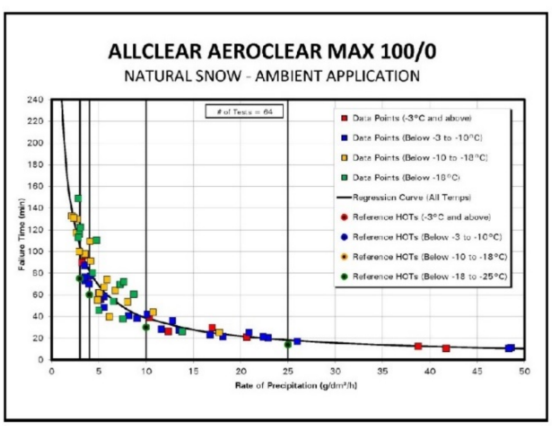

NATURAL SNOW
REMINDER: All Type II/IV Fluids given generic HOTs below -14°C
ABAX ECOWING AD-2 100/0
NATURAL SNOW
Meets Generics
ABAX ECOWING AD-2 75/25
NATURAL SNOW
Meets Generics
ABAX ECOWING AD-2 50/50
NATURAL SNOW
Meets Generics

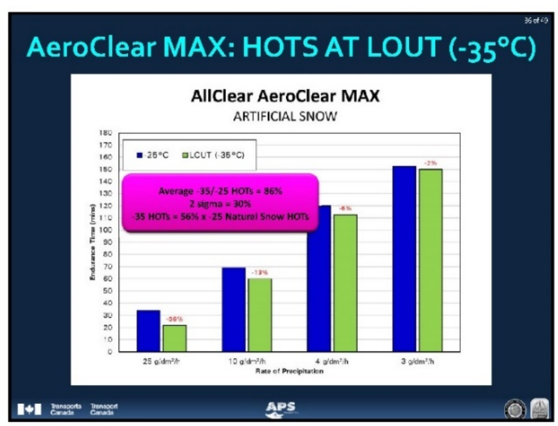

31 of 48
ALLCLEAR SYSTEMS
AEROCLEAR MAX
Transports Canada
Transport Canada
APS

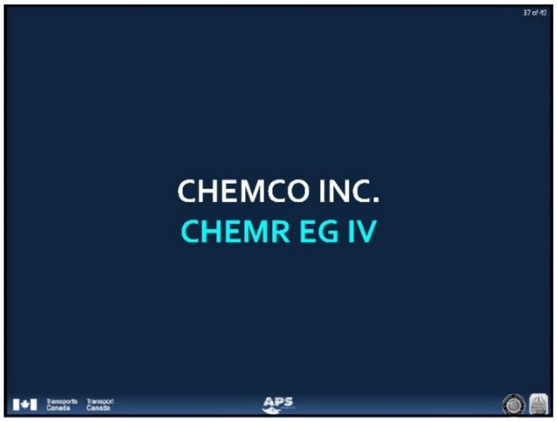

FREEZING FOG
FREEZING DRIZZLE
LIGHT FREEZING RAIN
RAIN ON
COLD-SOAKED WING


ALLCLEAR AEROCLEAR MAX 100/0
FREEZING FOG - AMBIENT APPLICATION
ALLCLEAR AEROCLEAR MAX 100/0
FREEZING DRIZZLE - AMBIENT APPLICATION
ALLCLEAR AEROCLEAR MAX 100/0
LIGHT FREEZING RAIN - AMBIENT APPLICATION
ALLCLEAR AEROCLEAR MAX 100/0
RAIN ON COLD SOAKED SURFACE - AMBIENT APPLICATION

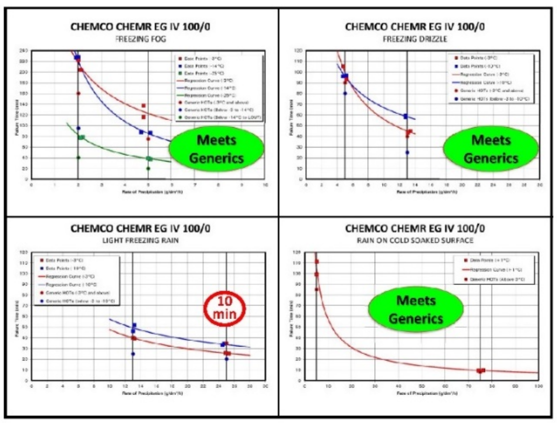

NATURAL SNOW


ALLCLEAR AEROCLEAR MAX 100/0
NATURAL SNOW - AMBIENT APPLICATION
# of Tests = 64
Data Points (-3°C and above)
Data Points (Below -3 to -10°C)
Data Points (Below -10 to -18°C)
Data Points (Below -18°C)
Regression Curve (All Temps)
Reference HOTs (-3°C and above)
Reference HOTs (Below -3 to -10°C)
Reference HOTs (Below -10 to -18°C)
Reference HOTs (Below -18 to -25°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

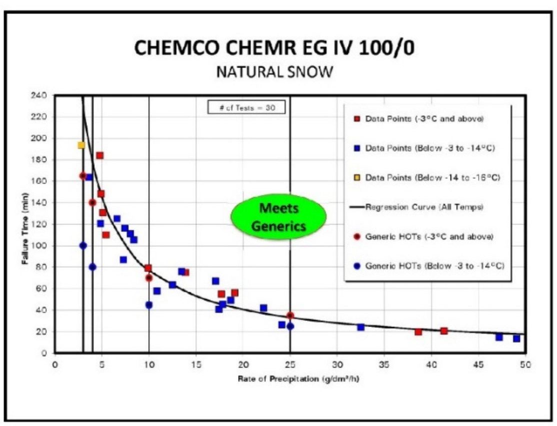

36 of 49
AeroClear MAX: HOTS AT LOUT (-35°C)
AllClear AeroClear MAX
ARTIFICIAL SNOW
-25°C
LOUT (-35°C)
Average -35/-25 HOTs = 86%
2 sigma = 30%
-35 HOTs = 56% x -25 Natural Snow HOTs
Endurance Time (mins)
25 g/dm²/h
10 g/dm²/h
4 g/dm²/h
3 g/dm²/h
Rate of Precipitation
Transports Canada
Transport Canada
APS

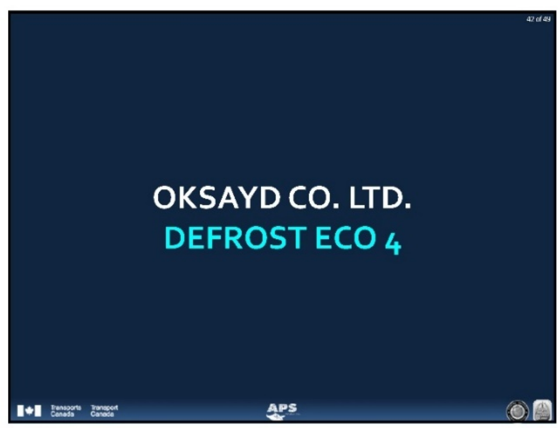

37 of 49
CHEMCO INC.
CHEMR EG IV
Transports Canada Transport Canada
APS


FREEZING FOG
FREEZING DRIZZLE
LIGHT FREEZING RAIN
RAIN ON
COLD-SOAKED WING

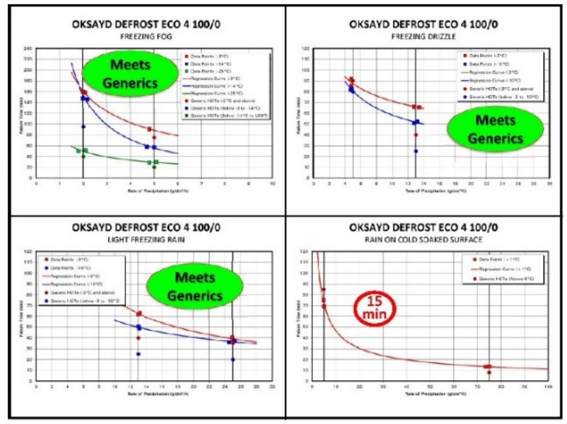

CHEMCO CHEMR EG IV 100/0
FREEZING FOG
Meets Generics
CHEMCO CHEMR EG IV 100/0
FREEZING DRIZZLE
Meets Generics
CHEMCO CHEMR EG IV 100/0
LIGHT FREEZING RAIN
10 min
CHEMCO CHEMR EG IV 100/0
RAIN ON COLD SOAKED SURFACE
Meets Generics


NATURAL SNOW

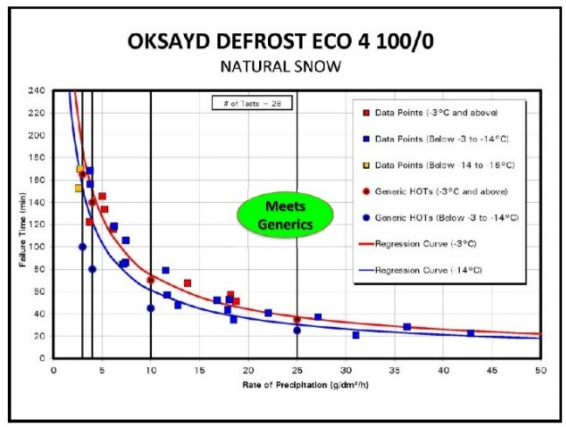

CHEMCO CHEMR EG IV 100/0
NATURAL SNOW
# of Tests = 30
Data Points (-3°C and above)
Data Points (Below -3 to -14°C)
Data Points (Below -14 to -18°C)
Regression Curve (All Temps)
Generic HOTs (-3°C and above)
Generic HOTs (Below -3 to -14°C)
Meets Generics
Failure Time (min)
Rate of Precipitation (g/dm²/h)


42 of 49
OKSAYD CO. LTD.
DEFROST ECO 4
Transports Canada Transport Canada
APS


FREEZING FOG
FREEZING DRIZZLE
LIGHT FREEZING RAIN
RAIN ON
COLD-SOAKED WING

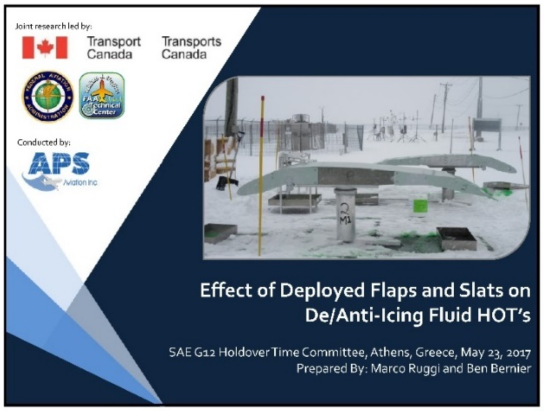

OKSAYD DEFROST ECO 4 100/0
FREEZING FOG
Meets
Generics
OKSAYD DEFROST ECO 4 100/0
FREEZING DRIZZLE
Meets
Generics
OKSAYD DEFROST ECO 4 100/0
LIGHT FREEZING RAIN
Meets
Generics
OKSAYD DEFROST ECO 4 100/0
RAIN ON COLD SOAKED SURFACE
15
min

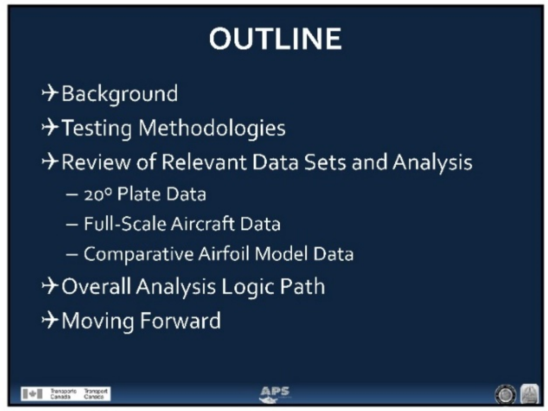

NATURAL SNOW

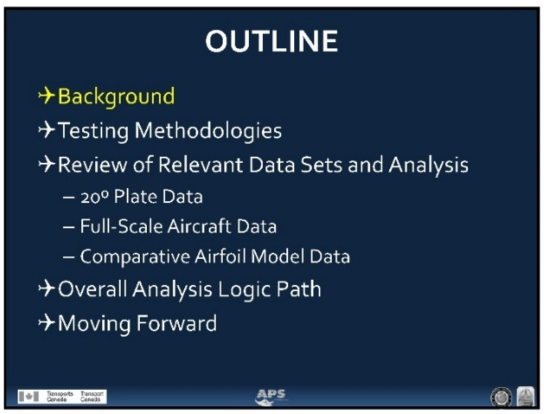

OKSAYD DEFROST ECO 4 100/0
NATURAL SNOW
# of Tests = 29
Data Points (-3°C and above)
Data Points (Below -3 to -14°C)
Data Points (Below -14 to -16°C)
Generic HOTs (-3°C and above)
Generic HOTs (Below -3 to -14°C)
Regression Curve (-3°C)
Regression Curve (-14°C)
Meets
Generics
Failure Time (min)
Rate of Precipitation (g/dm²/h)

SAE G-12 HOLDOVER TIME COMMITTEE, ATHENS, GREECE

PRESENTATION:
EFFEECT OF DEPLOYED FLAPS AND SLATS ON DE/ANTI-ICING FLUID HOT'S


Joint research led by:
Transport Canada
Transports Canada
Conducted by:
APS
Aviation Inc
Effect of Deployed Flaps and Slats on De/Anti-Icing Fluid HOT's
SAE G12 Holdover Time Committee, Athens, Greece, May 23, 2017
Prepared By: Marco Ruggi and Ben Bernier


OUTLINE
Background
Testing Methodologies
Review of Relevant Data Sets and Analysis
– 20° Plate Data
– Full-Scale Aircraft Data
– Comparative Airfoil Model Data
Overall Analysis Logic Path
Moving Forward


OUTLINE
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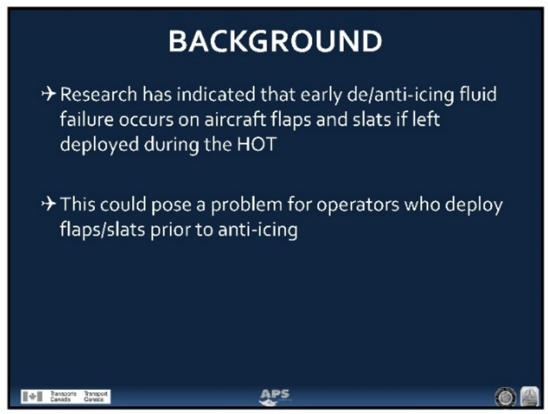
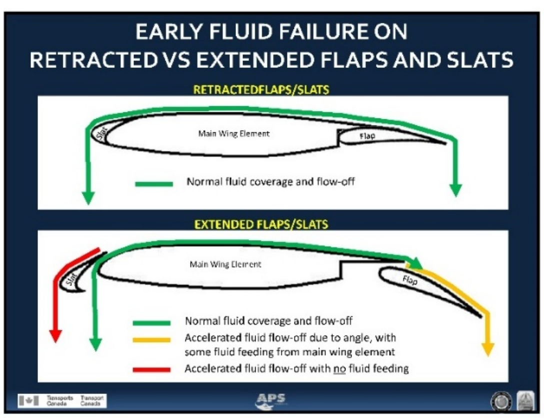
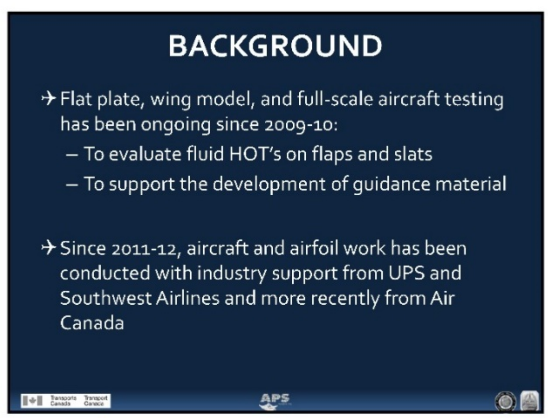

BACKGROUND
Research has indicated that early de/anti-icing fluid failure occurs on aircraft flaps and slats if left deployed during the HOT
This could pose a problem for operators who deploy flaps/slats prior to anti-icing


EARLY FLUID FAILURE ON RETRACTED VS EXTENDED FLAPS AND SLATS
RETRACTEDFLAPS/SLATS
Main Wing Element
Flap
Normal fluid coverage and flow-off
EXTENDED FLAPS/SLATS
Main Wing Element
Flap
Normal fluid coverage and flow-off
Accelerated fluid flow-off due to angle, with some fluid feeding from main wing element
Accelerated fluid flow-off with no fluid feeding


BACKGROUND
Flat plate, wing model, and full-scale aircraft testing has been ongoing since 2009-10:
– To evaluate fluid HOT's on flaps and slats
– To support the development of guidance material
Since 2011-12, aircraft and airfoil work has been conducted with industry support from UPS and Southwest Airlines and more recently from Air Canada

THANK YOU!

AÉRO MAG 2000

AÉROPORTS DE MONTRÉAL

Albany International Airport

DOW

LNT Solutions

CRYOTECH

UPS

SOUTHWEST AIRLINES

AIR CANADA

OUTLINE

- Background
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PAST TESTING SEASONS

- **Flaps and Slats testing has been ongoing since Winter 2009-10 and has included:**
  - **Wind tunnel testing**
    - High-performance wing model with hinged flap set to 20°
  - **Flat plate testing**
    - 10°/20°/35° plates in various configurations and orientations
  - **Full-scale testing**
    - Testing with A300 / B737 / A319 (with the support of UPS/SWA/Air Canada)
  - **Airfoil model testing**
    - Simple and slatted airfoil testing, both static and with a variety of rotation profiles

BACKGROUND

- Total data package now contains flat plate, airfoil model and full-scale test data
- For the winter of 2016-17, a new testing approach was developed in coordination with industry
  - Testing approach included comparative static vs. rotating airfoil testing
  - Facilitated the interpretation of the airfoil results
  - Supported the development of guidance

OUTLINE

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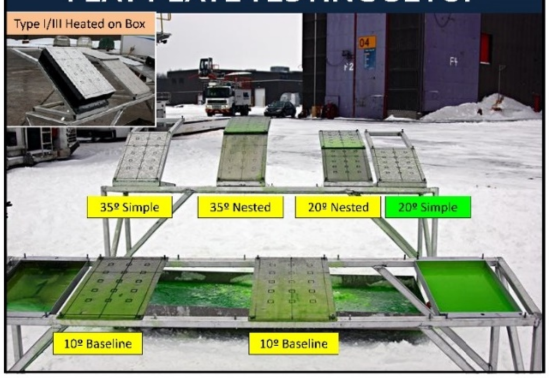
FLAT PLATE TESTING METHODOLOGY

- HOT's are developed using 10° plates
  - Historically correlated to full-scale aircraft tests
  - 33% fluid failure on the 10° flat plate correlates to first failure on the wing
  - See ARP5485, ARP5945, and TP13130E
- 20° and 35° simple and nested plates were used to simulate aircraft flaps and slats in the extended configuration
  - Angles selected based on aircraft schematics and actual aircraft measurements
- Reduction in fluid protection time on the higher angle surfaces was compared to the baseline 10° plate

FLAT PLATE TESTING SETUP



SUMMARY OF 20º PLATE TESTS

Fluid Type	# of Tests	Average Ratio of 20º Plate Compared to 10º Baseline Plate	StdDev of Ratio
I	46	84%	17%
III - Hot	27	72%	15%
III - Cold	18	65%	14%
II/IV	102	55%	16%
Total	193		

See Table 4.4 of TP 15342E for additional details

OUTLINE

- Background
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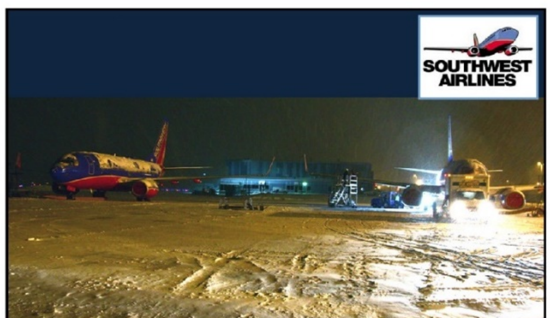
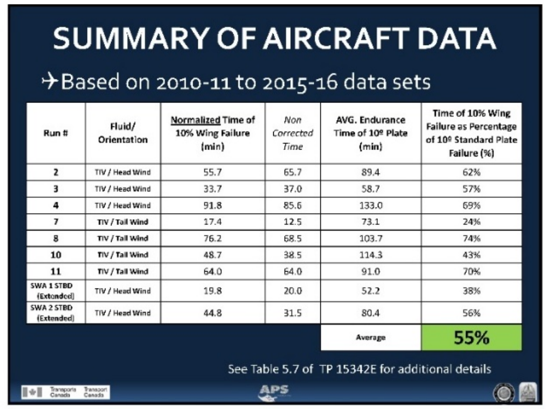
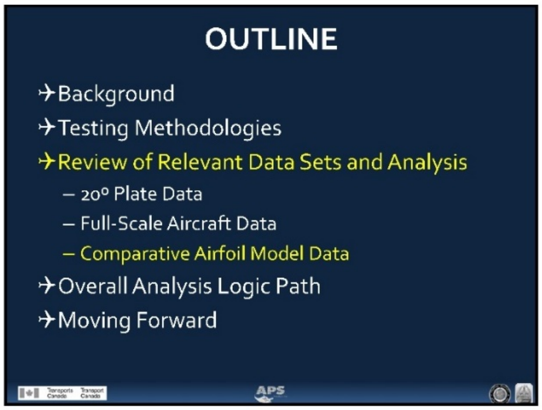
FULL-SCALE AIRCRAFT TESTING SUMMARY

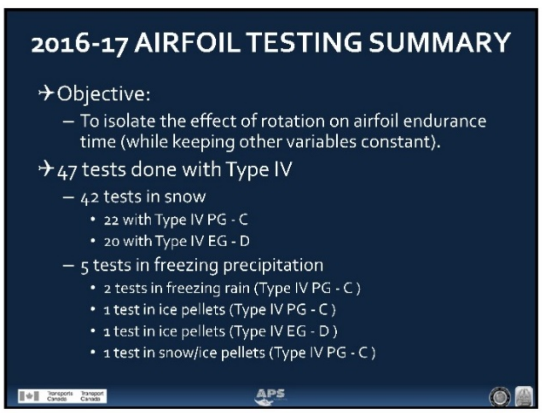
- Objective:
  - To compare the performance of de/anti-icing fluids on aircraft surfaces with the performance of de/anti-icing fluids on flat plates mounted at 10º, 15º, 20º, and 35º
- Tests conducted during the winters of 2010-11 to 2015-16 in collaboration with:
  - UPS Airlines
  - Southwest Airlines
  - Air Canada

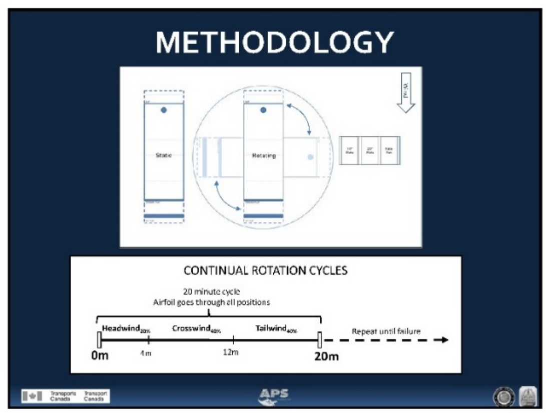




Run #	Fluid/ Orientation	Normalized Time of 10% Wing Failure (min)	*Non Corrected Time*	AVG. Endurance Time of 10º Plate (min)	Time of 10% Wing Failure as Percentage of 10º Standard Plate Failure (%)
2	TIV / Head Wind	55.7	65.7	89.4	62%
3	TIV / Head Wind	33.7	37.0	58.7	57%
4	TIV / Head Wind	91.8	85.6	133.0	69%
7	TIV / Tail Wind	17.4	12.5	73.1	24%
8	TIV / Tail Wind	76.2	68.5	103.7	74%
10	TIV / Tail Wind	48.7	38.5	114.3	43%
11	TIV / Tail Wind	64.0	64.0	91.0	70%
SWA 1 STBD (Extended)	TIV / Head Wind	19.8	20.0	52.2	38%
SWA 2 STBD (Extended)	TIV / Head Wind	44.8	31.5	80.4	56%
				Average	55%







RELATIVE RATIO BASED ANALYSIS

SNOW DATA		
Test Surface	**Test Count**	**Average Ratio of the Surface Compared to the 10° Baseline Plate**
10° Plate	42	100%
20° Plate	42	52%
Airfoil Rotating	42	68%
Airfoil Static (Headwind)	42	48%

AUGMENTATION FACTOR

- Developed to quantify the operational benefit provided by changing wind orientation during taxi
- Augmentation factor is calculated as the adjusted endurance time of the rotating airfoil divided by the adjusted endurance time of the static headwind airfoil

AUGMENTATION FACTOR CALCULATION EXAMPLE

RUN	FLUID	PIVOT TABLE PARAMETER	ADJUSTED ENDURANCE TIME (MIN)	RATIO	Augmentation Factor (Adj. ET Rot / Adj. ET Stat)
228	Type IV PG-C	10°	64.0	100%	N/A
228	Type IV PG-C	20° Simple	29.1	45%	N/A
228	Type IV PG-C	Airfoil Rotating	38.1	60%	132%
228	Type IV PG-C	Airfoil Static Head	28.9	45%	N/A

Augmentation Factor is calculated as the adjusted endurance time of the rotating airfoil divided by the adjusted endurance time of the static headwind airfoil i.e. 38.1/28.9 = 132%

AVERAGE AUGMENTATION FACTOR

- The Average Augmentation Factor is calculated as the average of all the individual calculated augmentation factors based on the rotating vs static airfoil adjusted endurance times
- The calculation is based on 42 runs conducted with Type IV PG-C and Type IV EG-D

Calculated Average Augmentation Factor: 139%

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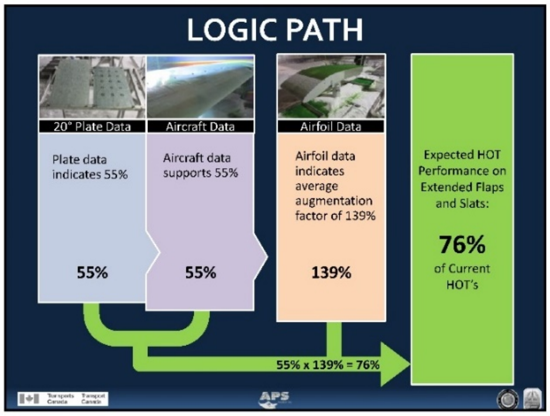
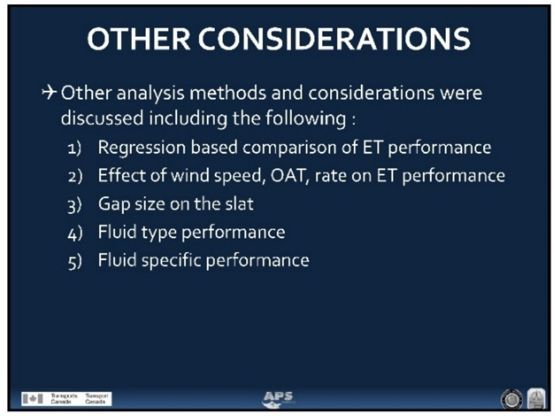
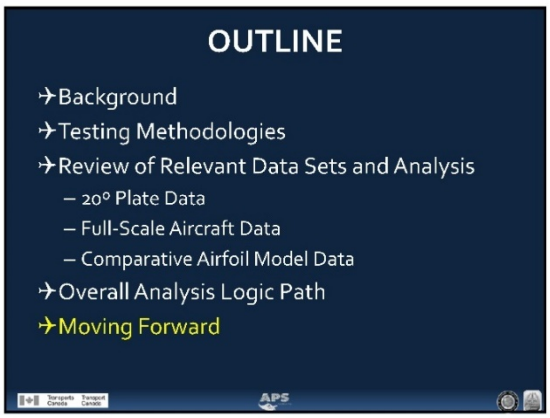
LOGIC PATH

20° Plate Data	Aircraft Data	Airfoil Data
Best method to collect large data set	Complex tests to perform therefore limited data	Large size model, with moderate difficulty level for testing
20º representative and selected based on study of aircraft surfaces	Validates the use of the 20º plate model	2014-16 preliminary testing done with 1 airfoil
Data indicates fluid protection decrement	Tests are static, and wind is more important consideration for high angle surfaces	Test methodology improved and agreed upon for 2016-17 to have 2 airfoils (static and rotating)
Suggested to validate with full-scale aircraft tests	Suggested to investigate with rotating airfoil tests	Data provides augmentation factor that can be applied to 20º plate data


LOGIC PATH
20° Plate Data
Aircraft Data
Airfoil Data
Plate data indicates 55%
Aircraft data supports 55%
Airfoil data indicates average augmentation factor of 139%
Expected HOT Performance on Extended Flaps and Slats:
76%
of Current HOT's
55%
55%
139%
55% x 139% = 76%
APS


OTHER CONSIDERATIONS
Other analysis methods and considerations were discussed including the following :
1) Regression based comparison of ET performance
2) Effect of wind speed, OAT, rate on ET performance
3) Gap size on the slat
4) Fluid type performance
5) Fluid specific performance
APS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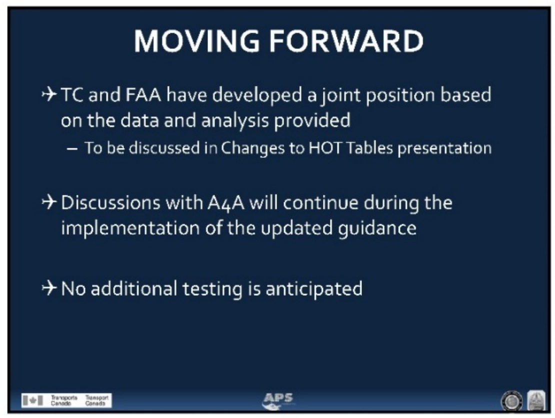
MOVING FORWARD
TC and FAA have developed a joint position based on the data and analysis provided
– To be discussed in Changes to HOT Tables presentation
Discussions with A4A will continue during the implementation of the updated guidance
No additional testing is anticipated
APS


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APS
Aviation Inc.
Marco Ruggi
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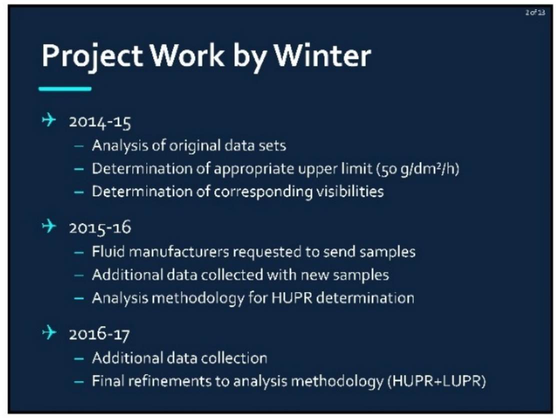
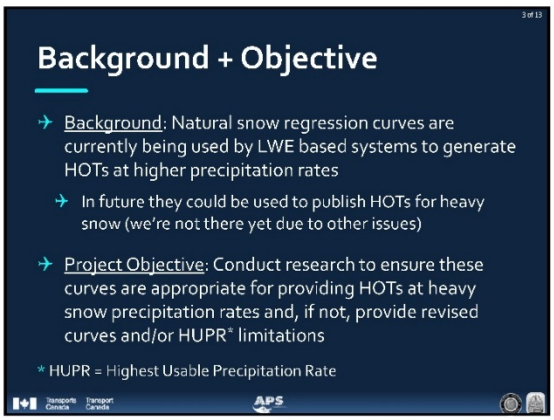
SAE G-12 HOLDOVER TIME COMMITTEE, ATHENS, GREECE

PRESENTATION:
RESEARCH TO DEVELOP HIGHEST USABLE PRECIPITATION RATES (HUPRs)
AND HOTS FOR HEAVY SNOW


Joint research led by:
Transport Canada
Transports Canada
Conducted by:
APS
RESEARCH TO DEVELOP HIGHEST USABLE PRECIPITATION RATES (HUPRs) AND HOTS FOR HEAVY SNOW
SAE G12 Holdover Time Committee, Athens, Greece, May 23, 2017
Presented By: Stephanie Bendickson, Senior Project Leader


2 of 13
Project Work by Winter
2014-15
– Analysis of original data sets
– Determination of appropriate upper limit (50 g/dm²/h)
– Determination of corresponding visibilities
2015-16
– Fluid manufacturers requested to send samples
– Additional data collected with new samples
– Analysis methodology for HUPR determination
2016-17
– Additional data collection
– Final refinements to analysis methodology (HUPR+LUPR)


3 of 13
Background + Objective
Background: Natural snow regression curves are currently being used by LWE based systems to generate HOTs at higher precipitation rates
In future they could be used to publish HOTs for heavy snow (we're not there yet due to other issues)
Project Objective: Conduct research to ensure these curves are appropriate for providing HOTs at heavy snow precipitation rates and, if not, provide revised curves and/or HUPR* limitations
* HUPR = Highest Usable Precipitation Rate
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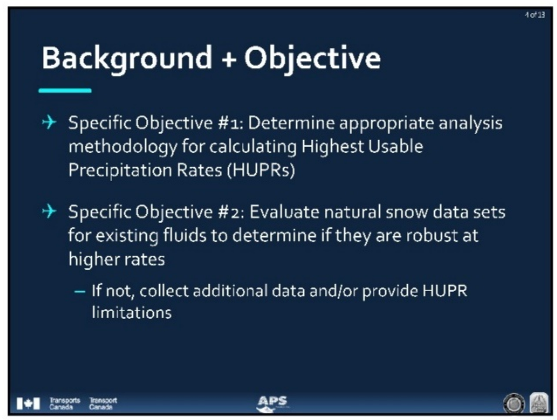
4 of 13
Background + Objective
Specific Objective #1: Determine appropriate analysis methodology for calculating Highest Usable Precipitation Rates (HUPRs)
Specific Objective #2: Evaluate natural snow data sets for existing fluids to determine if they are robust at higher rates
– If not, collect additional data and/or provide HUPR limitations
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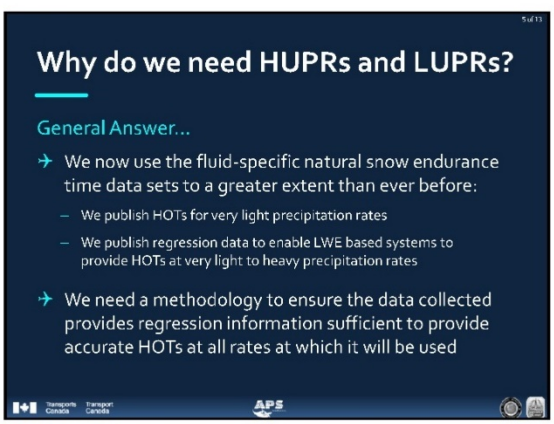
5 of 13
Why do we need HUPRs and LUPRs?
General Answer…
We now use the fluid-specific natural snow endurance time data sets to a greater extent than ever before:
– We publish HOTs for very light precipitation rates
– We publish regression data to enable LWE based systems to provide HOTs at very light to heavy precipitation rates
We need a methodology to ensure the data collected provides regression information sufficient to provide accurate HOTs at all rates at which it will be used
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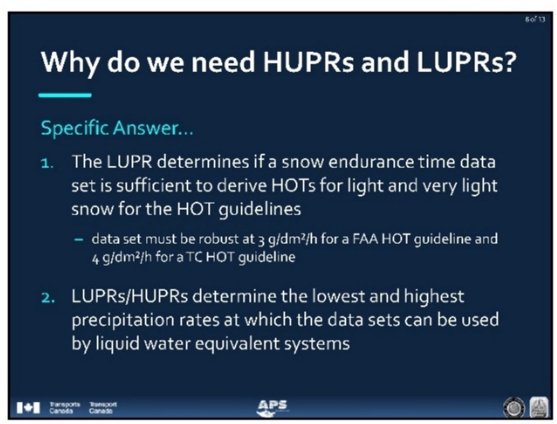
6 of 13
Why do we need HUPRs and LUPRs?
Specific Answer…
1. The LUPR determines if a snow endurance time data set is sufficient to derive HOTs for light and very light snow for the HOT guidelines
– data set must be robust at 3 g/dm²/h for a FAA HOT guideline and 4 g/dm²/h for a TC HOT guideline
2. LUPRs/HUPRs determine the lowest and highest precipitation rates at which the data sets can be used by liquid water equivalent systems
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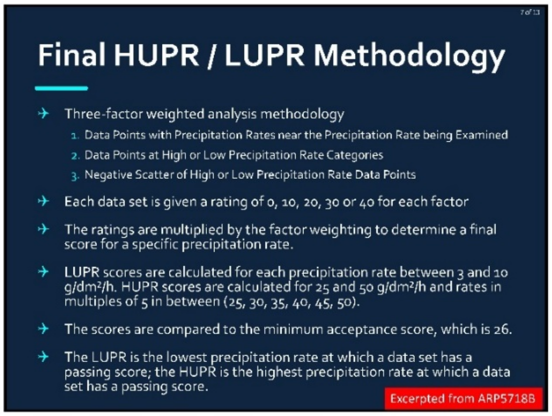
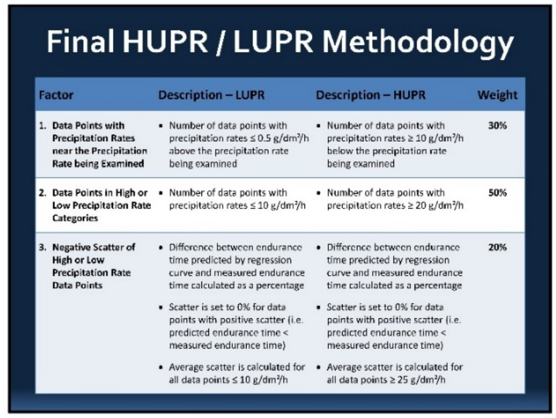
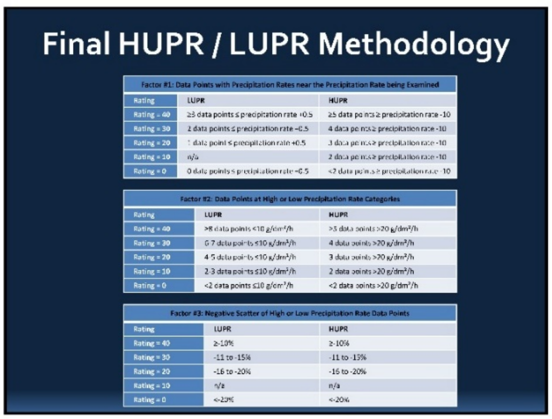
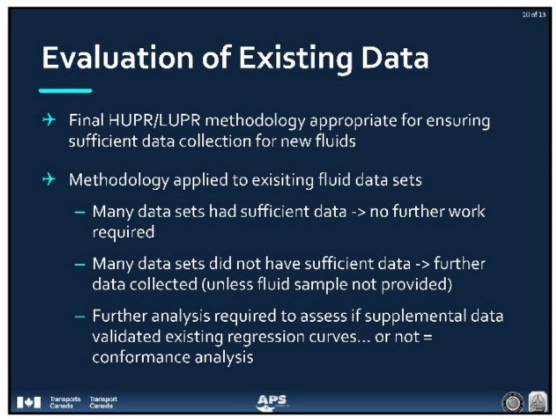

7 of 13
Final HUPR / LUPR Methodology
Three-factor weighted analysis methodology
1. Data Points with Precipitation Rates near the Precipitation Rate being Examined
2. Data Points at High or Low Precipitation Rate Categories
3. Negative Scatter of High or Low Precipitation Rate Data Points
Each data set is given a rating of 0, 10, 20, 30 or 40 for each factor
The ratings are multiplied by the factor weighting to determine a final score for a specific precipitation rate.
LUPR scores are calculated for each precipitation rate between 3 and 10 g/dm²/h. HUPR scores are calculated for 25 and 50 g/dm²/h and rates in multiples of 5 in between (25, 30, 35, 40, 45, 50).
The scores are compared to the minimum acceptance score, which is 26.
The LUPR is the lowest precipitation rate at which a data set has a passing score; the HUPR is the highest precipitation rate at which a data set has a passing score.
Excerpted from ARP5718B


Final HUPR / LUPR Methodology
Factor | Description – LUPR | Description – HUPR | Weight
1. Data Points with Precipitation Rates near the Precipitation Rate being Examined | Number of data points with precipitation rates ≤ 0.5 g/dm²/h above the precipitation rate being examined | Number of data points with precipitation rates ≥ 10 g/dm²/h below the precipitation rate being examined | 30%
2. Data Points in High or Low Precipitation Rate Categories | Number of data points with precipitation rates ≤ 10 g/dm²/h | Number of data points with precipitation rates ≥ 20 g/dm²/h | 50%
3. Negative Scatter of High or Low Precipitation Rate Data Points | Difference between endurance time predicted by regression curve and measured endurance time calculated as a percentage; Scatter is set to 0% for data points with positive scatter (i.e. predicted endurance time < measured endurance time); Average scatter is calculated for all data points ≤ 10 g/dm²/h | Difference between endurance time predicted by regression curve and measured endurance time calculated as a percentage; Scatter is set to 0% for data points with positive scatter (i.e. predicted endurance time < measured endurance time); Average scatter is calculated for all data points ≥ 25 g/dm²/h | 20%


Final HUPR / LUPR Methodology
Factor #1: Data Points with Precipitation Rates near the Precipitation Rate being Examined
Rating | LUPR | HUPR
Rating = 40 | ≥3 data points ≤ precipitation rate +0.5 | ≥5 data points ≥ precipitation rate -10
Rating = 30 | 2 data points ≤ precipitation rate +0.5 | 4 data points ≥ precipitation rate -10
Rating = 20 | 1 data point ≤ precipitation rate +0.5 | 3 data points ≥ precipitation rate -10
Rating = 10 | n/a | 2 data points ≥ precipitation rate -10
Rating = 0 | 0 data points ≤ precipitation rate +0.5 | <2 data points ≥ precipitation rate -10
Factor #2: Data Points at High or Low Precipitation Rate Categories
Rating | LUPR | HUPR
Rating = 40 | >8 data points ≤10 g/dm²/h | >5 data points >20 g/dm²/h
Rating = 30 | 6-7 data points ≤10 g/dm²/h | 4 data points >20 g/dm²/h
Rating = 20 | 4-5 data points ≤10 g/dm²/h | 3 data points >20 g/dm²/h
Rating = 10 | 2-3 data points ≤10 g/dm²/h | 2 data points >20 g/dm²/h
Rating = 0 | <2 data points ≤10 g/dm²/h | <2 data points >20 g/dm²/h
Factor #3: Negative Scatter of High or Low Precipitation Rate Data Points
Rating | LUPR | HUPR
Rating = 40 | ≥-10% | ≥-10%
Rating = 30 | -11 to -15% | -11 to -15%
Rating = 20 | -16 to -20% | -16 to -20%
Rating = 10 | n/a | n/a
Rating = 0 | <-20% | <-20%


10 of 13
Evaluation of Existing Data
Final HUPR/LUPR methodology appropriate for ensuring sufficient data collection for new fluids
Methodology applied to exisiting fluid data sets
– Many data sets had sufficient data -> no further work required
– Many data sets did not have sufficient data -> further data collected (unless fluid sample not provided)
– Further analysis required to assess if supplemental data validated existing regression curves… or not = conformance analysis
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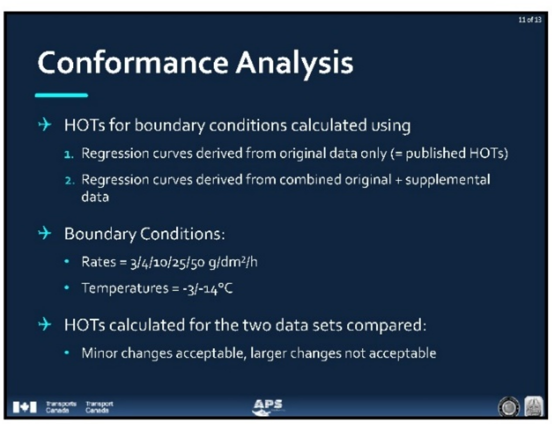
11 of 13
Conformance Analysis
HOTs for boundary conditions calculated using
1. Regression curves derived from original data only (= published HOTs)
2. Regression curves derived from combined original + supplemental data
Boundary Conditions:
• Rates = 3/4/10/25/50 g/dm²/h
• Temperatures = -3/-14°C
HOTs calculated for the two data sets compared:
• Minor changes acceptable, larger changes not acceptable
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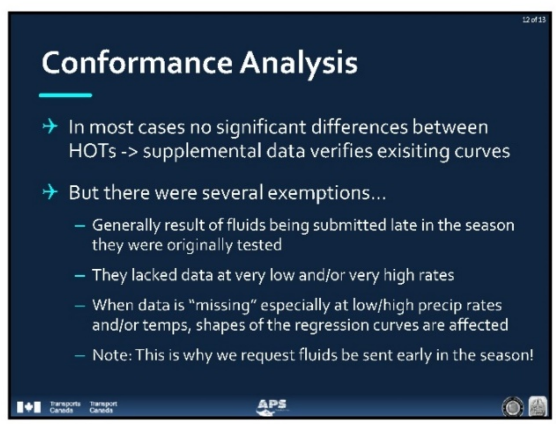
12 of 13
Conformance Analysis
In most cases no significant differences between HOTs -> supplemental data verifies exisiting curves
But there were several exemptions…
– Generally result of fluids being submitted late in the season they were originally tested
– They lacked data at very low and/or very high rates
– When data is "missing" especially at low/high precip rates and/or temps, shapes of the regression curves are affected
– Note: This is why we request fluids be sent early in the season!
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Recommendations
Make minor modifications to table of LUPRs
Final analysis methodology slightly different
Lowest possible LUPR = 3 g (was 2 g)
Publish complete table of HUPRs for Type II/III/IV fluids
Vast majority of fluids get highest possible HUPR = 50 g
Only exception is for non-participating fluid(s)
Make changes to snow HOTs for select fluids:
Cryotech Polar Guard Advance / Polar Guard II (100/0, 75/25, 50/50)
ABAX / Dow AD-49 (100/0, 75/25)
ABAX Ecowing 26 (75/25, 50/50)
Clariant Max Flight SNEG (100/0)


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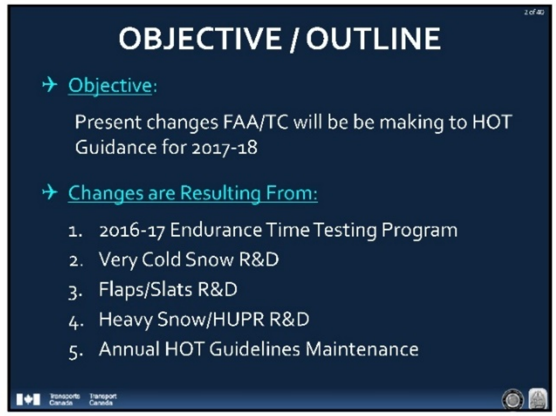
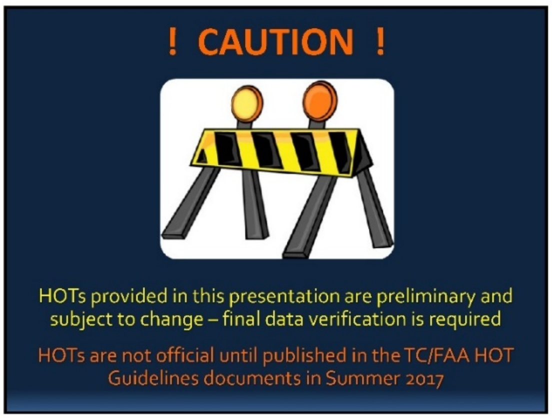
SAE G-12 HOT COMMITTEE, ATHENS, GREECE

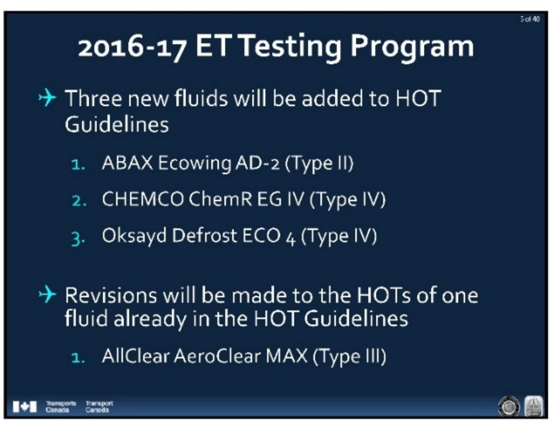
PRESENTATION:
CHANGES TO HOT GUIDELINES FOR WINTER 2017-18

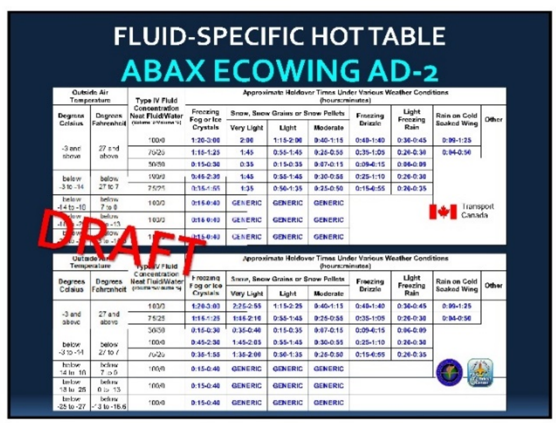

CHANGES TO HOT
GUIDELINES
FOR WINTER 2017-18
Presented By: Yvan Chabot and Chuck Enders
SAE G-12 HOT Committee, Athens, Greece – May 23, 2017
Transport Canada
Transports Canada

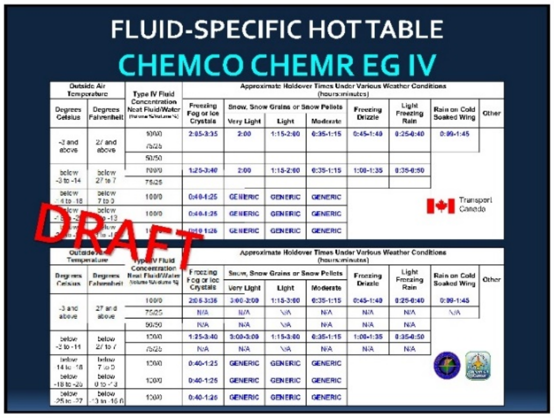

OBJECTIVE / OUTLINE
Objective:
Present changes FAA/TC will be be making to HOT Guidance for 2017-18
Changes are Resulting From:
1. 2016-17 Endurance Time Testing Program
2. Very Cold Snow R&D
3. Flaps/Slats R&D
4. Heavy Snow/HUPR R&D
5. Annual HOT Guidelines Maintenance

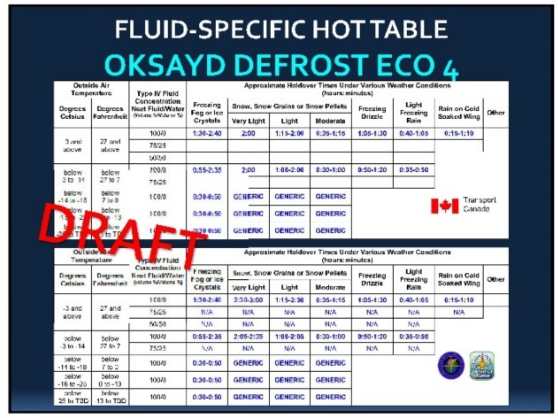

! CAUTION !
HOTs provided in this presentation are preliminary and subject to change – final data verification is required
HOTs are not official until published in the TC/FAA HOT Guidelines documents in Summer 2017

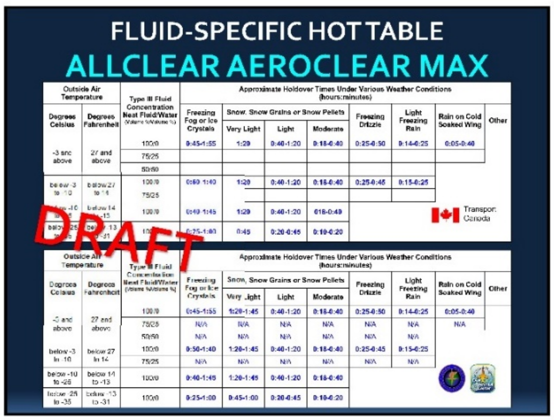

Changes resulting from…
2016-17
ENDURANCE TIME TESTING
PROGRAM

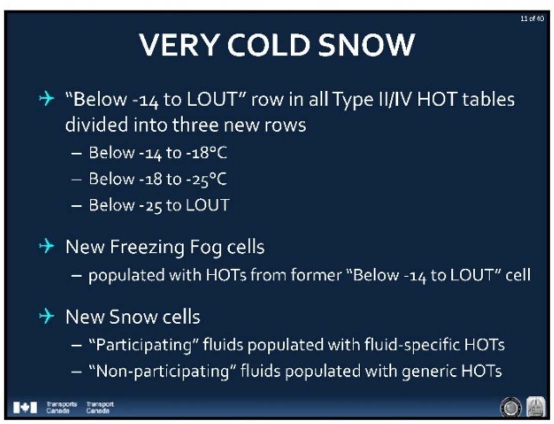

2016-17 ET Testing Program
Three new fluids will be added to HOT Guidelines
1. ABAX Ecowing AD-2 (Type II)
2. CHEMCO ChemR EG IV (Type IV)
3. Oksayd Defrost ECO 4 (Type IV)
Revisions will be made to the HOTs of one fluid already in the HOT Guidelines
1. AllClear AeroClear MAX (Type III)

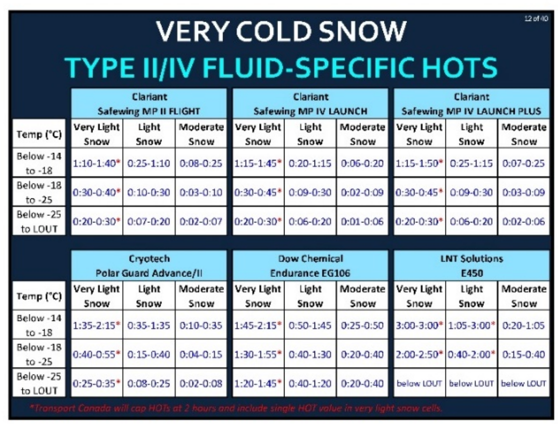

FLUID-SPECIFIC HOT TABLE
ABAX ECOWING AD-2
DRAFT





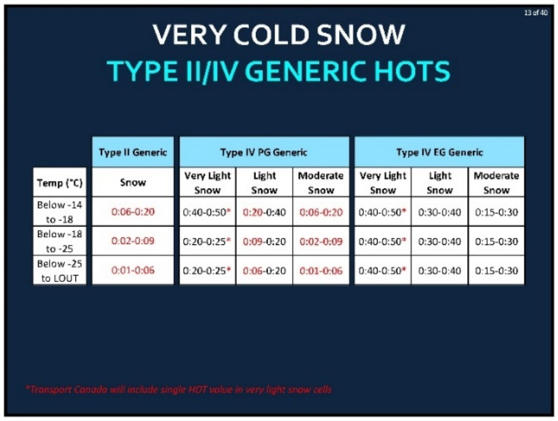




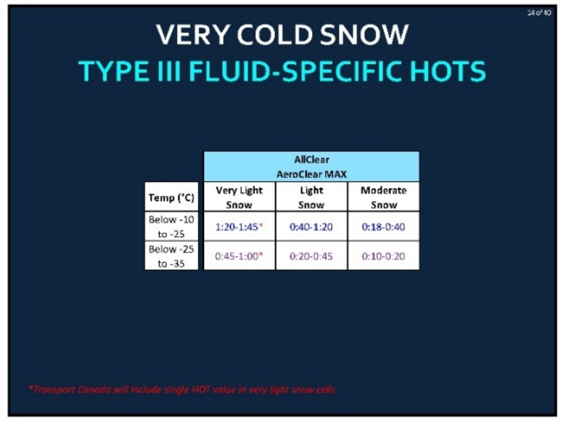


	Clariant Safewing MP II FLIGHT			Clariant Safewing MP IV LAUNCH			Clariant Safewing MP IV LAUNCH PLUS		
Temp (°C)	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow
Below -14 to -18	1:10-1:40*	0:25-1:10	0:08-0:25	1:15-1:45*	0:20-1:15	0:06-0:20	1:15-1:50*	0:25-1:15	0:07-0:25
Below -18 to -25	0:30-0:40*	0:10-0:30	0:03-0:10	0:30-0:45*	0:09-0:30	0:02-0:09	0:30-0:45*	0:09-0:30	0:03-0:09
Below -25 to LOUT	0:20-0:30*	0:07-0:20	0:02-0:07	0:20-0:30*	0:06-0:20	0:01-0:06	0:20-0:30*	0:06-0:20	0:02-0:06

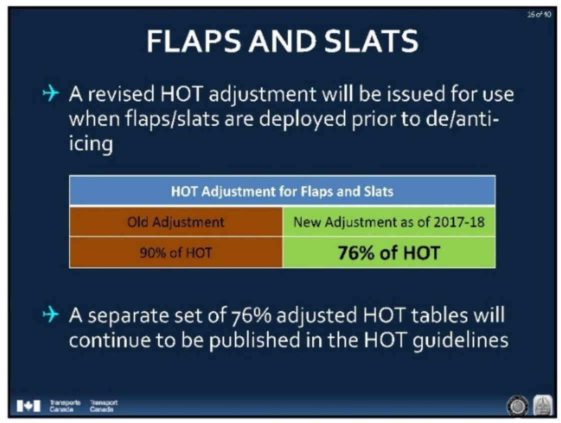
	Cryotech Polar Guard Advance/II			Dow Chemical Endurance EG106			LNT Solutions E450		
Temp (°C)	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow
Below -14 to -18	1:35-2:15*	0:35-1:35	0:10-0:35	1:45-2:15*	0:50-1:45	0:25-0:50	3:00-3:00*	1:05-3:00*	0:20-1:05
Below -18 to -25	0:40-0:55*	0:15-0:40	0:04-0:15	1:30-1:55*	0:40-1:30	0:20-0:40	2:00-2:50*	0:40-2:00*	0:15-0:40
Below -25 to LOUT	0:25-0:35*	0:08-0:25	0:02-0:08	1:20-1:45*	0:40-1:20	0:20-0:40	below LOUT	below LOUT	below LOUT



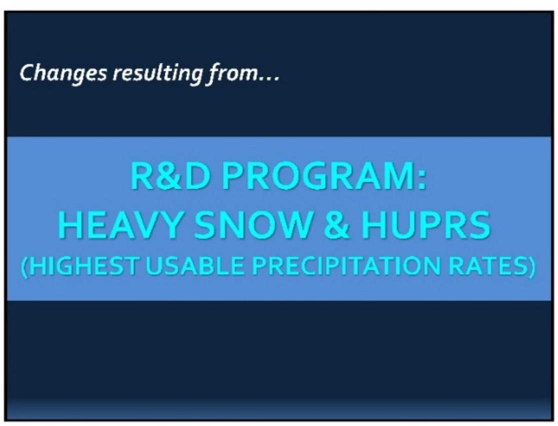
Temp (°C)	Type II Generic	Type IV PG Generic			Type IV EG Generic		
	Snow	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow
Below -14 to -18	0:06-0:20	0:40-0:50*	0:20-0:40	0:06-0:20	0:40-0:50*	0:30-0:40	0:15-0:30
Below -18 to -25	0:02-0:09	0:20-0:25*	0:09-0:20	0:02-0:09	0:40-0:50*	0:30-0:40	0:15-0:30
Below -25 to LOUT	0:01-0:06	0:20-0:25*	0:06-0:20	0:01-0:06	0:40-0:50*	0:30-0:40	0:15-0:30

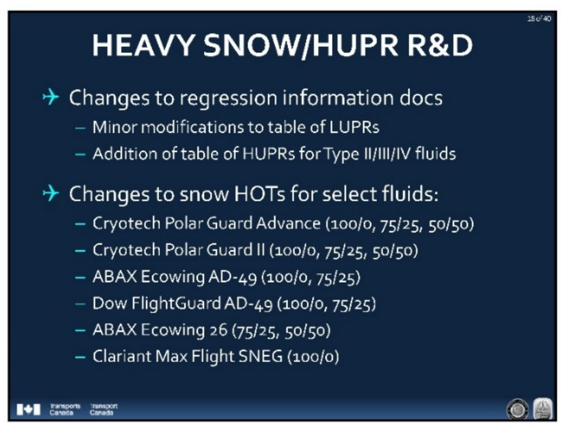


Temp (°C)	AllClear AeroClear MAX		
	Very Light Snow	Light Snow	Moderate Snow
Below -10 to -25	1:20-1:45*	0:40-1:20	0:18-0:40
Below -25 to -35	0:45-1:00*	0:20-0:45	0:10-0:20



HOT Adjustment for Flaps and Slats	
Old Adjustment	New Adjustment as of 2017-18
90% of HOT	76% of HOT





HEAVY SNOW/HUPR
CHANGES TO HOTS

Temp (°C)	Dil.	ABAX Ecowing 26 – Moderate Snow	ABAX Ecowing 26 – Light Snow	ABAX Ecowing 26 – Very Light Snow	ABAX Ecowing AD-49 / DOW UCAR FlightGuard AD-49 – Moderate Snow	ABAX Ecowing AD-49 / DOW UCAR FlightGuard AD-49 – Light Snow	ABAX Ecowing AD-49 / DOW UCAR FlightGuard AD-49 – Very Light Snow
-3°C and above	100/0	0:40-1:00	1:00-1:35	1:35-1:50	1:00-1:55	1:55-3:00	3:00-3:00
	75/25	0:20-0:40	0:40-1:20	1:20-1:40	0:45-1:35	1:35-3:00	3:00-3:00
	50/50	0:07-0:20	0:20-0:40	0:40-0:50	0:15-0:25	0:25-0:40	0:40-0:45
Below -3 to -14°C	100/0	0:35-0:55	0:55-1:25	1:25-1:40	0:40-1:15	1:15-2:25	2:25-3:00
	75/25	0:15-0:30	0:30-0:55	0:55-1:10	0:30-1:05	1:05-2:20	2:20-2:55

Temp (°C)	Dil.	Cryotech Polar Guard Advance / Cryotech Polar Guard II – Moderate Snow	Cryotech Polar Guard Advance / Cryotech Polar Guard II – Light Snow	Cryotech Polar Guard Advance / Cryotech Polar Guard II – Very Light Snow	Clariant Max Flight SNEG – Moderate Snow	Clariant Max Flight SNEG – Light Snow	Clariant Max Flight SNEG – Very Light Snow
-3°C and above	100/0	1:05-1:55	1:55-3:00	3:00-3:00	0:55-1:40	1:40-3:00	3:00-3:00
	75/25	0:40-1:25	1:25-3:00	3:00-3:00	0:55-1:30	1:30-2:25	2:25-2:50
	50/50	0:10-0:25	0:25-1:10	1:10-1:35	0:20-0:45	0:45-1:45	1:45-2:20
Below -3 to -14°C	100/0	0:40-1:10	1:10-2:00	2:00-2:20	0:40-1:10	1:10-2:05	2:05-2:30
	75/25	0:25-0:55	0:55-2:00	2:00-2:30	0:40-1:00	1:00-1:40	1:40-2:00

Note: TC HOTs will be capped at 2 hours, TC Very Light column will contain single value (lower HOT shown above)

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Table of LUPRs (Type II + III)

Type II De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing 26	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
ABAX Ecowing AD-2	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Aviation Shaanxi Hi-Tech Cleanwing II	3 g/dm^2/h	10 g/dm^2/h	4 g/dm^2/h	7 g/dm^2/h
Beijing Yadilite Aviation YD-102 Type II	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Clariant Safewing MP II FLIGHT	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Clariant Safewing MP II FLIGHT PLUS	4 g/dm^2/h	10 g/dm^2/h	3 g/dm^2/h	4 g/dm^2/h
Cryotech Polar Guard® II	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Kilfrost ABC-Ice Clear II	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Kilfrost ABC-K Plus	3 g/dm^2/h	10 g/dm^2/h	4 g/dm^2/h	3 g/dm^2/h
Newave Aerochemical FCY-2	3 g/dm^2/h	10 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Newave Aerochemical FCY-2 Bio+	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h

Type III De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-25°C and above***	***Below -25°C***	***-10°C and above***	***-3°C and above***
AllClear AeroClear MAX	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP III 2031 ECO	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h

Transports Canada Transport Canada

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Table of LUPRs (Type IV)

Type IV De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing AD-49	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
CHEMCO ChemR EG IV	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Max Flight 04	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Max Flight AVIA	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Max Flight SNEG	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Clariant Safewing EG IV NORTH	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Clariant Safewing MP IV LAUNCH PLUS	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Cryotech Polar Guard® Advance	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Deicing Solutions ECO-SHIELD®	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Dow UCAR Endurance EG106	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Kilfrost ABC-S Plus	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
LNT Solutions E450	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Newave Aerochemical FCY 9311	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Oksayd Defrost ECO 4	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h

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Table of HUPRs (Type II + III)

Type II De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing 26	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
ABAX Ecowing AD-2	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Aviation Shaanxi Hi-Tech Cleanwing II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Beijing Yadilite Aviation YD-102 Type II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Clariant Safewing MP II FLIGHT	40 g/dm^2/h	25 g/dm^2/h	40 g/dm^2/h	40 g/dm^2/h
Clariant Safewing MP II FLIGHT PLUS	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Cryotech Polar Guard® II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Kilfrost ABC-Ice Clear II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Kilfrost ABC-K Plus	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Newave Aerochemical FCY-2	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Newave Aerochemical FCY-2 Bio+	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h

Type III De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-25°C and above***	***Below -25°C***	***-10°C and above***	***-3°C and above***
AllClear AeroClear MAX	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP III 2031 ECO	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h

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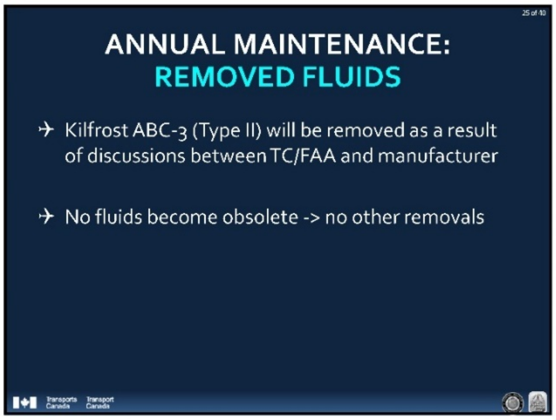
Table of HUPRs (Type IV)

Type IV De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing AD-49	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
CHEMCO ChemR EG IV	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Max Flight 04	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Max Flight AVIA	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Max Flight SNEG	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Clariant Safewing EG IV NORTH	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Clariant Safewing MP IV LAUNCH PLUS	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Cryotech Polar Guard® Advance	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Deicing Solutions ECO-SHIELD®	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Dow UCAR Endurance EG106	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Kilfrost ABC-S Plus	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
LNT Solutions E450	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Newave Aerochemical FCY 9311	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Oksayd Defrost ECO 4	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h

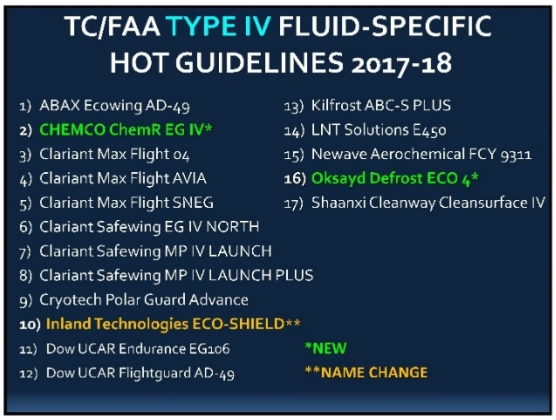
Transports Canada Transport Canada

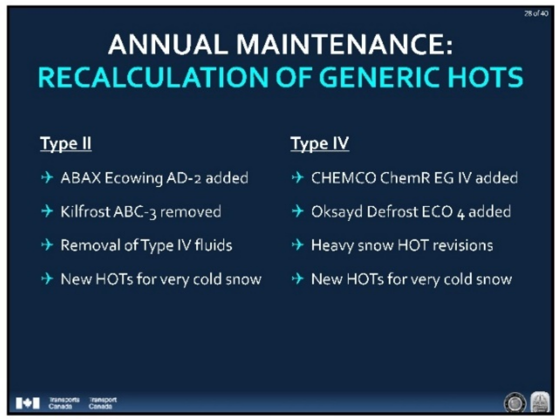
Changes resulting from…

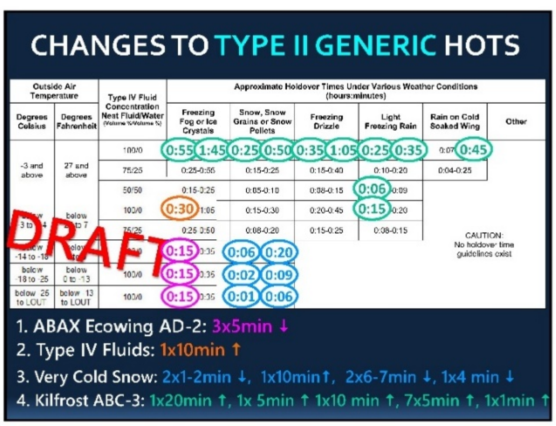
2017-18
ANNUAL HOT GUIDELINES MAINTENANCE

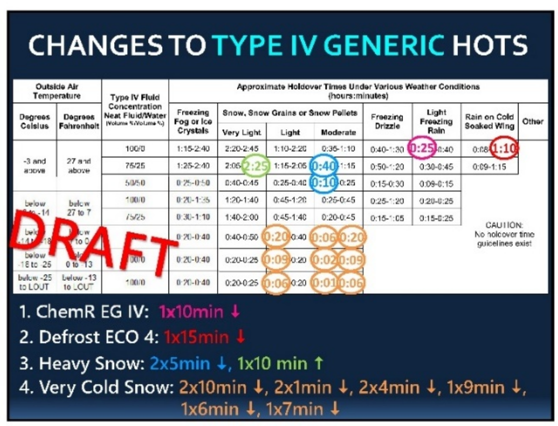

25 of 40
ANNUAL MAINTENANCE:
REMOVED FLUIDS
Kilfrost ABC-3 (Type II) will be removed as a result of discussions between TC/FAA and manufacturer
No fluids become obsolete -> no other removals

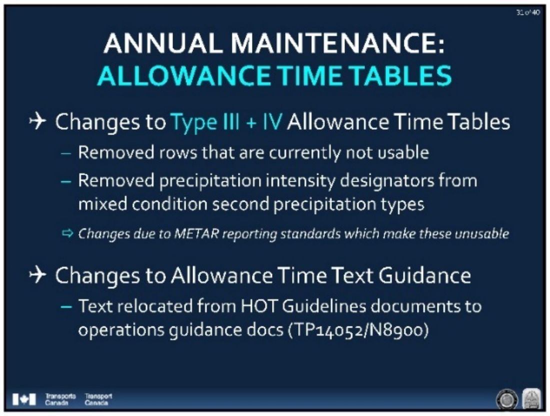

TC/FAA TYPE II FLUID-SPECIFIC HOT GUIDELINES 2017-18
1) ABAX Ecowing 26
2) ABAX Ecowing AD-2*
3) Aviation Shaanxi Cleanwing II
4) Beijing Yadilite YD-102
5) Clariant Safewing MP II FLIGHT
6) Clariant Safewing MP II FLIGHT PLUS
7) Cryotech Polar Guard II
8) Kilfrost ABC-K PLUS
9) Kilfrost ABC-Ice Clear II
10) LNT Solutions P250
11) Newave Aerochemical FCY-2
12) Newave Aerochemical FCY-2 Bio+
*NEW

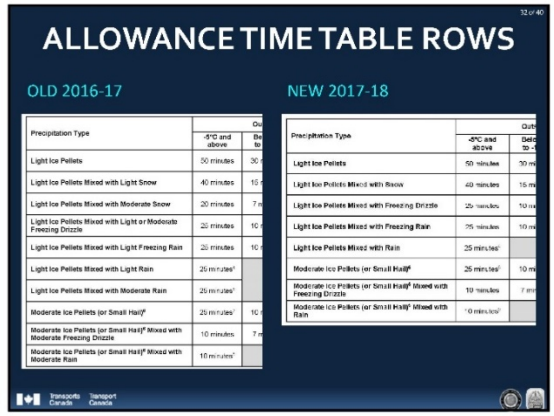

TC/FAA TYPE IV FLUID-SPECIFIC HOT GUIDELINES 2017-18
1) ABAX Ecowing AD-49
2) CHEMCO ChemR EG IV*
3) Clariant Max Flight 04
4) Clariant Max Flight AVIA
5) Clariant Max Flight SNEG
6) Clariant Safewing EG IV NORTH
7) Clariant Safewing MP IV LAUNCH
8) Clariant Safewing MP IV LAUNCH PLUS
9) Cryotech Polar Guard Advance
10) Inland Technologies ECO-SHIELD**
11) Dow UCAR Endurance EG106
12) Dow UCAR Flightguard AD-49
13) Kilfrost ABC-S PLUS
14) LNT Solutions E450
15) Newave Aerochemical FCY 9311
16) Oksayd Defrost ECO 4*
17) Shaanxi Cleanway Cleansurface IV
*NEW
**NAME CHANGE

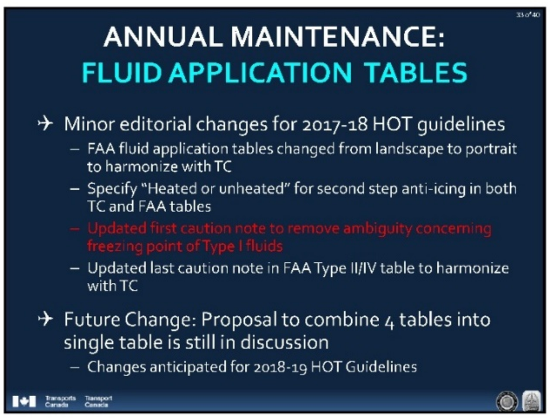

28 of 40
ANNUAL MAINTENANCE:
RECALCULATION OF GENERIC HOTS
Type II
ABAX Ecowing AD-2 added
Kilfrost ABC-3 removed
Removal of Type IV fluids
New HOTs for very cold snow
Type IV
CHEMCO ChemR EG IV added
Oksayd Defrost ECO 4 added
Heavy snow HOT revisions
New HOTs for very cold snow

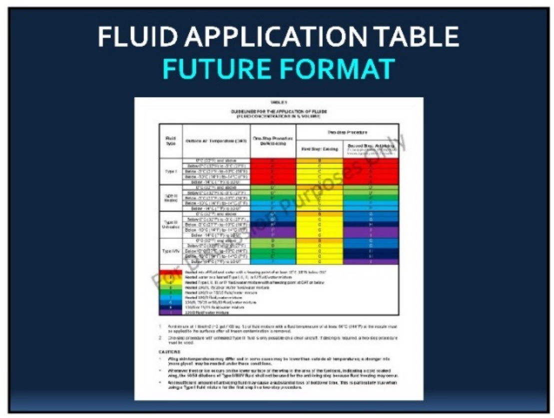

CHANGES TO TYPE II GENERIC HOTS
DRAFT
CAUTION: No holdover time guidelines exist
1. ABAX Ecowing AD-2: 3x5min ↓
2. Type IV Fluids: 1x10min ↑
3. Very Cold Snow: 2x1-2min ↓, 1x10min ↑, 2x6-7min ↓, 1x4 min ↓
4. Kilfrost ABC-3: 1x20min ↑, 1x 5min ↑ 1x10 min ↑, 7x5min ↑, 1x1min ↑

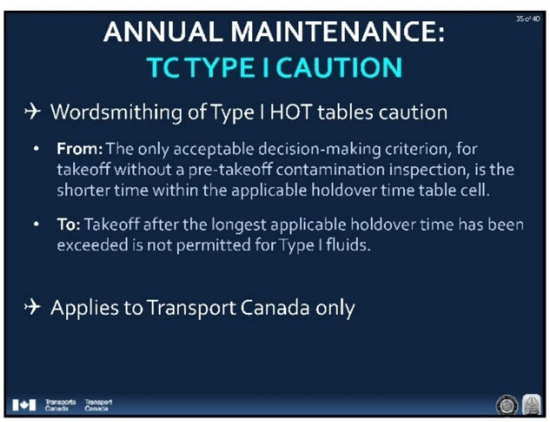

CHANGES TO TYPE IV GENERIC HOTS
DRAFT
CAUTION: No holdover time guidelines exist
1. ChemR EG IV: 1x10min ↓
2. Defrost ECO 4: 1x15min ↓
3. Heavy Snow: 2x5min ↓, 1x10 min ↑
4. Very Cold Snow: 2x10min ↓, 2x1min ↓, 2x4min ↓, 1x9min ↓, 1x6min ↓, 1x7min ↓

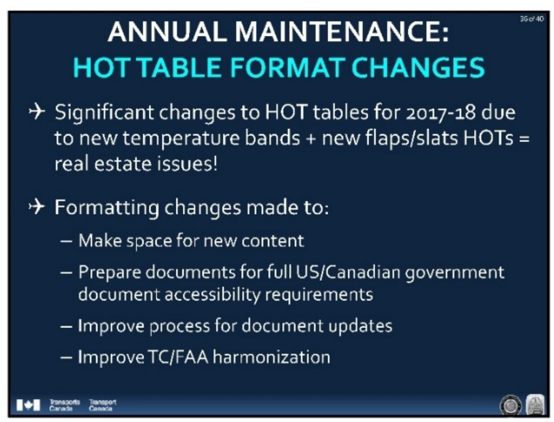

31 of 40
ANNUAL MAINTENANCE:
ALLOWANCE TIME TABLES
Changes to Type III + IV Allowance Time Tables
– Removed rows that are currently not usable
– Removed precipitation intensity designators from mixed condition second precipitation types
Changes due to METAR reporting standards which make these unusable
Changes to Allowance Time Text Guidance
– Text relocated from HOT Guidelines documents to operations guidance docs (TP14052/N8900)
Transports Canada Transport Canada

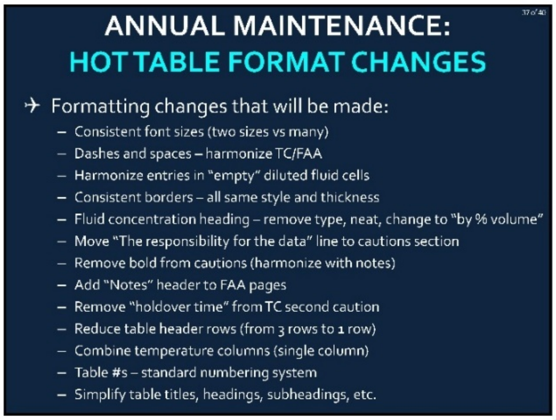

32 of 40
ALLOWANCE TIME TABLE ROWS
OLD 2016-17
Precipitation Type
-5°C and above
Light Ice Pellets 50 minutes
Light Ice Pellets Mixed with Light Snow 40 minutes
Light Ice Pellets Mixed with Moderate Snow 20 minutes
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle 25 minutes
Light Ice Pellets Mixed with Light Freezing Rain 25 minutes
Light Ice Pellets Mixed with Light Rain 25 minutes
Light Ice Pellets Mixed with Moderate Rain 25 minutes
Moderate Ice Pellets (or Small Hail) 25 minutes
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Freezing Drizzle 10 minutes
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Rain 10 minutes
NEW 2017-18
Precipitation Type
-5°C and above
Light Ice Pellets 50 minutes
Light Ice Pellets Mixed with Snow 40 minutes
Light Ice Pellets Mixed with Freezing Drizzle 25 minutes
Light Ice Pellets Mixed with Freezing Rain 25 minutes
Light Ice Pellets Mixed with Rain 25 minutes
Moderate Ice Pellets (or Small Hail) 25 minutes
Moderate Ice Pellets (or Small Hail) Mixed with Freezing Drizzle 10 minutes
Moderate Ice Pellets (or Small Hail) Mixed with Rain 10 minutes
Transports Canada Transport Canada

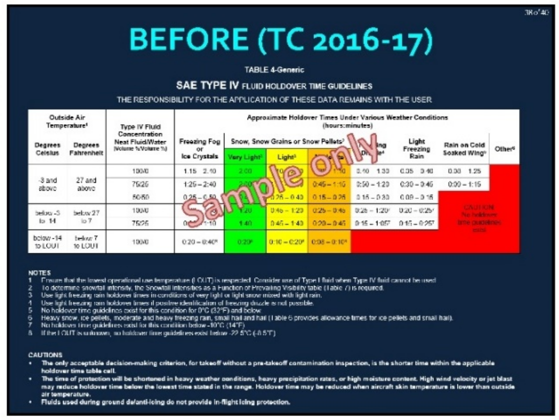

33 of 40
ANNUAL MAINTENANCE:
FLUID APPLICATION TABLES
Minor editorial changes for 2017-18 HOT guidelines
– FAA fluid application tables changed from landscape to portrait to harmonize with TC
– Specify "Heated or unheated" for second step anti-icing in both TC and FAA tables
– Updated first caution note to remove ambiguity concerning freezing point of Type I fluids
– Updated last caution note in FAA Type II/IV table to harmonize with TC
Future Change: Proposal to combine 4 tables into single table is still in discussion
– Changes anticipated for 2018-19 HOT Guidelines
Transports Canada Transport Canada

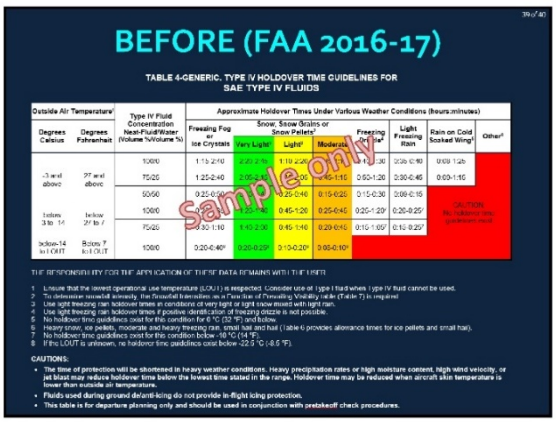

FLUID APPLICATION TABLE
FUTURE FORMAT
Transports Canada Transport Canada

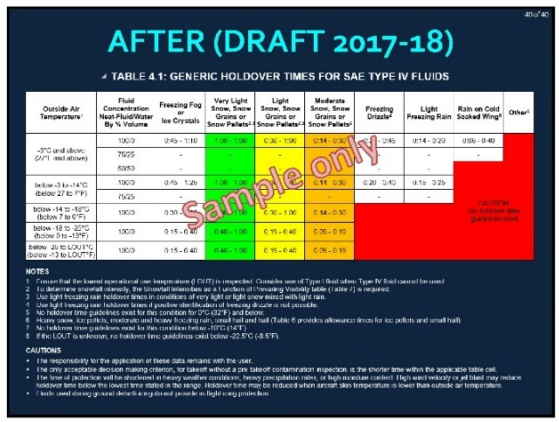

35 of 40
ANNUAL MAINTENANCE:
TC TYPE I CAUTION
Wordsmithing of Type I HOT tables caution
From: The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.
To: Takeoff after the longest applicable holdover time has been exceeded is not permitted for Type I fluids.
Applies to Transport Canada only
Transports Canada Transport Canada


36 of 40
ANNUAL MAINTENANCE:
HOT TABLE FORMAT CHANGES
Significant changes to HOT tables for 2017-18 due to new temperature bands + new flaps/slats HOTs = real estate issues!
Formatting changes made to:
– Make space for new content
– Prepare documents for full US/Canadian government document accessibility requirements
– Improve process for document updates
– Improve TC/FAA harmonization
Transports Canada Transport Canada


37 of 40
ANNUAL MAINTENANCE:
HOT TABLE FORMAT CHANGES
Formatting changes that will be made:
– Consistent font sizes (two sizes vs many)
– Dashes and spaces – harmonize TC/FAA
– Harmonize entries in "empty" diluted fluid cells
– Consistent borders – all same style and thickness
– Fluid concentration heading – remove type, neat, change to "by % volume"
– Move "The responsibility for the data" line to cautions section
– Remove bold from cautions (harmonize with notes)
– Add "Notes" header to FAA pages
– Remove "holdover time" from TC second caution
– Reduce table header rows (from 3 rows to 1 row)
– Combine temperature columns (single column)
– Table #s – standard numbering system
– Simplify table titles, headings, subheadings, etc.


BEFORE (TC 2016-17)
TABLE 4-Generic
SAE TYPE IV FLUID HOLDOVER TIME GUIDELINES
THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER
Sample only
NOTES
CAUTIONS


BEFORE (FAA 2016-17)
TABLE 4-GENERIC. TYPE IV HOLDOVER TIME GUIDELINES FOR
SAE TYPE IV FLUIDS
Sample only
CAUTIONS:


AFTER (DRAFT 2017-18)
TABLE 4.1: GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS
Sample only
NOTES
CAUTIONS


What
When
?
?
Who
ANY QUESTIONS?
How
?
?
Where
Why

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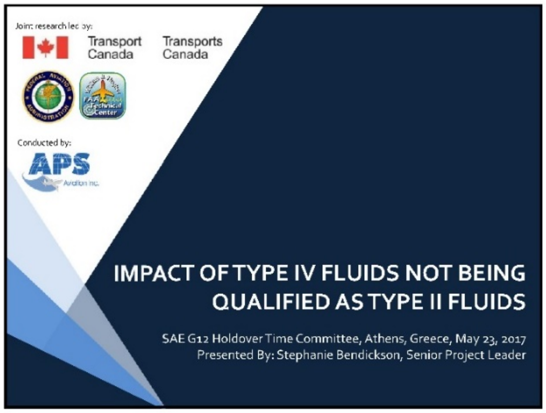
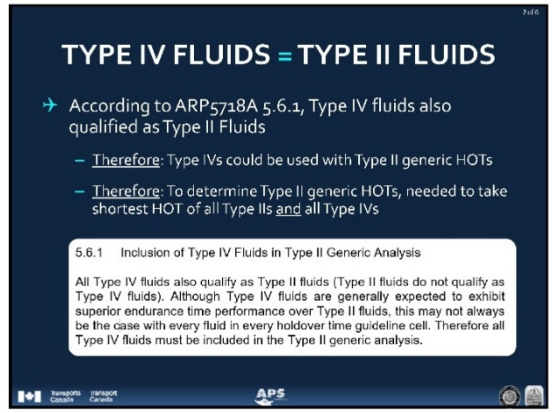
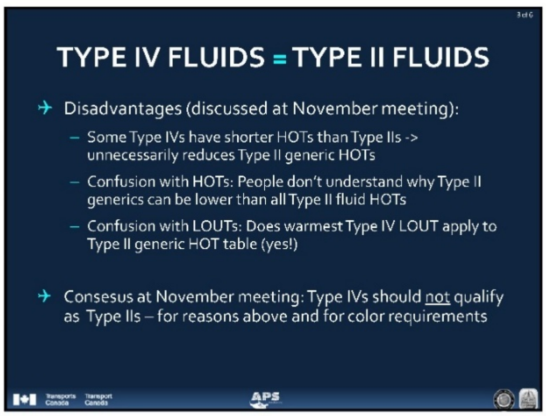
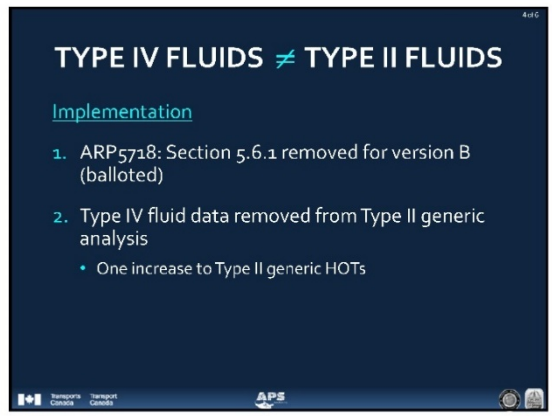
SAE G-12 HOLDOVER TIME COMMITTEE, ATHENS, GREECE

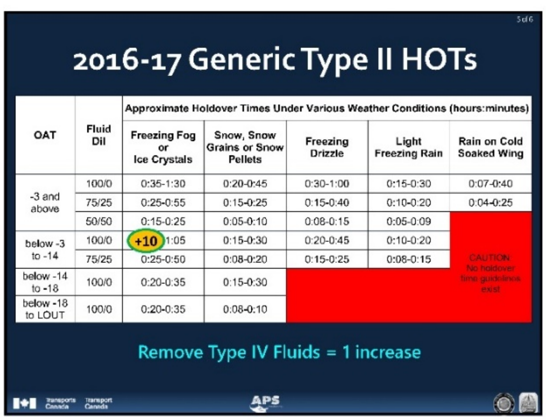
PRESENTATION:
IMPACT OF TYPE IV FLUIDS NOT BEING QUALIFIED AS TYPE II FLUIDS



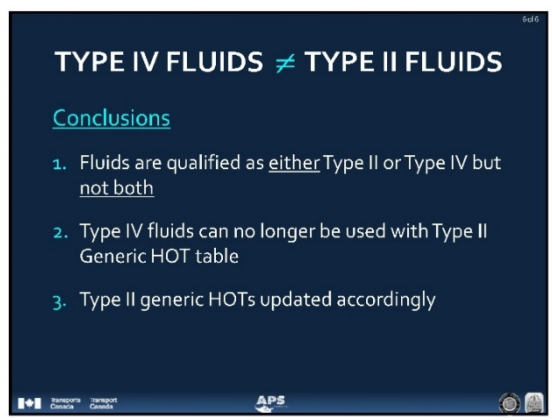








OAT	Fluid Dil	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)				
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
-3 and above	100/0	0:35-1:30	0:20-0:45	0:30-1:00	0:15-0:30	0:07-0:40
	75/25	0:25-0:55	0:15-0:25	0:15-0:40	0:10-0:20	0:04-0:25
	50/50	0:15-0:25	0:05-0:10	0:08-0:15	0:05-0:09	CAUTION No holdover time guidelines exist
below -3 to -14	100/0	+10 1:05	0:15-0:30	0:20-0:45	0:10-0:20	
	75/25	0:25-0:50	0:08-0:20	0:15-0:25	0:08-0:15	
below -14 to -18	100/0	0:20-0:35	0:15-0:30			
below -18 to LOUT	100/0	0:20-0:35	0:08-0:10			



SAE G-12 HOLDOVER TIME COMMITTEE, ATHENS, GREECE

PRESENTATION:
HOLDOVER TIMES FOR VERY COLD SNOW

Joint research led by: Transport Canada / Transports Canada

Conducted by: APS Aviation Inc.

HOLDOVER TIMES FOR VERY COLD SNOW

SAE G12 Holdover Time Committee, Athens, Greece, May 23, 2017
Presented By: Stephanie Bendickson, Senior Project Leader

Outline

- Background + Objective
- Data Collection
- Data Analysis Methodology
- Data for Participating Fluids
- Comparison to Type II/IV Generic HOTs
- Recommendations
  - Participating Fluids
  - Non-participating Fluids
- Future Work

Background

- Prior to 2016-17, HOTs for Type II/IV fluids < -14°C in snow were generic
  - Based on artificial snow data collected with limited fluids
  - Due to infrequency of natural snow occurrence in YUL
- Natural snow testing in 2014-15 + 2015-16 indicated these HOTs not appropriate -> reductions put in place
- Industry subsequently requested further research to collect sufficient data to provide fluid-specific HOTs

Objective

- Project Objective: Conduct research to provide fluid-specific HOTs for select fluids in snow below -14°C
  - obtain / confirm LOWV samples
  - collect data in natural and artificial snow
  - determine appropriate data analysis methdology
  - analyze data
- Fluid participation in project optional
- Project funded primarily by fluid manufacturers and in part by Transport Canada and FAA

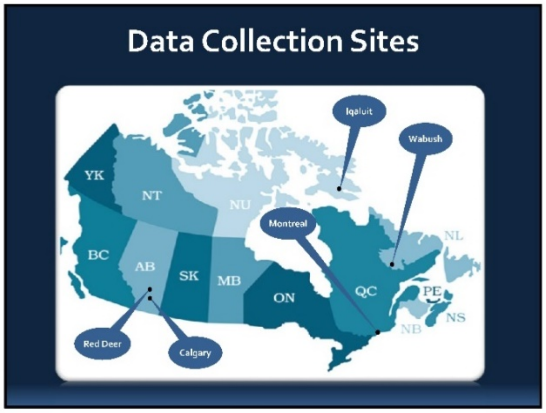
Participating Fluids

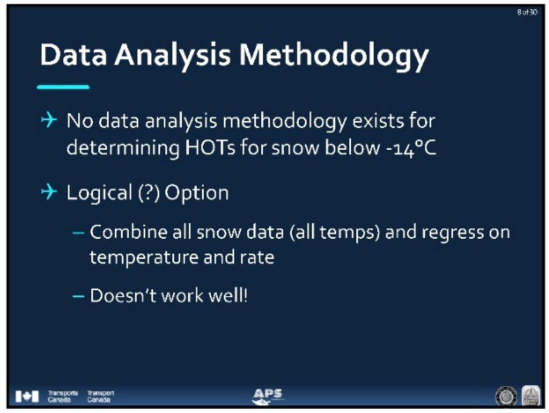
- Type II/IV
  1. Clariant Safewing MP II FLIGHT
  2. Clariant Safewing MP IV LAUNCH
  3. Clariant Safewing MP IV LAUNCH PLUS
  4. Cryotech Polar Guard Advance (also PG II)
  5. Dow Endurance EG106
  6. LNT Solutions E450
- Type III
  7. AllClear AeroClear MAX

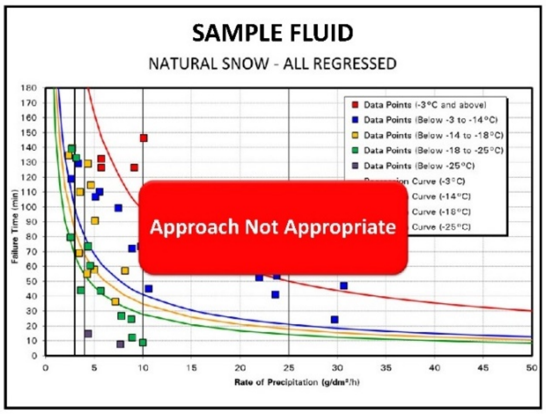
Data Collection

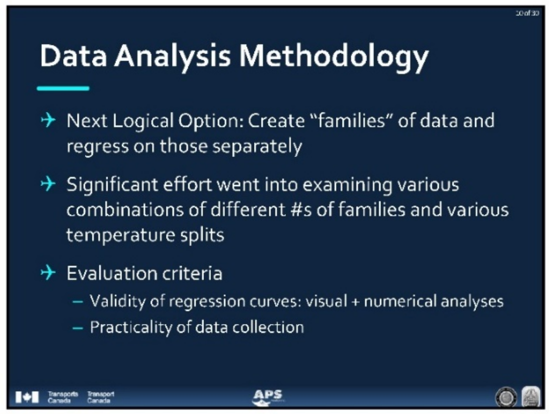
- 8 collection events at 5 test sites
- Temperatures = -14°C to -26°C
- Precipitation Rates = 2 to 14 g/dm²/h

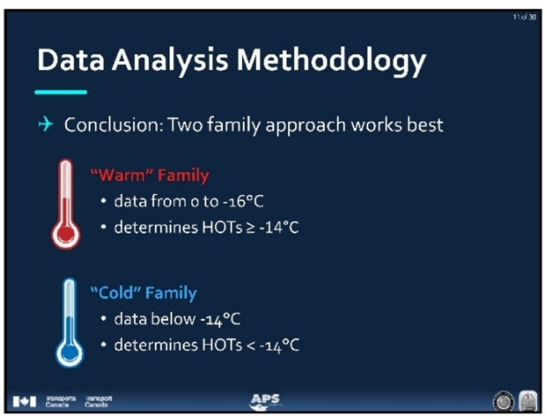
All Fluids		Rate (g/dm²/h)			
		VLS (0-4)	Light Snow (>4-10)	Moderate Snow (>10-25)	Heavy Snow (>25)
Temp (°C)	Below -14 to -18	27	51	0	0
	Below -18 to -21	22	20	0	0
	Below -21	7	34	5	0

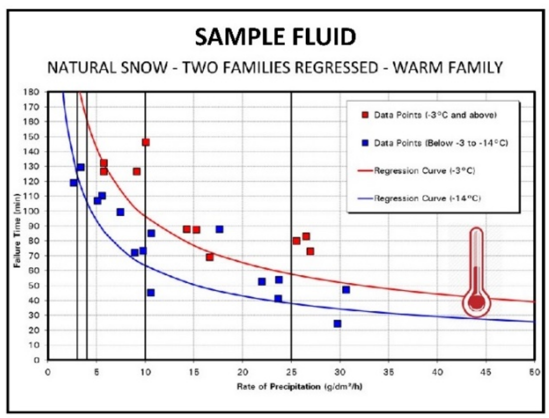

Data Collection Sites
Iqaluit
Wabush
Montreal
Red Deer
Calgary
YK
NT
NU
BC
AB
SK
MB
ON
QC
NL
PE
NS
NB

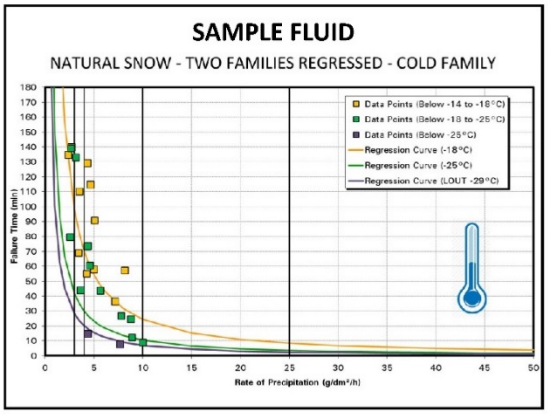

Data Analysis Methodology
No data analysis methodology exists for determining HOTs for snow below -14°C
Logical (?) Option
– Combine all snow data (all temps) and regress on temperature and rate
– Doesn't work well!
APS

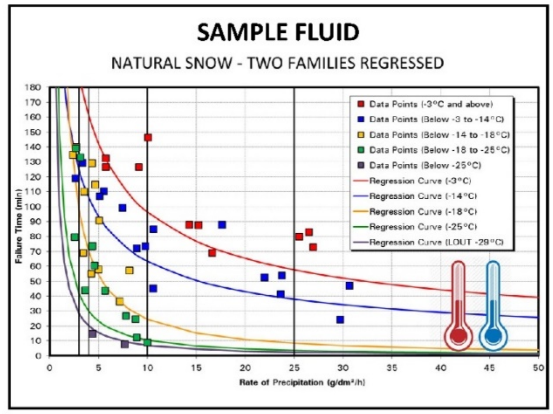

SAMPLE FLUID
NATURAL SNOW - ALL REGRESSED
Data Points (-3°C and above)
Data Points (Below -3 to -14°C)
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Approach Not Appropriate
Failure Time (min)
Rate of Precipitation (g/dm²/h)

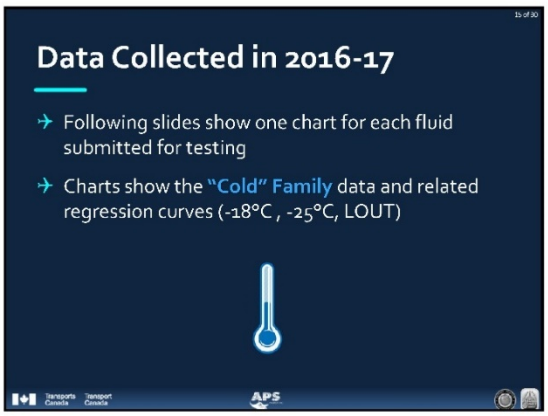

Data Analysis Methodology
Next Logical Option: Create "families" of data and regress on those separately
Significant effort went into examining various combinations of different #s of families and various temperature splits
Evaluation criteria
– Validity of regression curves: visual + numerical analyses
– Practicality of data collection
APS

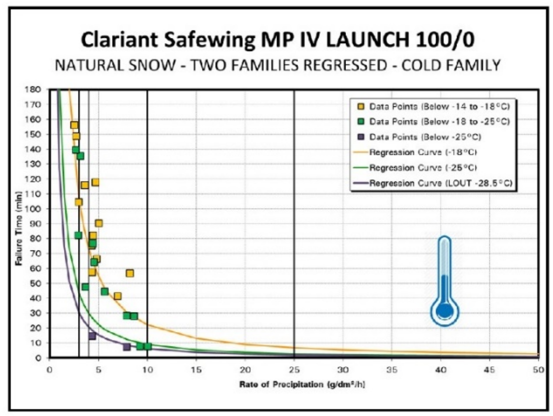

Data Analysis Methodology
Conclusion: Two family approach works best
"Warm" Family
• data from 0 to -16°C
• determines HOTs ≥ -14°C
"Cold" Family
• data below -14°C
• determines HOTs < -14°C
APS

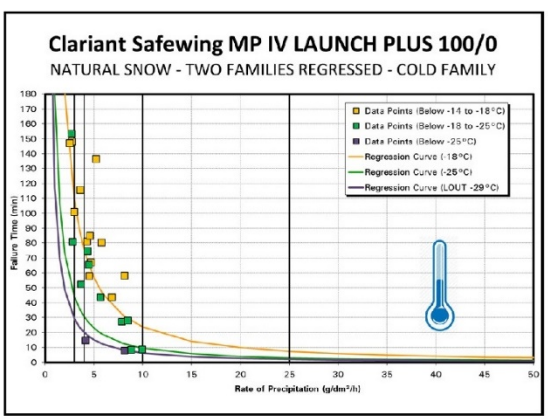

SAMPLE FLUID
NATURAL SNOW - TWO FAMILIES REGRESSED - WARM FAMILY
Data Points (-3°C and above)
Data Points (Below -3 to -14°C)
Regression Curve (-3°C)
Regression Curve (-14°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

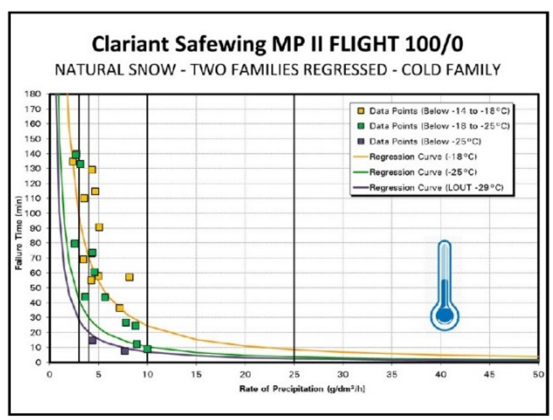

SAMPLE FLUID
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -29°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

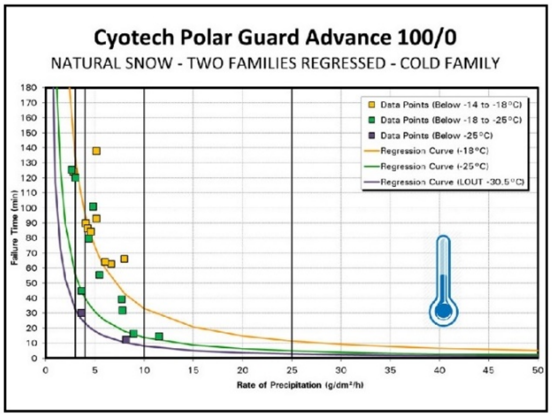

SAMPLE FLUID
NATURAL SNOW - TWO FAMILIES REGRESSED
Data Points (-3°C and above)
Data Points (Below -3 to -14°C)
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-3°C)
Regression Curve (-14°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -29°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

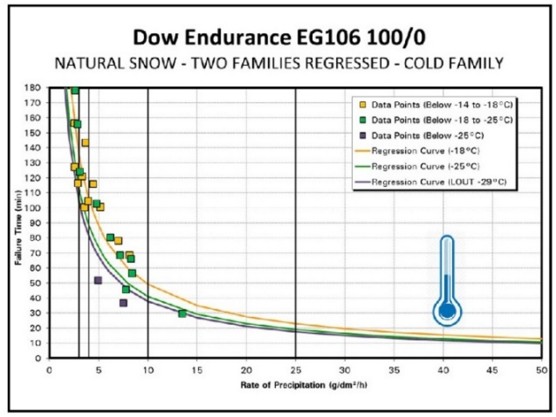

15 of 30
Data Collected in 2016-17
Following slides show one chart for each fluid submitted for testing
Charts show the "Cold" Family data and related regression curves (-18°C , -25°C, LOUT)
APS

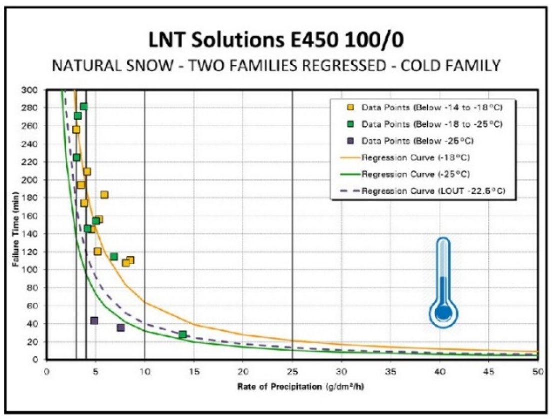

Clariant Safewing MP IV LAUNCH 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -28.5°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

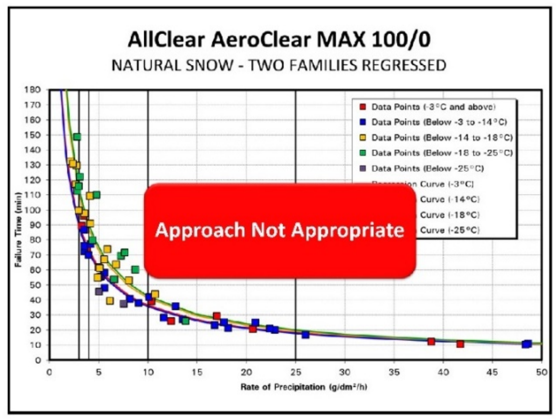

Clariant Safewing MP IV LAUNCH PLUS 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -29°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

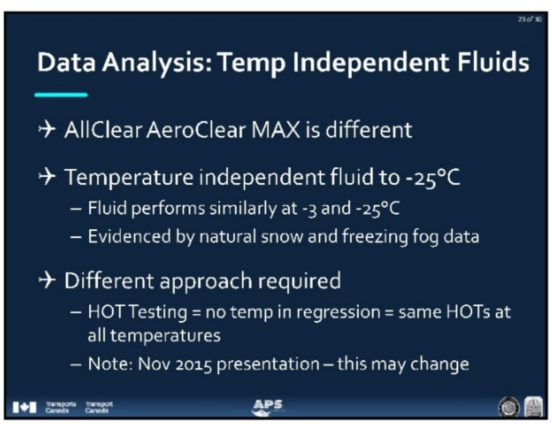

Clariant Safewing MP II FLIGHT 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -29°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

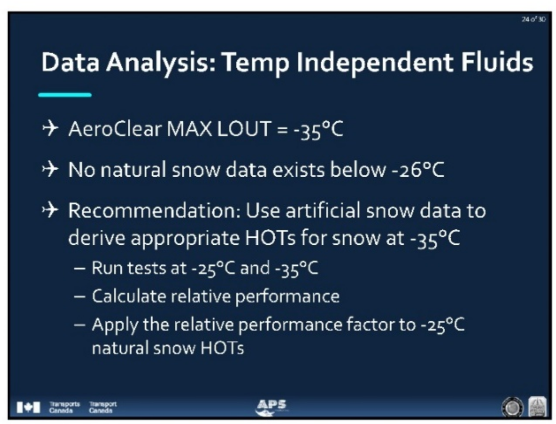

Cyotech Polar Guard Advance 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -30.5°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

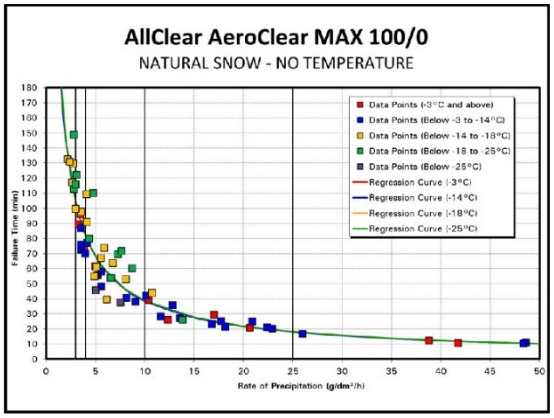

Dow Endurance EG106 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -29°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

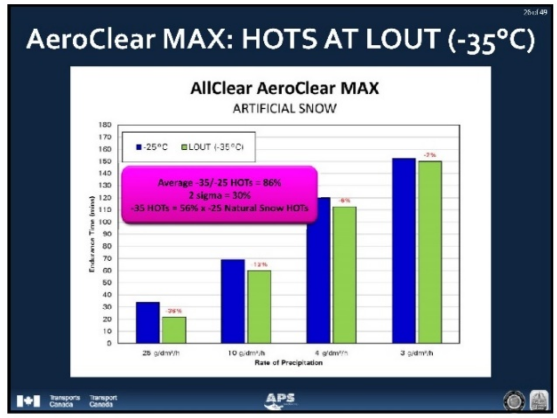

LNT Solutions E450 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED - COLD FAMILY
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Regression Curve (-18°C)
Regression Curve (-25°C)
Regression Curve (LOUT -22.5°C)
Failure Time (min)
Rate of Precipitation (g/dm²/h)

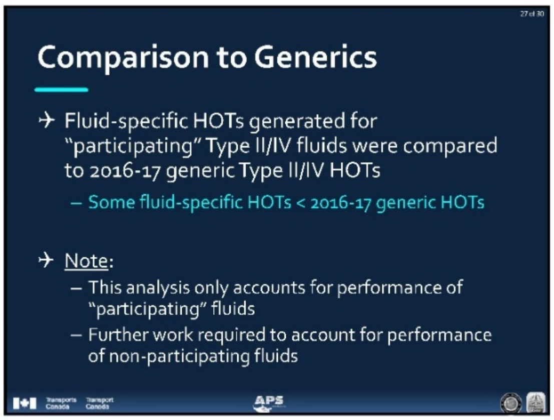

AllClear AeroClear MAX 100/0
NATURAL SNOW - TWO FAMILIES REGRESSED
Data Points (-3°C and above)
Data Points (Below -3 to -14°C)
Data Points (Below -14 to -18°C)
Data Points (Below -18 to -25°C)
Data Points (Below -25°C)
Approach Not Appropriate
Failure Time (min)
Rate of Precipitation (g/dm²/h)

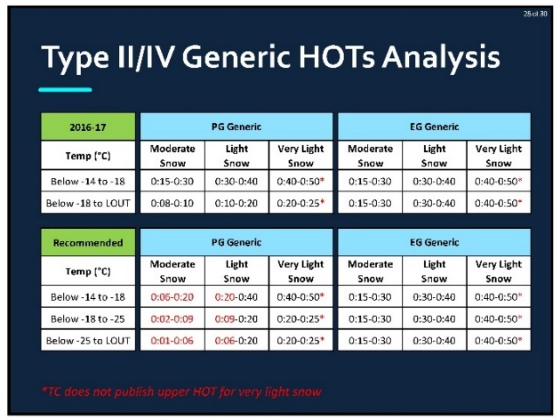

Data Analysis: Temp Independent Fluids
AllClear AeroClear MAX is different
Temperature independent fluid to -25°C
– Fluid performs similarly at -3 and -25°C
– Evidenced by natural snow and freezing fog data
Different approach required
– HOT Testing = no temp in regression = same HOTs at all temperatures
– Note: Nov 2015 presentation – this may change
APS


Data Analysis: Temp Independent Fluids
AeroClear MAX LOUT = -35°C
No natural snow data exists below -26°C
Recommendation: Use artificial snow data to derive appropriate HOTs for snow at -35°C
– Run tests at -25°C and -35°C
– Calculate relative performance
– Apply the relative performance factor to -25°C natural snow HOTs
APS



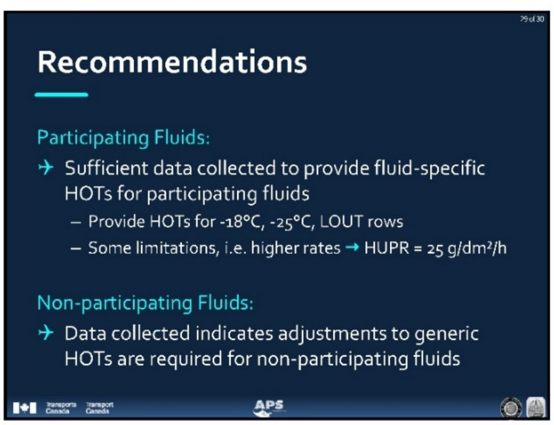


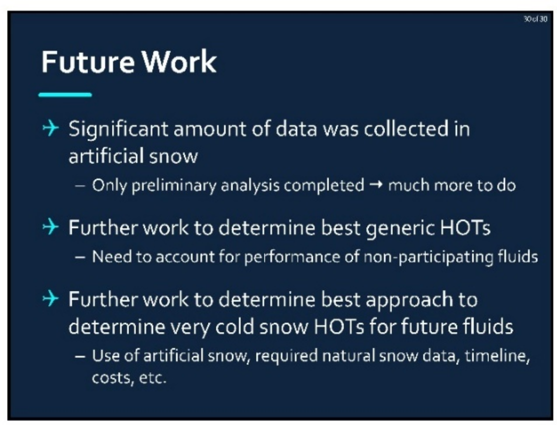




2016-17	PG Generic			EG Generic		
Temp (°C)	Moderate Snow	Light Snow	Very Light Snow	Moderate Snow	Light Snow	Very Light Snow
Below -14 to -18	0:15-0:30	0:30-0:40	0:40-0:50*	0:15-0:30	0:30-0:40	0:40-0:50*
Below -18 to LOUT	0:08-0:10	0:10-0:20	0:20-0:25*	0:15-0:30	0:30-0:40	0:40-0:50*

Recommended	PG Generic			EG Generic		
Temp (°C)	Moderate Snow	Light Snow	Very Light Snow	Moderate Snow	Light Snow	Very Light Snow
Below -14 to -18	0:06-0:20	0:20-0:40	0:40-0:50*	0:15-0:30	0:30-0:40	0:40-0:50*
Below -18 to -25	0:02-0:09	0:09-0:20	0:20-0:25*	0:15-0:30	0:30-0:40	0:40-0:50*
Below -25 to LOUT	0:01-0:06	0:06-0:20	0:20-0:25*	0:15-0:30	0:30-0:40	0:40-0:50*





A4A GROUND DEICING FORUM, WASHINGTON, USA

PRESENTATION:
CHANGES TO HOT GUIDELINES FOR WINTER 2017-18

CHANGES TO HOT GUIDELINES FOR WINTER 2017-18

Presented By: Stephanie Bendickson
on behalf of
Yvan Chabot and Chuck Enders

A4A Ground Deicing Forum, Washington, DC, – June 6, 2017

Transport Canada Transports Canada

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OBJECTIVE / OUTLINE

- Objective:

  Present changes FAA/TC will be be making to HOT Guidance for 2017-18

- Changes are Resulting From:

  1. 2016-17 Endurance Time Testing Program
  2. Very Cold Snow R&D
  3. Heavy Snow / HUPR R&D
  4. Flaps / Slats R&D (separate presentation)
  5. Annual HOT Guidelines Maintenance

Transports Canada Transport Canada

! CAUTION !

HOTs provided in this presentation are preliminary and subject to change – final data verification is required

HOTs are not official until published in the TC/FAA HOT Guidelines documents in Summer 2017

Changes resulting from…

2016-17 ENDURANCE TIME TESTING PROGRAM

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2016-17 ET Testing Program

- Five fluids tested
- Three new fluids added to HOT Guidelines
  1. ABAX Ecowing AD-2 (Type II)
  2. CHEMCO ChemR EG IV (Type IV)
  3. Oksayd Defrost ECO 4 (Type IV)
- Revisions will be made to the HOTs of one fluid already in the HOT Guidelines
  1. AllClear AeroClear MAX (Type III)

Transports Canada Transport Canada

FLUID-SPECIFIC HOT TABLE
ABAX ECOWING AD-2

DRAFT

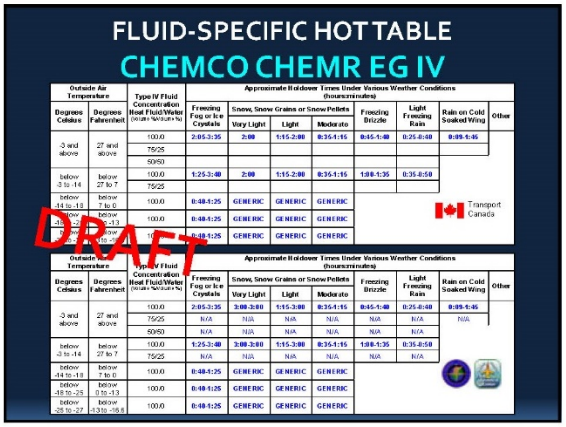
Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:20-3:00	2:00	1:15-2:00	0:40-1:15	0:40-1:40	0:30-0:45	0:09-1:25	
		75/25	1:15-1:25	1:45	0:55-1:45	0:25-0:55	0:35-1:05	0:20-0:30	0:04-0:50	
		50/50	0:15-0:30	0:35	0:15-0:35	0:07-0:15	0:09-0:15	0:06-0:09		
below -3 to -14	below 27 to 7	100/0	0:45-2:30	1:45	0:55-1:45	0:30-0:55	0:25-1:10	0:20-0:30		
		75/25	0:35-1:55	1:35	0:50-1:35	0:25-0:50	0:15-0:55	0:20-0:35		
below -14 to -18	below 7 to 0	100/0	0:15-0:40	GENERIC	GENERIC	GENERIC				
[illegible]	[illegible]	100/0	0:15-0:40	GENERIC	GENERIC	GENERIC				
[illegible]	[illegible]	[illegible]	[illegible]	GENERIC	GENERIC	GENERIC				

Approximate Holdover Times Under Various Weather Conditions (hours:minutes)

Transport Canada

Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:20-3:00	2:25-2:55	1:15-2:25	0:40-1:15	0:40-1:40	0:30-0:45	0:09-1:25	
		75/25	1:15-1:25	1:45-2:10	0:55-1:45	0:25-0:55	0:35-1:05	0:20-0:30	0:04-0:50	
		50/50	0:15-0:30	0:35-0:40	0:15-0:35	0:07-0:15	0:09-0:15	0:06-0:09		
below -3 to -14	below 27 to 7	100/0	0:45-2:30	1:45-2:05	0:55-1:45	0:30-0:55	0:25-1:10	0:20-0:30		
		75/25	0:35-1:55	1:35-2:00	0:50-1:35	0:25-0:50	0:15-0:55	0:20-0:35		
below -14 to -18	below 7 to 0	100/0	0:15-0:40	GENERIC	GENERIC	GENERIC				
below -18 to -25	below 0 to -13	100/0	0:15-0:40	GENERIC	GENERIC	GENERIC				
below -25 to -27	below -13 to -16.6	100/0	0:15-0:40	GENERIC	GENERIC	GENERIC				

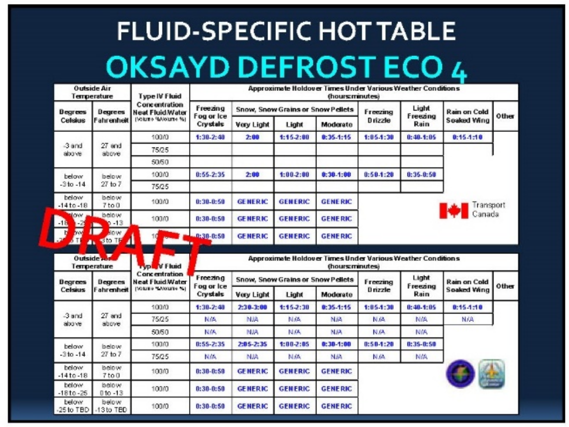
Approximate Holdover Times Under Various Weather Conditions (hours:minutes)



Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100.0	2:05-3:35	2:00	1:15-2:00	0:35-1:15	0:45-1:40	0:25-0:40	0:09-1:45	
		75/25								
		50/50								
below -3 to -14	below 27 to 7	100.0	1:25-3:40	2:00	1:15-2:00	0:35-1:15	1:00-1:35	0:35-0:50		
		75/25								
below -14 to -18	below 7 to 0	100.0	0:40-1:25	GENERIC	GENERIC	GENERIC				
[illegible]	below [illegible] -13	100.0	0:40-1:25	GENERIC	GENERIC	GENERIC				
[illegible]	[illegible]	[illegible]	0:40-1:25	GENERIC	GENERIC	GENERIC				

Approximate Holdover Times Under Various Weather Conditions (hours:minutes)

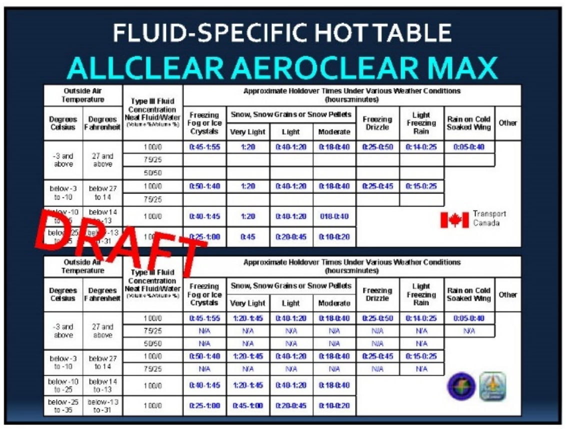
Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100.0	2:05-3:35	3:00-3:00	1:15-3:00	0:35-1:15	0:45-1:40	0:25-0:40	0:09-1:45	
		75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
		50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -14	below 27 to 7	100.0	1:25-3:40	3:00-3:00	1:15-3:00	0:35-1:15	1:00-1:35	0:35-0:50		
		75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	below 7 to 0	100.0	0:40-1:25	GENERIC	GENERIC	GENERIC				
below -18 to -25	below 0 to -13	100.0	0:40-1:25	GENERIC	GENERIC	GENERIC				
below -25 to -27	below -13 to -16.6	100.0	0:40-1:25	GENERIC	GENERIC	GENERIC				



Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:30-2:40	2:00	1:15-2:00	0:35-1:15	1:05-1:30	0:40-1:05	0:15-1:10	
		75/25								
		50/50								
below -3 to -14	below 27 to 7	100/0	0:55-2:35	2:00	1:00-2:00	0:30-1:00	0:50-1:20	0:35-0:50		
		75/25								
below -14 to -18	below 7 to 0	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
[illegible]	below [illegible] -13	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
[illegible]	[illegible]	[illegible]	0:30-0:50	GENERIC	GENERIC	GENERIC				

Approximate Holdover Times Under Various Weather Conditions (hours:minutes)

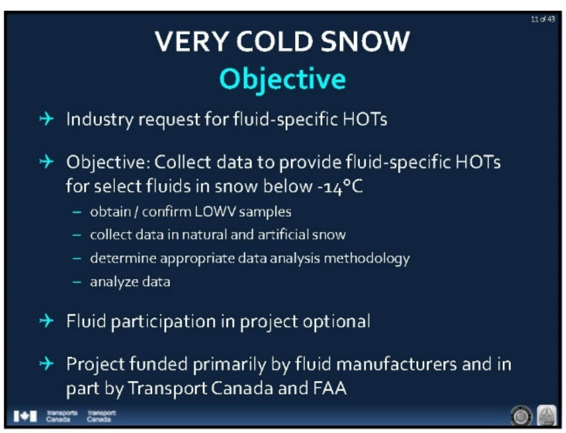
Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	1:30-2:40	2:30-3:00	1:15-2:30	0:35-1:15	1:05-1:30	0:40-1:05	0:15-1:10	
		75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
		50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -14	below 27 to 7	100/0	0:55-2:35	2:05-2:35	1:00-2:05	0:30-1:00	0:50-1:20	0:35-0:50		
		75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	below 7 to 0	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
below -18 to -25	below 0 to -13	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				
below -25 to TBD	below -13 to TBD	100/0	0:30-0:50	GENERIC	GENERIC	GENERIC				

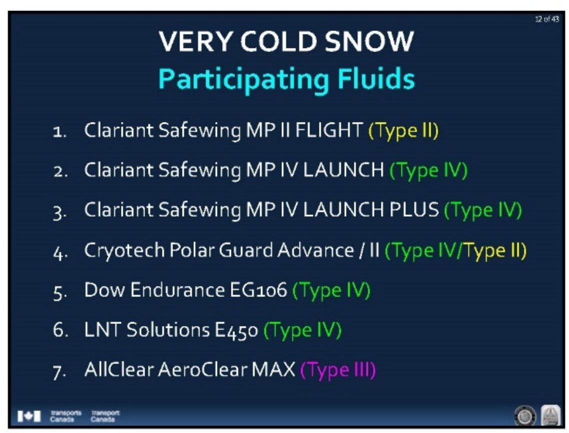


Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type III Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	0:45-1:55	1:20	0:40-1:20	0:18-0:40	0:25-0:50	0:14-0:25	0:05-0:40	
		75/25								
		50/50								
below -3 to -10	below 27 to 14	100/0	0:50-1:40	1:20	0:40-1:20	0:18-0:40	0:25-0:45	0:15-0:25		
		75/25								
[illegible]	below 14 [illegible] -13	100/0	0:40-1:45	1:20	0:40-1:20	018-0:40				
[illegible]	[illegible] -13 [illegible] -31	[illegible]	0:25-1:00	0:45	0:20-0:45	0:10-0:20				

Approximate Holdover Times Under Various Weather Conditions (hours:minutes)

Outside Air Temperature: Degrees Celsius	Outside Air Temperature: Degrees Fahrenheit	Type III Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	0:45-1:55	1:20-1:45	0:40-1:20	0:18-0:40	0:25-0:50	0:14-0:25	0:05-0:40	
		75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
		50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -10	below 27 to 14	100/0	0:50-1:40	1:20-1:45	0:40-1:20	0:18-0:40	0:25-0:45	0:15-0:25		
		75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -25	below 14 to -13	100/0	0:40-1:45	1:20-1:45	0:40-1:20	0:18-0:40				
below -25 to -35	below -13 to -31	100/0	0:25-1:00	0:45-1:00	0:20-0:45	0:10-0:20				





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VERY COLD SNOW
Data Collection

- 8 collection events at 5 test sites
- Temperatures = -14°C to -26°C
- Precipitation Rates = 2 to 14 g/dm²/h

All Fluids		Rate (g/dm²/h)			
		VLS (0-4)	Light Snow (>4-10)	Moderate Snow (>10-25)	Heavy Snow (>25)
Temp (°C)	Below -14 to -18	27	51	0	0
	Below -18 to -21	22	20	0	0
	Below -21	7	34	5	0

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Data Collection Sites

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VERY COLD SNOW
Impact on HOT Guidelines

- "Below -14 to LOUT" row in all Type II/IV HOT tables divided into three new rows
  - Below -14 to -18°C
  - Below -18 to -25°C
  - Below -25 to LOUT
- New cells populated with…
  - Freezing Fog: "Below -14 to LOUT" HOTs
  - Snow "Participating" Fluids: fluid-specific HOTs
  - Snow "Non-participating" Fluids: generic HOTs (some ↓s)

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VERY COLD SNOW
Type II/IV Fluid-Specific HOTS

Temp (°C)	Clariant Safewing MP II FLIGHT			Clariant Safewing MP IV LAUNCH			Clariant Safewing MP IV LAUNCH PLUS		
	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow
Below -14 to -18	1:10-1:40*	0:25-1:10	0:08-0:25	1:15-1:45*	0:20-1:15	0:06-0:20	1:15-1:50*	0:25-1:15	0:07-0:25
Below -18 to -25	0:30-0:40*	0:10-0:30	0:03-0:10	0:30-0:45*	0:09-0:30	0:02-0:09	0:30-0:45*	0:09-0:30	0:03-0:09
Below -25 to LOUT	0:20-0:30*	0:07-0:20	0:02-0:07	0:20-0:30*	0:06-0:20	0:01-0:06	0:20-0:30*	0:06-0:20	0:02-0:06

Temp (°C)	Cryotech Polar Guard Advance/II			Dow Chemical Endurance EG106			LNT Solutions E450		
	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow
Below -14 to -18	1:35-2:15*	0:35-1:35	0:10-0:35	1:45-2:15*	0:50-1:45	0:25-0:50	3:00-3:00*	1:05-3:00*	0:20-1:05
Below -18 to -25	0:40-0:55*	0:15-0:40	0:04-0:15	1:30-1:55*	0:40-1:30	0:20-0:40	2:00-2:50*	0:40-2:00*	0:15-0:40
Below -25 to LOUT	0:25-0:35*	0:08-0:25	0:02-0:08	1:20-1:45*	0:40-1:20	0:20-0:40	below LOUT	below LOUT	below LOUT

Transport Canada will cap HOTs at 2 hours and include single HOT value in very light snow cells.

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VERY COLD SNOW
Type II/IV Generic HOTS

Temp (°C)	Type II Generic	Type IV PG Generic			Type IV EG Generic		
	Snow	Very Light Snow	Light Snow	Moderate Snow	Very Light Snow	Light Snow	Moderate Snow
Below -14 to -18	0:06-0:20	0:40-0:50*	0:20-0:40	0:06-0:20	0:40-0:50*	0:30-0:40	0:15-0:30
Below -18 to -25	0:02-0:09	0:20-0:25*	0:09-0:20	0:02-0:09	0:40-0:50*	0:30-0:40	0:15-0:30
Below -25 to LOUT	0:01-0:06	0:20-0:25*	0:06-0:20	0:01-0:06	0:40-0:50*	0:30-0:40	0:15-0:30

Transport Canada will include single HOT value in very light snow cells

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VERY COLD SNOW
Type III Fluid-Specific HOTS

Temp (°C)	AllClear AeroClear MAX		
	Very Light Snow	Light Snow	Moderate Snow
Below -10 to -25	1:20-1:45*	0:40-1:20	0:18-0:40
Below -25 to -35	0:45-1:00*	0:20-0:45	0:10-0:20

Transport Canada will include single HOT value in very light snow cells

Changes resulting from…

R&D PROGRAM: HEAVY SNOW & HUPRS (HIGHEST USABLE PRECIPITATION RATES)

HEAVY SNOW/HUPR R&D
Objective

- Background: Natural snow regression curves used by LWE based systems to generate HOTs at higher precipitation rates
- Project Objective: Conduct research to ensure curves are appropriate for providing HOTs at heavy snow precipitation rates and, if not, provide revised curves and/or HUPR* limitations

* HUPR = Highest Usable Precipitation Rate

HEAVY SNOW/HUPR R&D
Background

- 2014-15
  - Analysis of original data sets
  - Determination of appropriate upper limit (50 $g/dm^2/h$)
  - Determination of corresponding visibilities
- 2015-16
  - Fluid manufacturers requested to send samples
  - Additional data collected with new samples
  - Analysis methodology for HUPR determination
- 2016-17
  - Additional data collection
  - Final refinements to analysis methodology (HUPR+LUPR)

HEAVY SNOW/HUPR R&D
Impact on HOT Guidelines

- Changes to regression information docs
  - Minor modifications to table of LUPRs
  - Addition of table of HUPRs for Type II/III/IV fluids
- Changes to snow HOTs for select fluids:
  - Cryotech Polar Guard Advance (100/0, 75/25, 50/50)
  - Cryotech Polar Guard II (100/0, 75/25, 50/50)
  - ABAX Ecowing AD-49 (100/0, 75/25)
  - Dow FlightGuard AD-49 (100/0, 75/25)
  - ABAX Ecowing 26 (75/25, 50/50)
  - Clariant Max Flight SNEG (100/0)

HEAVY SNOW/HUPR
CHANGES TO HOTS

		ABAX Ecowing 26			ABAX Ecowing AD-49 / DOW UCAR FlightGuard AD-49		
Temp (°C)	Dil.	Moderate Snow	Light Snow	Very Light Snow	Moderate Snow	Light Snow	Very Light Snow
-3°C and above	100/0	0:40-1:00	1:00-1:35	1:35-1:50	1:00-1:55	1:55-3:00	3:00-3:00
	75/25	0:20-0:40	0:40-1:20	1:20-1:40	0:45-1:35	1:35-3:00	3:00-3:00
	50/50	0:07-0:20	0:20-0:40	0:40-0:50	0:15-0:25	0:25-0:40	0:40-0:45
Below -3 to -14°C	100/0	0:35-0:55	0:55-1:25	1:25-1:40	0:40-1:15	1:15-2:25	2:25-3:00
	75/25	0:15-0:30	0:30-0:55	0:55-1:10	0:30-1:05	1:05-2:20	2:20-2:55

		Cryotech Polar Guard Advance / Cryotech Polar Guard II			Clariant Max Flight SNEG		
Temp (°C)	Dil.	Moderate Snow	Light Snow	Very Light Snow	Moderate Snow	Light Snow	Very Light Snow
-3°C and above	100/0	1:05-1:55	1:55-3:00	3:00-3:00	0:55-1:40	1:40-3:00	3:00-3:00
	75/25	0:40-1:25	1:25-3:00	3:00-3:00	0:55-1:30	1:30-2:25	2:25-2:50
	50/50	0:10-0:25	0:25-1:10	1:10-1:35	0:20-0:45	0:45-1:45	1:45-2:20
Below -3 to -14°C	100/0	0:40-1:10	1:10-2:00	2:00-2:20	0:40-1:10	1:10-2:05	2:05-2:30
	75/25	0:25-0:55	0:55-2:00	2:00-2:30	0:40-1:00	1:00-1:40	1:40-2:00

Note: TC HOTs will be capped at 2 hours, TC Very Light column will contain single value (lower HOT shown above)

Table of LUPRs (Type II + III)

Type II De/Anti-Icing Fluids

FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX Ecowing 26	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
ABAX Ecowing AD-2	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
Aviation Shaanxi Hi-Tech Cleanwing II	3 $g/dm^2/h$	10 $g/dm^2/h$	4 $g/dm^2/h$	7 $g/dm^2/h$
Beijing Yadilite Aviation YD-102 Type II	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
Clariant Safewing MP II FLIGHT	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
Clariant Safewing MP II FLIGHT PLUS	4 $g/dm^2/h$	10 $g/dm^2/h$	3 $g/dm^2/h$	4 $g/dm^2/h$
Cryotech Polar Guard® II	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
Kilfrost ABC-Ice Clear II	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
Kilfrost ABC-K Plus	3 $g/dm^2/h$	10 $g/dm^2/h$	4 $g/dm^2/h$	3 $g/dm^2/h$
Newave Aerochemical FCY-2	3 $g/dm^2/h$	10 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$
Newave Aerochemical FCY-2 Bio+	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$

Type III De/Anti-Icing Fluids

FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-25°C AND ABOVE*	*BELOW -25°C*	*-10°C AND ABOVE*	*-3°C AND ABOVE*
AllClear AeroClear MAX	3 $g/dm^2/h$	3 $g/dm^2/h$	not applicable	not applicable
Clariant Safewing MP III 2031 ECO	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$	3 $g/dm^2/h$

Table of LUPRs (Type IV)

Type IV De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing AD-49	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
CHEMCO ChemR EG IV	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Max Flight 04	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Max Flight AVIA	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Max Flight SNEG	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Clariant Safewing EG IV NORTH	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Clariant Safewing MP IV LAUNCH PLUS	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Cryotech Polar Guard® Advance	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Deicing Solutions ECO-SHIELD®	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Dow UCAR Endurance EG106	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
Kilfrost ABC-S Plus	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h
LNT Solutions E450	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Newave Aerochemical FCY 9311	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Oksayd Defrost ECO 4	3 g/dm^2/h	3 g/dm^2/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h	3 g/dm^2/h

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Table of HUPRs (Type II + III)

Type II De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing 26	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
ABAX Ecowing AD-2	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Aviation Shaanxi Hi-Tech Cleanwing II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Beijing Yadilite Aviation YD-102 Type II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Clariant Safewing MP II FLIGHT	40 g/dm^2/h	25 g/dm^2/h	40 g/dm^2/h	40 g/dm^2/h
Clariant Safewing MP II FLIGHT PLUS	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Cryotech Polar Guard® II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Kilfrost ABC-Ice Clear II	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Kilfrost ABC-K Plus	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Newave Aerochemical FCY-2	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Newave Aerochemical FCY-2 Bio+	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h

Type III De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-25°C and above***	***Below -25°C***	***-10°C and above***	***-3°C and above***
AllClear AeroClear MAX	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP III 2031 ECO	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h

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Table of HUPRs (Type IV)

Type IV De/Anti-Icing Fluids				
Fluid Dilution	**100/0**		**75/25**	**50/50**
Temperature	***-14°C and above***	***Below -14°C***	***-14°C and above***	***-3°C and above***
ABAX Ecowing AD-49	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
CHEMCO ChemR EG IV	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Max Flight 04	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Max Flight AVIA	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Max Flight SNEG	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Clariant Safewing EG IV NORTH	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Clariant Safewing MP IV LAUNCH PLUS	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Cryotech Polar Guard® Advance	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Deicing Solutions ECO-SHIELD®	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Dow UCAR Endurance EG106	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
Kilfrost ABC-S Plus	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h
LNT Solutions E450	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Newave Aerochemical FCY 9311	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Oksayd Defrost ECO 4	50 g/dm^2/h	25 g/dm^2/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	50 g/dm^2/h	25 g/dm^2/h	50 g/dm^2/h	50 g/dm^2/h

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Changes resulting from…

FLAPS AND SLATS R&D

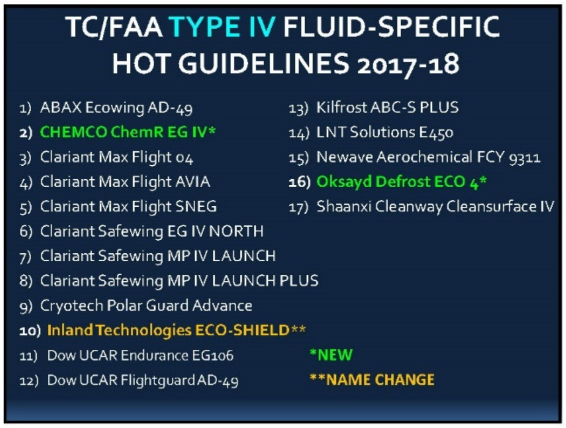
Changes resulting from…

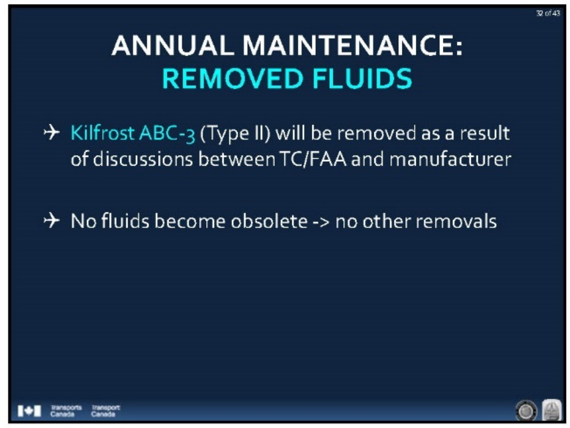
2017-18 ANNUAL HOT GUIDELINES MAINTENANCE

TC/FAA TYPE II FLUID-SPECIFIC HOT GUIDELINES 2017-18

1) ABAX Ecowing 26
2) **ABAX Ecowing AD-2***
3) Aviation Shaanxi Cleanwing II
4) Beijing Yadilite YD-102
5) Clariant Safewing MP II FLIGHT
6) Clariant Safewing MP II FLIGHT PLUS
7) Cryotech Polar Guard II
8) Kilfrost ABC-K PLUS
9) Kilfrost ABC-Ice Clear II
10) LNT Solutions P250
11) Newave Aerochemical FCY-2
12) Newave Aerochemical FCY-2 Bio+

*NEW


TC/FAA TYPE IV FLUID-SPECIFIC HOT GUIDELINES 2017-18
1) ABAX Ecowing AD-49
2) CHEMCO ChemR EG IV*
3) Clariant Max Flight 04
4) Clariant Max Flight AVIA
5) Clariant Max Flight SNEG
6) Clariant Safewing EG IV NORTH
7) Clariant Safewing MP IV LAUNCH
8) Clariant Safewing MP IV LAUNCH PLUS
9) Cryotech Polar Guard Advance
10) Inland Technologies ECO-SHIELD**
11) Dow UCAR Endurance EG106
12) Dow UCAR Flightguard AD-49
13) Kilfrost ABC-S PLUS
14) LNT Solutions E450
15) Newave Aerochemical FCY 9311
16) Oksayd Defrost ECO 4*
17) Shaanxi Cleanway Cleansurface IV
*NEW
**NAME CHANGE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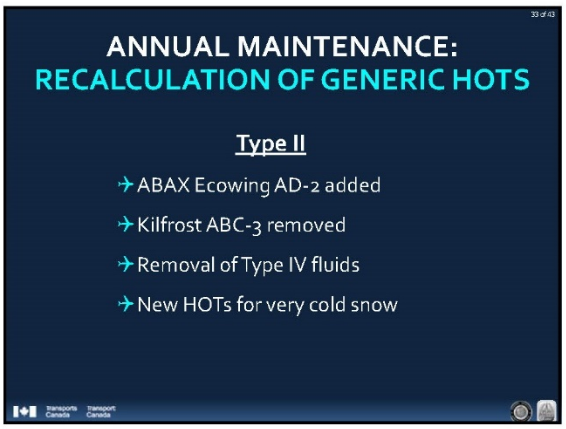
ANNUAL MAINTENANCE: REMOVED FLUIDS
Kilfrost ABC-3 (Type II) will be removed as a result of discussions between TC/FAA and manufacturer
No fluids become obsolete -> no other removals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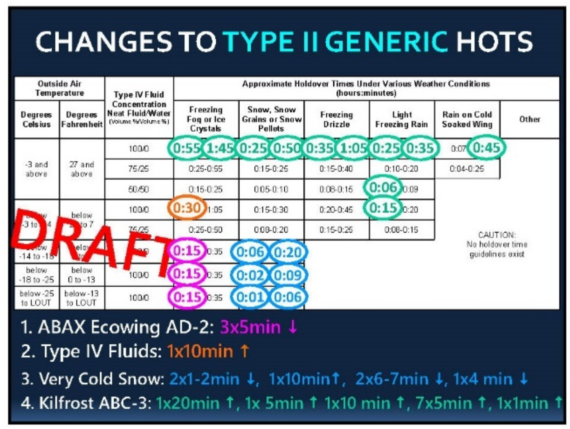
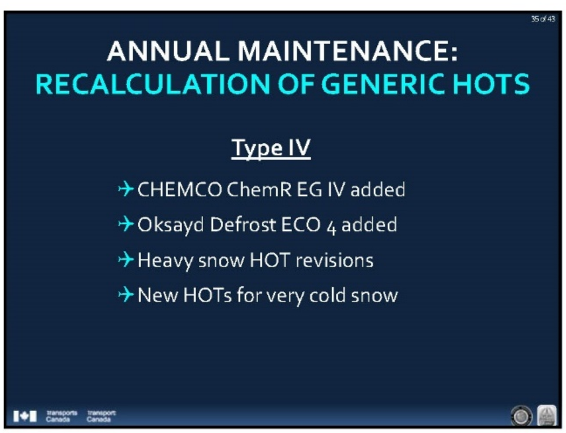
ANNUAL MAINTENANCE: RECALCULATION OF GENERIC HOTS
Type II
ABAX Ecowing AD-2 added
Kilfrost ABC-3 removed
Removal of Type IV fluids
New HOTs for very cold snow


CHANGES TO TYPE II GENERIC HOTS
DRAFT
1. ABAX Ecowing AD-2: 3x5min ↓
2. Type IV Fluids: 1x10min ↑
3. Very Cold Snow: 2x1-2min ↓, 1x10min↑, 2x6-7min ↓, 1x4 min ↓
4. Kilfrost ABC-3: 1x20min ↑, 1x 5min ↑ 1x10 min ↑, 7x5min ↑, 1x1min ↑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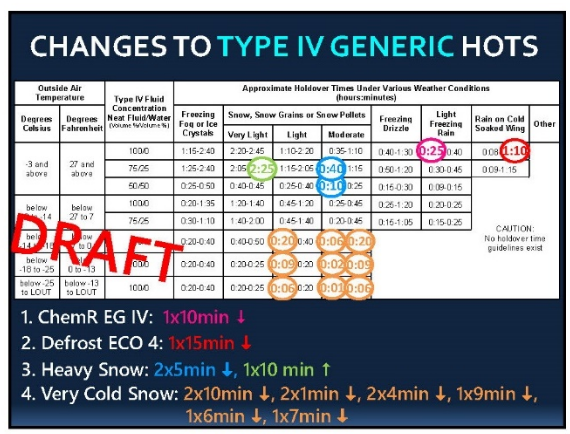
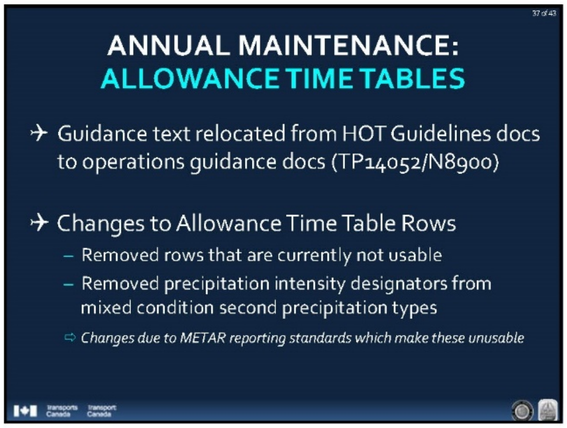
ANNUAL MAINTENANCE: RECALCULATION OF GENERIC HOTS
Type IV
CHEMCO ChemR EG IV added
Oksayd Defrost ECO 4 added
Heavy snow HOT revisions
New HOTs for very cold snow


CHANGES TO TYPE IV GENERIC HOTS
DRAFT
1. ChemR EG IV: 1x10min ↓
2. Defrost ECO 4: 1x15min ↓
3. Heavy Snow: 2x5min ↓, 1x10 min ↑
4. Very Cold Snow: 2x10min ↓, 2x1min ↓, 2x4min ↓, 1x9min ↓, 1x6min ↓, 1x7min ↓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ANNUAL MAINTENANCE:
ALLOWANCE TIME TABLES
Guidance text relocated from HOT Guidelines docs to operations guidance docs (TP14052/N8900)
Changes to Allowance Time Table Rows
– Removed rows that are currently not usable
– Removed precipitation intensity designators from mixed condition second precipitation types
Changes due to METAR reporting standards which make these unusable
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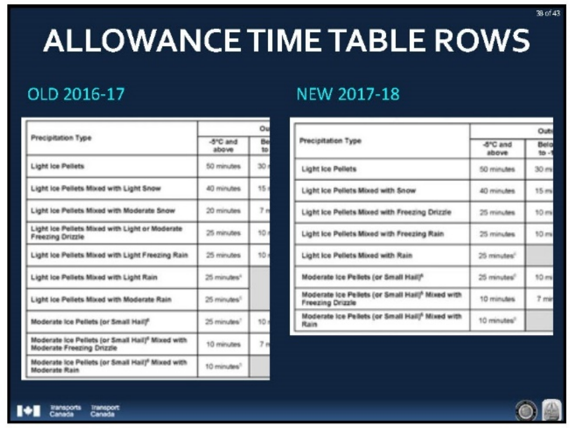
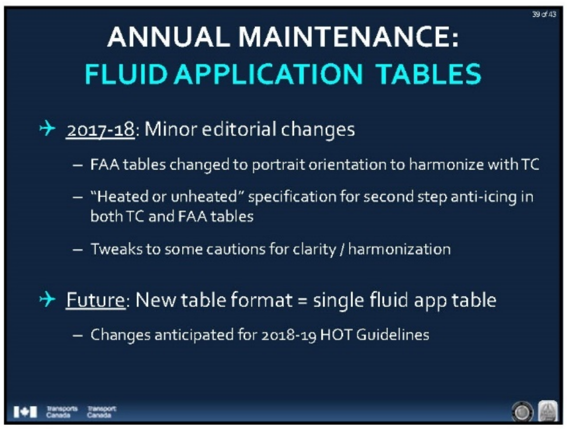
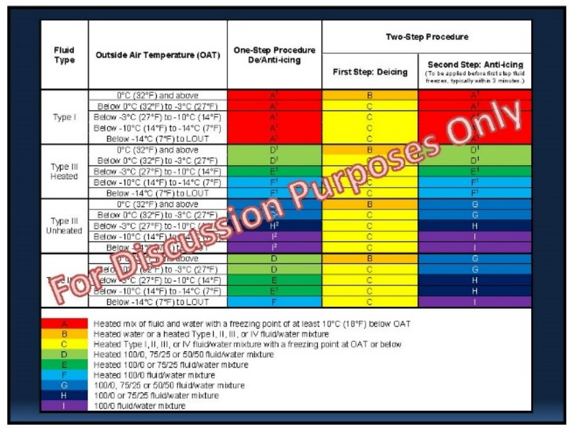
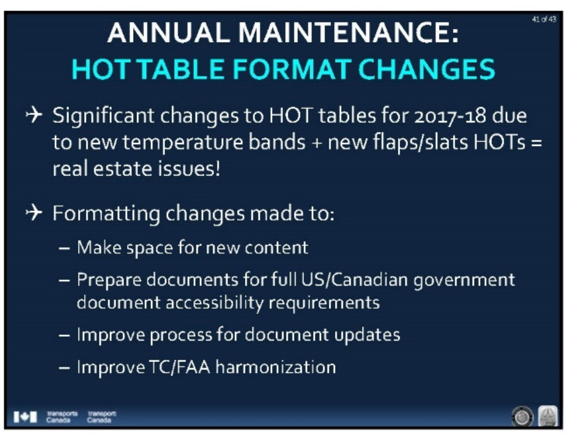
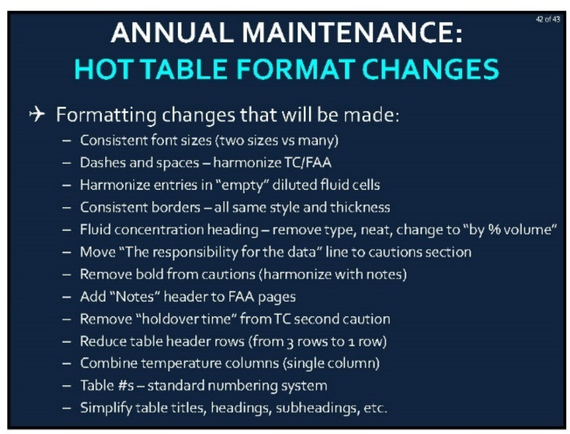

38 of 43
ALLOWANCE TIME TABLE ROWS
OLD 2016-17
NEW 2017-18
Precipitation Type
-5°C and above
Light Ice Pellets
50 minutes
Light Ice Pellets Mixed with Light Snow
40 minutes
Light Ice Pellets Mixed with Moderate Snow
20 minutes
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle
25 minutes
Light Ice Pellets Mixed with Light Freezing Rain
25 minutes
Light Ice Pellets Mixed with Light Rain
Light Ice Pellets Mixed with Moderate Rain
Moderate Ice Pellets (or Small Hail)
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Freezing Drizzle
10 minutes
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Rain
Precipitation Type
-5°C and above
Light Ice Pellets
50 minutes
Light Ice Pellets Mixed with Snow
40 minutes
Light Ice Pellets Mixed with Freezing Drizzle
25 minutes
Light Ice Pellets Mixed with Freezing Rain
25 minutes
Light Ice Pellets Mixed with Rain
Moderate Ice Pellets (or Small Hail)
Moderate Ice Pellets (or Small Hail) Mixed with Freezing Drizzle
10 minutes
Moderate Ice Pellets (or Small Hail) Mixed with Rain
Transports Canada Transport Canada


39 of 43
ANNUAL MAINTENANCE:
FLUID APPLICATION TABLES
2017-18: Minor editorial changes
– FAA tables changed to portrait orientation to harmonize with TC
– "Heated or unheated" specification for second step anti-icing in both TC and FAA tables
– Tweaks to some cautions for clarity / harmonization
Future: New table format = single fluid app table
– Changes anticipated for 2018-19 HOT Guidelines
Transports Canada Transport Canada


Fluid Type
Outside Air Temperature (OAT)
One-Step Procedure De/Anti-icing
Two-Step Procedure
First Step: Deicing
Second Step: Anti-icing
(To be applied before first step fluid freezes, typically within 3 minutes.)
Type I
Type III Heated
Type III Unheated
0°C (32°F) and above
Below 0°C (32°F) to -3°C (27°F)
Below -3°C (27°F) to -10°C (14°F)
Below -10°C (14°F) to -14°C (7°F)
Below -14°C (7°F) to LOUT
For Discussion Purposes Only
A Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT
B Heated water or a heated Type I, II, III, or IV fluid/water mixture
C Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below
D Heated 100/0, 75/25 or 50/50 fluid/water mixture
E Heated 100/0 or 75/25 fluid/water mixture
F Heated 100/0 fluid/water mixture
G 100/0, 75/25 or 50/50 fluid/water mixture
H 100/0 or 75/25 fluid/water mixture
I 100/0 fluid/water mixture


41 of 43
ANNUAL MAINTENANCE:
HOT TABLE FORMAT CHANGES
Significant changes to HOT tables for 2017-18 due to new temperature bands + new flaps/slats HOTs = real estate issues!
Formatting changes made to:
– Make space for new content
– Prepare documents for full US/Canadian government document accessibility requirements
– Improve process for document updates
– Improve TC/FAA harmonization
Transports Canada Transport Canada

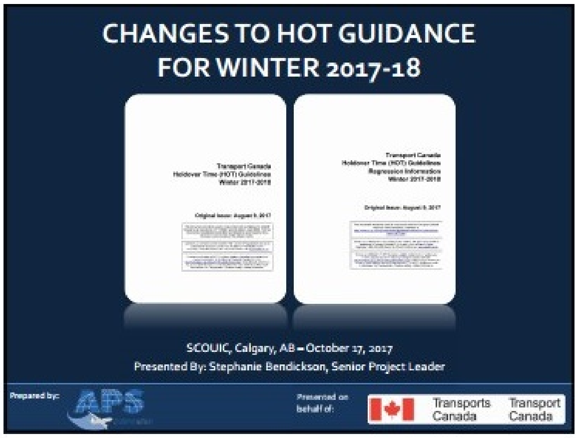

42 of 43
ANNUAL MAINTENANCE:
HOT TABLE FORMAT CHANGES
Formatting changes that will be made:
– Consistent font sizes (two sizes vs many)
– Dashes and spaces – harmonize TC/FAA
– Harmonize entries in "empty" diluted fluid cells
– Consistent borders – all same style and thickness
– Fluid concentration heading – remove type, neat, change to "by % volume"
– Move "The responsibility for the data" line to cautions section
– Remove bold from cautions (harmonize with notes)
– Add "Notes" header to FAA pages
– Remove "holdover time" from TC second caution
– Reduce table header rows (from 3 rows to 1 row)
– Combine temperature columns (single column)
– Table #s – standard numbering system
– Simplify table titles, headings, subheadings, etc.

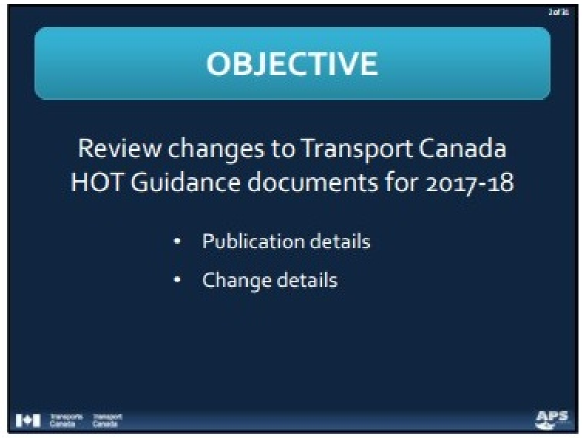
Outside Air Temperature[1]		Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2] Very Light[3]	Light[3]	Moderate	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:20-3:55	3:00-3:00	1:40-3:00	0:50-1[illegible]	[illegible]	0:50-0:55	0:08-2:00	
		75/25	N/A	N/A	N/A	[illegible]	N/A	N/A	N/A	
		50/50	N/A	[illegible]	[illegible]	N/A	N/A	N/A		CAUTION: No holdover time guidelines exist
below -3 to -14	below 27 to 7	100/0	1:45-[illegible]	[illegible]	1:30-2:45	0:50-1:30	1:05-1:50[7]	0:55-1:25[7]		
		75/25	[illegible]	N/A	N/A	N/A	N/A	N/A		
below -14 to -30	below 7 to -22	100/0	0:40-1:20	0:20-0:25	0:10-0:20	0:08-0:10				

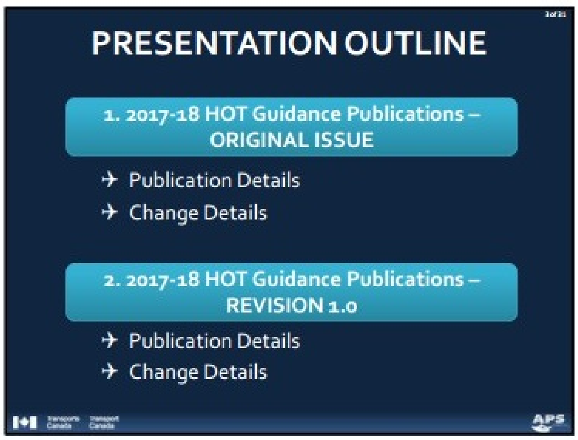
Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:20 - 3:55	3:00 - 3:40	1:40 - 3:00	0:50 - 1:40	[illegible]	0:50 - 0:55	0:08 - 2:00	
	75/25	-	-	-	[illegible]	[illegible]	-	-	
	50/50	-	-	-	[illegible]	-	-		
below -3 to -14°C (below 27 to 7°F)	100/0	1:45 - 4:00	2:45 - 3:20	1:30 - [illegible]	[illegible] - 1:30	1:05 - 1:50	0:55 - 1:25		
	75/25	-	[illegible]	-	-	-	-		
below -14 to -18°C (below 7 to 0°F)	100/0	0:40 - 1:20	[illegible]	0:30 - 0:40	0:15 - 0:30			CAUTION: No holdover time guidelines exist	
below -18 to -25°C (below 0 to -13°F)	100/0	0:40 - 1:20	0:40 - 0:50	0:30 - 0:40	0:15 - 0:30				
below -25 to -30°C (below -13 to -22°F)	100/0	0:40 - 1:20	0:40 - 0:50	0:30 - 0:40	0:15 - 0:30				

STANDING COMMITTEE MEETING ON AIRCRAFT OPERATIONS UNDER ICING CONDITIONS (SCOUIC), CALGARY, CANADA

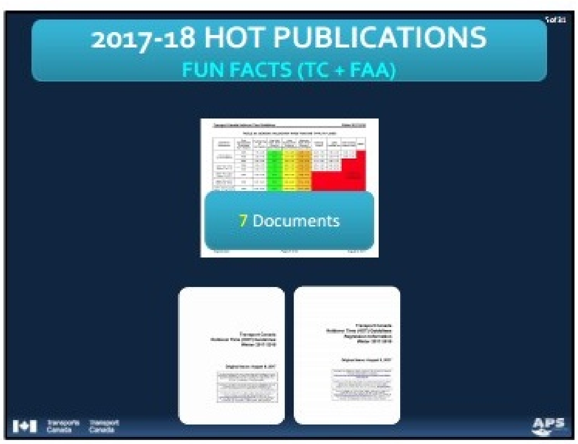
PRESENTATION:
CHANGES TO HOT GUIDANCE FOR WINTER 2017-18

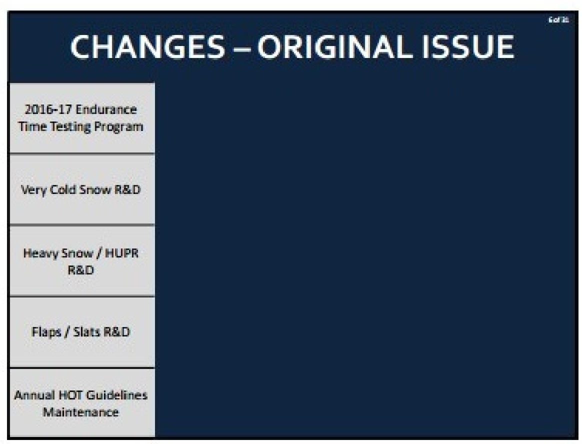

CHANGES TO HOT GUIDANCE FOR WINTER 2017-18
SCOUIC, Calgary, AB – October 17, 2017
Presented By: Stephanie Bendickson, Senior Project Leader
Prepared by:
APS
Presented on behalf of:
Transports Canada
Transport Canada

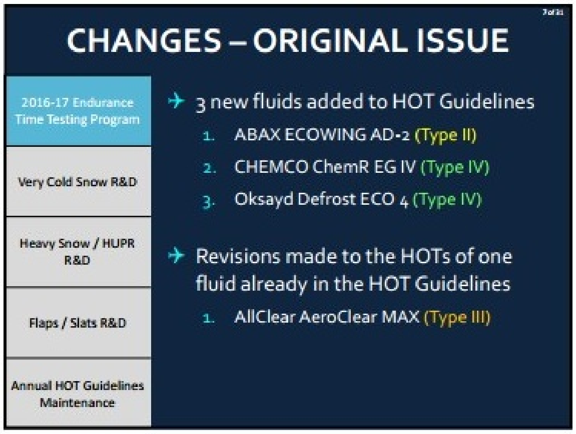

OBJECTIVE
Review changes to Transport Canada HOT Guidance documents for 2017-18
• Publication details
• Change details

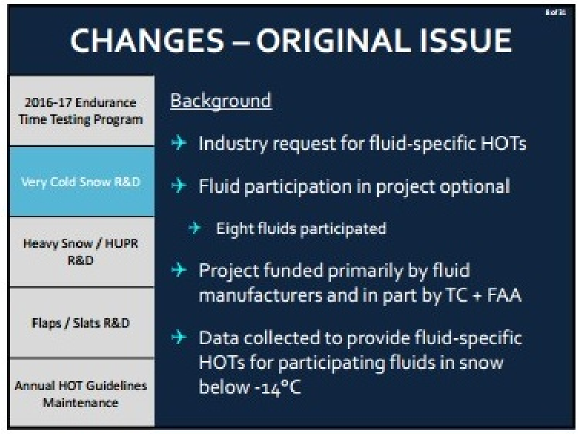

PRESENTATION OUTLINE
1. 2017-18 HOT Guidance Publications – ORIGINAL ISSUE
Publication Details
Change Details
2. 2017-18 HOT Guidance Publications – REVISION 1.0
Publication Details
Change Details

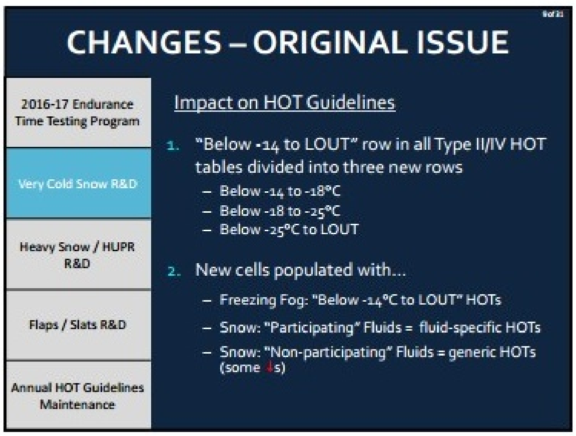

2017-18 HOT PUBLICATIONS
ORIGINAL ISSUE
Published August 9, 2017
Four Documents:
1. 2017-18 Holdover Time Guidelines, Original Issue (English)
2. 2017-18 Holdover Time Guidelines, Original Issue (French)
3. 2017-18 Regression Information, Original Issue (English)
4. 2017-18 Regression Information, Original Issue (French)
Available Online:
• www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm
• www.tc.gc.ca/fra/aviationcivile/normes/commerce-delaisdefficacite-menu-1877.htm

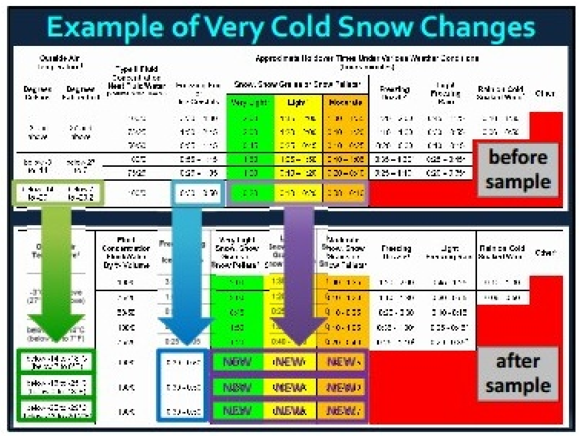

2017-18 HOT PUBLICATIONS
FUN FACTS (TC + FAA)
7 Documents

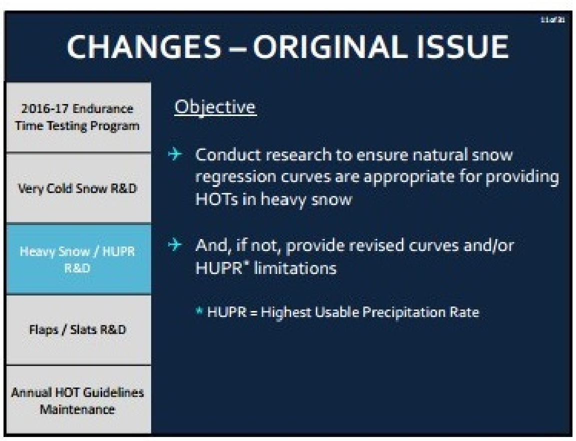

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance

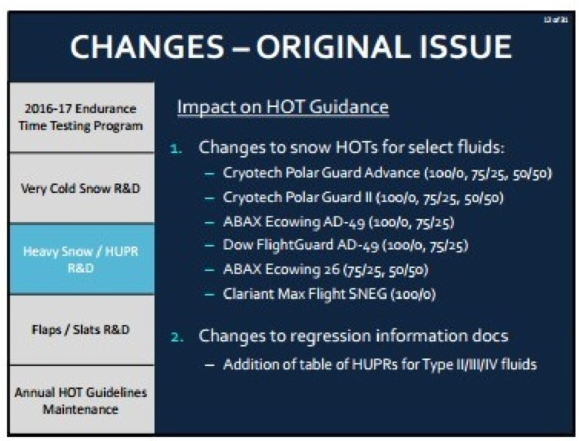

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
3 new fluids added to HOT Guidelines
1. ABAX ECOWING AD-2 (Type II)
2. CHEMCO ChemR EG IV (Type IV)
3. Oksayd Defrost ECO 4 (Type IV)
Revisions made to the HOTs of one fluid already in the HOT Guidelines
1. AllClear AeroClear MAX (Type III)

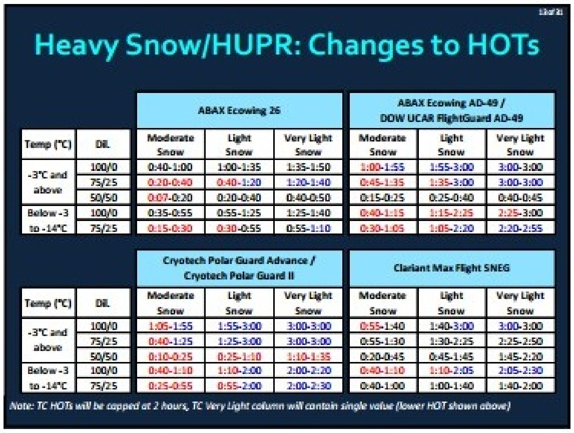

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Background
Industry request for fluid-specific HOTs
Fluid participation in project optional
Eight fluids participated
Project funded primarily by fluid manufacturers and in part by TC + FAA
Data collected to provide fluid-specific HOTs for participating fluids in snow below -14°C

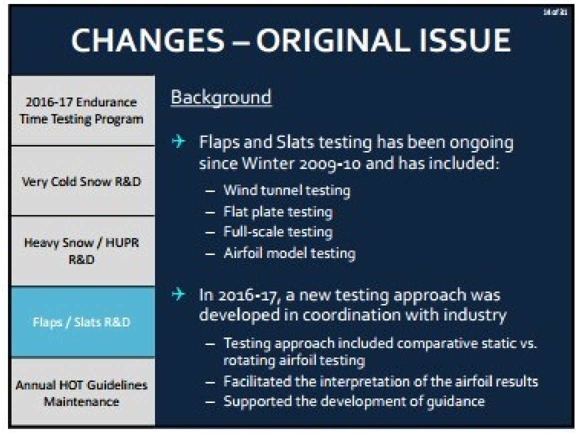

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Impact on HOT Guidelines
1. "Below -14 to LOUT" row in all Type II/IV HOT tables divided into three new rows
– Below -14 to -18°C
– Below -18 to -25°C
– Below -25°C to LOUT
2. New cells populated with…
– Freezing Fog: "Below -14°C to LOUT" HOTs
– Snow: "Participating" Fluids = fluid-specific HOTs
– Snow: "Non-participating" Fluids = generic HOTs (some ↓s)

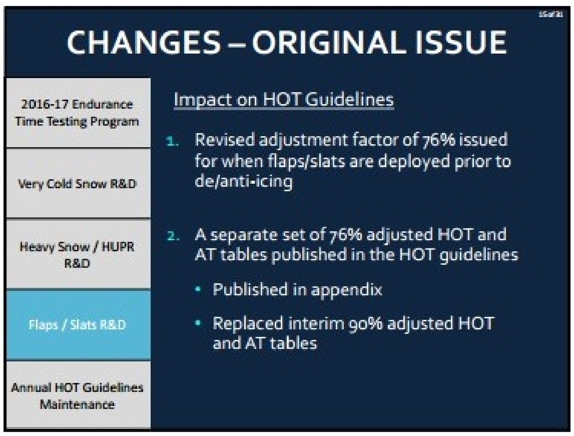

Example of Very Cold Snow Changes
before sample
after sample
NEW


CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Objective
Conduct research to ensure natural snow regression curves are appropriate for providing HOTs in heavy snow
And, if not, provide revised curves and/or HUPR* limitations
* HUPR = Highest Usable Precipitation Rate

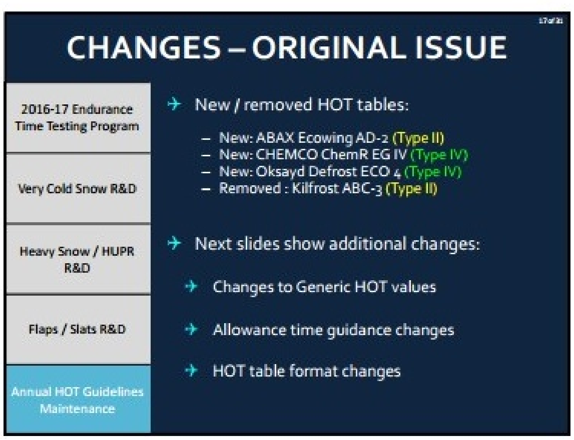

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Impact on HOT Guidance
1. Changes to snow HOTs for select fluids:
– Cryotech Polar Guard Advance (100/0, 75/25, 50/50)
– Cryotech Polar Guard II (100/0, 75/25, 50/50)
– ABAX Ecowing AD-49 (100/0, 75/25)
– Dow FlightGuard AD-49 (100/0, 75/25)
– ABAX Ecowing 26 (75/25, 50/50)
– Clariant Max Flight SNEG (100/0)
2. Changes to regression information docs
– Addition of table of HUPRs for Type II/III/IV fluids

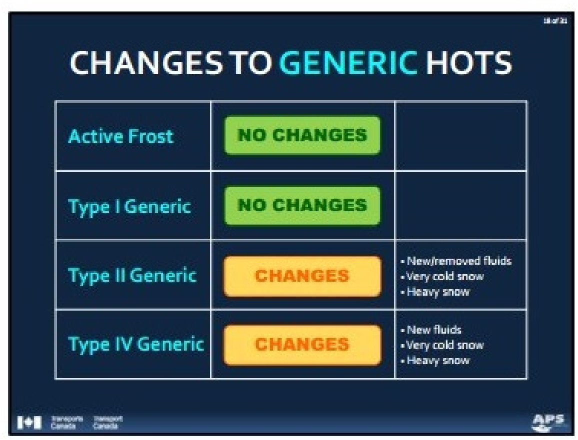

Heavy Snow/HUPR: Changes to HOTs
ABAX Ecowing 26
ABAX Ecowing AD-49 / DOW UCAR FlightGuard AD-49
Temp (°C) | Dil. | Moderate Snow | Light Snow | Very Light Snow | Moderate Snow | Light Snow | Very Light Snow
-3°C and above | 100/0 | 0:40-1:00 | 1:00-1:35 | 1:35-1:50 | 1:00-1:55 | 1:55-3:00 | 3:00-3:00
75/25 | 0:20-0:40 | 0:40-1:20 | 1:20-1:40 | 0:45-1:35 | 1:35-3:00 | 3:00-3:00
50/50 | 0:07-0:20 | 0:20-0:40 | 0:40-0:50 | 0:15-0:25 | 0:25-0:40 | 0:40-0:45
Below -3 to -14°C | 100/0 | 0:35-0:55 | 0:55-1:25 | 1:25-1:40 | 0:40-1:15 | 1:15-2:25 | 2:25-3:00
75/25 | 0:15-0:30 | 0:30-0:55 | 0:55-1:10 | 0:30-1:05 | 1:05-2:20 | 2:20-2:55
Cryotech Polar Guard Advance / Cryotech Polar Guard II
Clariant Max Flight SNEG
Temp (°C) | Dil. | Moderate Snow | Light Snow | Very Light Snow | Moderate Snow | Light Snow | Very Light Snow
-3°C and above | 100/0 | 1:05-1:55 | 1:55-3:00 | 3:00-3:00 | 0:55-1:40 | 1:40-3:00 | 3:00-3:00
75/25 | 0:40-1:25 | 1:25-3:00 | 3:00-3:00 | 0:55-1:30 | 1:30-2:25 | 2:25-2:50
50/50 | 0:10-0:25 | 0:25-1:10 | 1:10-1:35 | 0:20-0:45 | 0:45-1:45 | 1:45-2:20
Below -3 to -14°C | 100/0 | 0:40-1:10 | 1:10-2:00 | 2:00-2:20 | 0:40-1:10 | 1:10-2:05 | 2:05-2:30
75/25 | 0:25-0:55 | 0:55-2:00 | 2:00-2:30 | 0:40-1:00 | 1:00-1:40 | 1:40-2:00
Note: TC HOTs will be capped at 2 hours, TC Very Light column will contain single value (lower HOT shown above)

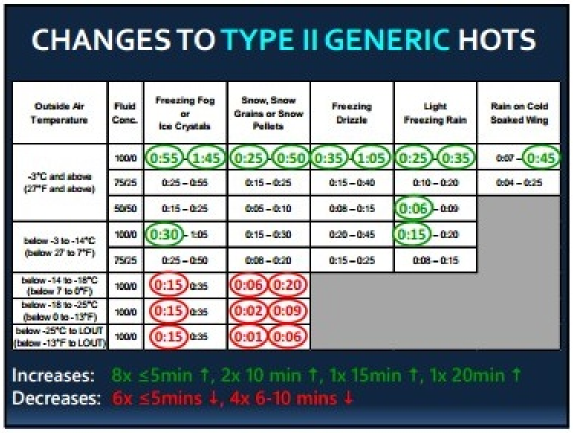

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Background
Flaps and Slats testing has been ongoing since Winter 2009-10 and has included:
– Wind tunnel testing
– Flat plate testing
– Full-scale testing
– Airfoil model testing
In 2016-17, a new testing approach was developed in coordination with industry
– Testing approach included comparative static vs. rotating airfoil testing
– Facilitated the interpretation of the airfoil results
– Supported the development of guidance

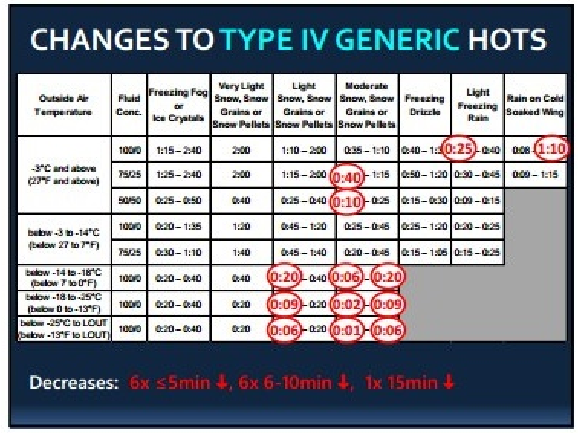

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Impact on HOT Guidelines
1. Revised adjustment factor of 76% issued for when flaps/slats are deployed prior to de/anti-icing
2. A separate set of 76% adjusted HOT and AT tables published in the HOT guidelines
• Published in appendix
• Replaced interim 90% adjusted HOT and AT tables

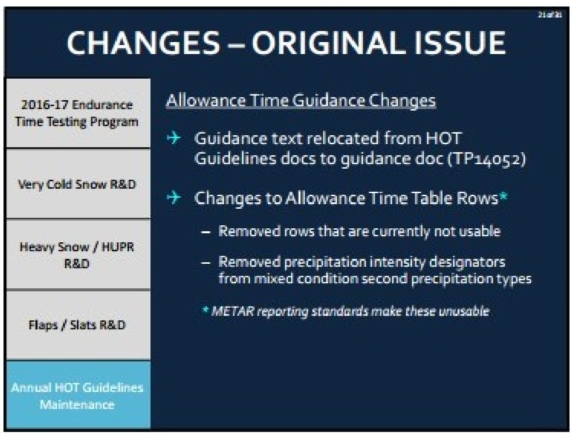

Standard HOTs (100%)
Freezing Fog or Ice Crystals
Very Light Snow, Snow Grains or Snow Pellets
Light Snow, Snow Grains or Snow Pellets
Moderate Snow, Snow Grains or Snow Pellets
Freezing Drizzle
Light Freezing Rain
Adjusted HOTs (76%)


CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
New / removed HOT tables:
– New: ABAX Ecowing AD-2 (Type II)
– New: CHEMCO ChemR EG IV (Type IV)
– New: Oksayd Defrost ECO 4 (Type IV)
– Removed : Kilfrost ABC-3 (Type II)
Next slides show additional changes:
Changes to Generic HOT values
Allowance time guidance changes
HOT table format changes


CHANGES TO GENERIC HOTS
Active Frost
NO CHANGES
Type I Generic
NO CHANGES
Type II Generic
CHANGES
• New/removed fluids
• Very cold snow
• Heavy snow
Type IV Generic
CHANGES
• New fluids
• Very cold snow
• Heavy snow
APS


CHANGES TO TYPE II GENERIC HOTS
Outside Air Temperature
Fluid Conc.
Freezing Fog or Ice Crystals
Snow, Snow Grains or Snow Pellets
Freezing Drizzle
Light Freezing Rain
Rain on Cold Soaked Wing
Increases: 8x ≤5min ↑, 2x 10 min ↑, 1x 15min ↑, 1x 20min ↑
Decreases: 6x ≤5mins ↓, 4x 6-10 mins ↓


CHANGES TO TYPE IV GENERIC HOTS
Outside Air Temperature
Fluid Conc.
Freezing Fog or Ice Crystals
Very Light Snow, Snow Grains or Snow Pellets
Light Snow, Snow Grains or Snow Pellets
Moderate Snow, Snow Grains or Snow Pellets
Freezing Drizzle
Light Freezing Rain
Rain on Cold Soaked Wing
Decreases: 6x ≤5min ↓, 6x 6-10min ↓, 1x 15min ↓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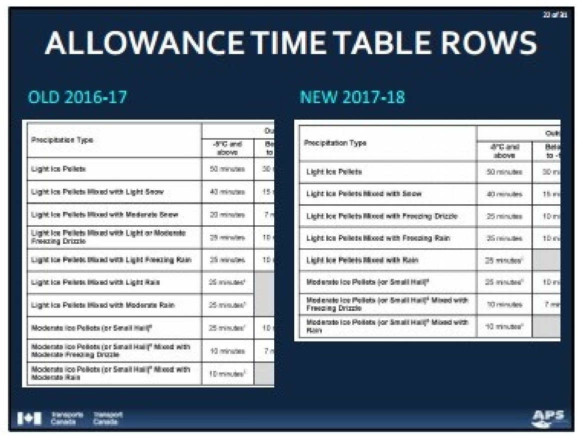
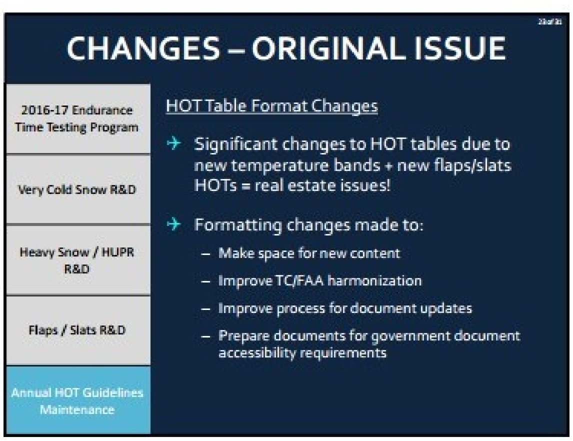
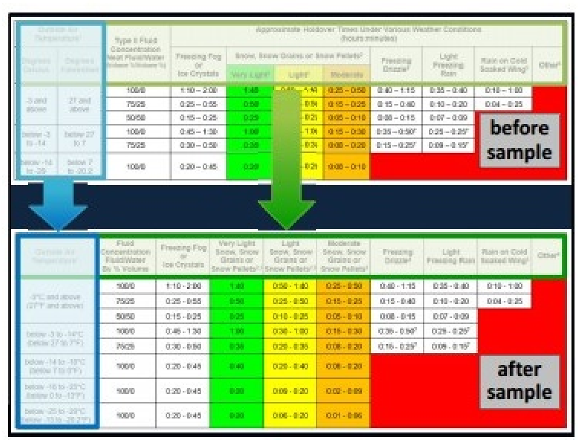
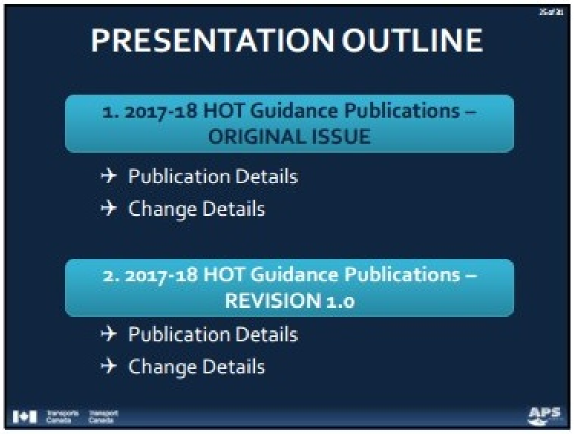
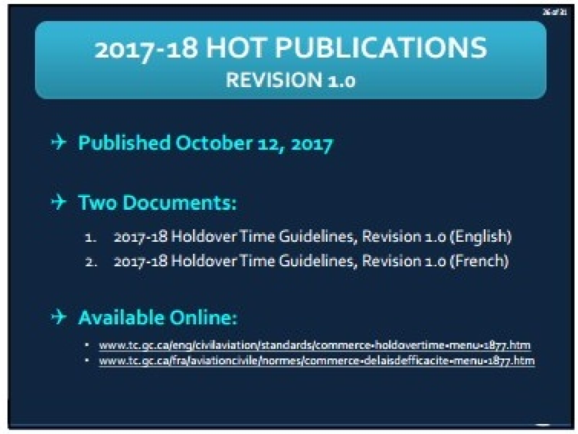
CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Allowance Time Guidance Changes
Guidance text relocated from HOT Guidelines docs to guidance doc (TP14052)
Changes to Allowance Time Table Rows*
– Removed rows that are currently not usable
– Removed precipitation intensity designators from mixed condition second precipitation types
* METAR reporting standards make these unusable

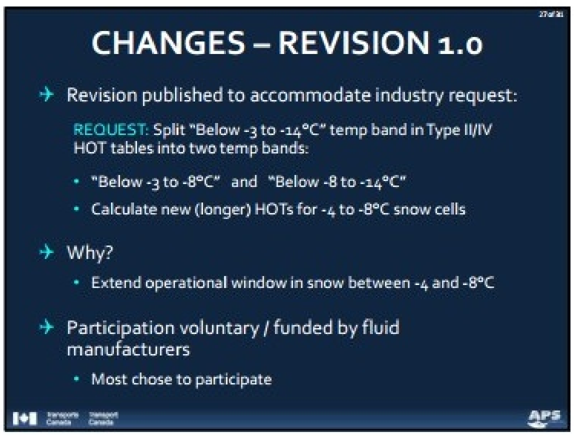

22 of 31
ALLOWANCE TIME TABLE ROWS
OLD 2016-17
NEW 2017-18

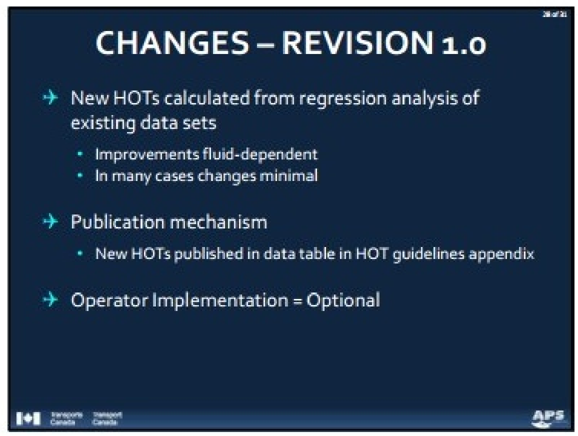

23 of 31
CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
HOT Table Format Changes
Significant changes to HOT tables due to new temperature bands + new flaps/slats HOTs = real estate issues!
Formatting changes made to:
– Make space for new content
– Improve TC/FAA harmonization
– Improve process for document updates
– Prepare documents for government document accessibility requirements


before sample
after sample









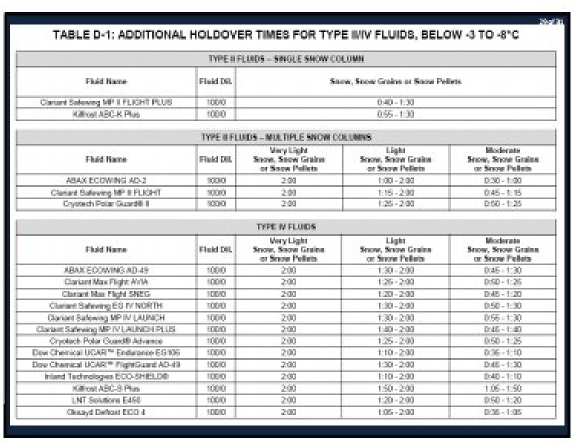


TABLE D-1: ADDITIONAL HOLDOVER TIMES FOR TYPE II/IV FLUIDS, BELOW -3 TO -8°C

TYPE II FLUIDS – SINGLE SNOW COLUMN

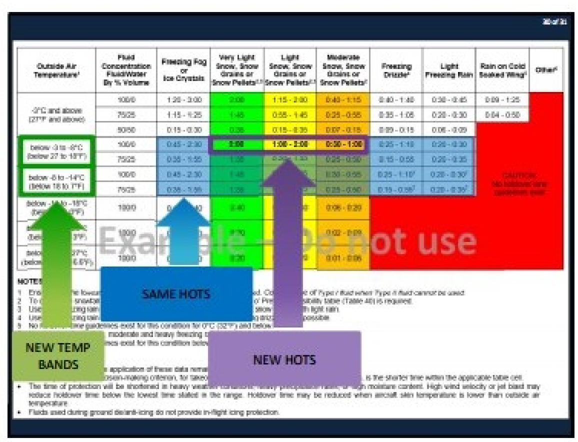
Fluid Name	Fluid Dil.	Snow, Snow Grains or Snow Pellets
Clariant Safewing MP II FLIGHT PLUS	100/0	0:40 - 1:30
Killfrost ABC-K Plus	100/0	0:55 - 1:30

TYPE II FLUIDS – MULTIPLE SNOW COLUMNS

Fluid Name	Fluid Dil.	Very Light Snow, Snow Grains or Snow Pellets	Light Snow, Snow Grains or Snow Pellets	Moderate Snow, Snow Grains or Snow Pellets
ABAX ECOWING AD-2	100/0	2:00	1:00 - 2:00	0:30 - 1:00
Clariant Safewing MP II FLIGHT	100/0	2:00	1:15 - 2:00	0:45 - 1:15
Cryotech Polar Guard® II	100/0	2:00	1:25 - 2:00	0:50 - 1:25

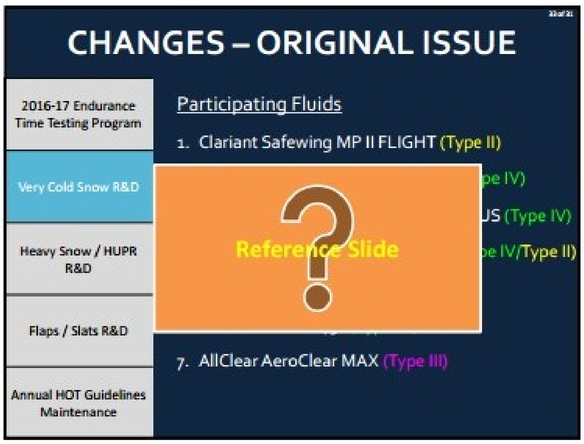
TYPE IV FLUIDS

Fluid Name	Fluid Dil.	Very Light Snow, Snow Grains or Snow Pellets	Light Snow, Snow Grains or Snow Pellets	Moderate Snow, Snow Grains or Snow Pellets
ABAX ECOWING AD-49	100/0	2:00	1:30 - 2:00	0:45 - 1:30
Clariant Max Flight AVIA	100/0	2:00	1:25 - 2:00	0:50 - 1:25
Clariant Max Flight SNEG	100/0	2:00	1:20 - 2:00	0:45 - 1:20
Clariant Safewing EG IV NORTH	100/0	2:00	1:30 - 2:00	0:50 - 1:30
Clariant Safewing MP IV LAUNCH	100/0	2:00	1:30 - 2:00	0:55 - 1:30
Clariant Safewing MP IV LAUNCH PLUS	100/0	2:00	1:40 - 2:00	0:45 - 1:40
Cryotech Polar Guard® Advance	100/0	2:00	1:25 - 2:00	0:50 - 1:25
Dow Chemical UCAR™ Endurance EG106	100/0	2:00	1:10 - 2:00	0:35 - 1:10
Dow Chemical UCAR™ FlightGuard AD-49	100/0	2:00	1:30 - 2:00	0:45 - 1:30
Inland Technologies ECO-SHIELD®	100/0	2:00	1:10 - 2:00	0:40 - 1:10
Killfrost ABC-S Plus	100/0	2:00	1:50 - 2:00	1:05 - 1:50
LNT Solutions E450	100/0	2:00	1:20 - 2:00	0:50 - 1:20
Oksayd Defrost ECO 4	100/0	2:00	1:05 - 2:00	0:35 - 1:05




Questions?
APS Aviation Inc
Stephanie Bendickson
Project Leader, APS Aviation
sbendickson@apsaviation.ca

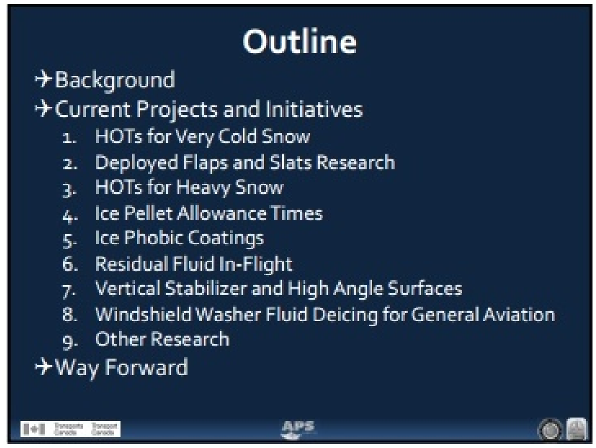

2017-18 HOT PUBLICATIONS
FUN FACTS (TC + FAA)
7 Documents
489 Pages
234 HOT Table
Regression + ication Tables
7,692
24 HOT + AT Values
Not animated – use for circulation file, fix page #
57 Type I Fluids
30 Type II/III/IV Fluids

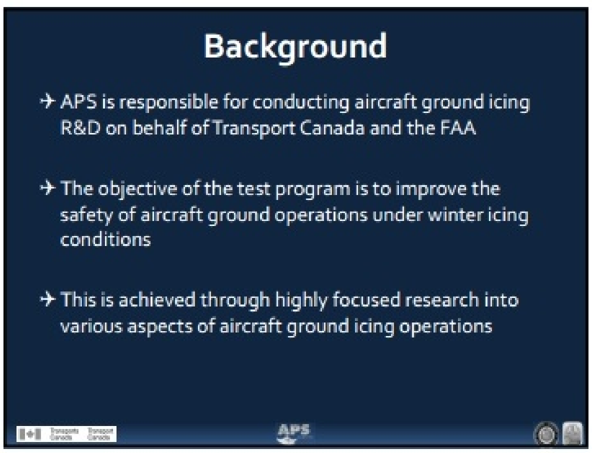

CHANGES – ORIGINAL ISSUE
2016-17 Endurance Time Testing Program
Very Cold Snow R&D
Heavy Snow / HUPR R&D
Flaps / Slats R&D
Annual HOT Guidelines Maintenance
Participating Fluids
1. Clariant Safewing MP II FLIGHT (Type II)
pe IV)
US (Type IV)
pe IV/Type II)
7. AllClear AeroClear MAX (Type III)
Reference Slide

STANDING COMMITTEE MEETING ON AIRCRAFT OPERATIONS UNDER ICING CONDITIONS (SCOUIC), CALGARY, CANADA

PRESENTATION:
GROUND ICING RESEARCH PROGRAM PROJECTS AND INITIATIVES


Joint research led by:
Transports Canada
Transport Canada
Conducted by:
APS
Ground Icing Research Program
Projects and Initiatives
SCOUIC, Calgary, October 17, 2017
Marco Ruggi, Eng., M.B.A., Senior Project Leader


Outline
Background
Current Projects and Initiatives
1. HOTs for Very Cold Snow
2. Deployed Flaps and Slats Research
3. HOTs for Heavy Snow
4. Ice Pellet Allowance Times
5. Ice Phobic Coatings
6. Residual Fluid In-Flight
7. Vertical Stabilizer and High Angle Surfaces
8. Windshield Washer Fluid Deicing for General Aviation
9. Other Research
Way Forward
APS


Background
APS is responsible for conducting aircraft ground icing R&D on behalf of Transport Canada and the FAA
The objective of the test program is to improve the safety of aircraft ground operations under winter icing conditions
This is achieved through highly focused research into various aspects of aircraft ground icing operations
APS


Major Program Elements
Fluids
Weather
Aircraft Performance
Operations
Sensors
Information Dissemination
APS


Primary Research Facilities
TC/APS MONTREAL AIRPORT (YUL) TEST SITE FACILITY
NRC OTTAWA CLIMATIC ENGINEERING FACILITY
NRC OTTAWA PROPULSION ICING WIND TUNNEL FACILITY (PIWT)
APS


HOTs for Very Cold Snow

Background

- Generic HOTs for below -14°C have been used since 2004
- A testing initiative was started in 2014-15 and looked at validating these HOTs for the current
  - generation of de/anti-icing fluids
  - format of HOT table (VLS and LS)
- Type II/IV results were unexpected and a number of data points were below generic HOTs
- Industry request for fluid-specific HOTs to avoid across the board HOT reductions

Very Cold Snow Storm Chasing in Canada

*Fluid manufacturer participation was optional
**Project funded primarily by fluid manufacturers and in part by Transport Canada and FAA

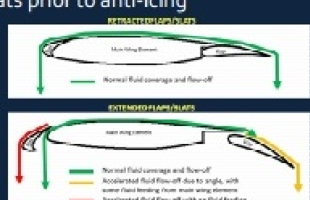
Changes to HOT Guidelines

- Using traditional regression analysis methods did not work; a more complex analysis was required
- New rows were added to all Type II, III, and IV fluid specific, generic and frost tables
  - No changes were required for Type I fluid

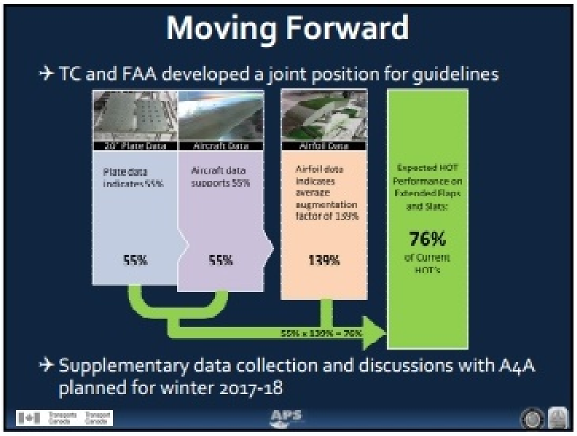
- Current focus is on refining methodology for future fluids

Background

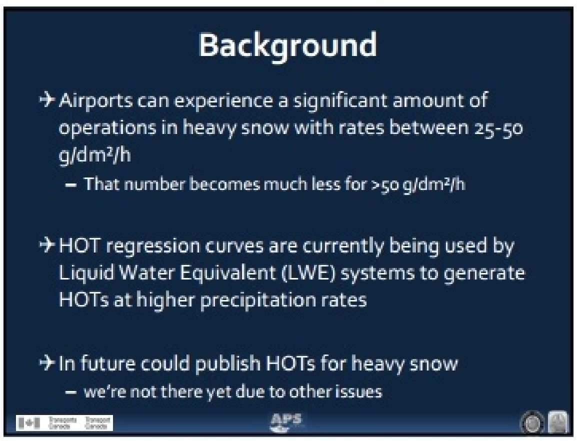
- Research has indicated that early de/anti-icing fluid failure occurs on aircraft flaps and slats if left deployed during the HOT
- This could pose a problem for operators who deploy flaps/slats prior to anti-icing



Flaps/Slats Research


Moving Forward
TC and FAA developed a joint position for guidelines
20" Plate Data
Aircraft Data
Airfoil Data
Plate data indicates 55%
Aircraft data supports 55%
Airfoil data indicates average augmentation factor of 139%
Expected HOT Performance on Extended Flaps and Slats:
55%
55%
139%
76%
of Current HOT's
55% x 139% = 76%
Supplementary data collection and discussions with A4A planned for winter 2017-18
APS


HOTs for Heavy Snow


Background
Airports can experience a significant amount of operations in heavy snow with rates between 25-50 g/dm²/h
– That number becomes much less for >50 g/dm²/h
HOT regression curves are currently being used by Liquid Water Equivalent (LWE) systems to generate HOTs at higher precipitation rates
In future could publish HOTs for heavy snow
– we're not there yet due to other issues
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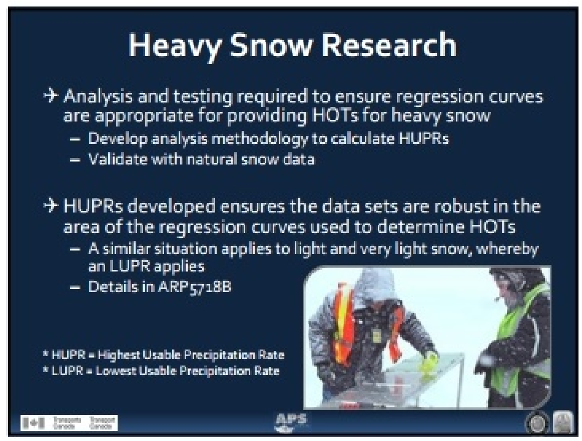
Heavy Snow Research
Analysis and testing required to ensure regression curves are appropriate for providing HOTs for heavy snow
– Develop analysis methodology to calculate HUPRs
– Validate with natural snow data
HUPRs developed ensures the data sets are robust in the area of the regression curves used to determine HOTs
– A similar situation applies to light and very light snow, whereby an LUPR applies
– Details in ARP5718B
* HUPR = Highest Usable Precipitation Rate
* LUPR = Lowest Usable Precipitation Rate
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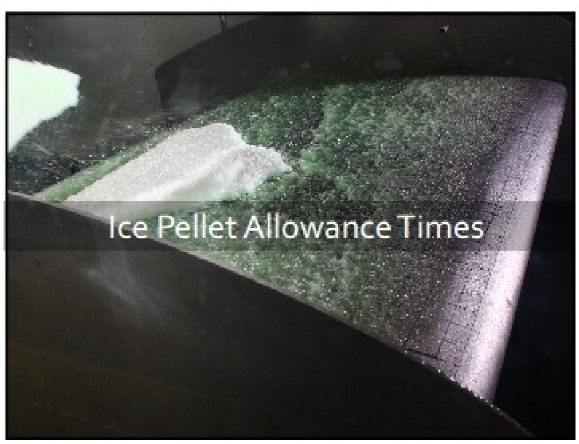
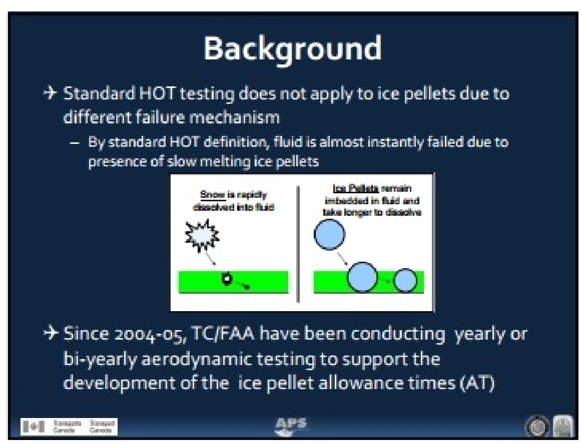

Ice Pellet Allowance Times


Background
Standard HOT testing does not apply to ice pellets due to different failure mechanism
– By standard HOT definition, fluid is almost instantly failed due to presence of slow melting ice pellets
Snow is rapidly dissolved into fluid
Ice Pellets remain imbedded in fluid and take longer to dissolve
Since 2004-05, TC/FAA have been conducting yearly or bi-yearly aerodynamic testing to support the development of the ice pellet allowance times (AT)
APS


Video


Latest 2015-16 Research
The focus of the 2015-16 research was on:
– Validating Allowance Times for 3 New Type IV Fluids
– Expanding Allowance Times to include New Conditions
• (IP/ZD, IP/R, IP/SN, IP-/SN-, IP-/SN)
– Type III fluid Allowance Time Research
• New Fluid
• Lower speed (80 knots)
Continued research is planned for Jan-Feb 2017-18
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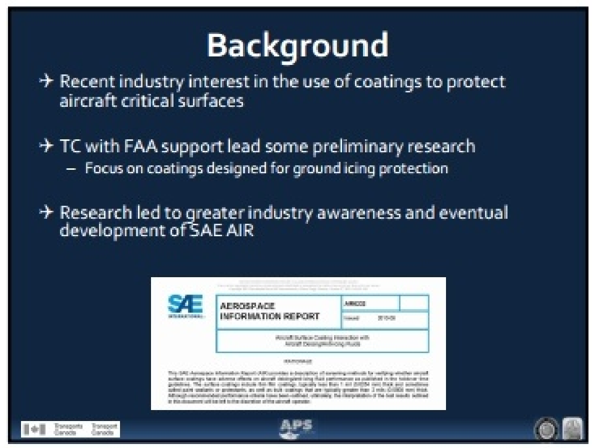
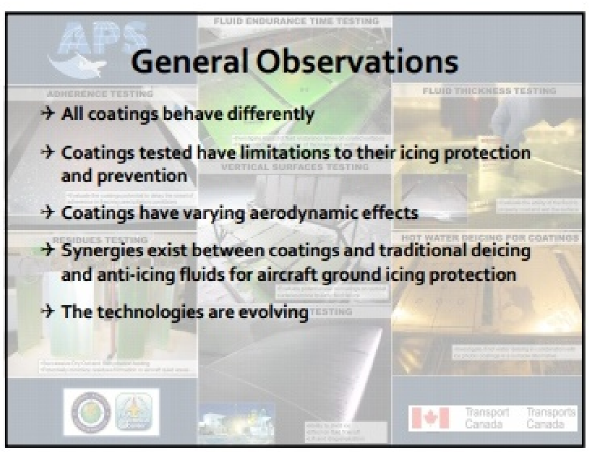
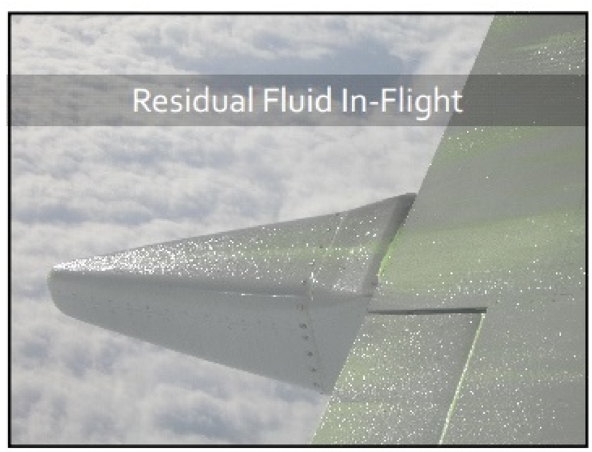
Ice Phobic Coatings


Background
Recent industry interest in the use of coatings to protect aircraft critical surfaces
TC with FAA support lead some preliminary research
– Focus on coatings designed for ground icing protection
Research led to greater industry awareness and eventual development of SAE AIR
SAE
AEROSPACE INFORMATION REPORT
APS


General Observations
All coatings behave differently
Coatings tested have limitations to their icing protection and prevention
Coatings have varying aerodynamic effects
Synergies exist between coatings and traditional deicing and anti-icing fluids for aircraft ground icing protection
The technologies are evolving


Residual Fluid In-Flight


Background
Industry and flying public had reported concerns of residual anti-icing fluid on aircraft surfaces in flight
Both Air Canada and West Jet provided photos of these reported incidents to the regulators to support this research
West Jet: B737
Anti-iced with Type IV in Light Snow
Air Canada: A330
Anti-iced with Type IV in Light Snow
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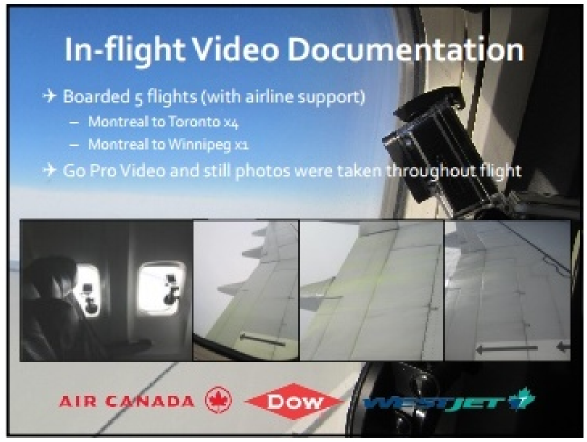
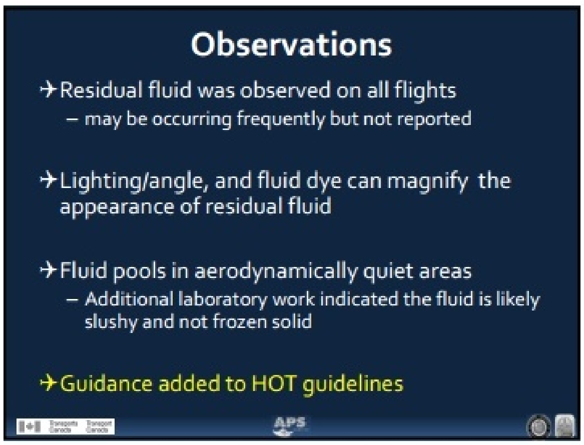

In-flight Video Documentation
Boarded 5 flights (with airline support)
– Montreal to Toronto x4
– Montreal to Winnipeg x1
Go Pro Video and still photos were taken throughout flight
AIR CANADA
DOW
WESTJET


Observations
Residual fluid was observed on all flights
– may be occurring frequently but not reported
Lighting/angle, and fluid dye can magnify the appearance of residual fluid
Fluid pools in aerodynamically quiet areas
– Additional laboratory work indicated the fluid is likely slushy and not frozen solid
Guidance added to HOT guidelines
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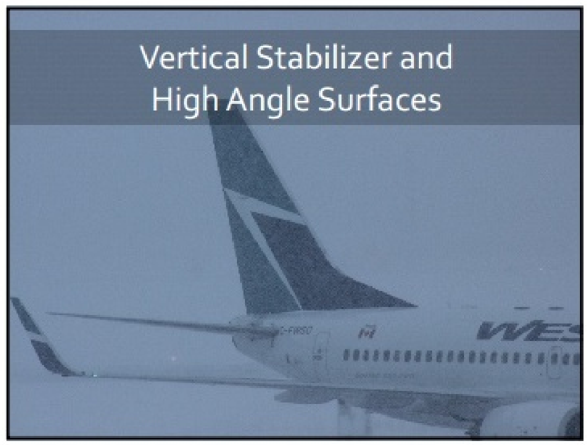
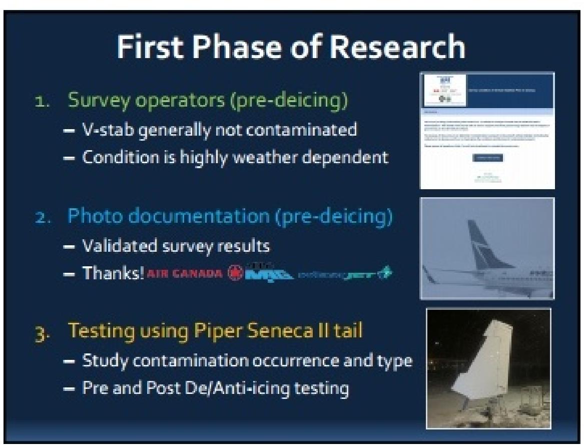
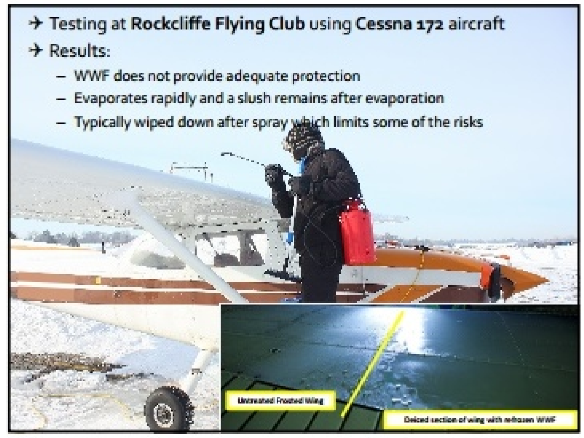

Vertical Stabilizer and High Angle Surfaces

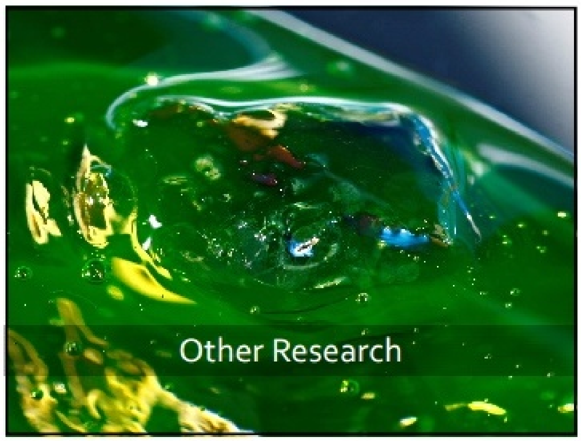

First Phase of Research
1. Survey operators (pre-deicing)
– V-stab generally not contaminated
– Condition is highly weather dependent
2. Photo documentation (pre-deicing)
– Validated survey results
– Thanks! AIR CANADA
3. Testing using Piper Seneca II tail
– Study contamination occurrence and type
– Pre and Post De/Anti-icing testing

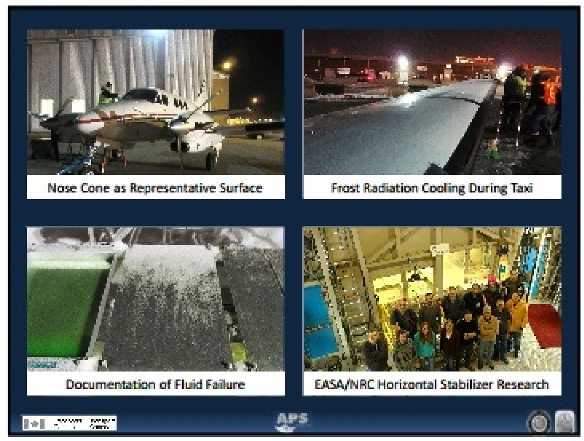

Windshield Washer Fluid Deicing for General Aviation

Background

- Some General Aviation (GA) operators have resorted to using off-the-shelf Windshield Washer Fluid (WWF) for active frost removal due to:
  - Environmental concerns and restrictions with glycol use
  - Limited access to, and costs associated with Type I Fluid
  - Cannot meet low speed aerodynamics for Type I fluid
- TC studied the WWF performance in frost conditions to understand limitation and risks







Upcoming Research Focus

- Research will continue for winter 2017-18 and focus on current industry relevant topics
  - Flaps and Slats Continued Research
  - Cold Snow Evaluation
  - Substantiation of Frost HOTs
  - Wind Tunnel Testing
- Longer-term initiatives under consideration
  - Aerodynamic fluid failure
  - Vertical surfaces


?
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