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July 2021

ARTIFICIAL SNOW RESEARCH ACTIVITIES FOR THE 2018-19 AND 2019-20 WINTERS

Prepared for:

Transport Canada Innovation Centre

In cooperation with:

Federal Aviation Administration William J. Hughes Technical Center

Transport Canada Civil Aviation

Federal Aviation Administration Flight Standards – Air Carrier Operations

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ARTIFICIAL SNOW RESEARCH ACTIVITIES FOR THE 2018-19 AND 2019-20 WINTERS

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PREFACE

Under contract to the Transport Canada Innovation Centre, APS Aviation Inc. has undertaken a research program to advance aircraft ground de/anti-icing technology. The primary objectives of the research program are the following:

- To develop holdover time data for all new de/anti-icing fluids;
- To conduct testing to determine holdover times for Type II and Type IV fluids in snow at temperatures below -14°C;
- To conduct additional testing and analysis to evaluate and/or determine appropriate holdover times for Type I fluids in snow at temperatures below -14°C;
- To evaluate and develop the use of artificial snow for holdover time development;
- To conduct wind tunnel testing with a thin high performance wing model to support the development of guidance material for operating in ice pellet conditions;
- To conduct wind tunnel testing with a vertical stabilizer model to characterize clean and contaminated fluid flow-off before and after a simulated takeoff;
- To conduct further research for the development of temperature-specific snow holdover time data;
- To conduct general and exploratory de/anti-icing research;
- To finalize the publication and delivery of current and historical reports;
- To update the regression information report to reflect changes made to the holdover time guidelines; and
- To update the holdover time guidance materials for annual publication by Transport Canada and the Federal Aviation Administration.

Some project timelines were impacted due to the COVID-19 pandemic. The details of these impacts are described in the individual reports, if applicable. The research activities of the program conducted on behalf of Transport Canada during the winter of 2019-20 are documented in six reports. The titles of the reports are as follows:

- TP 15450E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2019-20 Winter;
- TP 15451E Regression Coefficients and Equations Used to Develop the Winter 2020-21 Aircraft Ground Deicing Holdover Time Tables;
- TP 15452E Aircraft Ground Icing General Research Activities During the 2019-20 Winter;
- TP 15453E Wind Tunnel Trials to Support Further Development of Ice Pellet Allowance Times: Winter 2019-20;
- TP 15454E Wind Tunnel Testing to Evaluate Contaminated Fluid Flow-Off from a Vertical Stabilizer; and

- TP 15455E Artificial Snow Research Activities for the 2018-19 and 2019-20 Winters.

This report, TP 15455E, has the following objective:

- To further develop artificial snow endurance time testing for the use of holdover time development.

This objective was met by conducting natural snow characterization endurance time tests with fluids in natural snow at the APS Aviation Inc. test site at Montreal-Trudeau Airport, and by further developing the multi-organizational project plan for artificial snow research.

PROGRAM ACKNOWLEDGEMENTS

This multi-year research program has been funded by the Transport Canada Innovation Centre, with support from the Federal Aviation Administration William J. Hughes Technical Center, Transport Canada Civil Aviation, and Federal Aviation Administration Flight Standards – Air Carrier Operations. This program could not have been accomplished without the participation of many organizations. APS Aviation Inc. would therefore like to thank Transport Canada, the Federal Aviation Administration, National Research Council Canada, and supporting members of the SAE International G-12 Aircraft Ground Deicing Committees.

APS Aviation Inc. would also like to acknowledge the dedication of the research team, whose performance was crucial to the acquisition of hard data, completion of data analysis, and preparation of reports. This includes the following people: Brandon Auclair, David Beals, Steven Baker, Stephanie Bendickson, Benjamin Bernier, Chloë Bernier, Chris D'Avirro, John D'Avirro, Peter Dawson, Jaycee Ewald, Noemie Gokhool, Benjamin Guthrie, Shaney Herrmann, Peter Kitchener, Shahdad Movaffagh, Dany Posteraro, Annaelle Reuveni, Marco Ruggi, Javad Safari, James Smyth, Saba Tariq, Jodi Wilson, Ian Wittmeyer, and David Youssef.

Special thanks are extended to Antoine Lacroix, Yvan Chabot, Deborah deGrasse, Warren Underwood, and Charles J. Enders, who on behalf of Transport Canada and the Federal Aviation Administration, have participated, contributed, and provided guidance in the preparation of these documents.

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Several research reports for testing of de/anti-icing technologies were produced for previous winters on behalf of Transport Canada (TC). These are available from the TC Innovation Centre. Several reports were produced as part of this winter's research program. Their subject matter is outlined in the preface. This project was co-sponsored by the Federal Aviation Administration.

16. Abstract

In the winter of 2018-19, Transport Canada (TC) and the Federal Aviation Administration (FAA) tasked APS Aviation Inc. (APS) to conduct natural snow characterization testing in order to investigate factors affecting variance in natural snow endurance time testing.

APS conducted 139 natural snow characterization tests comprising 52 test runs during the 2018-19 and 2019-20 winters. The test runs consisted of standard endurance time tests with three reference fluids; additional environmental and fluid data was collected during each test to allow for investigation into factors that contribute to variance in natural snow endurance time testing. Data packages containing the full complement of environmental data were assembled for each of the test runs performed.

Analysis of the data collected identified several environmental parameters that contribute to variance in the fluid endurance time performance. The specific effects of the identified environmental parameters differed for each of the three fluids tested. The primary environmental parameter affecting the variance in the propylene glycol (PG) Type II data set was identified as wind speed. The primary environmental parameters affecting the variance in the PG Type IV data set were identified as wind speed and particle size. The ethylene glycol (EG) Type III data set was found to not have been as significantly affected by the environmental parameters analysed. Many additional environmental parameters were examined, but were not found to be as significant.

It is recommended that APS, National Center for Atmospheric Research, TC, and the FAA continue their joint efforts in developing artificial snow endurance time testing as a tool for holdover time development. It is also recommended that wind speed and particle size data be collected during future natural snow research efforts related to the artificial snow development program, in order to further validate the observed effects on endurance time variance.

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

16. Résumé

Au cours de l'hiver 2018-2019, Transports Canada (TC) et la Federal Aviation Administration (FAA) ont chargé APS Aviation Inc. (APS) de réaliser des essais de caractérisation de la neige naturelle afin d'étudier les facteurs influant sur la variance dans les durées d'endurance dans des conditions de neige naturelle.

APS a effectué 139 essais de caractérisation de la neige naturelle, dont 52 essais de fonctionnement au cours des hivers 2018-2019 et 2019-2020. Les essais de fonctionnement consistaient en des essais standards sur les durées d'endurance avec trois liquides de référence; des données supplémentaires sur l'environnement et le liquide ont été recueillies durant chaque essai afin d'étudier les facteurs contribuant à la variance des durées d'endurance dans des conditions de neige naturelle. Des ensembles contenant l'intégralité du complément de données environnementales ont été assemblés pour chacun des essais effectués.

L'analyse des données recueillies a permis de cerner plusieurs paramètres environnementaux qui contribuent à la variance des durées d'endurance d'un liquide. Les effets spécifiques des paramètres environnementaux relevés diffèrent pour chacun des trois liquides mis à l'essai. Le principal paramètre environnemental influant sur la variance dans les données sur les liquides de type II à base de propylène glycol (PG) est la vitesse du vent. Les principaux paramètres environnementaux influant sur la variance dans les données sur les liquides de type IV à base de PG sont la vitesse du vent et la dimension des particules. Les données sur les liquides de type III à base d'éthylène glycol (EG) ne semblent pas avoir été aussi touchées par les paramètres environnementaux analysés. De nombreux autres facteurs environnementaux ont été examinés, mais ils n'ont pas été jugés aussi significatifs que ceux mentionnés précédemment.

APS, le National Center for Atmospheric Research, TC et la FAA devraient poursuivre leurs efforts communs afin d'élaborer d'autres essais sur les durées d'endurance dans la neige artificielle comme outil pour établir les durées d'efficacité. Il est aussi recommandé de recueillir des données sur la vitesse du vent et la dimension des particules dans le cadre de futurs efforts de recherche dans des conditions de neige naturelle liés au programme de développement de la neige artificielle afin de valider les effets observés sur la variance des durées d'endurance.

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EXECUTIVE SUMMARY

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APS conducted 139 natural snow characterization tests comprising 52 test runs during the 2018-19 and 2019-20 winters. The test runs consisted of standard endurance time tests with three reference fluids; additional environmental and fluid layer data was collected during each test to allow for investigation into factors that contribute to variance in natural snow endurance time testing. Data packages containing the full complement of environmental data were assembled for each of the test runs performed.

Analysis of the data collected identified several environmental parameters that contribute to variance in the fluid endurance time performance. The effects of the identified environmental parameters differed for each of the three fluids tested. The primary environmental parameter affecting the variance in the propylene glycol (PG) Type II data set was identified as wind speed. The primary environmental parameters affecting the variance in the PG Type IV data set were identified as wind speed and particle size. The ethylene glycol (EG) Type III data set was found to not have been as significantly affected by the environmental parameters analysed. Many additional environmental factors were examined, but were found to not be as consistently significant as those previously mentioned.

It is recommended that APS, National Center for Atmospheric Research, TC, and the FAA continue their joint efforts in developing artificial snow endurance time testing as a tool for holdover time development. It is also recommended that wind speed and particle size data be collected during future natural snow testing related to the artificial snow development program, in order to further validate the observed effects on endurance time variance.

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SOMMAIRE

Au cours de l'hiver 2018-2019, Transports Canada (TC) et la Federal Aviation Administration (FAA) ont chargé APS Aviation Inc. (APS) de réaliser des essais de caractérisation de la neige naturelle afin d'étudier les facteurs influant sur la variance dans les durées d'endurance dans des conditions de neige naturelle.

APS a effectué 139 essais de caractérisation de la neige naturelle, dont 52 essais de fonctionnement au cours des hivers 2018-2019 et 2019-2020. Les essais de fonctionnement consistaient en des essais standards sur les durées d'endurance avec trois liquides de référence; des données supplémentaires sur l'environnement et la couche de liquide ont été recueillies durant chaque essai afin d'étudier les facteurs contribuant à la variance des durées d'endurance dans des conditions de neige naturelle. Des ensembles contenant l'intégralité du complément de données environnementales ont été assemblés pour chacun des essais effectués.

L'analyse des données recueillies a permis de cerner plusieurs paramètres environnementaux qui contribuent à la variance des durées d'endurance d'un liquide. Les effets des paramètres environnementaux relevés diffèrent pour chacun des trois liquides mis à l'essai. Le principal paramètre environnemental influant sur la variance dans les données sur les liquides de type II à base de propylène glycol (PG) est la vitesse du vent. Les principaux paramètres environnementaux influant sur la variance dans les données sur les liquides de type IV à base de PG sont la vitesse du vent et la dimension des particules. Les données sur les liquides de type III à base d'éthylène glycol (EG) ne semblent pas avoir été aussi touchées par les paramètres environnementaux analysés. De nombreux autres facteurs environnementaux ont été examinés, mais ils n'ont pas été jugés aussi systématiquement significatifs que ceux mentionnés précédemment.

APS, le National Center for Atmospheric Research, TC et la FAA devraient poursuivre leurs efforts communs afin d'élaborer d'autres essais sur les durées d'endurance dans la neige artificielle comme outil pour établir les durées d'efficacité. Il est aussi recommandé de recueillir des données sur la vitesse du vent et la dimension des particules dans le cadre de futurs essais dans des conditions de neige naturelle liés au programme de développement de la neige artificielle afin de valider les effets observés sur la variance des durées d'endurance.

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GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
EG	Ethylene Glycol
ET	Endurance Time
FAA	Federal Aviation Administration
HOT	Holdover Time
NCAR	National Center for Atmospheric Research
NRC	National Research Council Canada
OAT	Outside Air Temperature
PG	Propylene Glycol
TC	Transport Canada

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1. INTRODUCTION

Under winter precipitation conditions, aircraft are cleaned prior to takeoff. This is typically done with aircraft ground deicing fluids, which are freezing point depressant fluids developed specifically for aircraft use. If required, aircraft are then protected against further accumulation of precipitation by the application of aircraft ground anti-icing fluids, which are also freezing point depressant fluids. Most anti-icing fluids contain thickeners to extend protection time.

Prior to the 1990s, aircraft ground de/anti-icing had not been extensively researched. However, following several ground icing related incidents in the late 1980s, an aircraft ground icing research program was initiated by Transport Canada (TC). The objective of the program is to improve knowledge, improve safety, and enhance operational capabilities of aircraft operating in winter precipitation conditions.

Since its inception in the early 1990s, the aircraft ground icing research program has been managed by TC, with the co-operation of the United States Federal Aviation Administration (FAA), the National Research Council Canada (NRC), several major airlines, and de/anti-icing fluid manufacturers.

There is still an incomplete understanding of some of the hazards related to aircraft ground icing. As a result, the aircraft ground icing research program continues, with the objective of further reducing the risks posed by the operation of aircraft in winter precipitation conditions.

Under contract to the TC Innovation Centre, with support from the FAA William J. Hughes Technical Center, TC Civil Aviation, and FAA Flight Standards – Air Carrier Operations, APS Aviation Inc. (APS) carried out research in the winter of 2019-20 in support of the aircraft ground icing research program. Each major project completed as part of the 2019-20 research is documented in a separate individual report. This report documents the artificial snow research project.

1.1 Background

APS has been involved in artificial snow research for almost two decades, conducting numerous artificial snow equipment assessments, tests, and analyses on behalf of TC and the FAA. Development of artificial snow testing capabilities has been a priority for TC and the FAA for many years, as testing in artificial snow can be conducted at any time of year (not just winter) and test variables such as temperature and precipitation rate can be tightly controlled. In addition, holdover times (HOTs) could potentially be determined with fewer tests, as testing in natural conditions is conducted over a range of uncontrolled temperatures and precipitation rates. Testing in artificial snow need only be conducted at the boundary conditions of each HOT table cell (tests are conducted at the lowest temperature in the cell: two tests at the low precipitation rate and two tests at the high precipitation rate).

Despite significant research efforts, correlation between natural and artificial snow data has not been sufficiently positive for artificial snow data to replace natural snow data in the derivation of HOTs. As a result, regulators have not been willing to publish fluid-specific HOTs derived from artificial snow data.

As a result of other pressing research priorities, artificial snow research has been limited in recent years. However, in the winter of 2016-17, various industry stakeholders (fluid manufacturers, operators) called on TC and the FAA to renew their research efforts in this area. As a result, artificial snow research initiatives were reinitiated in the winter of 2017-18. This work was documented in the TC report, TP 15399E, *Artificial Snow Research Activities for the 2017-18 Winter* (1) and resulted in the creation and development of a new multi-year research plan, which commenced in the winter of 2018-19.

1.2 Objectives

The detailed objectives of this project are provided in Appendix A, in an excerpt from the related TC statement of work for the winters of 2018-19 and 2019-20.

In summary, TC and the FAA tasked APS to conduct natural snow characterization testing to investigate factors affecting variance in natural snow endurance time test results.

This report documents the work completed by APS to meet these project objectives.

1.3 Report Format

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

- Section 2 describes the testing methodology and the data collected for the natural snow characterization project that was conducted in the winters of 2018-19 and 2019-20;
- Section 3 describes the global data set analysis conducted in 2019-20 as part of the natural snow characterization project;
- Section 4 describes the point-to-point comparative analysis conducted in 2019-20 as part of the natural snow characterization project;
- Section 5 describes the conclusions reached following the completion of the natural snow characterization project; and
- Section 6 lists recommendations for future work relating to artificial snow development.

2. NATURAL SNOW CHARACTERIZATION TESTING – TESTING METHODOLOGY AND DATA

This section documents the test methodology and the data collected as part of the natural snow characterization project during the winters of 2018-19 and 2019-20.

2.1 Background

There is an ongoing effort involving APS, TC, the FAA, and the National Center for Atmospheric Research (NCAR) to further develop the artificial snow machine for use as a tool in HOT development. Despite significant research efforts, correlation between natural and artificial snow data has remained challenging. As a result, regulators have not been willing to publish fluid-specific HOTs derived from artificial snow data.

As part of the continued effort to improve the correlation between natural and artificial snow data, it was determined that there would be value in conducting natural snow endurance time tests with a limited subset of fluids to better understand the factors affecting variance in natural snow endurance time test results. To assist with this goal, NCAR installed various environmental sensors at the APS test site. These sensors will provide APS with additional real-time, localized environmental data. The output from these sensors was used to supplement the endurance time test data collected in the winters of 2018-19 and 2019-20 by APS, forming a more robust overall data package for analysis.

2.2 Objective

The primary objective of this research is to conduct natural snow endurance time testing with select anti-icing fluids, with the goal of identifying environmental factors that affect variance in fluid endurance time performance.

2.3 Methodology

This subsection describes the overall approach, test parameters, and experimental procedure followed during the winters of 2018-19 and 2019-20. For additional information, see the detailed testing procedures included in Appendix B.

APS measurement instruments and test equipment are calibrated and verified on an annual basis. This process is carried out according to a calibration plan derived from approved International Organization for Standardization 9001:2015 standards and developed internally by APS.

2.3.1 Test Location – APS Montréal–Pierre Elliott Trudeau International Airport Test Site

Fluid endurance time testing during natural snow conditions was conducted by APS personnel at the APS test site located at the Montréal–Pierre Elliott Trudeau International Airport in Montreal. The location of the test site is shown on the plan view of the airport in Figure 2.1.

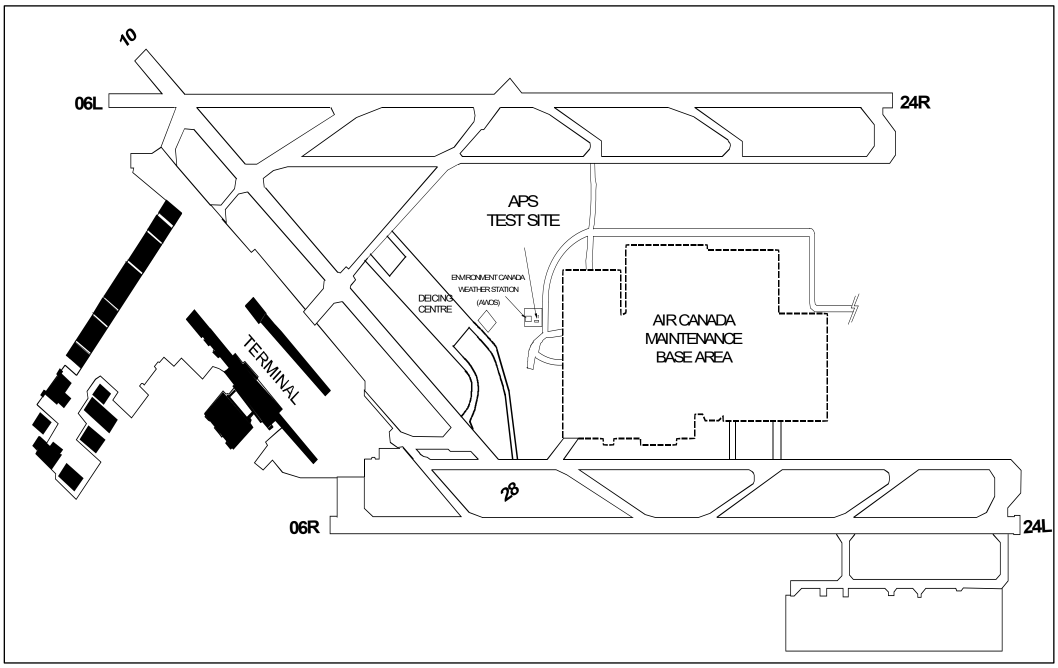

Figure 2.1: Plan View of APS Montréal–Pierre Elliott Trudeau International Airport Test Site

2.3.2 Test Methodology

The general premise of the natural snow characterization testing was to conduct standard natural snow endurance time tests, with additional environmental and fluid layer data being recorded. The environmental data package was supplemented using data collected from environmental sensors installed at the test site. The fluid layer data package was supplemented by making additional manual measurements of certain fluid layer characteristics, as well as by capturing the fluid failure progression using a revised photography process.

The general natural snow endurance time testing procedure is described in the APS procedure, *Endurance Time Testing in Natural Snow with SAE Type I, II, III, and IV De/Anti-Icing Fluids* (included in Appendix B). While the above-mentioned procedure provided the basis for this testing, several modifications to this procedure were made relating to set-up and secondary data collection. These modifications are described in the following subsections, and they are detailed in-depth in the APS procedure, *Natural Snow Characterization Endurance Time Testing* (also included in Appendix B).

2.3.2.1 Test Surface Set-Up

A total of four standard aluminum test plates (each inclined at 10°) were used for this testing. The test stand set-up is depicted below in Figure 2.2.

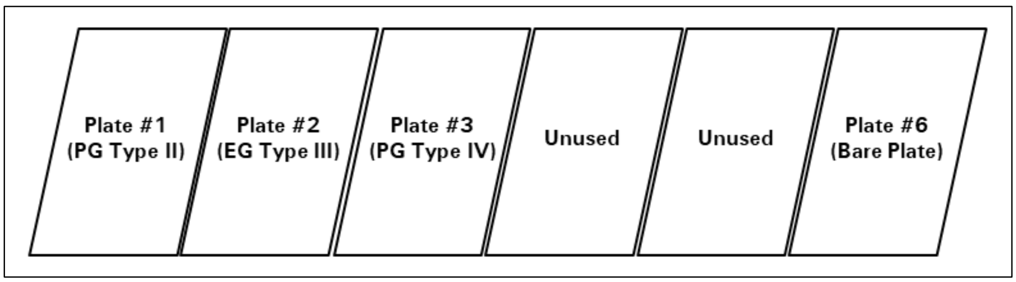

Figure 2.2: Natural Snow Characterization Test Stand Set-Up

Fluid and plate positions were kept static to simplify data handling. The plate on position six was kept bare to assess the characteristics of the snowfall on an untreated surface.

2.3.2.2 Photography Set-Up and Equipment

Each test run was documented photographically to allow for a thorough review of each run during the analysis phase of this research activity.

The photographic equipment used for the testing includes the following:

1. DSLR camera: Used to document the fluid failure progression on each plate during the testing process;
2. GoPro™ cameras: Used to capture time-lapse imagery of plates one, two, and three during the testing process; and
3. PowerShot™ camera: Used to document the snowflake morphology during the testing process.

Figure 2.3 depicts the test stand photography set-up for this project.

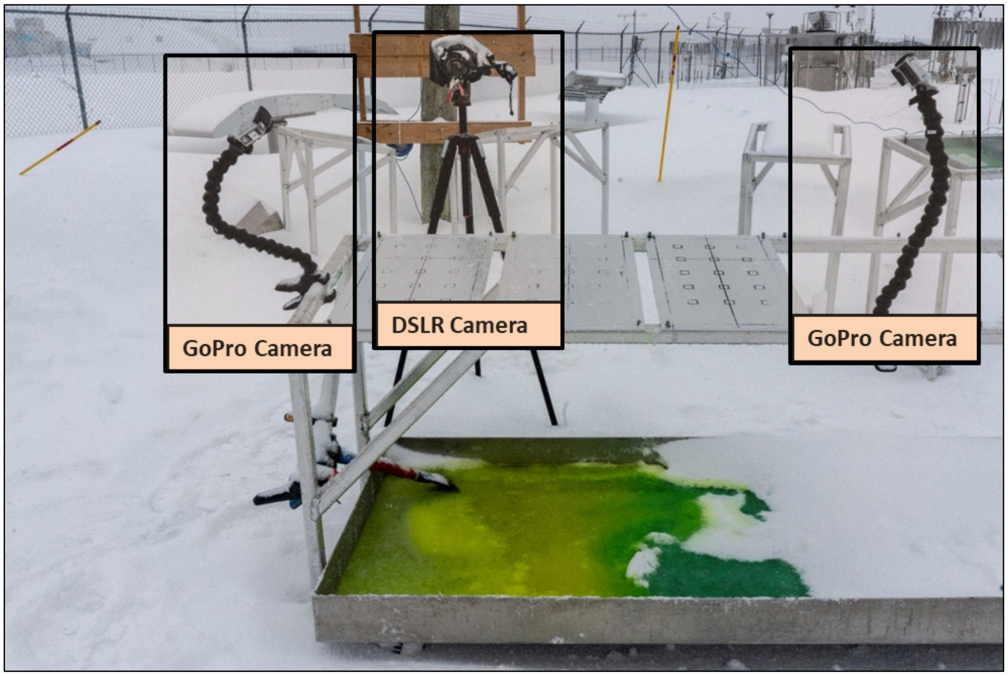

Figure 2.3: Test Stand Photography Set-Up

2.3.3 Fluids

Testing was conducted using neat, mid-production viscosity samples of currently commercialized anti-icing fluids. Three fluids were specifically selected for this testing to ensure diversity of fluid type, fluid formulation (propylene vs. ethylene glycol), and fluid endurance time performance. The selected fluids are listed below in Table 2.1.

Table 2.1: List of Fluids for Natural Snow Characterization Testing

Fluid Test Name	Fluid Type	Fluid Formulation	Fluid Dilution	Viscosity Profile
PG Type II	II	Propylene Glycol	100	Mid-Production
EG Type III	III	Ethylene Glycol	100	Mid-Production
PG Type IV	IV	Propylene Glycol	100	Mid-Production

Natural snow characterization data collection took place over two winters (2018-19 and 2019-20). As such, the viscosity of the test fluids was measured periodically to ensure that no degradation of the fluids had taken place. The measured viscosity results are shown below in Table 2.2.

Table 2.2: Natural Snow Characterization Test Fluid Viscosity Results

	Test #1		Test #2		Test #3	
Fluid	**Test Date**	**Test Result (cP)**	**Test Date**	**Test Result (cP)**	**Test Date**	**Test Result (cP)**
PG Type II	15-May-19	**14,380**[(1)]	10-Jul-19	**14,340**[(1)]	22-Oct-19	**14,900**[(1)]
EG Type III	19-Feb-19	**16,500**[(2)]	17-May-19	**15,400**[(2)]	24-Oct-19	**15,700**[(2)]
PG Type IV	8-Jan-19	**15,000**[(1)]	15-May-19	**15,360**[(1)]	22-Oct-19	**15,520**[(1)]

[1] LV1 (with guard leg), 600 mL beaker, 575 mL fluid volume, 20°C, 0.3 rpm, 10 minutes, method error ± 200 cP
[2] SC4-31/13R, small sample adapter, 9 mL fluid volume, 0°C, 0.3 rpm, 65 minutes, method error ± 2,000 cP

As the viscosities of the test fluids showed minimal change from their initial measurements to the measurements made in October 2019, the samples were suitable for testing for the 2019-20 winter.

2.3.3.1 Environmental Sensor Set-Up

To ensure that a complete set of high-quality environmental data could be captured during each test run, NCAR installed several environmental sensors at the APS test site. The sensors that were used are as follows:

1. WS600 Multi-Parameter Weather Sensor: Used to measure the temperature, wind speed, wind direction, barometric pressure, and relative humidity within the area surrounding the test surfaces;
2. GEONOR Rain Gauge: Used to measure snowfall; and
3. Parsivel[2] Disdrometer: Used to measure the particle size distribution and rate of the falling snow.

The sensors are respectively depicted in Figure 2.4, Figure 2.5, and Figure 2.6.

Figure 2.4: WS600 Multi-Parameter Weather Sensor

Figure 2.5: GEONOR Rain Gauge

Figure 2.6: Parsivel^2 Disdrometer

2.3.4 Procedure Modifications for 2019-20 Data Collection

The following modifications were made to the testing procedure after the 2018-19 testing season was completed, and they were in place for all natural snow characterization data collection that took place during the 2019-20 testing season.

1) The snowflake morphology photography, previously captured using a PowerShot™ camera, was captured with a DSLR camera inside a specialized structure designated for photography only. A felt pad used to observe the snowflakes was kept inside this unheated structure to ensure that the snowflake photography was not affected by the temperature of the testing trailer. The intent of the change was to obtain more standardized output from the snowflake morphology photography process.
2) A field was added to the testing data form to allow the testing manager to indicate the relative difficulty of each failure call at the time that it is performed. The intent of the change was to provide additional context to the failure calls to complement the data analysis packages.
3) Fluid thickness measurements at failure were added to the testing process, in addition to the regularly scheduled thickness measurements. The intent of the change was to provide a more complete measure of the fluid thickness profile of each fluid during each test.

2.4 Data

This subsection describes the natural snow characterization data collected during the winters of 2018-19 and 2019-20.

2.4.1 Data Log

A total of 139 natural snow characterization tests composing 52 test runs were conducted in 2018-19 and 2019-20. The majority of the test runs consisted of three individual tests, one for each fluid being tested (PG Type II, EG Type III, and PG Type IV). Several early 2018-19 test runs consisted of only two tests as the PG Type II fluid was received later in the 2018-19 test season.

A log containing details on all natural snow characterization runs conducted is provided in Appendix C.

2.4.2 Data Packages

A data package has been assembled for each of the tests conducted with each fluid. The contents of each data package are summarized below in Table 2.3.

The data packages for the PG Type II runs, the EG Type III runs, and the PG Type IV runs are provided in Appendices D, E, and F, respectively.

Table 2.3: Summary of Data Package Contents

Data Package Element	Description
General Test Information	Contains general details including test number, date, start and end times, environmental data averages, fluid Brix at failure, ET, and expected ET based on regression analysis.
Precipitation Rate Chart	Depicts the average test rate, the APS pan-measured precipitation rate, and the precipitation rate measured by the Parsivel[2] sensor during the test run.
Temperatures Chart	Depicts the average test temperature (as measured by Environment Canada), the plate temperature, and the temperature measured by the WS600 sensor during the test run.
Wind Speeds Chart	Depicts the average test wind speed (as measured by Environment Canada), as well as the average wind speed and maximum wind speed recorded each minute by the WS600 sensor during the test run.
Wind Direction Chart	Depicts the wind direction recorded each minute by the WS600 sensor during the test run.
Relative Humidity Chart	Depicts the relative humidity recorded each minute by the WS600 sensor during the test run.
Barometric Pressure Chart	Depicts the barometric pressure recorded each minute by the WS600 sensor during the test run.
Fluid Layer Thickness Progression Chart	Depicts the fluid layer thickness measurements taken during the test run.
Fluid Brix Progression Chart	Depicts the fluid Brix measurements taken during the test run.
Particle Size Distribution Chart	Depicts the distribution of the snow particle sizes recorded by the Parsivel[2] sensor during the test run.
Failure Progression Photos	Depicts the progression of the fluid failure on the test surface in a series of photos.
Snow Characteristics Photos	Depicts the felt pad and bare plate photos captured during the test run.

2.4.3 Natural Snow Results and Regression Curves

Regression analysis was performed on the data sets collected with each fluid to generate regression curves in accordance with the standard HOT analysis methodology. The regression analysis methodology for deriving HOT regression curves is described within the APS report, *Methodology for Endurance Time Testing of Type II, III, and IV Fluids, Winter 2019-20* (included in Appendix B).

Table 2.4 provides the outputs from the regression analyses. Figure 2.7, Figure 2.8, and Figure 2.9 present the endurance time data included in the regression analyses with each of the three fluids tested.

Data points collected at temperatures below -16°C were excluded from the regression analyses for the PG Type II and PG Type IV fluids (consistent with how standard warm snow HOT data sets are handled). Data points at all temperatures were included in the regression analysis for the EG Type III data, as this fluid was found to exhibit temperature-independent characteristics.

The data set used for the PG Type II regression analysis included two runs that were conducted with a separate batch of the PG Type II fluid. These runs were conducted before the receipt of the test batch of the PG Type II fluid, and they are identified in the test log included in Appendix C.

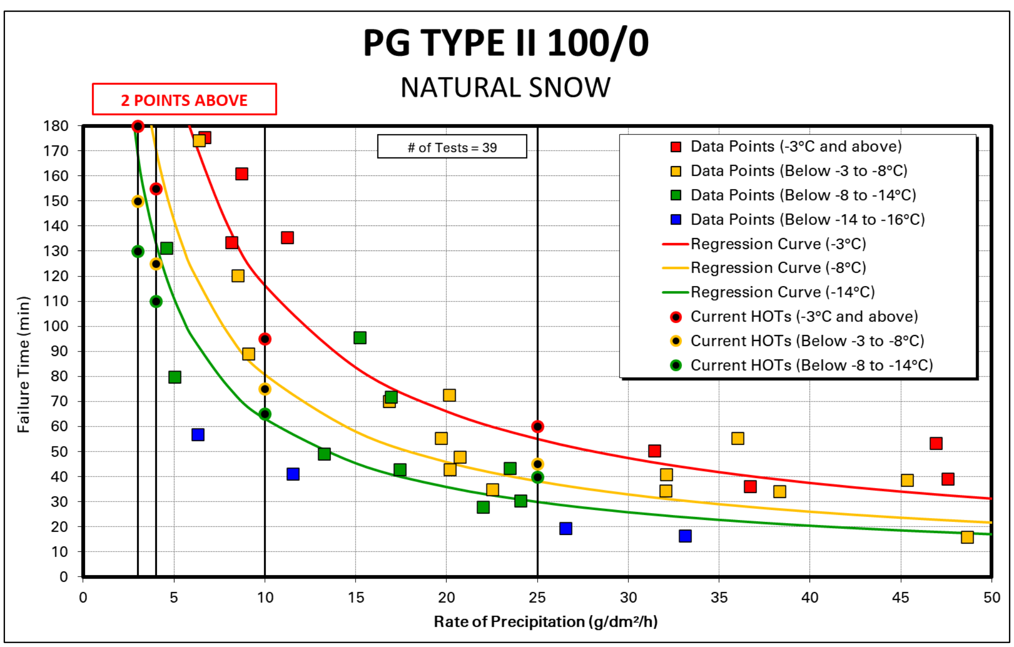

Figure 2.7: PG Type II 100/0 Natural Snow Characterization Test Results

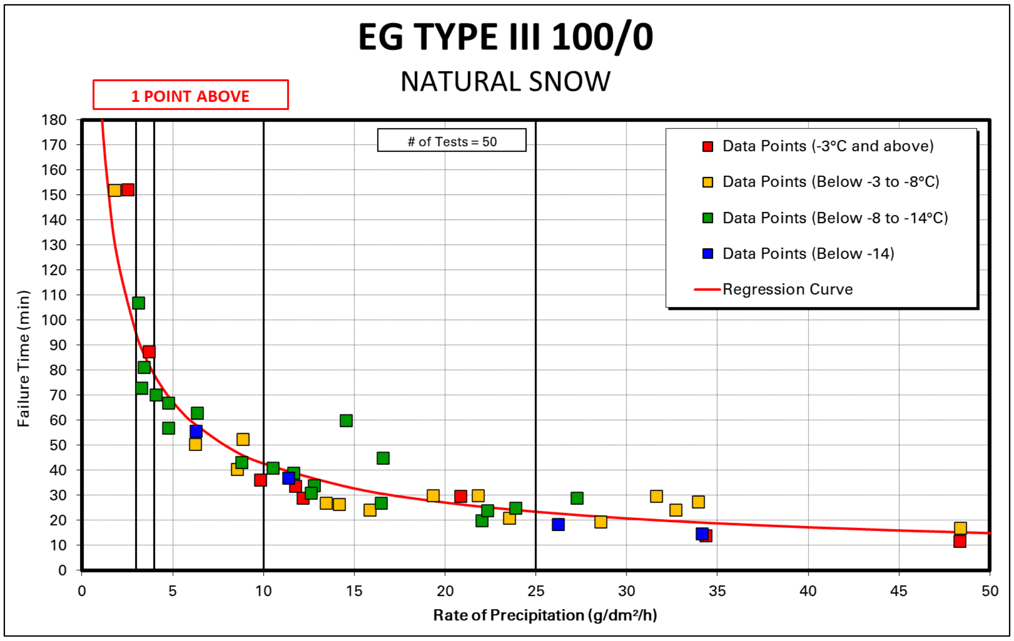

Figure 2.8: EG Type III 100/0 Natural Snow Characterization Test Results

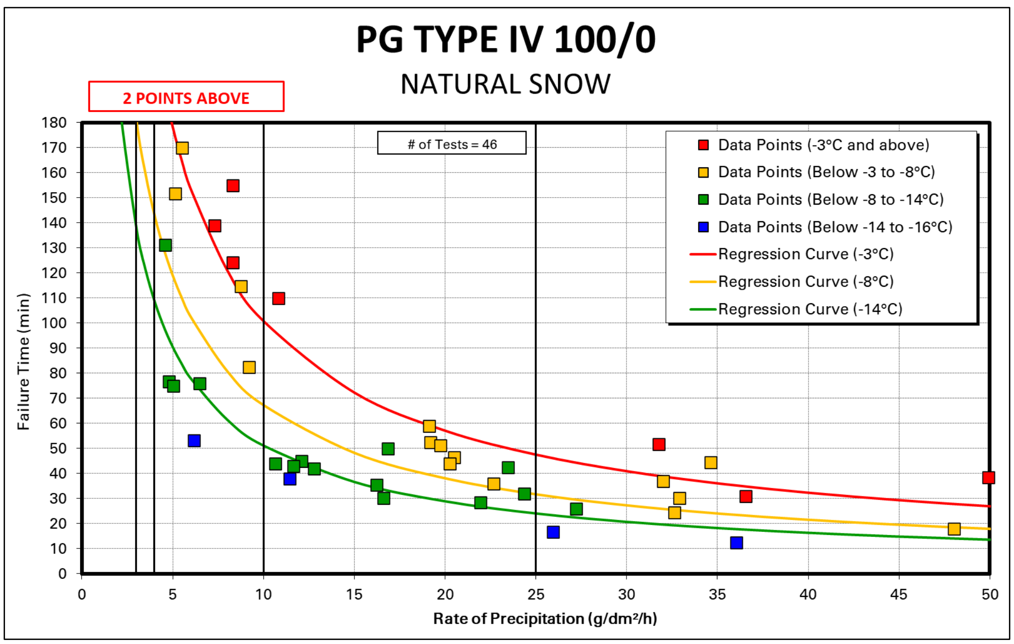

Figure 2.9: PG Type IV 100/0 Natural Snow Characterization Test Results

Table 2.4: Natural Snow Characterization Regression Equation Coefficients

Fluid	Dil.	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Coeff. Temp. (B)	Total Pts.
PG Type II[1]	100%	≥ -14°C	85%	3.2499	-0.8159	-0.5720	39
EG Type III[2]	100%	All	90%	2.2860	-0.6566	N/A	50
PG Type IV[1]	100%	≥ -14°C	90%	3.2306	-0.8210	-0.5820	46

[1] Standard HOT Regression Equation Format: $t = 10^{I}\, R^{A}\, (2\text{-}T)^{B}$

[2] Temperature-Independent HOT Regression Equation Format: $t = 10^{I}\, R^{A}$

2.4.4 Status of Natural Snow Characterization Data Sets

A natural snow data set used to derive natural snow HOTs through multi-variable regression analysis should include data collected across a range of temperatures and precipitation rates. This is necessary to ensure that the output of the derived regression equation is appropriate and can be applied across the same range of temperatures and precipitation rates.

Although it was not the intent of this research activity to derive natural snow HOTs for the fluids being tested, the outputs from the multi-variable regression analyses were used as a baseline for comparison within the global data set analysis described in Section 3.

Table 2.5 provides the recommended natural snow data requirements for regression analysis of a neat anti-icing fluid, categorized by temperature and precipitation rate. The table also provides the data counts for each fluid tested in these respective categories. The data requirements were met in all categories for all fluids, except for the very light snow requirement for the PG Type II fluid data set (one data point was collected, while the target was two data points).

Table 2.5: Natural Snow Characterization Data Sets Analysis

Temperature / Rate Criteria	Minimum Data Points Required for Neat Fluid	Current Data Point Total – PG Type II	Current Data Point Total – EG Type III	Current Data Point Total – PG Type IV
≥-3°C	4	8	9	8
<-3 to -8°C	6	17	18	17
<-8 to -13°C	4	10	19	17
<-13 to -16°C	1	4	4	4
0 to 4 g/dm²/h	2	**1**	7	2
>4 to 10 g/dm²/h	5	10	10	12
>10 to 25 g/dm²/h	5	15	20	18
>25 to 40 g/dm²/h	2	8	8	9
>40 g/dm²/h	1	5	5	5

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3. NATURAL SNOW CHARACTERIZATION – GLOBAL DATA SET ANALYSIS

This section describes the global data set analyses performed on the natural snow characterization data sets.

3.1 Background

Anti-icing fluid endurance time performance in snow is primarily determined by precipitation rate and by ambient temperature. This characteristic is reflected in the current HOT regression methodology: HOT regression equations include coefficients for precipitation rate and temperature, but not for any other environmental parameters.

Unique regression equations have been derived for each anti-icing fluid that has undergone HOT testing through regression analysis of the endurance time data set collected with the fluid. These regression equations quantify the effects of precipitation rate and temperature on a given fluid's endurance time performance. As such, they can be used to predict a given fluid's endurance time performance in snow, provided that the precipitation rate and temperature are known.

Variance in anti-icing fluid performance in snow can be defined as the deviation between measured endurance time at a specific precipitation rate and temperature and the expected time derived from a fluid's regression equation at the same precipitation rate and temperature. The term *variance* in this context is illustrated in Subsection 3.4.1. As the regression equation is believed to accurately encapsulate the effects of precipitation rate and temperature on endurance time performance, any deviation from this expectation is therefore considered to be due to other environmental factors. Furthermore, the magnitude of an endurance time test result's deviation from its corresponding regression prediction can be seen as an indication of how significantly these other factors impacted the test result.

This principle can be used to investigate the impact of environmental factors on endurance time performance by assessing which factors have a statistically significant relationship with the variance seen in the endurance time test data collected.

This analysis used multiple linear regression to investigate these relationships on a global data set level and, as such, has been titled the global data set analysis.

3.2 Analysis Objective

The objective of the analysis was to use multiple linear regression to assess the impact of various environmental parameters on endurance time test variance within the data sets collected as part of the natural snow characterization project.

3.3 Data

All of the natural snow characterization test data that was included within the HOT regression curves described in Subsection 2.4.3 was used within the global data set analysis. As such, PG Type II and PG Type IV data points that were collected at temperatures below -16°C were excluded from this analysis.

3.4 Analysis Methodology

This subsection describes the methodology employed for the global data set analysis.

3.4.1 Quantifying Variance in Endurance Time Testing

To assess variance within the data set through linear regression, endurance time variance must first be quantified so that it can be used as the dependent variable within a regression analysis.

For a given test, endurance time variance due to factors other than temperature or precipitation rate can be quantified by expressing the difference between the measured endurance time (ET_M) and the regression-expected endurance time (ET_{Reg}) as a percentage of the ET_{Reg}. This value can be expressed as either a positive or a negative value, depending on if the endurance time was longer or shorter than the regression-expected endurance time.

A sample endurance time variance calculation is shown below in Figure 3.1.

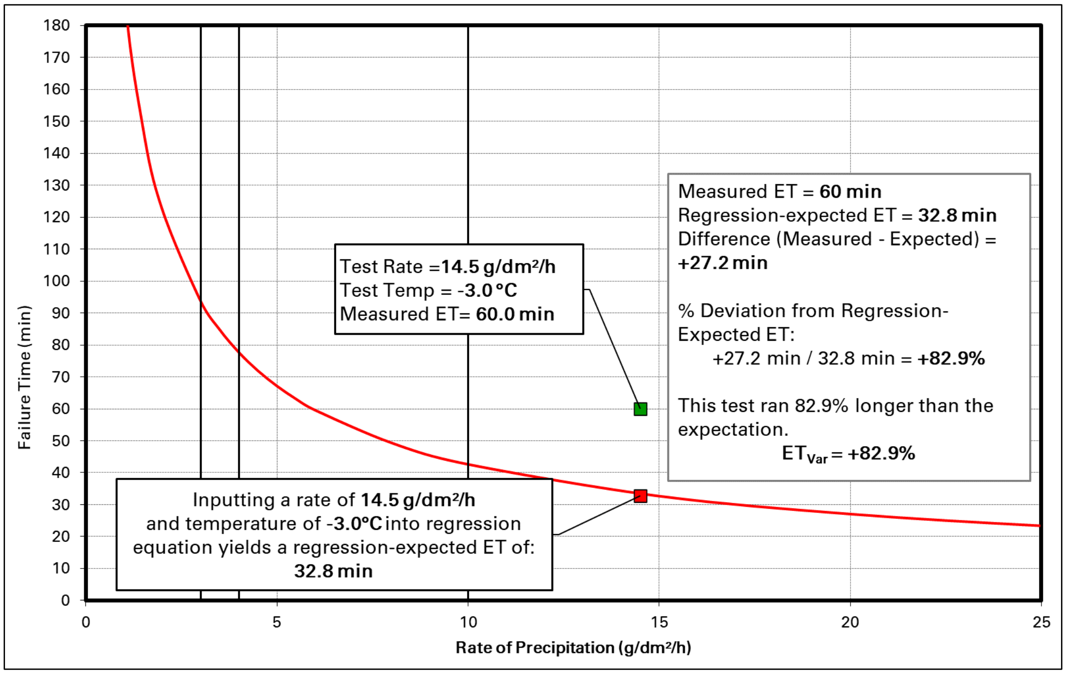

Figure 3.1: Endurance Time Variance Calculation Example

This endurance time variance calculation was performed for each test conducted with the three reference fluids. The calculated endurance time variance provides a quantitative measure for how much each test was affected by environmental parameters unrelated to precipitation rate and temperature. It should be noted that the endurance time variance metric was created specifically for use in this analysis; it is not related to statistical variance.

3.4.2 Assessing Factors Contributing to Variance

Regression analysis was performed with each of the fluid data sets using the calculated test endurance time variances as the dependent variable and various environmental parameters from the test run data packages as independent variables.

Each test run with a given fluid was included in this analysis, provided that the full slate of environmental parameter data was available for that test (there were a small number of tests where this information was not available, generally due to sensor malfunction at the time the test was conducted).

Table 3.1 below lists the different parameters included in the regression analyses as independent variables. The data sets used for the regression analyses are included in Appendix G.

Table 3.1: Independent Variables in the Global Data Set Analysis

Parameter	Description
Average Wind Speed	The average wind speed recorded by the WS600 sensor during the test.
Average Particle Size	The average bin size of all snow particles measured by the Parsivel^2 disdrometer during the ET test. A description of the bin sizes can be found in within the data package appendices (Appendix D, E, and F).
Final Rate vs. Average Rate	The difference between the final measured precipitation rate (APS pan rate) during the test and the calculated average precipitation rate for the entire test.
Rate Standard Deviation	The standard deviation of the individual precipitation rate measurements (APS pan rate).
Relative Humidity	The average relative humidity recorded by the WS600 sensor during the test.
Barometric Pressure	The average barometric pressure recorded by the WS600 sensor during the test.
Day/Night	The time at which the test took place, recorded as a binary value (1 for daytime, 0 for nighttime). Tests occurring primarily between 6:00 AM and 5:59 PM were categorized as "Day." Tests occurring primarily between 6:00 PM and 5:59 AM were categorized as "Night."
Precipitation Rate	The average precipitation rate during the test (APS pan rate). This was included as a control variable.
Test Temperature	The average ambient temperature during the test. This was included as a control variable.

The outputs of the initial regression analyses were reviewed to determine which independent variables demonstrated a statistically significant link to change in the calculated endurance time variances within each fluid data set.

Statistical significance was assessed by reviewing the R-square of the regression analysis, as well as the individual p-values assigned to each independent variable included within the regression model.

The R-square was used to confirm that the observed differences in the individual test endurance time variances could be attributed to the independent variables included in the analysis.

The p-values were used to evaluate the relationship between the individual variables and the endurance time variances. A p-value of less than 0.05 indicates that the null hypothesis (the assumption that a given independent variable has no effect on the dependent variable) can be rejected for the independent variable in question.

Following the review of the initial regression analysis output for each data set (where all listed independent variables were included), the regression model for each fluid data set was refined by removing the independent variables that were found to not have a significant relationship with the endurance time variance. This included the control variables, average precipitation rate and average temperature, as would be expected. The regression analysis on the endurance time variances was then repeated with only the statistically significant variables for further validation.

It should be noted that the goal of these analyses was not to conclusively model the relationship between the environmental parameters and the endurance time variance; the intent was only to identify which parameters are linked to the endurance time variance in a meaningful way.

3.5 Analysis Results and Findings

This subsection describes the results of the analysis for each of the fluid data sets.

3.5.1 Global Data Set Analysis Results – PG Type II

For the PG Type II fluid, the initial regression model including all of the independent variables listed in Table 3.1 yielded the regression outputs seen below in Table 3.2. Of all the parameters included in the initial model, only average wind speed was found to have a statistically significant link to change in the endurance time variance. The regression analysis was then repeated with average wind speed as the only independent variable. The regression outputs from this subsequent analysis are seen below in Table 3.3.

Removing the nonsignificant variables decreased the R-square of the regression model from 59 percent to 50 percent; however, the p-value associated with the average wind speed also decreased (from 3.28×10^{-5} to 6.48×10^{-7}). The refined model explained slightly less of the change in the endurance time variance (as indicated by the lower R-square) but it also revealed a greater likelihood that the relationship between wind speed and endurance time variance within the PG Type II data set is statistically significant.

Table 3.2: Global Data Set Analysis Multiple Regression Results – PG Type II

R-Square of Regression	# of Tests	Dependent Variable
59%	37*	ET Variance
Independent Variables		**Parameter p-Value**
Average Wind Speed		3.28×10^{-5}
Average Particle Size		0.742
Final Rate vs. Average Rate		0.726
Rate Standard Deviation		0.920
Average Relative Humidity		0.269
Average Barometric Pressure		0.618
Day/Night		0.378
Average Precipitation Rate		0.922
Average Test Temperature		0.113
*A total of 39 tests were conducted with the PG Type II fluid. Two tests were omitted from the analysis due to incomplete environmental data.		

Table 3.3: Global Data Set Analysis Refined Regression Results – PG Type II

R-Square of Regression	# of Tests	Dependent Variable
50%	38*	ET Variance
Independent Variable		**Parameter p-Value**
Average Wind Speed		6.48×10^{-7}
*A total of 39 tests were conducted with the PG Type II fluid. One test was omitted from the analysis due to incomplete environmental data.		

3.5.2 Global Data Set Analysis Results – EG Type III

For the EG Type III fluid, the initial regression model including all of the independent variables listed in Table 3.1 yielded the regression outputs seen below in Table 3.4.

Of all the parameters included in the initial model, only average wind speed was found to have a statistically significant link to change in the endurance time variance.

The regression analysis was then repeated with average wind speed as the only independent variable. The regression outputs from this subsequent analysis are seen below in Table 3.5.

Removing the nonsignificant variables from the analysis decreased the R-square of the regression model from 36 percent to 5 percent. The refined model accounts for only a very small amount of the observed change in the endurance time variance metric, which indicates that there is no strong relationship between endurance time variance and average wind speed.

Ultimately, none of the parameters evaluated in the EG Type III data set were found to have statistically significant links to the endurance time variance.

Table 3.4: Global Data Set Analysis Multiple Regression Results – EG Type III

<table>
<tr><th>R-Square of Regression</th><th># of Tests</th><th>Dependent Variable</th></tr>
<tr><td>36%</td><td>48*</td><td>ET Variance</td></tr>
<tr><th colspan="2">Independent Variables</th><th>Parameter
p-Value</th></tr>
<tr><td colspan="2">Average Wind Speed</td><td>0.0184</td></tr>
<tr><td colspan="2">Average Particle Size</td><td>0.379</td></tr>
<tr><td colspan="2">Final Rate vs. Average Rate</td><td>0.351</td></tr>
<tr><td colspan="2">Rate Standard Deviation</td><td>0.914</td></tr>
<tr><td colspan="2">Relative Humidity</td><td>0.229</td></tr>
<tr><td colspan="2">Barometric Pressure</td><td>0.107</td></tr>
<tr><td colspan="2">Day/Night</td><td>0.142</td></tr>
<tr><td colspan="2">Precipitation Rate</td><td>0.303</td></tr>
<tr><td colspan="2">Test Temperature</td><td>0.162</td></tr>
<tr><td colspan="3">*A total of 50 tests were conducted with the EG Type III fluid. Two tests were omitted from the analysis due to incomplete environmental data.</td></tr>
</table>

Table 3.5: Global Data Set Analysis Refined Regression Results – EG Type III

R-Square of Regression	# of Tests	Dependent Variable
5%	49*	ET Variance
Independent Variable		**Parameter p-Value**
Average Wind Speed		0.133
*A total of 50 tests were conducted with the EG Type III fluid. One test was omitted from the analysis due to incomplete wind speed data.		

3.5.3 Global Data Set Analysis Results – PG Type IV

For the PG Type IV fluid, the initial regression model including all of the independent variables listed in Table 3.1 yielded the regression outputs seen below in Table 3.6.

Of all the parameters included in the initial model, only average wind speed and average particle size were found to have a statistically significant link to change in the endurance time variance. The regression analysis was then repeated with average wind speed and average particle size as the only independent variables. The regression outputs from this subsequent analysis are seen below in Table 3.7.

Removing the nonsignificant variables decreased the R-square of the regression model from 48 percent to 41 percent; however, the p-values associated with both average wind speed and average particle size remained below the 0.05 threshold for statistical significance. This outcome suggests that both average wind speed and average particle size are linked to the endurance time variance for the PG Type IV data set.

Table 3.6: Global Data Set Analysis Multiple Regression Results – PG Type IV

R-Square of Regression	# of Tests	Dependent Variable
48%	44*	ET Variance
Independent Variables		**Parameter p-Value**
Average Wind Speed		0.0338
Average Particle Size		0.00352
Final Rate vs. Average Rate		0.583
Rate Standard Deviation		0.417
Relative Humidity		0.800
Barometric Pressure		0.507
Day/Night		0.682
Precipitation Rate		0.698
Test Temperature		0.335
*A total of 46 tests were conducted with the PG Type IV fluid. Two tests were omitted from the analysis due to incomplete environmental data.		

Table 3.7: Global Data Set Analysis Refined Regression Results – PG Type IV

R-Square of Regression	# of Tests	Dependent Variable
41%	44*	ET Variance
Independent Variables		**Parameter p-Value**
Average Wind Speed		0.00508
Average Particle Size		0.00298
*A total of 46 tests were conducted with the PG Type IV fluid. Two tests were omitted from the analysis due to incomplete environmental data.		

3.6 Observations

The environmental parameters that were found to have a statistically significant effect on the variance in the endurance time data sets differed for each of the three fluids tested.

- For the PG Type II fluid, average wind speed was found to have a statistically significant effect on the endurance time variance.
- For the EG Type III fluid, no variable was found to have a statistically significant effect on the endurance time variance.
- For the PG Type IV fluid, average wind speed and average particle size were found to have a statistically significant effect on the endurance time variance.

The other parameters examined (rate variance, relative humidity, barometric pressure, and daytime testing vs. nighttime testing) were not found to have statistically significant effects on the endurance time variance in the data sets collected.

4. NATURAL SNOW CHARACTERIZATION – POINT-TO-POINT ANALYSIS

This section documents the point-to-point analysis completed as part of the natural snow characterization work completed in the winters of 2018-19 and 2019-20.

4.1 Analysis Background

As mentioned in the introduction, fluids qualified for use as de/anti-icing aircraft fluids have gone through a series of tests to ensure they meet industry specifications and standards. The endurance time data obtained for fluids used in this research was collected following that same methodology. This data was then plotted to obtain fluid regression curves and used for this analysis. Ideally, the same fluid tested under identical temperatures and precipitation rates should give rise to the same HOT value. However, this is not always the case. Some discrepancies in endurance times have been obtained for many tested fluids, and the fluids used in this study are no exception. The differences in measured endurance times are considered to be due to environmental factors other than temperature and precipitation rate. Therefore, an in-depth analysis based on a point-to-point comparative analysis on data points with differing endurance times but similar temperatures and precipitation rates should aid in identifying the underlying parameters affecting this variance.

4.2 Analysis Objective

The primary objective of the point-to-point analysis was to determine environmental parameters that influence natural snow endurance times.

4.3 Data and Data Selection Methodology

To identify data points that were strong candidates for comparison, the data collected with each fluid was reviewed and suitable pairs of tests were identified using the following criteria[1]:

1) Similar Test Rate (± ≈15%);
2) Similar Test Temperature (± ≈17.5%); and
3) Differing Endurance Times (> 17.5%).

[1] *Note: A small number of data points lay outside the range of these criteria.*

Also included in this analysis was one pairing for each fluid where Criterion 1 and Criterion 2 were slightly modified to approximately ± 25% but where Criterion 3 had very similar endurance times (< ≈20%). This pairing was included for control purposes.

Table 4.1 below lists all the test pairings satisfying the above criteria that were identified within the data set.

The data point pairings for each fluid are shown in the context of their regression curves in Figure 4.1, Figure 4.2, and Figure 4.3.

Table 4.1: List of Test Pairings Included in Point-to-Point Analysis

Pairing Number	Fluid	Test 1 (Run #)	Test 1 Rate ($g/dm^2/h$)	Test 1 Temperature (°C)	Test 1 ET (Min)	Test 2 (Run #)	Test 2 Rate ($g/dm^2/h$)	Test 2 Temperature (°C)	Test 2 ET (Min)
1*	PG Type II	PG2-13	22.5	-7.4	35.0	PG2-11	20.2	-5.9	43.0
2	PG Type II	PG2-35	24.1	-8.7	30.5	PG2-5	23.5	-8.2	43.5
3	PG Type II	PG2-14	9.1	-7.1	89.0	PG2-2	8.5	-7.8	120.3
4	PG Type II	PG2-32	13.2	-9.9	49.0	PG2-3	15.2	-11.5	95.5
5	PG Type II	PG2-33	17.4	-9.6	43.0	PG2-4	16.9	-9.8	71.8
6	PG Type II	PG2-11	20.2	-5.9	43.0	PG2-28	20.1	-5.8	72.5
7	PG Type II	PG2-7	38.3	-7.2	34.2	PG2-6	32.1	-6.5	41.0
8	PG Type II	PG2-7	38.3	-7.2	34.2	PG2-29	36.0	-6.1	55.3
9	PG Type II	PG2-4	16.9	-9.8	71.8	PG2-3	15.2	-11.5	95.5
10	PG Type II	PG2-12	48.6	-6.7	16.0	PG2-8	45.3	-7.3	38.7
11*	EG Type III	EG3-8	11.7	-10.7	39.0	EG3-7	10.5	-10.8	41.0
12**	EG Type III	EG3-2	7.6	-19.4	110.0	EG3-1	6.7	-21.2	150.0
13	EG Type III	EG3-6	4.8	-10.4	67.0	EG3-10	3.4	-9.2	81.2
14	EG Type III	EG3-11	8.8	-8.1	43.3	EG3-23	8.9	-7.1	52.5
15	EG Type III	EG3-44	12.6	-9.9	31.0	EG3-12	14.5	-11.6	60.0
16	EG Type III	EG3-40	14.2	-5.6	26.3	EG3-20	19.3	-5.7	30.0
17	EG Type III	EG3-45	16.5	-9.6	27.0	EG3-13	16.6	-10.0	44.8
18	EG Type III	EG3-47	22.0	-8.7	20.0	EG3-14	23.9	-8.5	24.8
19	EG Type III	EG3-14	23.9	-8.5	24.8	EG3-5	27.3	-8.6	29.0
20	EG Type III	EG3-41	28.5	-6.0	19.4	EG3-16	33.9	-7.1	27.5
21	EG Type III	EG3-16	33.9	-7.1	27.5	EG3-15	31.6	-6.5	29.7
22*	PG Type IV	PG4-6	5.0	-10.5	75.0	PG4-3	6.5	-11.8	76.0
23	PG Type IV	PG4-6	5.0	-10.5	75.0	PG4-10	4.6	-9.0	131.2
24	PG Type IV	PG4-28	8.3	-1.6	124.1	PG4-45	8.3	-0.3	155.0
25	PG Type IV	PG4-11	9.2	-8.0	82.3	PG4-23	8.8	-7.1	114.7
26	PG Type IV	PG4-20	20.2	-5.9	44.0	PG4-37	19.1	-5.7	59.0
27	PG Type IV	PG4-44	24.4	-8.7	32.0	PG4-14	23.5	-8.2	42.5
28	PG Type IV	PG4-16	32.6	-7.1	24.5	PG4-15	32.0	-6.5	37.0
29	PG Type IV	PG4-5	27.2	-8.6	26.0	PG4-14	23.5	-8.2	42.5
30	PG Type IV	PG4-16	32.6	-7.1	24.5	PG4-38	34.6	-6.0	44.5

** **Note 1**: These tests were conducted with the same temperature and rate but similar endurance times as a control test.*
*** **Note 2**: This test was conducted in very cold temperatures compared to rest of data.*

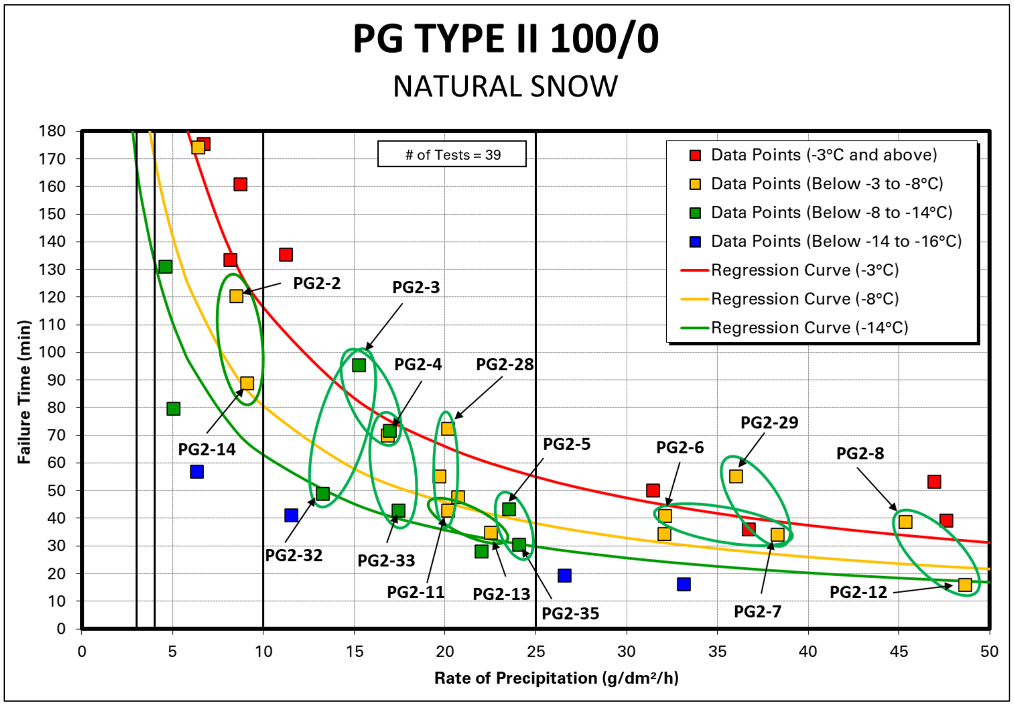

Figure 4.1: PG Type II Regression Curve with Point-to-Point Analysis Pairings Identified

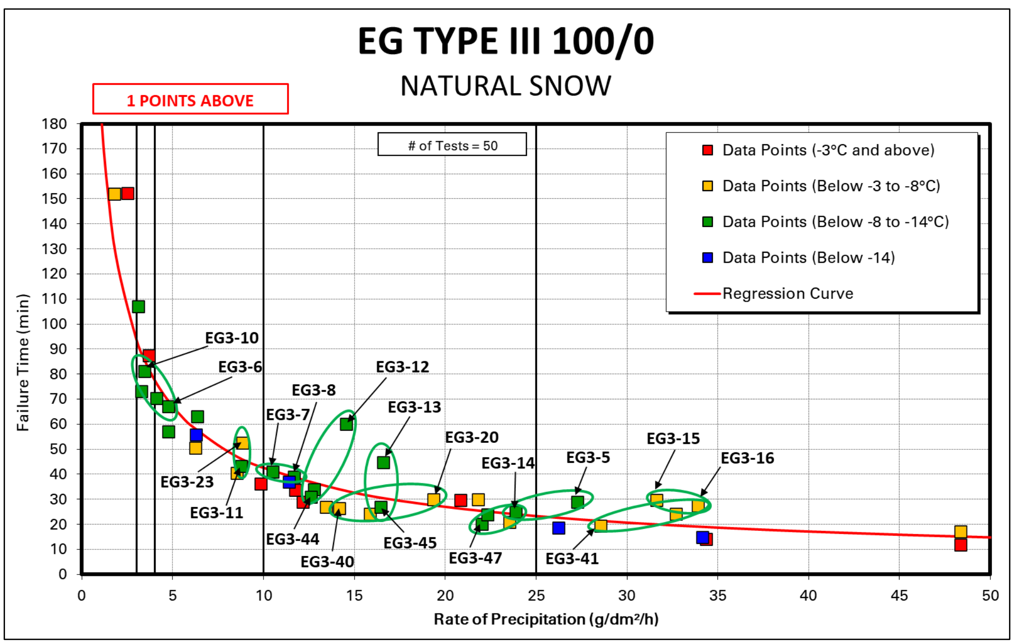

Figure 4.2: EG Type III Regression Curve with Point-to-Point Analysis Pairings Identified

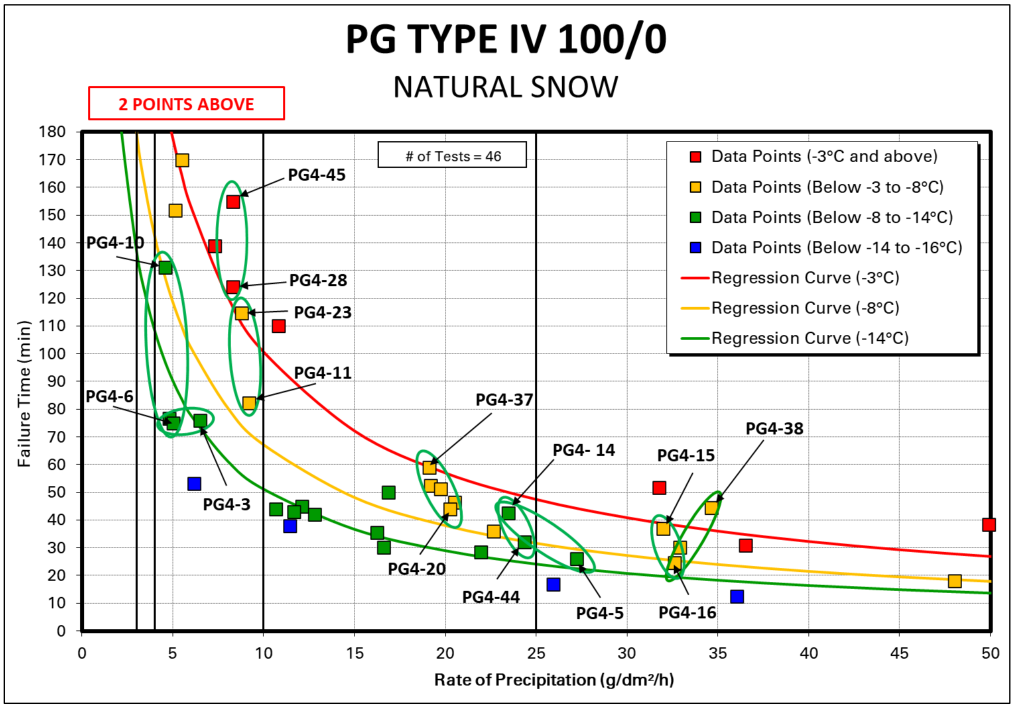

Figure 4.3: PG Type IV Regression Curve with Point-to-Point Analysis Pairings Identified

4.4 Analytical Methodology

HOT regression curves are generated based on data obtained by varying the temperature and precipitation rate for a specific type of precipitation and fluid. All other factors that may affect the regression curve are not directly accounted for due to their significantly lower impacts. Ideally, any variable that has the possibility of influencing the final regression of a fluid should be considered. However, if the impacts are minimal and pose no substantial risk to the industry, they can generally be disregarded. Still, for the purpose of this research, which is to better correlate natural snow testing with the artificial snow machine, all variables that can affect the HOT regression curve were determined with the goal to maximize effectiveness.

The collection of data involved the standard methodology for the collection of HOT data, augmented with additional data collection capabilities described in Subsection 2.3. An example of the list of variables is illustrated in Table 4.2.

Table 4.2: List of Variables Obtained for Each Test Run

Variable
Date
OAT (°C)
Average Rate (g/dm^2/hr)
Fail Time (min)
Brix @ Fail (°)
Average Wind Speed (km/hr)
Wind Direction (°)
Average Snowflake Size (Bin)
Thickness @ 5 Mins (mm)
Thickness @ Mid Test (mm)
Thickness @ Fail (mm)
Rate Last 15 Mins (g/dm^2/hr)
Failure Call By
Day/Night
Amount of Precipitation on Bare Plate at End of Test (mm)
Average Humidity (%)
Average Pressure (hPa)

4.4.1 Effects of Variables on Endurance Time

To characterize the effect of each variable on a fluid's endurance time, each variable was observed to produce a particular impact. The following is a list of variables and their potential impacts or implications on the endurance time of a fluid.

4.4.1.1 Precipitation Rate

If the variance during the last 15 minutes of a test has a higher rate compared to the average, the endurance time may be shortened. The opposite also holds true.

4.4.1.2 Wind Direction

No effect is expected on the endurance time of a fluid since the testing stands were always positioned into the wind (head wind).

4.4.1.3 Wind Speed

The wind speed may have a two-pronged effect on the endurance time of a fluid. High wind speeds may cause the fluid to remain on the test plate for an extended period (preventing runoff) while simultaneously warming up the fluid due to convection and viscous drag. These effects increase the endurance time of the fluid and decrease its concentration (measured Brix) at fail. The opposite may also hold true.

4.4.1.4 Particle Size

Large particles size may decrease the rate of fluid absorption due to the decreased surface area available compared to smaller particles. Large snowflakes will cause the fluid to reach failure earlier, as unabsorbed particles contribute to visual failure. Smaller snowflakes will produce the opposite effect. See Appendix H for a mathematical proof concerning total surface area available for absorption between different particle sizes.

4.4.1.5 Initial Fluid Temperature

A cooler initial fluid temperature may increase the fluid thickness on the plate due to the higher fluid viscosity, decreasing fluid runoff. The opposite may also hold true.

4.4.1.6 Plate Temperature (Thermal Analysis)

The plate temperature will be cooler than the Outside Air Temperature (OAT) if no/low winds are present due to sensible cooling of the fluid. As a snowflake (solid) enters the fluid (liquid), a phase change occurs due to the lower freezing point of the fluid mixture, which consists of mostly glycol. Going from a solid to a liquid phase, the process is endothermic and results in a cooler plate temperature than the OAT. Observations should also be made regarding the last 10 minutes of the test where less melting occurs resulting in an increase in plate temperature.

4.4.1.7 Time of Testing (Day or Night)

Daytime testing may result in a warmer plate temperature since thermal radiation from the atmosphere can warm up the fluid. The reverse is also true of nighttime testing.

4.4.1.8 Failure Calls

Failure calls may vary depending on personnel. The same person should determine or validate all failure times to maintain consistency.

4.4.1.9 Bare Plate

If precipitation accumulates on the bare plate during a testing event, it may indicate two potential causes. The first may be a greater amount of water content within the precipitation than usual. The precipitation would effectively "stick" to the plate when contact occurs. The second may be low wind speeds. A low wind speed would not provide enough kinetic energy for the snow to overcome the frictional forces of the plate; thus, it would remain on the plate.

4.4.1.10 Outdoor Ambient Temperature

The variance in OAT may affect the endurance time of a fluid. If the OAT increases in temperature during testing, the effect may be an increase in endurance time or vice versa.

4.4.2 Determination of Trends

By considering the above-mentioned impacts when evaluating a selected test pairing, the variables affecting the observed differences in endurance time performance were determined. This process was repeated for each identified pairing, and the findings were tallied to determine if any trends could be found.

It is important to note that, when analysing individual tests in a pairing, many variables may simultaneously affect the endurance time of the fluid. In these cases, only the net effect of the combined variables is observed on the test plate.

4.5 Analysis Examples

The following subsections detail several examples of a point-to-point analysis and have been included to demonstrate the analytical methodology.

Note that the examples included below are in summary form; detailed versions of these examples containing the full set of analytical observations have been included within Appendix I.

In addition, summaries of each point-to-point analysis have been included within Appendix J.

4.5.1 Example 1 – Pairing #6 (Test PG2-11 vs. Test PG2-28)

Using the analytical methodology presented in Subsection 4.4, the relevant variables for each test pairing were identified and compiled. Table 4.3 depicts these variables for Test PG2-11 vs. Test PG2-28.

Table 4.3: List of Variables for Pairing #6 – Point-to-Point Comparison

Variable	Test PG2-11	Test PG2-28
Date	21-Feb-19	07-Feb-20
OAT (°C)	-5.9	-5.8
Average Rate (g/dm^{2}hr)	20.2	20.1
Endurance Time (min)	43	72.5
Brix @ Fail (°)	14	13
Average Wind Speed (km/hr)	15.5	38.1
Wind Direction (°)	Varies between 95 and 72	17
Thickness @ 5 Mins (mm)	1.2	1.5
Estimated Thickness @ Mid Test (mm)	1.55	1.45
Thickness @ Fail (mm)	1.6	3.3
Average Snowflake Size (Bin)	6.3	6.87
Rate Last 15 Mins	At Average – 21.64	Above Average – 27.19
Failure Call By	Senior Observer	Senior Observer
Day/Night	Night	Day
Accumulation of Precipitation on Bare Plate at End of Test (mm)	1.25	0
Average Humidity (%)	85	90
Average Pressure (hPa)	1012	983

Test PG2-11 had an endurance time of 43 minutes, while Test PG2-28 had an endurance time of 72.5 minutes. The average precipitation rates and average test temperatures were similar for both tests.

Overall, the key variables to consider for the endurance time extension of Test PG2-28 are the higher wind speed, thermal radiation from daytime testing, and possibly the rate variance. The combined effects of thermal radiation and convective heat transfer supply the system with energy, which effectively keeps the fluid at a warmer temperature and closer to OAT compared to Test PG2-11. In addition, the higher wind speeds experienced in Test PG2-28 may also extend the endurance time by preventing fluid runoff. In so doing, more precipitation would be required to achieve fluid failure. Finally, the rate variance may also contribute to the extended endurance time in Test PG2-28 by maintaining a lower average rate for the first half of the run compared to Test PG2-11. When combined, all key variables – namely, wind speed, daytime testing, and rate variance – aid in extending the endurance time of Test PG2-28 while the opposite also holds true of Test PG2-11.

4.5.2 Example 2 – Pairing #23 (Test PG4-6 vs. Test PG4-10)

Using the analytical methodology presented in Subsection 4.4, the relevant variables for each test pairing were identified and compiled. Table 4.4 depicts these variables for Test PG4-6 vs. Test PG4-10.

Table 4.4: List of Variables for Pairing #23 – Point-to-Point Comparison

Variable	Test PG4-6	Test PG4-10
Date	29-Jan-20	02-Feb-20
OAT (°C)	-10.5	-9
Average Rate (g/dm^2/hr)	5	4.6
Fail Time (min)	75	131.2
Brix @ Fail (°)	19.5	14
Average Wind Speed (km/hr)	19	26
Wind Direction (°)	Consistent between 28 and 34	Consistent between 230 and 250
Average Snowflake Size (Bin)	9.19	6.68
Thickness @ 5 Mins (mm)	0.7	1
Thickness @ Mid Test (mm)	1	1.1
Thickness @ Fail (mm)	1	1.1
Rate Last 15 Mins	Above Average – 6.91	Above Average – 7.54
Failure Call By	Senior Observer	Senior Observer
Day/Night	Night	Day
Accumulation of Precipitation on Bare Plate at End of Test (mm)	0	0
Average Humidity (%)	83	80
Average Pressure (hPa)	1007	1012

Test PG4-6 had an endurance time of 75 minutes, while Test PG4-10 had an endurance time of 131.2 minutes. The average precipitation rates and average test temperatures were similar for both tests.

The key variables associated with this comparison are the snowflake size and time of testing (day/night). Test PG4-10 had a smaller snowflake size and was conducted during the day, while Test PG4-6 had a larger snowflake size and was performed at night. The combined effects of smaller particle size and thermal radiation supply a greater overall surface area for absorption and increased thermal energy to the system, respectively. This effectively prolongs the endurance time of Test PG4-10 compared to Test PG4-6 and decreases the Brix at fail.

4.6 Analysis – Photographic Evaluation Examples

Photographic evaluations were performed on three point-to-point comparisons to visually illustrate the impacts of variables on the endurance time of a fluid. In addition, a cross-fluid photographic evaluation was conducted to determine fluid effects.

4.6.1 PG Type II Pairing #6 (Test PG2-11 vs. Test PG2-28)

A visual side-by-side comparison was generated to better understand the effects of the key parameters on fluid failure. The key parameters to consider for this comparison are the low wind speed and nighttime testing for Test PG2-11 and vice versa for Test PG2-28.

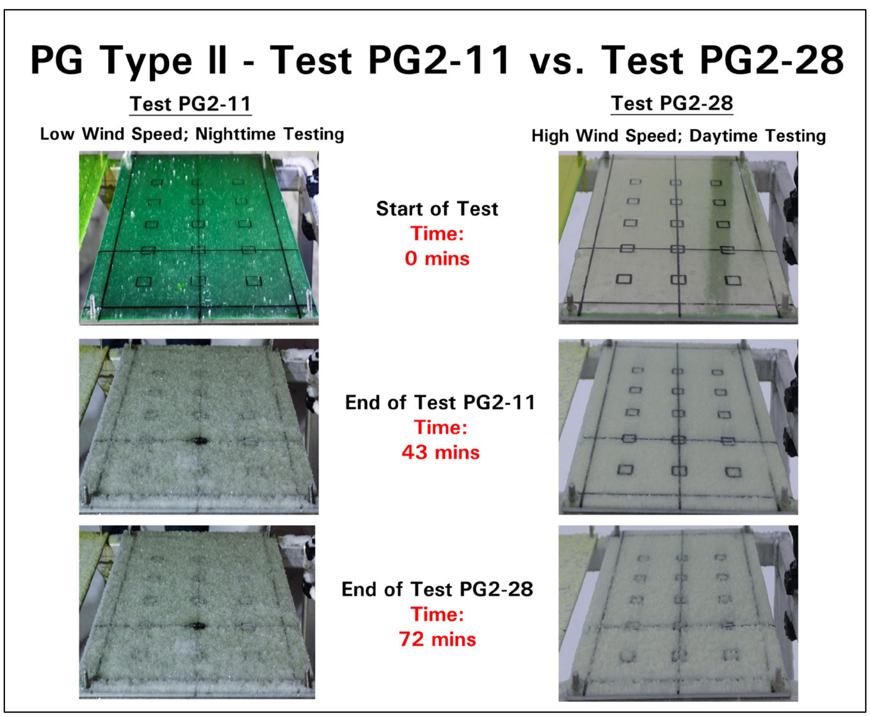

Figure 4.4: Side-by-Side Comparison: PG Type II Pairing #6 – Test PG2-11 vs. Test PG2-28

The comparison in Figure 4.4 illustrates the effects of wind speed and time of testing for each plate. Test PG2-11 shows the snow particles resting on top of the fluid. Test PG2-28 shows more snow embedded within the fluid compared to Test PG2-11. This observation may be the result of the added thermal energy in Test PG2-28 compared to Test PG2-11. The fluid layer becomes slightly cooler than the OAT but, through convective heat transfer and thermal radiation, is warmer when compared to Test PG2-11. This effectively melts the snow particles, which are penetrating the fluid, and delays visual failure, prolonging the endurance time of Test PG2-28, as evidenced by the photo comparison.

4.6.2 PG Type IV Pairing #26 (Test PG4-20 vs. Test PG4-37)

A photographic evaluation was also conducted to determine the effects of the key parameters on fluid failure and fluid type. The key parameters to consider for this comparison are, again, the low wind speed and nighttime testing for Test PG4-20 and vice versa for PG4-37.

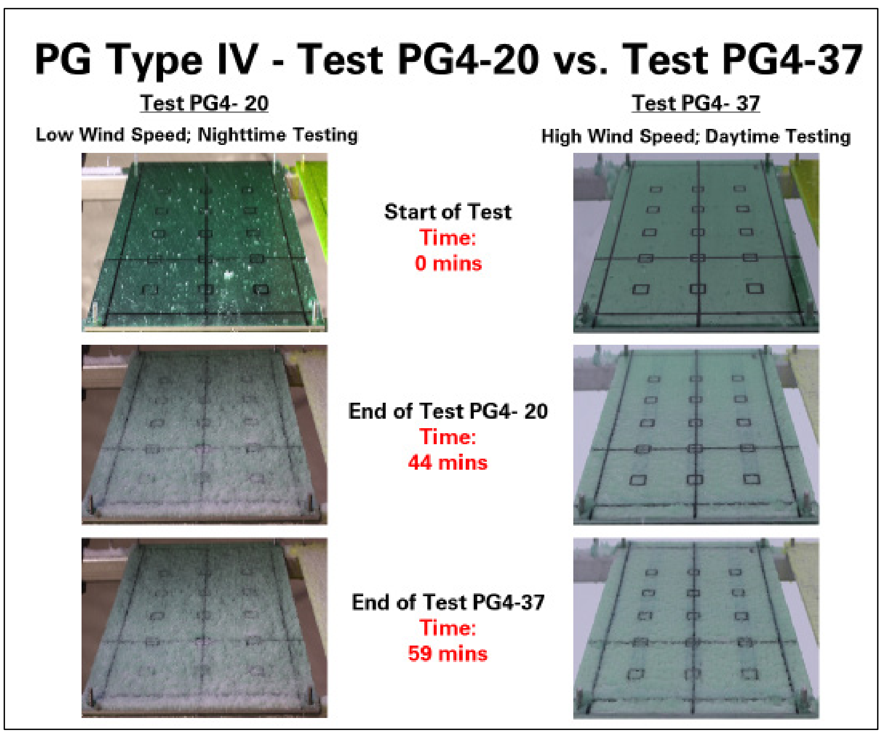

Figure 4.5: Side-by-Side Comparison: PG Type IV Pairing #26 – Test PG4-20 vs. Test PG4-37

Similar to Pairing #6, the comparison in Figure 4.5 illustrates the effects of wind speed and time of testing for each plate. Test PG4-20 shows the snow particles resting on top of the fluid. Test PG4-37 shows that more snow is embedded within the fluid compared to Test PG4-20. This observation may be the result of the added thermal energy in Test PG4-37 compared to Test PG4-20. Through convective heat transfer and thermal radiation, the fluid layer becomes slightly warmer compared to Test PG4-20. This difference in plate temperature gradient, which is on average 1.9°C warmer (in Test PG4-37), is sufficient to effectively melt the snow particles penetrating the fluid and delay visual failure, as evidenced by the photo comparison.

4.6.3 Cross-Fluid Comparison – EG Type III Pairing #16 (Test EG3-40 vs. Test EG3-20)

Pairing #16 was simultaneously tested alongside Pairing #6 and Pairing #26. A photographic evaluation was thus performed to determine the effects of the key parameters on fluid failure and fluid type. The key parameters for this comparison are, again, the low wind speed and nighttime testing for Test EG3-20 and vice versa for Test EG3-40.

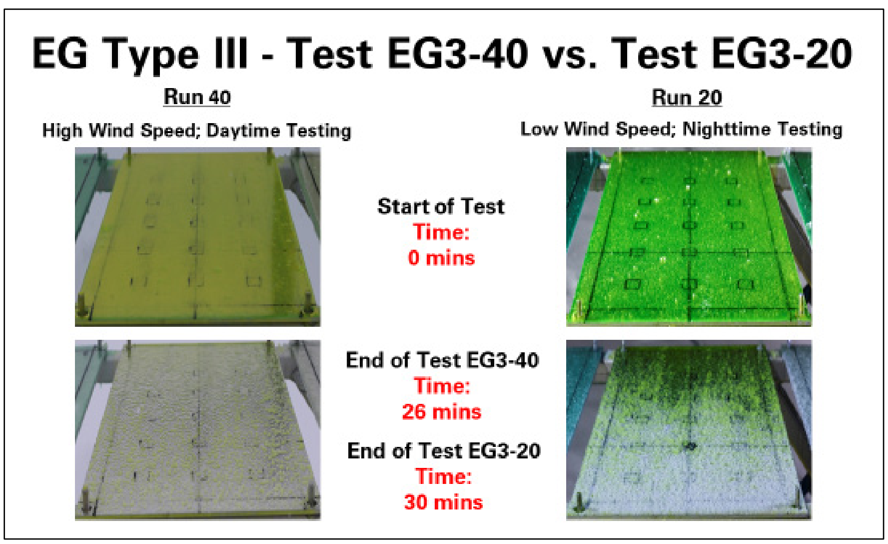

Figure 4.6: Side-by-Side Comparison: EG Type III Pairing #16 – Test EG3-40 vs. Test EG3-20

Figure 4.6 reveals the effects of wind speed and time of testing for each plate. Test EG3-20 shows the snow particles resting on top of the fluid with some bare areas. Similar to Test EG3-20, Test EG3-40 also shows that snow is resting on the fluid with bare areas. With this particular fluid, the added thermal energy in Test EG3-40 compared to Test EG3-20 has little to no effect on the endurance time, which may be due to fluid resistance. Although the fluid temperature is slightly increased through convective heat transfer and thermal radiation in Test EG3-40, the plate temperature gradient alone is not sufficient to affect the endurance time for this fluid type. Therefore, the parameters that affect the PG Type II and IV fluids do not affect the EG Type III fluid. This is a critical finding and must be considered when conducting further research pertaining to the overall scope of this project.

4.7 Analysis – General Findings

The general findings for this analysis were obtained by analysing a total of 30 pairings with 1 pairing for each fluid as a control test. Of the 27 remaining pairs, 9, 8, and 10 pairings were analysed using the Type II, IV, and III, respectively.

4.7.1 General Findings – PG Type II

Table 4.5 displays the findings obtained for each parameter that was flagged and found to be influencing the endurance time variance of a test. Table 4.5, Table 4.6, and Table 4.7, which refer to PG Type II, PG Type IV, and EG Type III, respectively, should be read as follows, using Table 4.5 as an example.

A total of 9 pairings were compared. Of these 9 pairs, the snowflake size was flagged a total of 6 times as a contributor affecting the endurance time. Of these 6 pairs, the larger snowflake size was found to be associated with the longer endurance time in 2 of the 6; the smaller snowflake size was found to be associated with the longer endurance time in 4 of the 6.

Table 4.5: PG Type II – Influence of Parameters on Endurance Time

TYPE II - Point-to-Point Comparison Analysis Summary Total Point-to-Point Comparison Tests Analysed : 9*			
Parameter	**# of Comparisons Where Parameter Was Flagged**	**Specific Parameter**	**Tests Associated with Longer ET**
Snowflake	6 of 9	*Large Snowflakes*	2 of 6
		Small Snowflakes	4 of 6
Wind Speed	6 of 9	*High Wind Speed*	6 of 6
		Low Wind Speed	0 of 6
Initial Fluid Temperature	3 of 9	*Cooler Fluid Temperature Compared to OAT and/or Comparison Test*	1 of 3
		Warmer Fluid Temperature Compared to OAT and/or Comparison Test	2 of 3
Time of Testing	4 of 9	*Day Time Testing*	3 of 4
		Night Time Testing	1 of 4
Rate Last 15 Min	7 of 9	*Greater Rate Last 15 Min*	4 of 7
		Average Rate Last 15 Min	0 of 7
		Lower Rate Last 15 Min	3 of 7
Bare Plate (Possible Indication of Wet Snow)	3 of 9	*Greater Amount of Snow on Bare Plate*	0 of 3
		Smaller Amount of Snow on Bare Plate	3 of 3

** **Note** : One point-to-point comparison (similar point comparison) was not included in this summary table.*

From Table 4.5, the most significant parameter affecting the PG Type II fluid was the wind speed. Specifically, the greater wind speed was always associated with the longer endurance time. Other variables also influenced the endurance time but to a lesser extent. These secondary variables include, but are not limited to, the following:

- Snowflake Size;
- Time of Testing (daytime or nighttime testing); and
- Bare Plate (possible indication of wet snow).

4.7.2 General Findings – PG Type IV

Table 4.6 illustrates the general findings for the PG Type IV fluid.

Table 4.6: PG Type IV – Influence of Parameters on Endurance Time

TYPE IV - Point-to-Point Comparison Analysis Summary Total Point-to-Point Comparison Tests Analysed : 8*			
Parameter	**# of Comparisons Where Parameter Was Flagged**	**Specific Parameter**	**Tests Associated with Longer ET**
Snowflake	6 of 8	*Large Snowflakes*	1 of 6
		Small Snowflakes	5 of 6
Wind Speed	7 of 8	*High Wind Speed*	7 of 7
		Low Wind Speed	0 of 7
Initial Fluid Temperature	4 of 8	*Cooler Fluid Temperature Compared to OAT and/or Comparison Test*	3 of 4
		Warmer Fluid Temperature Compared to OAT and/or Comparison Test	1 of 4
Time of Testing	5 of 8	*Day Time Testing*	3 of 5
		Night Time Testing	2 of 5
Rate Last 15 Min	5 of 8	*Greater Rate Last 15 Min*	3 of 5
		Average Rate Last 15 Min	0 of 5
		Lower Rate Last 15 Min	2 of 5
Bare Plate (Possible Indication of Wet Snow)	3 of 8	*Greater Amount of Snow on Bare Plate*	1 of 3
		Smaller Amount of Snow on Bare Plate	2 of 3

** Note : One point-to-point comparison (similar point comparison) was not included in this summary table.*

The most significant parameters affecting the PG Type IV fluid are the wind speed and the snowflake size. Specifically, the higher wind speed and smaller snowflake size are associated with the longer endurance time of the fluid. Another variable influenced the endurance time but to a lesser extent. This secondary variable includes, but is not limited to, the following:

- Initial Fluid Temperature.

It is important to note that, although the initial fluid temperature is considered a secondary variable, it may have a significant impact on the endurance time of a fluid if not tightly controlled. In a previous study conducted and reported in TC report, TP 14874E, *Effect of Heat on Endurance Times of Anti-Icing Fluids* (2)*,* the author provides some insight on how the endurance time of a fluid is affected when heated. The current endurance time testing protocol outlined in the SAE International (SAE) standard Aerospace Recommended Practice (ARP) 5485, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type II, III, and IV* (3), states that an initial fluid temperature must be within ± 3°C of the OAT. However, the differences in thickness measurements (indicating viscosity differences) observed during this research within this temperature range may be substantial enough to affect the endurance time.

4.7.3 General Findings – EG Type III

Table 4.7 illustrates the general findings for the EG Type III fluid.

Table 4.7: EG Type III – Influence of Parameters on Endurance Time

TYPE III - Point-to-Point Comparison Analysis Summary Total Point-to-Point Comparison Tests Analysed : 10*			
Parameter	**# of Comparisons Where Parameter Was Flagged**	**Specific Parameter**	**Tests Associated with Longer ET**
Snowflake	3 of 10	*Large Snowflakes*	0 of 3
		Small Snowflakes	3 of 3
Wind Speed	3 of 10	*High Wind Speed*	3 of 3
		Low Wind Speed	0 of 3
Initial Fluid Temperature	1 of 10	*Cooler Fluid Temperature Compared to OAT and/or Comparison Test*	1 of 1
		Warmer Fluid Temperature Compared to OAT and/or Comparison Test	0 of 1
Time of Testing	0 of 10	*Day Time Testing*	0 of 0
		Night Time Testing	0 of 0
Rate Last 15 Min	2 of 10	*Greater Rate Last 15 Min*	1 of 2
		Average Rate Last 15 Min	0 of 2
		Lower Rate Last 15 Min	1 of 2
Bare Plate (Possible Indication of Wet Snow)	0 of 10	*Greater Amount of Snow on Bare Plate*	0 of 0
		Smaller Amount of Snow on Bare Plate	0 of 0

*** Note** : *One point-to-point comparison (similar point comparison) was not included in this summary table.*

The most significant parameters affecting the EG Type III fluid are the wind speed and the snowflake size. Specifically, the higher wind speed and smaller snowflake size are associated with the longer endurance time of the fluid.

It is important to note, however, that the number of times the wind speed and snowflake size were flagged as a parameter compared to the number of pairs analysed is significantly less than those observed for the PG Type II and the PG Type IV fluids. This finding also supports the observations from the visual analysis described in Subsection 4.6.3, where the parameters have no effect on the endurance time of the fluid. Therefore, it is reasonable to conclude that the parameters influencing both PG Type II and the PG Type IV fluids have no bearing on the EG Type III fluid.

4.8 Final Observations

Many parameters were investigated to determine their impacts, if any, on the endurance time of a fluid. The following are observations obtained from the point-to-point analysis.

4.8.1 PG Type II

The main parameter affecting the endurance time for the PG Type II fluid is as follows:

- Wind Speed.

Possible secondary parameters include the following:

- Snowflake Size;
- Time of Testing (daytime or nighttime testing); and
- Bare Plate (possible indication of wet snow).

4.8.2 EG Type III

The EG Type III fluid is affected by the following parameters:

- Snowflake Size; and
- Wind Speed.

It is important to note, however, that the parameters affecting the EG Type III fluid are less significant. As stated in Subsection 4.7.3, these variables were only flagged in 3 out of 10 comparisons.

4.8.3 PG Type IV

The PG Type IV fluid is mainly affected by the following parameters:

- Snowflake Size; and
- Wind Speed.

A possible secondary parameter includes the following:

- Initial Fluid Temperature.

4.9 Suggestions

The SAE testing standard ARP5485 (3) indicates that the fluid application temperature must be within 3°C of the OAT for natural snow tests. However, it was observed that differences in fluid application temperature within the acceptable range defined by the SAE standard could produce observable differences in fluid layer thickness, which could in turn affect the fluid endurance time.

It is therefore recommended that further research be conducted to determine how the fluid application temperature affects the endurance time of a fluid.

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5. CONCLUSIONS

The analyses conducted on the natural snow characterization data collected have identified several environmental factors that contributed to variance within the endurance time test results.

The global data set analysis identified which environmental parameters had a statistically significant impact on the endurance time variance, noting that the relevant parameters differed for each of the three fluids tested.

- For the PG Type II fluid, average wind speed was found to have a statistically significant effect on endurance time variance.
- For the EG Type III fluid, no variable was found to have a statistically significant effect on endurance time variance.
- For the PG Type IV fluid, average wind speed and average particle size were found to have a statistically significant effect on endurance time variance.

The other parameters examined (rate variance, relative humidity, barometric pressure, and daytime testing vs. nighttime testing) were not found to have statistically significant effects on the variance in the endurance time data sets collected.

The point-to-point analysis also identified several primary and secondary parameters as having an impact on the endurance time variance within the data collected. The identified parameters differed for each of the three fluids tested.

- For the PG Type II fluid, average wind speed was found to be the primary parameter influencing endurance time variance. Snowflake size, time of testing, rate variance, wet/dry snow, and changing OAT during the test run were identified as possible secondary parameters having a more minor effect.
- For the EG Type III fluid, snowflake size and wind speed were identified as parameters that influenced endurance time variance; however, it was noted that the effects of these parameters were less significant when compared to the effects of the primary parameters identified for the PG Type II and PG Type IV data.
- For the PG Type IV fluid, average wind speed and average particle size were found to be the primary parameters influencing endurance time variance. Initial fluid application temperature, rate variance, and changing OAT during the test run were identified as possible secondary parameters having a more minor effect.

In summary, both analyses demonstrated that wind speed and particle size were the parameters with the greatest effect on endurance time variance. Both analyses also revealed that each fluid tested is affected differently by the parameters that were investigated.

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6. RECOMMENDATIONS

It is recommended that APS, NCAR, TC, and the FAA continue their joint efforts in developing artificial snow endurance time testing as a tool for HOT development.

As the development of the next-generation NCAR snow machine is nearing completion, it is recommended that a round of artificial vs. natural comparison testing be performed to evaluate if the new machine produces results that are well-correlated with natural snow testing.

The comparison testing should include data collection in natural snow conditions with four reference fluids, with the goal of obtaining separate data sets in both warm (≥-14°C) and cold (<-14°C) snow. The natural snow data sets should then be replicated with the artificial snow testing systems to allow for comparison of the HOTs derived from each testing set-up (natural and artificial). This activity is recommended to be completed within the next two years.

It is also recommended that wind speed and particle size data be collected during future natural snow testing related to the artificial snow development program, to further validate the observed effects on endurance time variance.

Additionally, it was observed that differences in fluid application temperature within the acceptable range defined by the SAE standard could produce observable differences in fluid layer thickness, which could in turn affect fluid endurance time. It is therefore recommended that further research be conducted to determine how the fluid application temperature affects the endurance time of a fluid.

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REFERENCES

1. Bendickson, S., Bernier, B., *Artificial Snow Research Activities for the 2017-18 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2018, TP 15399E, 82.

2. Dawson, P., *Effect of Heat on Endurance Times of Anti-Icing Fluids*, APS Aviation Inc., Transportation Development Centre, Montreal, July 2009, TP 14874E, 106

3. Society of Automotive Engineers Aerospace Recommended Practice 5485, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type II, III, and IV*, July 2004.

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APPENDIX A

TRANSPORT CANADA
STATEMENT OF WORK EXCERPT –
AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2018-2019 & 2019-20

TRANSPORT CANADA
STATEMENT OF WORK EXCERPT –
AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2018-19

2. Snow Machine R&D Project: Natural Snow Characterization Testing and Support for NCAR Snow Machine Hardware Improvements

a) Develop and finalize long term testing and development plan.

b) Provide support to NCAR for snow machine hardware and test method improvements including: distribution adjustments, snowflake size, and frosticator gap/plate temperature.

c) Provide failure call training for NCAR personnel.

d) Perform setup and planning activities for natural snow characterization testing including: fluids test selection, development of test plan and procedure, setup for fluids monitoring, setup for environmental monitoring, fluid management, and training.

e) Conduct natural snow characterization testing at P.E.T. airport test site.

f) Coordinate filing, log entry and charting of characterization test data.

g) Conduct preliminary analysis of results.

h) Prepare presentations as required and attend team meetings.

i) Prepare an interim report.

j) Review and modify testing and development plan for the 2019-20 testing season.

TRANSPORT CANADA
STATEMENT OF WORK EXCERPT –
AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2019-20

3. Snow Machine R&D Project: Natural Snow Characterization Testing and Support for NCAR Snow Machine Hardware Improvements (Continuation)

a) Review and modify long term testing and development plan.

b) Provide support to NCAR for snow machine hardware and test method improvements including: distribution adjustments, snowflake size, and frosticator gap/plate temperature.

c) Provide failure call training for NCAR personnel.

d) Review and modify setup and planning activities for natural snow characterization testing including: development of test plan and procedure, setup for fluids monitoring, setup for environmental monitoring, fluid management, and training.

e) Conduct natural snow characterization testing at P.E.T. airport test site.

f) Coordinate filing, log entry, and charting of characterization test data.

g) Conduct analysis of results.

h) Prepare presentations as required and attend team meetings.

i) Prepare report.

j) Review and modify testing and development plan for the 2020-21 testing season.

APPENDIX B

NATURAL SNOW CHARACTERIZATION TESTING – TEST PROCEDURES

- Procedure: Endurance Time Testing in Natural Snow with SAE Type I, II, III, and IV De/Anti-Icing Fluids
- Procedure: Natural Snow Characterization Endurance Time Testing
- Methodology for Endurance Time Testing of Type II, III, and IV Fluids — Winter 2019-20

PROCEDURE:
ENDURANCE TIME TESTING IN NATURAL SNOW
WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

300293

PROCEDURE:

ENDURANCE TIME TESTING IN NATURAL SNOW WITH SAE TYPE I, II, III AND IV DE/ANTI-ICING FLUIDS

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Benjamin Bernier

Reviewed by: John D'Avirro

November 2018
Final Version 1.0

PROCEDURE:
ENDURANCE TIME TESTING IN NATURAL SNOW WITH SAE TYPE I, II, III AND IV DE/ANTI-ICING FLUIDS

1. BACKGROUND

The Society of Automotive Engineers (SAE) has published standards detailing acceptable practices for endurance time testing in natural snow conditions. The Aerospace Recommended Practice (ARP) documents ARP5945 and ARP5485 outline these practices for Type I and Type II/III/IV anti-icing fluids, respectively. These documents set the requirements for fluid samples, testing materials, test conditions, and test practices for anti-icing fluid endurance time testing. These standards are continually reviewed and updated at the discretion of the SAE Holdover Time committee.

APS has been conducting outdoor natural snow endurance time testing with the goal of measuring the effectiveness of new holdover time fluids since the early 1990's. All testing is conducted in accordance with the established SAE standards, ARP5945 and ARP5485.

This procedure serves as an update to the previous APS procedure, *Procedure for Conducting Endurance Time Tests for SAE Deicing/Anti-Icing Fluids – SAE Type II, III and IV*, which was issued in January 2004. This new document serves to incorporate refinements to the procedure that have been made in the intervening years, as well as to provide additional information relating to event planning and APS-specific processes.

2. OBJECTIVE

This procedure describes the testing protocols used to evaluate the endurance time performance of Type I, II, III and IV fluids in natural snow conditions.

3. PRE-TESTING ACTIVITIES

This section describes activities that need to be performed prior to commencing a natural snow testing session.

3.1 Forecasting Natural Snow

Natural snow events are generally identified and monitored up to a week in advance. Storm duration, temperature and expected precipitation type and intensity must all be considered when evaluating a potential event. There are many forecasting resources available, each differing in accuracy and type of information offered. As such, it is generally best to consult multiple sources when attempting to evaluate an upcoming natural snow event.

The weather forecasting resources that are typically used are listed and described below:

3.1.1 Weather Network Montreal Forecast

Found at https://www.theweathernetwork.com/ca/weather/quebec/

The Weather Network forecast contains a wide variety of general weather information for the Montreal area. General forecasts are available for up to 14 days after the search date. Hourly forecasts, including precipitation probabilities and estimated snowfall, are available for up to 72 hours from the search time.

As this forecast covers a relatively long time-period, it can be useful for early identification of upcoming testing opportunities. However, its short-term forecasts tend to be somewhat less accurate than the other forecasts, therefore weather information should be confirmed using another source before making final testing event planning decisions.

3.1.2 Environment Canada Montreal Forecast

Found at http://weather.gc.ca/city/pages/qc-147_metric_e.html/

The Environment Canada forecast provides similar information to the Weather Network forecast and is generally more accurate as the station issuing the reports is located directly adjacent to the APS test site.

General forecasts are available for up to 7 days after the search date. Hourly forecasts are available for up to 24 hours from the search time. Given that the forecasting range is smaller than that of the Weather Network, the Environment Canada forecast is particularly useful in confirming details identified earlier as a prospective snow event approaches.

3.1.3 METAR/TAF Reports

Found at https://flightplanning.navcanada.ca/

In order to access the METAR/TAF reports, select METAR/TAF from the menu and enter CYUL in the aerodrome ID field. Ensure that the output is set to "plain language" in order to obtain the information in an easily comprehensible format.

The TAF is a highly reliable source of short-term forecasting which is issued by airport authorities for use by air operators. Updated forecasts issued every three/four hours and generally provide a forecast for the 24 hours following the time of publication.

A sample TAF report is shown in Figure 3.1. Note that all times listed in the TAF are in UTC (five hours ahead of EST during standard time). Wind direction is measured in degrees clockwise from due north. For example, a wind direction value of 90° would indicate that the wind is blowing due west (originating from due east). Snowfall intensity can be determined by comparing the predicted visibility to the Snowfall Intensities as a Function of Prevailing Visibility Table, published annually in the TC/FAA Holdover Time Guidelines.

TIMES [UTC]	WIND [DEGREES TRUE]	VISIBILITY [STAT. MILES]	WEATHER	CLOUDINESS [FEET AGL]
02 NOV - 1500 to 02 NOV - 1700	150 @ 7 KNOTS	6+	NIL	600 SCATTERED 3000 OVERCAST
TEMPORARY CHANGES 02 NOV - 1500 to 02 NOV - 1700		5	LIGHT RAIN MIST	600 BROKEN 3000 OVERCAST
02 NOV - 1700 to 02 NOV - 2300	180 @ 12 KNOTS	6+	NIL	1500 SCATTERED 2500 OVERCAST
TEMPORARY CHANGES 02 NOV - 1700 to 02 NOV - 2300		5	LIGHT RAIN SHOWER MIST	800 SCATTERED 1500 BROKEN
02 NOV - 2300 to 03 NOV - 0500	180 @ 12 KNOTS	6+	LIGHT RAIN SHOWER	3000 OVERCAST
03 NOV - 0500 to 03 NOV - 1200	190 @ 12 KNOTS	5	LIGHT RAIN MIST	1000 OVERCAST
BECOMING 03 NOV - 0700 to 03 NOV - 0900	260 @ 10 KNOTS			
REMARKS THE NEXT FORECAST WILL BE ISSUED BY 1800 UTC ON DAY 02				

Figure 3.1 – Sample YUL TAF Report

METAR reports are real-time weather bulletins providing similar information to the TAF bulletins. They are issued on the hour, 24 hours a day and are meant to provide real-time weather information to air operators.

In cases where a sudden change in the current weather is observed, a special type of METAR report known as a SPECI is generally issued (this is to ensure that there is always up-to-date information on the current weather available to operators).

These reports can be used to confirm the current weather, particularly when a sudden change is observed. From a testing perspective, they are particularly useful for confirming suspected changes in wind direction or precipitation type.

3.1.4 BUFKIT Software (short-term)

The BUFKIT software package draws data from several meteorological models. The software has a lot of functionality, however due to its complexity it is generally used by APS personnel to estimate total snowfall and corresponding temperatures for discrete one or three hour blocks (depending on the forecasting models used).

Note that BUFKIT forecasting is generally supplementary and is most often used to confirm details on storms for remote testing opportunities, however it can be used to obtain or confirm information relating to snowfall for test events at the APS test site if additional information is desired.

3.1.5 McGill Weather Radar

Found at: http://weather.gc.ca/radar/index_e.html?id=WMN

The McGill weather radar provides a radar view of the island of Montreal and the surrounding area. This view allows the user to visualize the path and intensity of an on-going storm over a one or three hour period.

This resource is primarily used during an event to determine upcoming changes to an on-going storm's intensity. By monitoring the path of the storm throughout the event, sudden changes in precipitation can be predicted and testing plans can be adjusted accordingly.

3.2 Event Coordination

It is the responsibility of the testing manager to determine personnel and appropriate start/end times for each testing session. Arrangements should be made for all personnel to arrive approximately one hour prior to the start of snowfall to allow for sufficient time for set-up activities and to maximize the usable testing time.

If a specific temperature range or snowfall intensity is being targeted, the testing manager can adjust start times such that testing will only begin once the desired conditions are present. It should be noted however that natural conditions can be unpredictable and it is generally better to err on the side of caution (i.e. arrive early in case the weather does not cooperate).

The testing manager should review the fluids planned to be used prior to an event and should have an idea of the expected endurance times of the fluids in the expected snow conditions. This will allow the manager to make informed decisions when determining what tests to pour and in what order. Different fluids will have different measured endurance times and therefore differing test durations; having an understanding of these differences is critical to ensure that testing sessions proceed in an efficient and timely fashion.

The testing manager should also monitor the status of the storm throughout the testing event. Upcoming changes to temperature, wind direction and precipitation rate should be considered when determining what tests to run, in order to avoid unnecessary scrapped tests.

3.3 Data Requirements and Test Planning

The testing manager should be mindful of the data requirements and current data set status for each of the fluids being tested in a given session. This information should be used to steer testing decisions, both when deciding what events to pursue and what tests to run during an event.

3.3.1 Type I Fluid Data Requirements

For Type I fluids, a minimum of 20 natural snow data points is the target for validation of the existing holdover times. Tests run with Type I fluids should be equally divided between aluminium and composite test surfaces (in order to validate both sets of holdover times). Note that for each natural snow test run with a new Type I fluid, a baseline test must be run simultaneously with a known Type I fluid to serve as a point of comparison.

Natural snow data gathered with a specific dilution of a fluid should cover the full range of precipitation rates and temperatures as outlined in the Type I fluid holdover time tables.

3.3.2 Type II/III/IV Fluid Data Requirements

For neat and 75/25 dilutions of Type II/III/IV fluids, a minimum of 25 natural snow data points is required to generate the regression curves that are used to determine the fluid endurance times. For 50/50 dilutions of Type II/III/IV fluids, the minimum is 12 natural snow data points.

Table 3.1 lists the range of ambient temperatures and precipitation rates in which natural snow endurance time testing is conducted with Type II/III/IV fluids.

Table 3.1 – Natural Snow Test Rates and Temperatures for Type II/III/IV Fluids

Fluid Type, Dilution	Air Temperature	Precipitation Rate
Type II/III/IV, Neat	≥2°C below LOUT	Any, ideally 3-25 g/dm²/h
Type II/IV, 75/25	≥-16°C	Any, ideally 3-25 g/dm²/h
Type III, 75/25	≥-12°C	Any, ideally 3-25 g/dm²/h
Type II/III/IV, 50/0	≥-5°C	Any, ideally 3-25 g/dm²/h

Data gathered with a specific dilution of a fluid should cover the full range of precipitation rates and temperatures as outlined in Table 3.1.

3.3.2.1 Very Cold Snow Data Requirements

For the development of the cold snow regression curves that are used to determine fluid specific HOTs, a minimum of 20 natural snow data points, during a minimum of 4 different events, is required.

This testing is optional and at the discretions of the fluid manufacturer.

Table 3.2 lists the recommended minimum data points required to determine fluid specific holdover times for very cold snow.

Table 3.2: Minimum Natural Snow Data Points Required to Determine Fluid-Specific HOTs for Very Cold Snow

Temperature	Precipitation Rate (g/dm²/h)				
	0 to <4	4 to <10	10 to	≥25	All
<-14 to -18°C	2	2	0	0	**6**
<-18 to -22°C	1	2	0	0	**4**
<-22 to -25°C	0	1	0	0	**2**
<-25°C	0	0	0	0	**1**
All	**5**	**7**	**1**	**0**	**20**

3.4 Fluid Preparation and Management

This section describes the steps necessary to ensure that the fluids to be tested are properly prepared for testing.

3.4.1 Type I Fluid Preparation

Type I fluids will generally be sent to APS by the manufacturer in concentrate form. Prior to commencing a test session, an appropriately buffered mixture of the fluid must be prepared. As per ARP5945A, Type I fluids must be tested at dilutions where the freezing point of the solution is 10°C colder than the OAT at which testing is taking place.

To prepare the buffered solution, you must first determine the range of temperatures that the testing will take place in. The solution should be prepared such that it is properly buffered for the coldest temperature to be experienced during the test session. If a very large change in temperature is expected during the test session, (>10°C), consideration should be given to preparing two distinct batches of Type I fluid, with freeze points appropriate to the different expected phases of testing.

The Type I concentrate must be diluted with hard water, which is prepared by dissolving 400mg of calcium acetate dehydrate and 280 mg of magnesium sulfate heptahydrate into 1L of water (the quantities can be scaled up proportionally if preparing a larger batch). Consult the dilution chart associated with the Type I fluid being tested in order to determine the appropriate glycol/hard water ratio necessary to achieve the desired freeze point. Dilution charts are generally available on the fluid manufacturer's website or directly from the manufacturer.

Confirm that the glycol concentration in your prepared solution is appropriate by measuring the Brix (generally Type I dilution charts will indicate the target Brix for the desired fluid freeze point). Ensure that the container in which the solution is mixed is clearly marked with the freeze point and Brix of the fluid. Pour container labels listing the fluid name, Brix and freeze point should also be created and affixed to all pour containers to be used during the test session.

Note that although ARP5945A stipulates that Type I fluid samples be sheared in a laboratory blender prior to testing, previous work has indicated that the effects of this shearing process on resulting Type I fluid endurance times are negligible. The Type I fluid shearing process is generally not performed with fluid samples as part of the typical natural snow testing process.

3.4.2 Type II/III/IV Fluid Management

In order to ensure that a testing session runs smoothly with minimal disruptions, it is critical that a sufficient number of filled 1L pour containers are prepared and tempered prior to the start of the test session. The targeted amount is a minimum of four pour containers per fluid/dilution to be tested.

Used pour containers should be periodically refilled when time permits to prevent delays in the fluid application process. All pour containers must be affixed with labels listing the fluid name, batch number and dilution and special care must be taken when refilling to ensure that the proper fluid, batch and dilution are used.

All fluids to be used in natural snow endurance time testing must be properly stored in order to ensure that they are at the correct temperature when a test session begins. As per Subsection 11.1.1 of ARP5485B, the temperature of Type II, III (unheated) or IV fluid being applied to a test surface in a natural snow endurance time test must be within 3°C of the OAT. Valuable testing time can be lost waiting for fluids to temper if the proper storage procedures have not been followed.

Fluid jugs and pour containers of neat and 75/25 formulations of Type II/III/IV fluids that are to be used in a given test event should be stored outside such that their temperature consistently reflects the changing OAT. Note the following exceptions:

1) All containers containing 75/25 formulations of Type II/III/IV fluids must be temporarily stored inside the main trailer if the outdoor temperature on a given day is scheduled to drop below -14°C for a period exceeding four hours.
2) In the case of extreme cold (temperatures falling below -22°C for a period exceeding four hours), neat formulations of certain fluids may also need to be temporarily stored inside the main trailer. The freezing points of the individual

fluids need to be consulted in order to determine which (if any) fluids will need to be moved.

Fluid jugs of 50/50 formulations of Type II/III/IV fluids that are to be used in a given test event are to be stored inside the main trailer at all times due to the relatively warm freezing point of 50/50 fluids. Pour containers of 50/50 formulations of fluids to be used are to be stored inside a chest freezer set at a temperature of -3°C.

All fluids that are stored in clear jugs must be covered with an opaque covering in order to ensure that the fluid is not exposed to light in storage.

4. TEST SITES

This section documents the test sites where APS conducts natural snow endurance time testing with Type I, II, III and IV fluids.

4.1 Pierre-Elliott-Trudeau International Airport Test Site

Natural snow testing is typically and predominantly performed at the APS test site located at the Montréal Pierre-Elliott-Trudeau International Airport. The test site is located near Environment Canada's Meteorological Services of Canada automated weather observation station, as shown in Figure 4.1 on a plan view of the airport.

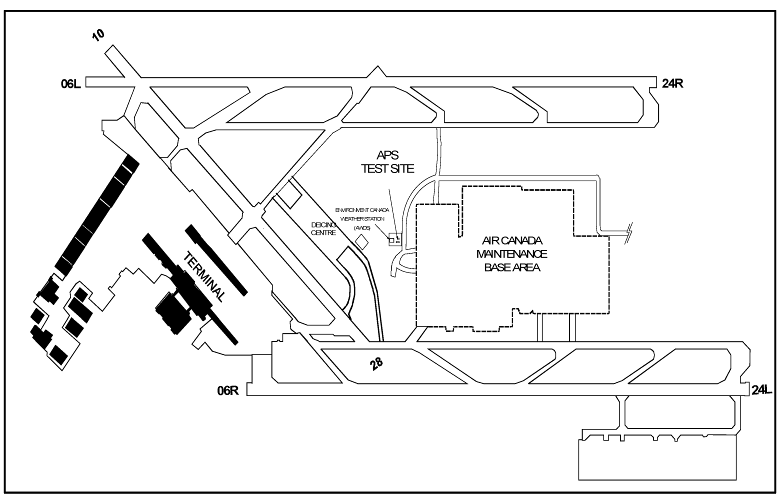


Figure 4.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

4.2 Remote Test Sites

There are instances where data requirements will necessitate natural snow testing at a location other than the APS test site. In the past, this has typically been due to a need to obtain data at specific temperatures (generally colder temperatures than typically experienced in Montreal) or times of the year (generally after the conclusion of the winter season when natural snow data is no longer obtainable in Montreal).

Remote test sites can be set-up in any region where the desired natural snow conditions are expected to occur, using test stands that have been specially modified for improved transportability. When using a remote site for testing, the testing trailers are generally replaced by either rented vehicles or a rented hotel room (location permitting).

Several factors must be considered when choosing a location for a remote test site, including:

1) **Ground Surface**

   The ground surface should be level and firm to simplify the process of levelling the test stands.

2) **Wind Direction**

   The selected location must also be open to oncoming wind; all possible wind directions that may be experienced during a given event should be considered.

3) **Foot/Vehicle Traffic**

   The selected location should also be out of the way of foot and vehicle traffic, if possible, to minimize the chance of outside forces interfering with a test session.

5. TESTING PROCEDURE

This section describes the procedure to be followed during a natural snow test event.

The procedure conforms to the requirements for natural snow testing outlined in Section 11 of the *Aerospace Recommended Practice (ARP) 5485B – Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type II, III, and IV*.

The procedure also conforms to the requirements for natural snow testing outlined in Section 11 of *ARP5945A – Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type I*.

5.1 Set-Up

The set-up steps for a natural snow endurance time testing session are listed below:

1) Ensure that the fluids to be tested are properly prepared as per the guidelines in Subsection 3.4. Prepare appropriately buffered mixtures of all Type I fluids to be tested. Confirm that all Type II/III/IV fluids being tested were stored correctly and are at the proper temperature relative to the current OAT.
2) Confirm the current wind direction and orient two full six-position test stands into the wind. Ensure they are levelled such that the test surfaces lie at a 10° angle (within 9.8° and 10.2° is acceptable, check each test surface). The angle of the test stand can be adjusted as needed by placing poker chips under the stand legs. Whenever the configuration is adjusted by adding or removing chips ensure that the stand is reasonably stable and that all test surfaces are at the proper angle. Ensure the fluid collection pans are placed beneath the test stands to collect fluid runoff.
3) Equip the two six-position test stands with the appropriate test surfaces (leading edge thermal equivalent boxes if testing Type I or heated Type III fluid, aluminum test plates if testing unheated Type II/III/IV fluids). All test surfaces used must be equipped with Smart Buttons that are actively logging temperature data. Ensure that one position on one stand is equipped with a rate collection pan. Figure 5.1 depicts the proper plate set-up for the two test stands.
4) Clean the surface of the test surfaces by removing any adhered ice or contamination. If any solvent or heat is used in the cleaning process, ensure the plates are allowed to cold-soak long enough.
5) Prepare the rate station inside the main trailer: ensure that the scale being used is properly leveled, open the latest version of the APS rate program on the rate computer (an Excel spreadsheet created to record frost rate measurements), and test that the scale and computer are functioning normally together.
6) If using paper data forms, prepare the forms to be used during the test session. Fill out as much information as possible ahead of time in order to streamline the subsequent fluid application process. If using the Data Form app to record the test data, ensure all fluids to be tested during the session have been added to the app database.
7) Prepare a digital camera for use by formatting the memory card and syncing the device time with the time that is displayed on the test site clocks.
8) Arrange all unheated fluids to be poured by placing the filled pour containers behind their respective positions on the test stands.

Figure 5.1 – Test Stand Set-Up

5.2 Procedure for Rate Collection

The steps for rate collection in natural snow are summarized below:

1) After initial set-up is complete, fill an empty rate collection pan with a thin layer of anti-icing fluid from the container near the rate station (container will be marked "rate fluid"). This fluid layer allows natural snow collected in the rate pan to dissolve. Note that overfilling the pan should be avoided, as accurate rate collection will be compromised if any fluid is spilled during the collection process.
2) Open the APS Rate Program spreadsheet on the designated rate laptop and save a copy of the sheet with the current date in the file name. Measure and record the initial weight of the filled rate collection pan in the first empty cell in the Interface tab of the spreadsheet. Once recorded, place the rate collection pan outside on the test stand in the designated position.
3) Approximately once every ten minutes, the rate pan must be brought inside and weighed. Note that this rate cycle must be shortened during periods of high precipitation rate or wind speed (cycle can be shortened to as little as 2 minutes). Carefully transport the pan from the test stand to the rate station inside the main trailer, ensuring that none of the contents are lost in transit. If any fluid is lost from the pan, the rate cycle must be restarted by recording a new initial weight in the spreadsheet (ensure that a row is

skipped in the spreadsheet to indicate to the program that a new cycle has begun).

4) Once inside the main trailer, clear off any precipitation accumulated on the outer edges of the pan (do not dump this mass into the pan). Weigh the rate pan and record the weight and time in the next empty cell of the spreadsheet.

5) Once recorded, return the pan to its position outside on the test. Note that this process should be completed as quickly as possible, ideally the rate pan should not be inside the main trailer for more than 14 seconds before being returned to the test stand (as 14 seconds is the amount of buffer time programmed into the rate spreadsheet).

6) Repeat this cycle every ten minutes. The rate collection cycle can be abbreviated as necessary; a new rate is generally collected whenever a failure is noted on an active endurance time test, for example.

7) At the halfway mark of the “outside” phase of each rate cycle, invert the orientation of the rate pan (the edge that previously rested on the lower end of the test stand should now rest on the upper end).

8) If at any point the rate pan begins to become overly saturated with absorbed precipitation, a new rate pan can be prepared and swapped in at the completion of a rate cycle. When introducing a new rate pan, a new initial weight must be recorded (ensure that a row is skipped in the spreadsheet to indicate to the program that a new cycle has begun).

9) Rate collection is to continue throughout the entire test session, with the last rate being collected after the failure of the last endurance time test.

5.3 Procedure for Fluid Endurance Time Tests

The steps for conducting natural snow fluid endurance time tests are summarized below.

5.3.1 Procedure for Unheated Fluids (Type II, III-Unheated and IV)

1) Prepare the data form / data form app by recording the fluids to be poured in their respective positions.

2) Measure the initial fluid temperature of all fluids that are to be poured during the test session. Confirm that all fluids are within 3°C of the current OAT. If fluids are not at the correct temperature, warm them in the main trailer or cool them in a chest freezer as needed.

3) Clear the test surfaces to be used of existing contamination using a squeegee. To ensure that each position is properly cleaned, apply a small quantity of the fluid being tested to the test surface and use a squeegee to spread it across the full test surface.

4) Confirm that the data form manager is ready to begin the fluid application process. At each position, pour 1L of the selected fluid onto the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer. Record the time of fluid application on the chosen data form.

5) After fluid application is complete, each plate must be inspected periodically in order to assess the condition of the fluid layer. The fluid is considered failed when the accumulating snow is no longer being absorbed by the fluid. Typically, there are two types of failure observed in natural snow tests. Dilution failure occurs when the fluid layer has thinned due to exposure to precipitation and snow beings to accumulate on the plate surface. Snow-bridging failure occurs when the fluid layer does not thin considerably but instead eventually fails to absorb incoming snow, leading to white snow visibly accumulating on the top of the fluid.

6) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed. Announce the fluid failure and ensure the failure time is recorded by the data form manager. It is good practice to collect a rate whenever a plate is deemed failed (foregoing the typical 10-minute rate period). A poker chip should be placed on the plate once failure has been declared to denote that the plate is no longer running an active test.

7) Ensure all test surfaces are properly cleaned after testing and that all fluid within the collection pans is disposed of appropriately (all glycol waste must be vacuumed up and subsequently disposed of in the waste fluid tote).

5.3.2 Procedure for Heated Fluids (Type I and III-Heated)

1) Prepare the data form / data form app by recording the fluids to be poured in their respective positions.

2) Clear the test surfaces to be used of existing contamination using a squeegee. To ensure that each position is properly cleaned, apply a small quantity of the fluid being tested to the test surface and use a squeegee to spread it across the full test surface. Note that the small quantity of fluid used to clean the surface must not be heated. If heat is required to clear

the test surfaces, they must be allowed to cold soak prior to fluid application.

3) Heat a batch of the fluid(s) to be applied using the microwaves within the main trailer. As fluids are to be applied at 60°C, a temperature of 62°C should be targeted when heating. Ensure that a microwave-safe container is used. It can take upwards of 10 minutes to attain the required temperature; the temperature of the mixture should be checked periodically during the heating process using a hand-held thermistor. Knowing that 0.5L of fluid must be applied to each test surface, ensure that a sufficient total volume of fluid is heated. Once the full batch is heated, transfer the fluid to thermos' to preserve the temperature until the fluid is applied.

4) Confirm that the data form manager is ready to begin the fluid application process. At each position, pour 0.5L of the heated fluid onto the top of the test surface using a 12-hole spreader to ensure even distribution. This process must be completed quickly after the fluid is heated to ensure that the fluid temperature is as close to 60°C as possible at the time of application. Record the time of fluid application on the chosen data form.

5) After fluid application is complete, each test surface must be inspected periodically in order to assess the condition of the fluid layer. The fluid is considered failed when the accumulating snow is no longer being absorbed by the fluid. For heated fluids, failure may occur quickly as the test surface cools after fluid application. It is best to remain close to the test stand after application to ensure that the failure time is not missed.

6) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed. Announce the fluid failure and ensure the failure time is recorded by the data form manager. It is good practice to collect a rate whenever a plate is deemed failed (foregoing the typical 10-minute rate period). A poker chip should be placed on the plate once failure has been declared to denote that the plate is no longer running an active test.

The primary types of failure are depicted below in Photo 5.1 and Photo 5.2. Photo 5.1 depicts dilution failure of an anti-icing fluid on an aluminum plate. Photo 5.2 depicts snow-bridging failure of an anti-icing fluid on an aluminum plate.

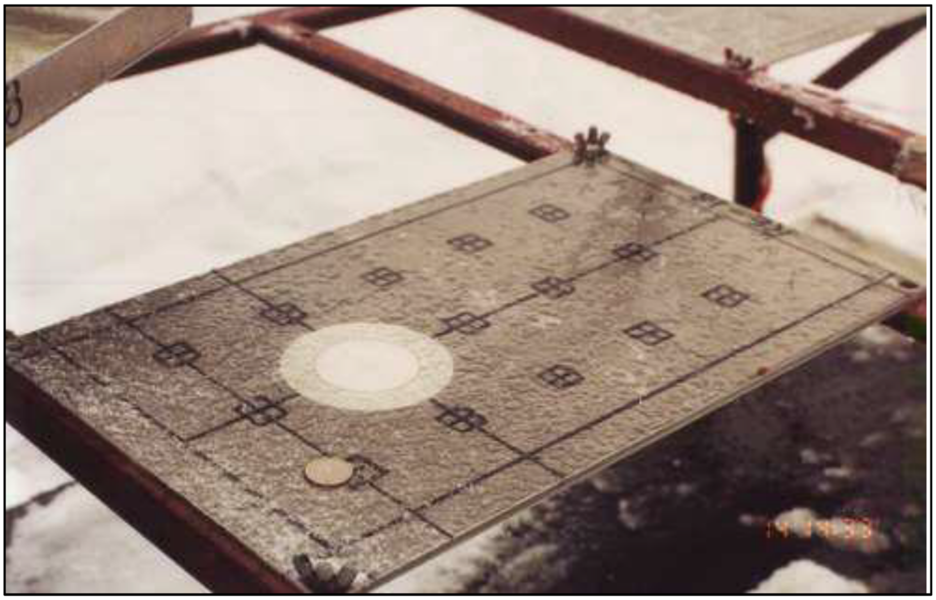


Photo 5.1 – Dilution Failure of Anti-Icing Fluid on an Aluminum Plate

Photo 5.2 – Snow-Bridging Failure of Anti-Icing Fluid on an Aluminum Plate

5.4 End of Test Session Activities

The steps for concluding a natural snow endurance time testing session are summarized below.

1) Ensure all test surfaces are properly cleaned after testing and that all fluid within the collection pans is disposed of appropriately (all glycol waste must be vacuumed up and disposed of in the waste fluid tote). Ensure that the fluid collection pans are flipped upside down so that they do not fill up with precipitation in between test sessions.
2) Save a copy of the completed APS Rate Program spreadsheet in the Data and Rates folder of the APS Test Site Dropbox.
3) If using the HOT Data Form app to record endurance times, export the data file and save a copy in the Data and Rates folder of the APS Test Site Dropbox.
4) If using paper data forms, place the completed forms in an envelope and mark the envelope with the date and number of forms.
5) Ensure that all Smart Button data from all test surfaces used is saved and uploaded to the APS Test Site Dropbox.
6) Complete a Test Session Summary form (available on the APS Test Site Dropbox). Save a completed copy in the Test Session Forms folder of the APS Test Site Dropbox. Print a copy of the completed form and place it in the data form envelope. Ensure that this envelope is brought to the APS offices the following day.
7) Ensure that the Dropbox program is synced and that all saved files have been uploaded.
8) Ensure that the heating system and lights are turned off, all doors are locked, and that the alarm system is armed prior to leaving the site.

6. EQUIPMENT

The equipment required for endurance time testing in natural snow at the APS test site is listed in Attachment 1. The equipment required for testing at remote test sites is listed in Attachment 2.

7. PERSONNEL

Generally, three people are required for natural snow endurance time testing:

1) **Testing Manager** – responsible for overseeing the test event, determining which tests are to be run, applying fluids and calling all failures;
2) **Data Form Manager** – responsible for managing all data forms and ensuring all information is properly transcribed and captured; and
3) **Testing Assistant** – responsible for set-up activities, rate collection, clean-up and assisting with any other tasks as determined by the testing manager.

Note that the above roles are not necessarily strict; any person participating in a test event may be required to perform tasks associated with any of the above roles at a given time.

8. SAFETY

Testing in cold temperatures can pose significant safety issues. Jackets, gloves and boots should be rated to very low temperatures. Eye protection (ski goggles) and face protection should be worn if testing in very cold temperatures (< -20°C). Employees should be mindful of dangers associated with hypothermia and frostbite. Additional information can be found in the Test Site Safety Management manual, of which copies are available at the test site.

If ever one person is conducting testing alone, they must make use of the "Loner" monitoring system to ensure their safety during the testing event.

9. DATA FORMS AND SOFTWARE

The following data forms and software programs are typically used for natural snow endurance time testing:

1) End Condition Data Form for Endurance Time Tests (Attachment 3);
2) App Data Form for Fluid Endurance Time Tests (Attachment 4);
3) APS Rate Program Spreadsheet (Attachment 5); and
4) Test Session Summary Form (Attachment 6).

Attachment 1: Equipment List for Natural Snow Testing

NATURAL SNOW APS SITE TESTING
LOCATION: TEST SITE
6–position test stand x 2
Air Temperature gauge x 1
Aluminum test plates (as needed)
Compass x 1
Data forms (as needed - if app not being used)
Digital Camera and accessories
Fluid collection pans x 2
Fluid pour containers x 4 per fluid
Fluids (as needed)
Immersion temperature probe x 1
Inclinometer x 1
iPad with data form app x 1
Leading edge thermal equivalent boxes aluminum + composite (as needed)
Microwave x 1
Poker chips (for stand levelling) x 1 pack
Rate collection pan x 1
Rate computer x 1
Rate fluid (10L) x 1
Scrapers x 2
Shop vacuum x 1
Smart Buttons and Smart Button Kit (as needed)
Spreader (for heated fluid application) x 1
Squeegees x 2
Thermos (as needed)
Weigh scale + connectors x 1

Attachment 2: Equipment List for Remote Natural Snow Testing

NATURAL SNOW REMOTE TESTING	
LARGE LUGGAGE : GENERAL EQUIPMENT	
Air Probe x 1	Pencils, Sharpies, Erasers and Sharpener
APS Hats	Poker Chips x 3 Small Packs
Backup Scale (Ice Crystal Scale) x 1	Power Bars x 2
Batteries (16 AA and 2 x 9V)	Rate Pans x 2
Brixometer x 2	Scrapers x 2
Car Antenna Wind Sock x 1	Shop Towels x 2
Clipboards x 2	Shovel x 1
Compass x 1	Ski Goggles x 3
Cotton Gloves x 2	Small Garbage Bags x 3
Extension Cords x 2	Small Squeegies x 2
Extra Black Gloves x 3	Small White Extension Cords x 1
Extra Jacket x 1	Speed and Electrical Tape x 1 Each
First Aid Kit x 1	Standard Set of Tools x 1
Flashlights x 4	Stopwatch x 1
Garbage Bags x 2	Surface Probes x 2
Hammer x 1	Tarp x 1
Hand & Toe Warmers (many included)	Thickness Gauges (Octogonal) x 2
Immersion Probes x 2	Thickness Gauges (Rectangular) x 2
Inclinometers x 2	Tie Wraps x 10
Inverter x 2	Water Phobic Paper
Isopropyl x 1	Working Hands Cream
Latex Gloves x 1 Box	
SMALL LUGGAGES: FLUIDS	
Small luggage #1 with 20 pour containers	Small luggage #2 with 20 pour containers
LONG LUGGAGE : SCALES	
Sartorius Scales with Styrofoam Top x 2 (Including Cables & Power Adapters)	
SKI CASE LUGGAGE : TEST STAND EQUIPMENT	
All Supporting Hardware and Crossbars	Remote Test Stand
Aluminum Test Plates x 5 Sets (10 half plates total)	
RATE STATION AND DATA FORMS	
Data Forms on water phobic paper	iPad with Sim Card
Electronic Copy of Log	Laptop and cables/adapters with Rate Program
ADDITIONAL EQUIPMENT FOR TYPE I	
Spreader (for heated fluid application) x 1	Dilution Charts
Hard Water	Measuring Cups
Microwave	Thermos (as needed)
Leading edge thermal equivalent boxes aluminum + composite (as needed) and boards	
PHOTOGRAPHY	
Camera Batteries x 3	Digital Camera x 2
Camera Memory Cards x 3	Small Tripod Mountable to Stand (Optional)
PERSONNEL CLOTHING	
Cold Rated Gloves	Winter Hats
Face Covers (Belaclava and Face Shield)	Winter Jackets
Winter Boots	

Attachment 3: End Condition Data Form for Endurance Time Tests

REMEMBER TO SYNCHRONIZE TIME

LOCATION: PRECIP. CONDITION: DATE: RUN NUMBER: STAND # :

Time of Fluid Application: ______ ______ ______ ______ ______ ______

Time of Fluid Failure: ______ ______ ______ ______ ______ ______

Fluid Name/Dilution: ______ ______ ______ ______ ______ ______

PLATE 1 PLATE 2 PLATE 3 PLATE 4 PLATE 5 PLATE 6

Failure Call:
(describe) ______ ______ ______ ______ ______ ______

Time of Fluid Application: ______ ______ ______ ______ ______ ______

Time of Fluid Failure: ______ ______ ______ ______ ______ ______

Fluid Name/Dilution: ______ ______ ______ ______ ______ ______

PLATE 7 PLATE 8 PLATE 9 PLATE 10 PLATE 11 PLATE 12

Failure Call:
(describe) ______ ______ ______ ______ ______ ______

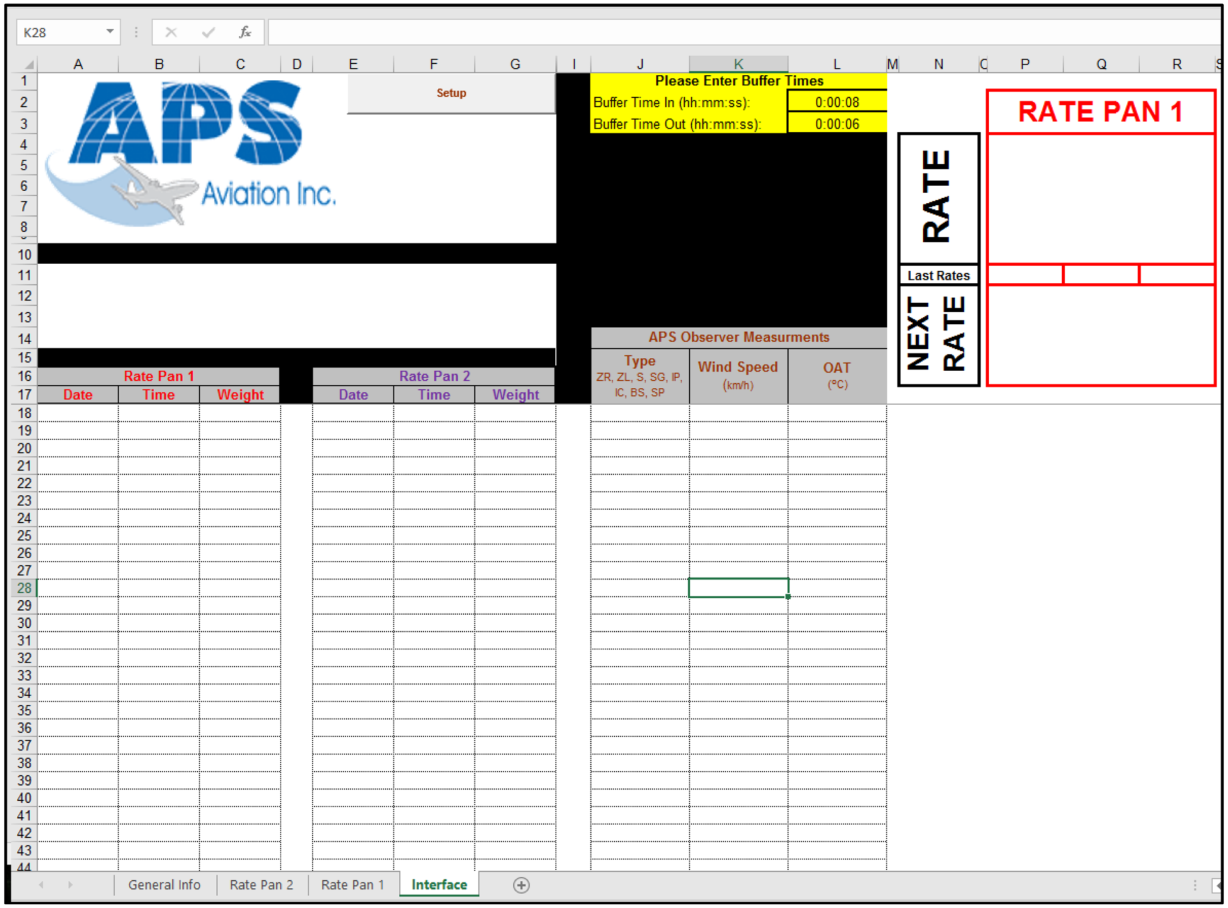
AMBIENT TEMPERATURE: ______ °C LEADER / MANAGER: ______ FAILURES CALLED BY: ______

COMMENTS: ______

NOTE:
Please ensure correct functioning of plate temperature logging system at the start of the test and at the end of the session.

Attachment 4: Screenshot of Holdover Time Data Form

Attachment 5: Screenshot of Rate Program Spreadsheet



Attachment 6: Example of Test Session Summary Form

TEST SESSION SUMMARY

OUTDOOR/OTHER

TEST MANAGER: ____________ DATE: ____________

LOCATION: ____________

# of Tests Conducted	Project	Person Responsible	Data Forms (# or electronic)	Rate File (#)	Logger Files (#)	Photos (#)	Comments
NATURAL SNOW							
	HOT Snow						
	Flaps and Slats						
	Other ____________						
	Other ____________						
ARTIFICIAL SNOW							
	HOT Snowmaker						
	Other ____________						
FROST							
	HOT Frost						
	Frost Substantiation						
	Other ____________						
OTHER NON TC/FAA PROJECTS (DO NOT INCLUDE IN CALENDAR OF COMPLETED TESTS)							
	SureWx						
	Other ____________						
	Other ____________						

FOR OFFICE USE ONLY		
Verification of Electronic and Paper Filing	PERSON: ____________	DATE: ____________

M:\Projects\PM2480.004 (TC Deicing 2017-18)\Data\Test Session Summaries\Test Session Summary v2.0
11/29/2017

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PROCEDURE:
NATURAL SNOW CHARACTERIZATION ENDURANCE TIME TESTING

300293

PROCEDURE:

NATURAL SNOW CHARACTERIZATION ENDURANCE TIME TESTING

Prepared for

Innovation Centre
Transport Canada

Prepared by: Benjamin Bernier

Reviewed by: John D'Avirro

January 17, 2019
Final Version 1.0

PROCEDURE:
NATURAL SNOW CHARACTERIZATION ENDURANCE TIME TESTING

1. BACKGROUND

APS Aviation Inc. (APS) has been involved in artificial snow research for almost two decades, conducting numerous artificial snow equipment assessments, tests, and analyses on behalf of Transport Canada (TC) and the Federal Aviation Administration (FAA). Development of artificial snow testing capabilities has been a priority for TC and the FAA for many years, as testing in artificial snow can be done at any time of year (not just winter) and test variables such as temperature, precipitation, rate and wind speed can be tightly controlled.

There is an ongoing effort involving APS, TC, the FAA, and National Center for Atmospheric Research (NCAR) to further develop the artificial snow machine for use as a tool in holdover time development. Despite significant research efforts, correlation between natural and artificial snow data has remained challenging. As a result, regulators have not been willing to publish fluid-specific holdover times derived from artificial snow data.

As part of the continued effort to improve the correlation between natural and artificial snow data, it was determined that there would be value in conducting natural snow endurance time tests with a limited subset of fluids in order to better understand the factors affecting variance in natural snow endurance time test results. In order to assist with this goal, NCAR has installed various environmental sensors at the APS test site. These sensors will provide APS with additional real-time, localized environmental data (including wind speed, wind direction, relative humidity, etc). The intent is that the output from these sensors will be used to supplement the data collected in 2018-19 by APS, forming a more complete overall data package for analysis.

2. OBJECTIVE

The primary objective of this research is to conduct natural snow endurance time testing with select anti-icing fluids with the goal of identifying environmental factors that affect variance in fluid endurance time performance. This procedure describes the testing protocols used to conduct natural snow characterization testing.

3. TEST SITE

Natural snow characterization testing will be performed at the APS test site located at the Montréal Pierre-Elliott-Trudeau International Airport. The test site is located near Environment Canada's Meteorological Services of Canada automated weather observation station, as shown in Figure 3.1 on a plan view of the airport.

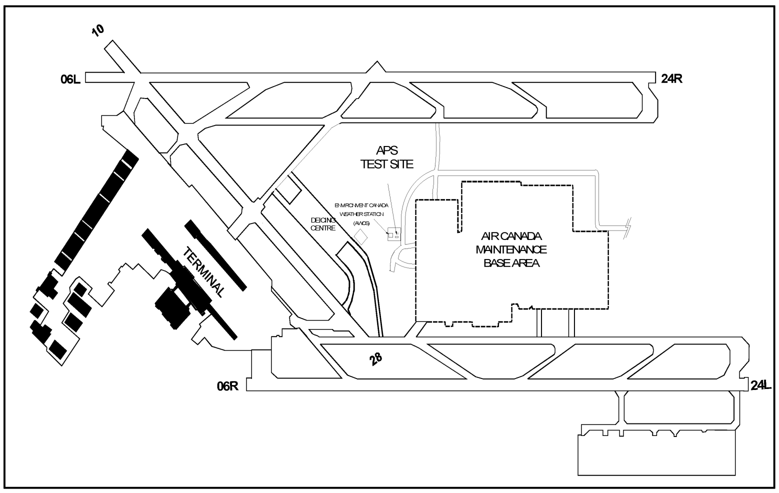


Figure 3.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

4. FLUIDS

All testing will be conducted using neat, mid-production viscosity samples of currently commercialized anti-icing fluids. The fluid names are coded for manufacturer confidentiality. The selected fluids are listed below in Table 4.1.

Table 4.1: List of Fluids for Natural Snow Characterization Testing 2018-19

Fluid Name	Fluid Type	Fluid Formulation	Fluid Dilution	Viscosity Profile
Fluid 023A	II	Propylene Glycol	100	Mid-Production
Fluid 024A	III	Ethylene Glycol	100	Mid-Production
Fluid 009A	IV	Propylene Glycol	100	Mid-Production

5. TESTING PROCEDURE

The general natural snow endurance time testing procedure is described in the APS procedure *Endurance Time Testing in Natural Snow with SAE Type I, II, III and IV De/Anti-Icing Fluids*. The above-mentioned procedure will provide the basis for this testing, with several modifications relating to set-up and secondary data collection. The modifications to the standard procedure are outlined in this section.

5.1 Test Surfaces

One six-position test stand will be used in this testing, equipped with four aluminum test plates. For a given test run, each of the three selected fluids will be applied to an aluminum test plate. One aluminum test plate will remain bare (no fluid applied) throughout the duration of each run. Figure 5.1 depicts the plate set-up for the test stand.

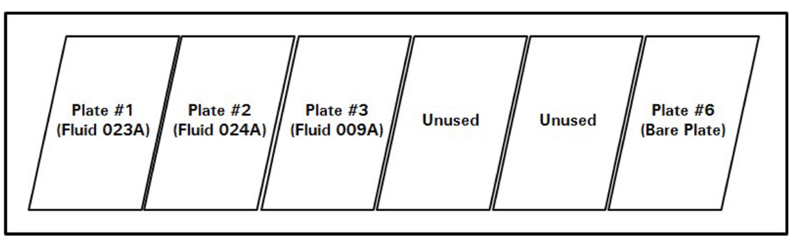


Figure 5.1 – Test Stand Set-Up

5.2 Rate Collection

Rates will be collected once every ten minutes at a minimum. It is recommended that rates be collected once every five minutes during periods of heavy precipitation.

It is expected that standard holdover time testing will be conducted at the APS test site whenever natural snow characterization testing is conducted. When this is the case, the rate data will be shared between both projects. Although it is likely that holdover time personnel will be assigned to rate collection, it is the responsibility of the natural snow characterization test manager to ensure that these collections are being performed with sufficient frequency.

In the event that no holdover time testing is being conducted during a natural snow characterization test event, rate cycle collections will be performed by a dedicated person.

5.3 Supplemental Measurements

In addition to measuring the endurance time performance of the fluids being tested, supplemental fluid thickness and fluid Brix concentration measurements will also be performed at set intervals.

5.3.1 Thickness Measurements

Fluid layer thickness will be manually measured at specific times on each of the test surfaces to which fluid has been applied using a wet film thickness gauge. The process for measuring fluid layer thicknesses is as follows:

1) Apply fluids. Begin a test run by applying the three selected fluids to their respective test surfaces and noting the start time;
2) Measure thickness after five minutes. At the five minute mark after fluid application, measure and record the fluid film thickness on all three active test surfaces, beginning with the first fluid poured. To measure fluid film thickness, take one reading on the right-hand side of the plate (near the crosshair) at the 15 cm line; and
3) Repeat the thickness measurement process at the 15 minute mark, and again every subsequent 15 minutes until the conclusion of the test run. Ensure that all measurements are recorded on the data form for each fluid being tested.

Note that all readings should be taken from the right-hand side of the plate to minimize disruption of the fluid layer. Consecutive readings should be taken from slightly off-set points along the 15 cm line, to ensure that an accurate measurement is recorded each time. Thickness measurements do not need to be continued on failed surfaces, or on surfaces whose last recorded thickness value is “Slush”.

In addition to the fluid layer thickness measurements, a measurement of the accumulated contamination thickness should be taken from the bare plate at the conclusion of each test run and documented on the data form. Note that an octagonal wet film thickness gauge or ruler can be used If the accumulated contamination is too thick for a rectangular gauge.

5.3.2 Fluid Brix Measurements

Fluid Brix will be manually measured at specific times on each of the test surfaces to which fluid has been applied using a Brixometer. The process for measuring fluid Brix is as follows:

1) Apply fluids. Begin a test run by applying the three selected fluids to their respective test surfaces and noting the start time;
2) Measure Brix after ten minutes. At the ten minute mark after fluid application, measure and record the fluid Brix on all three active test surfaces, beginning with the first fluid poured. To measure fluid Brix, take one reading on the right-hand side of the plate (near the crosshair) at the 15 cm line; and
3) Repeat the Brix measurement process at the 20 minute mark, and again every subsequent ten minutes until the conclusion of the test run. Ensure that all measurements are recorded on the data form for each fluid being tested.

Note that in conditions where the expected holdover times of the fluids applied exceed 120 minutes, the test manager may at their discretion adjust the Brix measurement process to be repeated every 20 minutes (as opposed to every 10 minutes).

5.3.3 Surface Temperature Measurements

Plate surface temperatures will be measured using SmartButtons mounted on the underside of the plates at the 15 cm line. The data from the SmartButtons must be downloaded after each session to ensure that it is captured.

5.4 Photography

This section describes the photography processes to be employed during testing. The photographic equipment used for the testing is described in the following sections and includes:

1. DSLR Camera: Used to photograph plate characteristics during the testing process.
2. GoPro Camera 1: Time-lapse camera mounted adjacent to Plate 1 to capture plates closest to Plate 1.
3. GoPro Camera 2: Time-lapse camera mounted adjacent to Plate 3 to capture plates closest to Plate 3.
4. Powershot Camera: Used to photograph snowflake morphology.

5.4.1 Photography Set-Up

Prior to the start of the test session, verify that all Powershot, GoPro and DSLR cameras are properly synced to the time on the test site clocks. Spare batteries for each camera type must be charged and ready to be swapped in as needed.

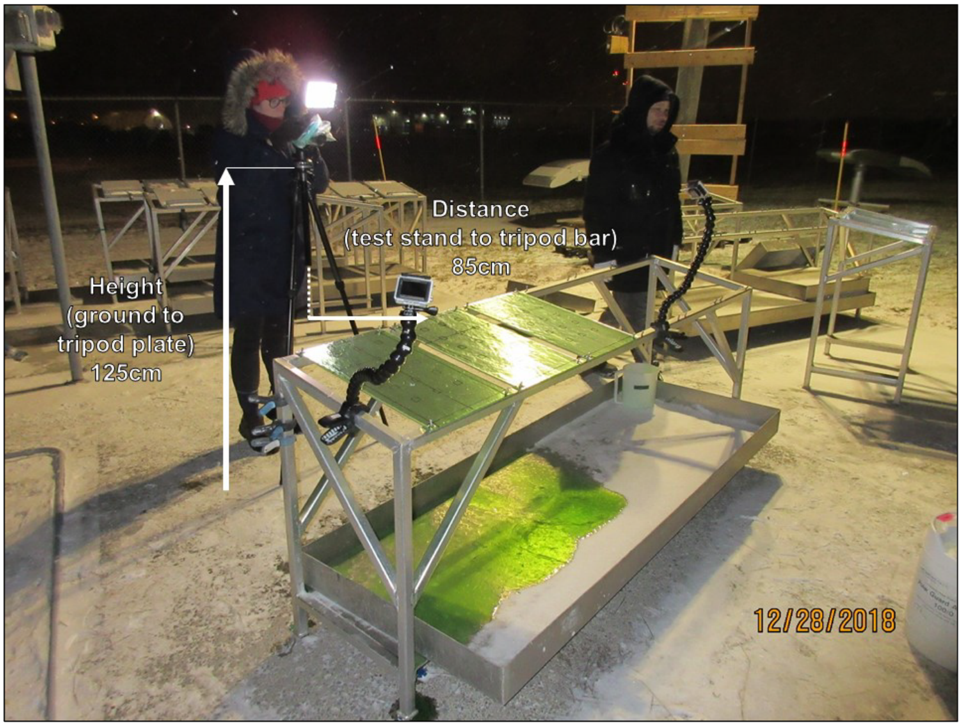
Prepare two dry black felt pads with metric rulers attached and fresh Whatman's paper discs clipped to the pad. The Powershot camera should be kept inside the trailer with the felt boards at all times to prevent condensation from forming on the camera lens.

GoPro cameras must be configured in time-lapse mode, with one photo being taken every 30 seconds when the camera is active. Two GoPro cameras are to be installed outside on the test stand using gooseneck attachments with clamps. The first camera must be attached to the side bar of the test stand (adjacent to Plate 1). The second camera must be attached to the bottom bar of the test at position 4 (not occupied by a plate during this testing). After installation, verify that each camera is capturing both the nearest and middle plates in their time-lapse photos.

The DSLR camera (used for plate photography) must be equipped with a 52mm lens and mounted on a tripod installed behind the first plate at a distance of 85 cm from the central tripod bar to the test stand. The tripod should be adjusted such that the height from the ground to the tripod plate is equal to 125 cm. The DSLR camera must be equipped with a Weather sleeve and a lens hood as it will be oriented into the oncoming precipitation for the duration of the event. After the initial tripod position is measured out, a small positional marker should be placed beneath the central bar in order to serve as a reference point. Repeat the positioning process (including placement of a positional marker) for plates 2 and 3, as well as for the bare plate in position 6.

Photo 5.1 depicts the plate photography set-up for this project.

Photo 5.1 – Plate Photography Set-Up



5.4.2 Plate Photography

Plate photography will be captured at specific times on each of the test surfaces to which fluid has been applied using the DSLR camera set-up. The process for capturing plate photography is as follows:

1) Apply fluids. Begin a test run by applying the three selected fluids to their respective test surfaces and noting the start time;
2) Capture post-pour photos. Immediately after fluid application, capture a round of plate photos. Position the tripod over the positional marker located

behind plate #1. Focus the camera on the center crosshair at the 15 cm line of plate #1, and capture a photo. Once done, position the tripod over the marker located behind plate #2 and repeat the photo-taking process. Repeat the process for plate #3 and the bare plate in position #6.

3) Reset tripod and check batteries. After the round of photos is complete, move the tripod back to position #1. Eject the camera memory card, and verify that the batteries on all outdoor cameras (GoPro and DSLR) have sufficient charge.

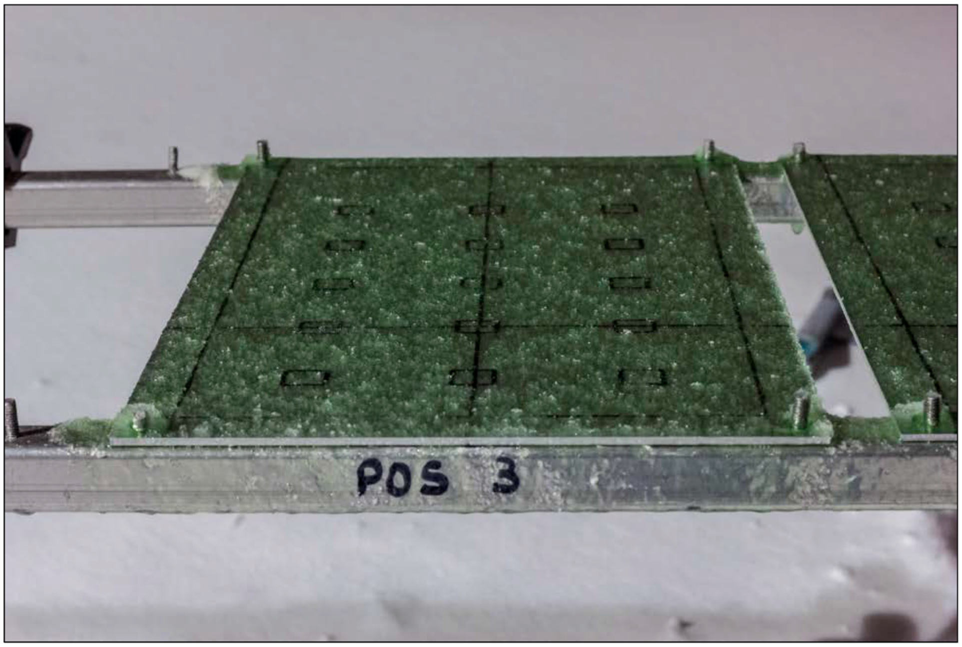
4) Review photos captured. Inside the trailer, review all DSLR photos taken in the previous round and determine if adjustments to the photo process are necessary. Additional external lightning may be necessary in certain conditions – it is critical that photos are checked during the run to ensure that the photo quality remains high. Notify the testing manager once the photos have been reviewed.

5) Repeat cycle every ten minutes. Repeat the plate photography cycle (steps #2 through #4) at the ten minute mark after fluid application (and every subsequent ten minutes until test run end). Ensure that a photo of each active test surface is captured in each cycle, and that all photos are checked between cycles.

Note that in conditions where the expected holdover times of the fluids applied exceed 120 minutes, the test manager may at their discretion adjust the plate photography process to be repeated every 20 minutes (as opposed to every 10 minutes). If this is done, the test manager should consider shortening the cycles to 10 minutes once the first surfaces begin to approach failure.

Plate photos must be continued on surfaces where the fluid has been determined to have failed until all surfaces have failed. After the final surface has failed, plate photography should be continued for a minimum of one additional round. Photo 5.2 depicts a sample plate photography photo (note that the fluid depicted has not yet failed).

Photo 5.2 – Sample Plate Photography Photo



5.4.3 Snowflake Morphology (Felt Pad) Photography

Felt pad photography (Powershot camera) will be captured at specific intervals, linked closely with the plate photography cycles. Immediately after a plate photography cycle is complete, one felt pad photo must be captured. The process for capturing felt pad photography is as follows:

1) Allow a dry black felt pad to cool outside of the trailer for five seconds. Ensure that the felt pad is shielded from precipitation during this cooling period;
2) After the five second cooling period, orient the felt pad into the wind and allow precipitation to accumulate on the pad for five seconds. Use the clock visible from the outside of the trailer to ensure that the cooling and collection periods do not exceed five seconds;
3) After the collection period, enter the trailer and place the felt pad on a nearby flat surface. Take a photo of the collected precipitation, ensuring that the full felt pad and ruler are visible in the photo. Do not delay the

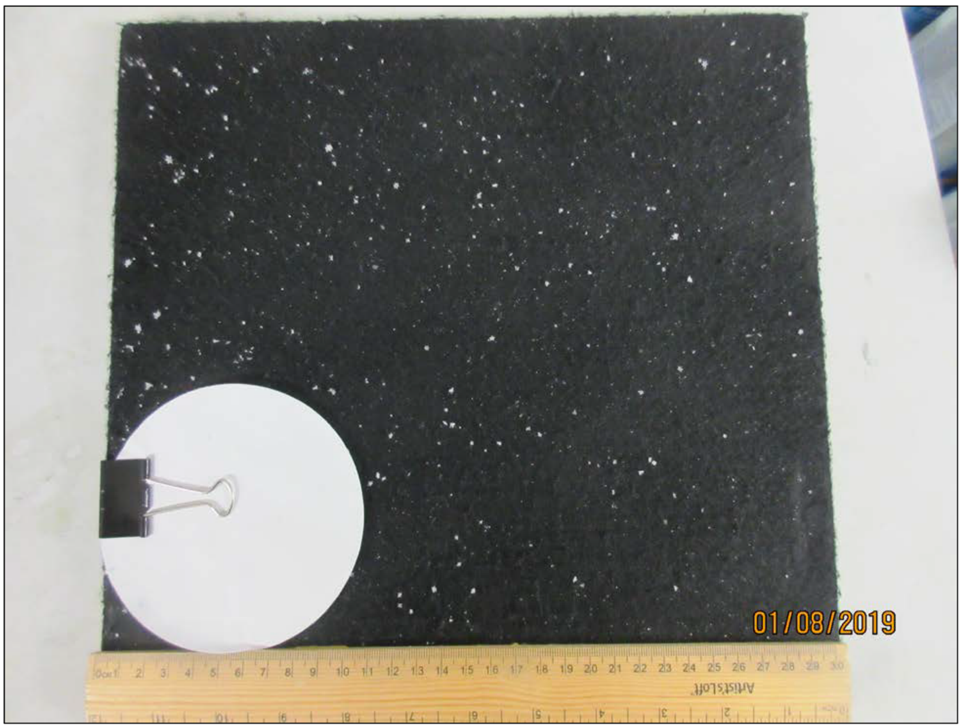
photo-taking process, as accumulated precipitation will begin to melt quickly inside the trailer;

4) Review the photo and ensure that the photo clarity is acceptable. Repeat the entire process if the photo quality is substandard. If necessary, swap out the Whatman's paper disk clipped to the pad; and

5) Clear the felt pad of precipitation in advance of the next photo.

Felt pad photography must be continued until all active test surfaces have failed. One felt pad photo should be captured for every round of plate photos. Photo 5.3 depicts a sample felt pad photography photo.

Photo 5.3 – Sample Felt Pad Photography Photo



5.5 End of Test Session Activities

The steps for concluding a natural snow characterization testing session are summarized below.

1) Ensure all test surfaces are properly cleaned after testing and that all fluid within the collection pans is disposed of appropriately (all glycol waste must be vacuumed up and disposed of in the waste fluid tote). Ensure that the fluid collection pans are flipped upside down so that they do not fill up with precipitation in between test sessions.
2) Save a copy of the completed APS Rate Program spreadsheet in the Data and Rates folder of the APS Test Site Dropbox.
3) Place the completed paper data forms in an envelope and mark the envelope with the date and number of forms.
4) Ensure that all SmartButton data from all test surfaces used is saved and uploaded to the APS Test Site Dropbox.
5) Ensure all photography equipment is brought into the trailer for storage between sessions. Ensure any camera batteries that have been used are charged for subsequent test sessions.
6) Ensure that all photography data is saved on the photography hard drive (GoPro, Powershot and DSLR photos must all be saved).
7) Complete a Test Session Summary form (available on the APS Test Site Dropbox). Save a completed copy in the Test Session Forms folder of the APS Test Site Dropbox. Print a copy of the completed form and place it in the data form envelope. If a Test Session Summary form is being completed for another project, ensure the relevant details from the Natural Snow Characterization test session are added.
8) Ensure that the Dropbox program is synced and that all saved files have been uploaded.
9) Ensure that the heating system and lights are turned off, all doors are locked, and that the alarm system is armed prior to leaving the site.

6. EQUIPMENT

The equipment required for natural snow characterization testing at the APS test site is listed in Attachment 1.

7. PERSONNEL

Three people are required for natural snow characterization testing:

1) **Testing Manager** – responsible for overseeing the test event, assisting with fluid application, determining fluid failure (assisted by an experienced senior staff member) and data form management;
2) **Photography Coordinator** – responsible for all GoPro, plate and felt pad photography including set-up, execution, maintenance of equipment and handling of photo data; and
3) **Testing Assistant** – responsible for set-up activities, fluid application, manual Brix and thickness measurements, and clean-up activities.

If rate collection is not being performed by the holdover time team, the testing manager/testing assistant must assist with rate collection.

8. SAFETY

Jackets, gloves, and boots should be rated to very low temperatures. Eye protection (ski goggles) and face protection should be worn if testing in very cold temperatures (< -20°C). Employees should be mindful of hypothermia and frostbite. Additional information can be found in the Test Site Safety Management manual, of which copies are available at the test site.

9. DATA FORMS AND SOFTWARE

The following data forms and software programs are typically used for natural snow characterization testing:

1) Natural Snow Characterization Run Data Form (Attachment 2);
2) APS Rate Program Spreadsheet (Attachment 3); and
3) Test Session Summary Form (Attachment 4).

Attachment 1: Equipment List for Natural Snow Testing

NATURAL SNOW APS SITE TESTING
LOCATION: TEST SITE
6–position test stand x 1
Air Temperature gauge x 1
Aluminum test plates (as needed)
Brixometer x 1
Compass x 1
Data forms (as needed)
DSLR Cameras with 52mm lens x 2 and accessories
Digital Camera and accessories (Powershot)
Fluid collection pans x 2
Fluid pour containers x 4 per fluid
Fluids (as needed)
GoPro Cameras x 2 and accessories
Gooseneck GoPro mount with clamp x 2
Immersion temperature probe x 1
Inclinometer x 1
Poker chips (for stand levelling) x 1 pack
Rate collection pan x 1
Rate computer x 1
Rate fluid (10L) x 1
Scrapers x 2
Shop vacuum x 1
SmartButtons and SmartButton Kit (as needed)
Squeegees x 2
Tripod
Weigh scale + connectors x 1
Wet Film Thickness Gauges (Rectangular x 1 / Octagonal x 1)

NATURAL SNOW CHARACTERIZATION ENDURANCE TIME TESTING

Attachment 2: Natural Snow Characterization Run Data Form

LOCATION: DATE: RUN NUMBER: PERSONNEL:

Time of Fluid Application:			
Fluid Name/Dilution:			
Fluid Batch:			
Initial Fluid Temp. / Brix:			
	PLATE 1	PLATE 2	PLATE 3
Failure Time:			

THICKNESS MEASUREMENTS - RECORDED IN MIL AT 15 CM LINE

Time After Pour	PLATE 1	PLATE 2	PLATE 3	Time After Pour	PLATE 1	PLATE 2	PLATE 3	Time After Pour	PLATE 1	PLATE 2	PLATE 3
5 Minutes				75 Minutes				150 Minutes			
15 Minutes				90 Minutes				165 Minutes			
30 Minutes				105 Minutes				180 Minutes			
45 Minutes				120 Minutes				195 Minutes			
60 Minutes				135 Minutes				210 Minutes			

Bare Plate Contamination Thickness (Recorded at End of Test Run): __________

BRIX MEASUREMENTS - RECORDED AT 15 CM LINE

Time After Pour	PLATE 1	PLATE 2	PLATE 3	Time After Pour	PLATE 1	PLATE 2	PLATE 3	Time After Pour	PLATE 1	PLATE 2	PLATE 3
10 Minutes				70 Minutes				130 Minutes			
20 Minutes				80 Minutes				140 Minutes			
30 Minutes				90 Minutes				150 Minutes			
40 Minutes				100 Minutes				160 Minutes			
50 Minutes				110 Minutes				170 Minutes			
60 Minutes				120 Minutes				180 Minutes			

PHOTOGRAPHY - TICK BOX ONCE PHOTOS TAKEN AND VERIFIED

Time After Pour	Plate Photos	Pad Photo	Time After Pour	Plate Photos	Pad Photo	Time After Pour	Plate Photos	Pad Photo
0 Minutes	☐	☐	70 Minutes	☐	☐	140 Minutes	☐	☐
10 Minutes	☐	☐	80 Minutes	☐	☐	150 Minutes	☐	☐
20 Minutes	☐	☐	90 Minutes	☐	☐	160 Minutes	☐	☐
30 Minutes	☐	☐	100 Minutes	☐	☐	170 Minutes	☐	☐
40 Minutes	☐	☐	110 Minutes	☐	☐	180 Minutes	☐	☐
50 Minutes	☐	☐	120 Minutes	☐	☐	190 Minutes	☐	☐
60 Minutes	☐	☐	130 Minutes	☐	☐	200 Minutes	☐	☐

RUN COMMENTS

LEADER / MANAGER: ________________ FAILURES CONFIRMED BY: ________________

COMMENTS:

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Final Version 1.0, January 2019

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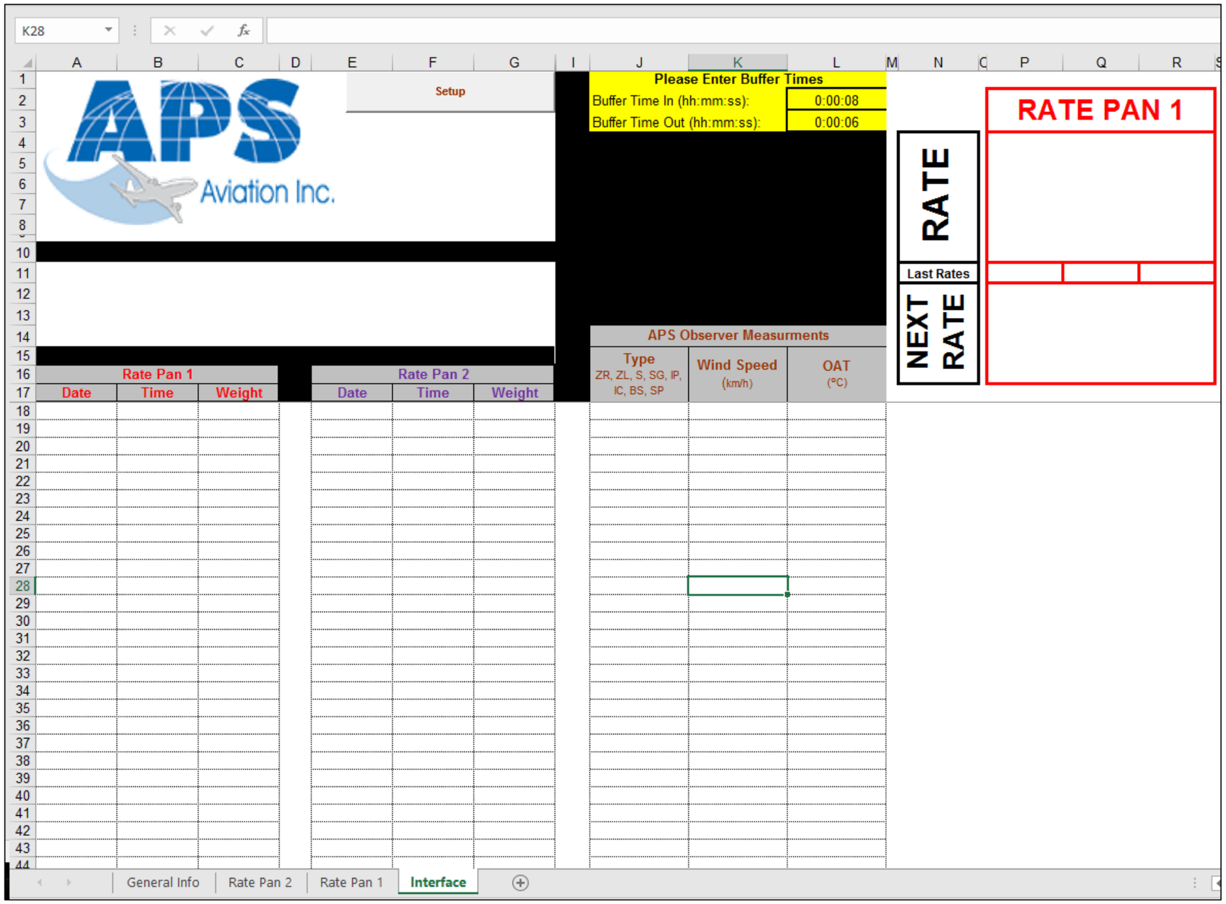
Attachment 3: Screenshot of Rate Program Spreadsheet



Attachment 4: Example of Test Session Summary Form

TEST SESSION SUMMARY
OUTDOOR/OTHER

TEST MANAGER: ______________ DATE: ________________

LOCATION: ______________

# of Tests Conducted	Project	Person Responsible	Data Forms (# or electronic)	Rate File (#)	Logger Files (#)	Photos (#)	Comments
NATURAL SNOW							
	HOT Snow						
	NS Characterization						
	Other ______________						
	Other ______________						
ARTIFICIAL SNOW							
	HOT Snowmaker						
	Other ______________						
FROST							
	HOT Frost						
	Other ______________						
	Other ______________						
OTHER NON TC/FAA PROJECTS (DO NOT INCLUDE IN CALENDAR OF COMPLETED TESTS)							
	SureWx						
	Other ______________						
	Other ______________						

FOR OFFICE USE ONLY		
Verification of Electronic and Paper Filing	PERSON: ______________	DATE: ________________

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12/04/2018

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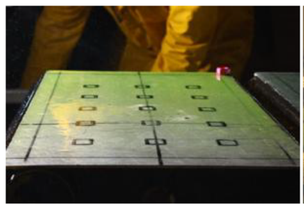
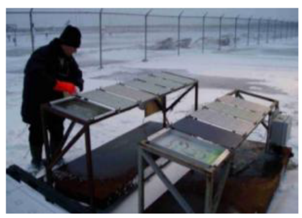
METHODOLOGY FOR ENDURANCE TIME TESTING OF TYPE II, III, AND IV FLUIDS — WINTER 2019-20

METHODOLOGY FOR ENDURANCE TIME TESTING OF TYPE II, III, AND IV FLUIDS

Winter 2019-20






Prepared by

APS Aviation Inc.

These tests were made possible with the guidance, participation, and contribution of Transport Canada and the Federal Aviation Administration.

September 2020
Version 1.0
Report No. M-2019-20

METHODOLOGY FOR ENDURANCE TIME TESTING OF TYPE II, III, AND IV FLUIDS

Winter 2019-20

Prepared by:

Benjamin Bernier, B.Sc.
Leader, Icing & Technical

September 22, 2020
Date

Reviewed by:

John D'Avirro, Eng., PBDM
Vice President, Aviation Services

September 22, 2020
Date

These tests were made possible with the guidance, participation, and contribution of Transport Canada and the Federal Aviation Administration.

September 2020
Version 1.0
Report No. M-2019-20

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SUMMARY

This report documents the key aspects of the testing and analysis methodologies employed by APS Aviation Inc. (APS) to carry out endurance time testing with Type II, III, and IV fluids in the winter of 2019-20.

The testing and analysis methodologies used are based on the protocols provided in Aerospace Recommended Practice (ARP) 5485. This report includes detailed information on:

- Test Sites;
- Test Equipment;
- Test Procedures;
- Test Conditions (precipitation rate limits, ambient temperatures, freezing precipitation droplet sizes); and
- Analysis Methodologies.

This report is intended to be used as a companion document to the reports written to document the individual performance of each Type II, III, and IV fluid tested in the winter of 2019-20. The data, analysis, and results provided in those reports are a function of the test and analysis methodologies described in this report and therefore should be used in conjunction with the information contained herein.

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GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
HUPR	Highest Usable Precipitation Rate
ISO	International Organization for Standardization
LOUT	Lowest Operational Use Temperature
LUPR	Lowest Usable Precipitation Rate
LWC	Liquid Water Content
MVD	Median Volume Diameter
NRC	National Research Council Canada
TC	Transport Canada

1. INTRODUCTION

This report has been created with the support of the fluid manufacturers, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Aircraft ground de/anti-icing has been the subject of concentrated industry attention in recent years due to the occurrence of several fatal icing-related aircraft accidents. Notably, attention has been placed on the enhancement of anti-icing fluids in order to provide an extended period of protection against further contamination following initial deicing. This emphasis has led to the development of fluid-specific de/anti-icing fluid holdover time (HOT) tables for Type II, Type III, and Type IV fluids. These tables, accepted by regulatory authorities, are used by aircraft operators for departure planning in adverse winter conditions. Specifically, they provide the duration of time that fluids provide protection against ice formation under specific weather conditions.

New anti-icing formulations continue to be developed by leading manufacturers with the specific objective of prolonging fluid HOTs without compromising the aerodynamic features of the airfoil. The purpose of the endurance time testing program is to measure the endurance times of these new fluids and develop fluid-specific HOT tables that provide guidance for their use.

Endurance time tests, conducted in natural and simulated precipitation, are used to develop HOT values for new fluids. These tests are carried out according to SAE Aerospace Recommended Practice (ARP) 5485, which provides the test protocols for measuring endurance times of Type II, III, and IV fluids.

This report documents the key aspects of the testing and analysis methodologies employed by APS Aviation Inc. (APS) to carry out endurance time testing with Type II, III, and IV fluids in the winter of 2019-20. It includes information on:

1) Chapter 2 – Test Sites;
2) Chapter 3 – Test Equipment;
3) Chapter 4 – Test Procedures;
4) Chapter 5 – Test Conditions (precipitation rate limits, ambient temperatures, freezing precipitation droplet sizes); and
5) Chapter 6 – Analysis Methodologies.

This report is intended to be used as a companion document to the reports on individual fluid performance. The data, analysis and results provided in those reports are a function of the test and analysis methodologies described in this report and therefore should be used in conjunction with the information contained herein.

2. TEST SITES

This section documents the test sites where APS conducted endurance time testing with Type II, III, and IV fluids during the winter of 2019-20.

2.1 Natural Snow, Natural Frost and Artificial Snow

Natural snow, natural frost, and artificial snow testing is typically and predominantly performed at the APS test site located at the Montréal Pierre-Elliott-Trudeau International Airport. The test site is located near Environment Canada's Meteorological Services of Canada automated weather observation station, as shown in Figure 2.1 on a plan view of the airport.

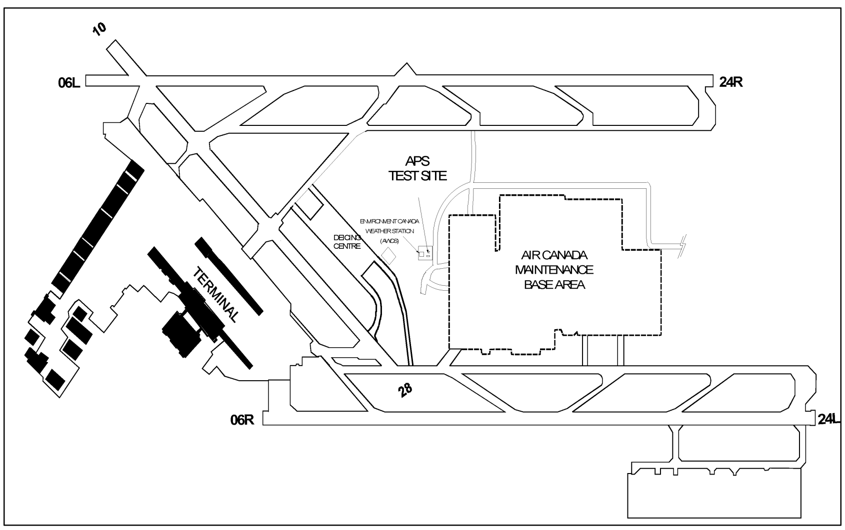


Figure 2.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

The APS test site consists of two trailers and three outdoor locations for test stands. One of the trailers is equipped with a refrigeration unit to enable indoor testing at controlled temperatures; artificial snow testing is typically conducted inside this trailer. In 2019-20, all artificial snow testing was conducted at PMG Technologies in Blainville, Quebec. This was primarily due to limitations on the achievable temperature of the refrigerated trailer at the APS test site. Photo 2.1 and Photo 2.2 show the test site as seen from the test pads and main trailer, respectively.

In winter 2019-20, additional natural snow testing was conducted using mobile test sites in Alma (Quebec), Cochrane (Ontario), Temiskaming Shores (Ontario), and Yellowknife (Northwest Territories).

2.2 Freezing Precipitation

Tests under conditions of freezing fog, rain on cold-soaked surface, freezing drizzle, and light freezing rain were conducted indoors at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF), where precipitation was artificially produced.

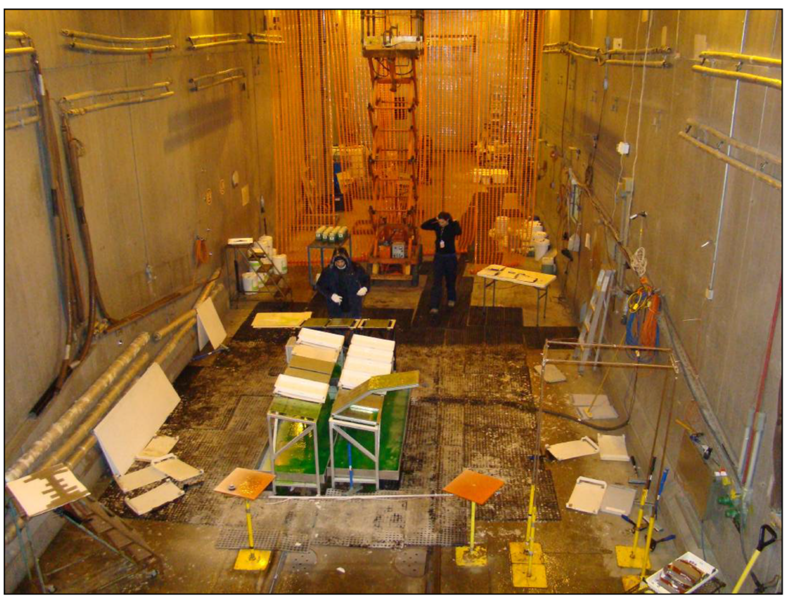
Photo 2.3 provides an outdoor view of the facility giving a general indication of its size (30 m by 5.4 m, height 8 m). The facility was originally designed for the testing of locomotives; Photo 2.4 provides an interior view of the CEF set up for endurance time testing. The lowest temperature achievable in the CEF is -46°C.

Photo 2.1: APS Test Site - View from Test Pad

Photo 2.2: APS Test Site - View from Trailer

Photo 2.3: Outdoor View of NRC Climatic Engineering Facility

Photo 2.4: Inside View of NRC Climatic Engineering Facility



3. TEST EQUIPMENT

The key equipment used in endurance time testing is described in this section, as are the calibration procedures APS follows for ensuring the accuracy of its test equipment.

3.1 Calibration

APS measurement instruments and test equipment are calibrated and/or verified on an annual basis. This calibration is carried out according to a calibration plan based upon approved International Organization for Standardization (ISO) 9001:2008 standards, and developed internally by APS.

3.2 Environmental Chamber Equipment

The general environmental chamber equipment used during tests (including air temperature sensor, data acquisition system, temperature control equipment, etc.) was as stipulated in the requirements set out in ARP5485.

3.3 Test Surface Structures

3.3.1 Flat Plates

The majority of endurance time testing is carried out on standard flat plates. A schematic of a standard flat plate is provided in Figure 3.1. It depicts the size and surface markings of a standard flat plate. Three parallel lines are positioned at 2.5 cm (1″), 15 cm (6″), and 30 cm (12″) from the top of the plate. The plates are marked with 15 crosshairs, which are used in determining when end conditions (see Subsection 4.5) are achieved. Photo 3.1, taken outdoors at the APS test site, shows six test plates mounted on a test stand.

3.3.2 Cold-Soak Boxes

Figure 3.2 shows a schematic of the sealed boxes used for tests simulating a cold-soaked wing. The top of the box consists of a flat plate identical to the standard flat plate. An insulated box shaped reservoir is welded to the bottom of the plate. Photo 3.2 shows a picture of a sealed box, which is referred to as a cold-soaked box when filled for simulated rain on cold-soaked wing tests.

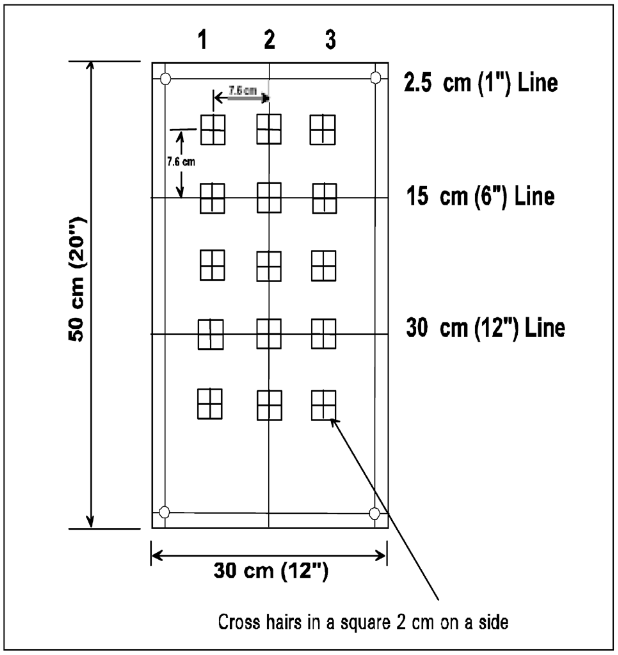


Figure 3.1: Standard Test Plate Schematic

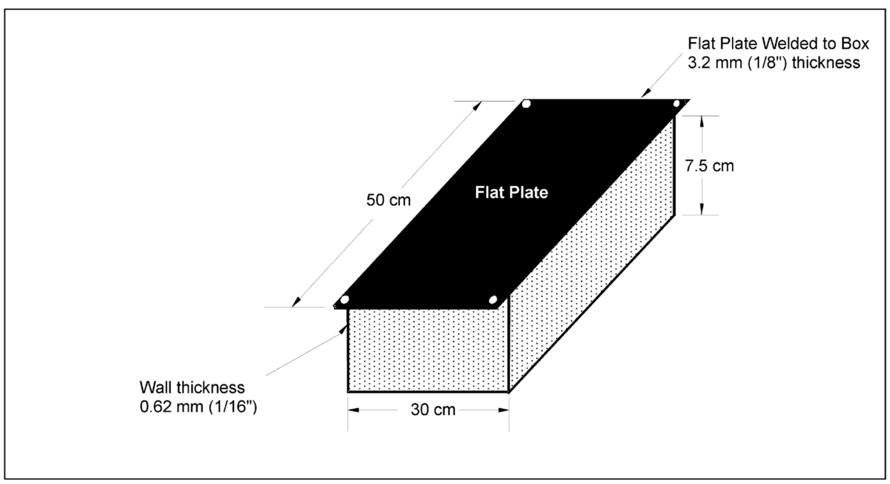


Figure 3.2: Cold-Soaked Box Schematic

3.3.3 Frosticator Plates

In natural frost, tests are conducted on frosticator plates, which are the current standard test surface used in frost HOT testing. The frosticator plates were constructed by attaching a Styrofoam insulation backing to the back of the test surface (either aluminum or composite). The insulation prevents heat exchange via the underside of the flat plate and allows for effective radiative cooling during active frost conditions. Photo 3.3 shows a white-painted aluminum frosticator plate.

3.3.4 Artificial Snow Machine Test Plate

In artificial snow, tests are conducted on a standard flat plate that has been mounted onto a specialized scale. This setup is shown in Photo 3.4.

3.4 Test Surface Materials

Testing of Type II, III, and IV fluids is carried out exclusively on aluminum surfaces. The aluminum used is 0.32 cm thick Alclad 2024 T3 aluminum.

3.5 Test Stands

Figure 3.3 shows a schematic of the test platform used for HOT testing. For natural snow tests, six test plates are normally mounted on the test stand, which has a working surface inclined at 10° to the horizontal. During normal winter operations two six-position stands are used in combination. Each plate represents a flat plate test. For simulated freezing precipitation tests at the NRC, 12 plates are mounted on 2 six-position stands. Photo 3.1 shows the test stands set up for testing.

3.6 Collection Pans

Figure 3.4 shows a schematic of the collection pan used for precipitation rate measurement in outdoor testing. It is the same size as a standard flat plate and is used to make precipitation rate measurements during outdoor tests. Photo 3.5 shows the collection pans used for measuring precipitation rates indoors at the NRC.

3. TEST EQUIPMENT

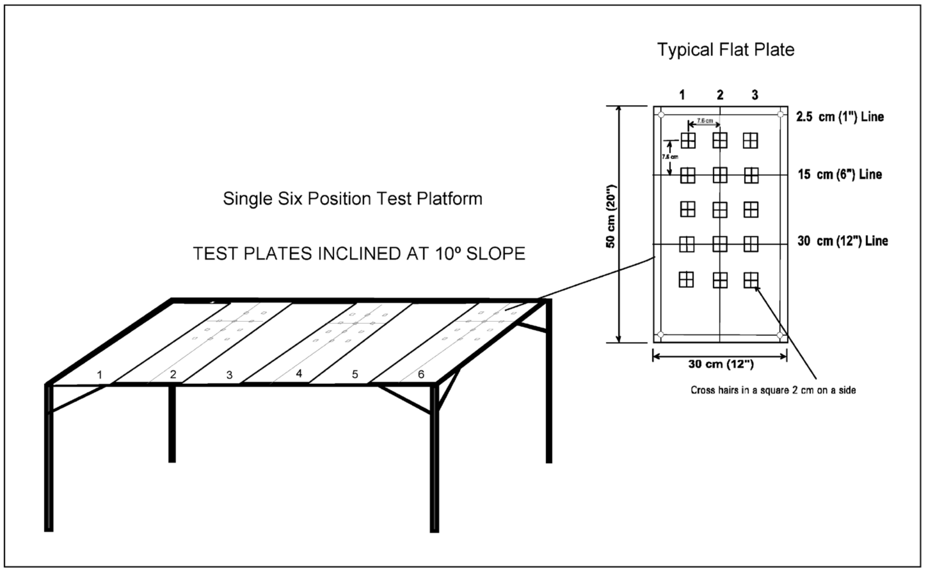


Figure 3.3: Test Stand Setup Schematic

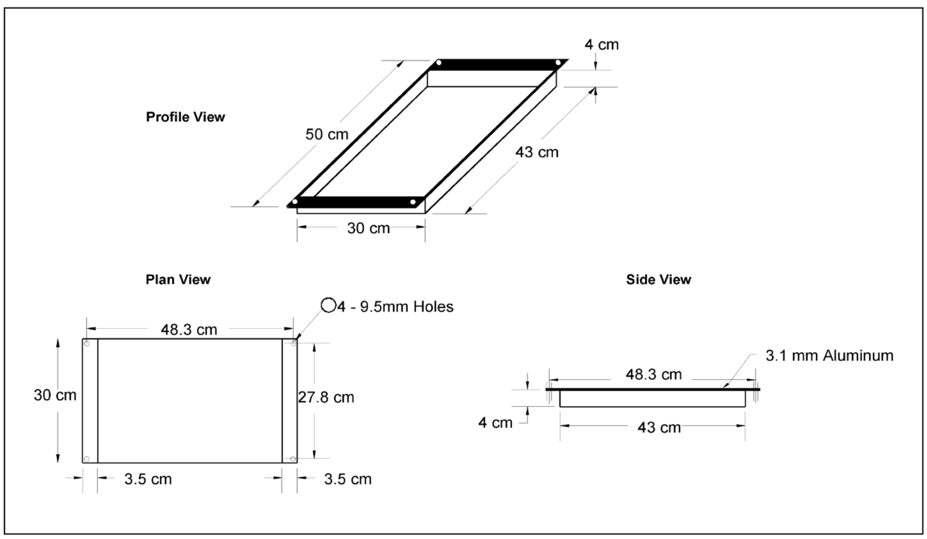


Figure 3.4: Schematic of Outdoor Precipitation Measurement Pan

APS/Library/Projects/300293 (TC Deicing 2019-20)/Reports/Fluid Manufacturer/2019-20 Type II-III-IV Methodology/Type II-III-IV Methodology Version 1.0.docx
Version 1.0, September 20

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3.7 NRC Sprayer Assembly

NRC developed an improved sprayer assembly, shown in Photo 3.6 and Photo 3.7, in 1997-98. The improved sprayer provides a larger scan area and improved spray uniformity over the test bed area. The scanner consists of a horizontal main shaft supported by two bearings. The actual spray head assembly is shaft-mounted on a rotating scanner, so that one scan covers a lateral running strip of the test bed area. A stepper motor is synchronized to index the relative angle of the spray head between scans along an axis perpendicular to the scan axis. This provides two axes of rotation, essentially an x-y plane; one along each axis. Each scan is consecutively indexed in order to complete the precipitation coverage of the test bed area. This defines one cycle of the spray unit. The scan rate, index angle, and the number of scans per cycle are adjusted, along with the fluid delivery pressures (water and air) to obtain appropriate droplet sizes and precipitation rates. The spray nozzle is shown in Photo 3.8.

3.8 Fluids

In most cases, testing was carried out with Type II, III, and IV fluids in the standard Type II, III, and IV fluid dilutions: 100/0, 75/25, and 50/50. Diluted fluids were prepared by the manufacturer; APS does not prepare diluted samples for endurance time testing of new fluids.

Photo 3.1: Test Plates Mounted on Stand

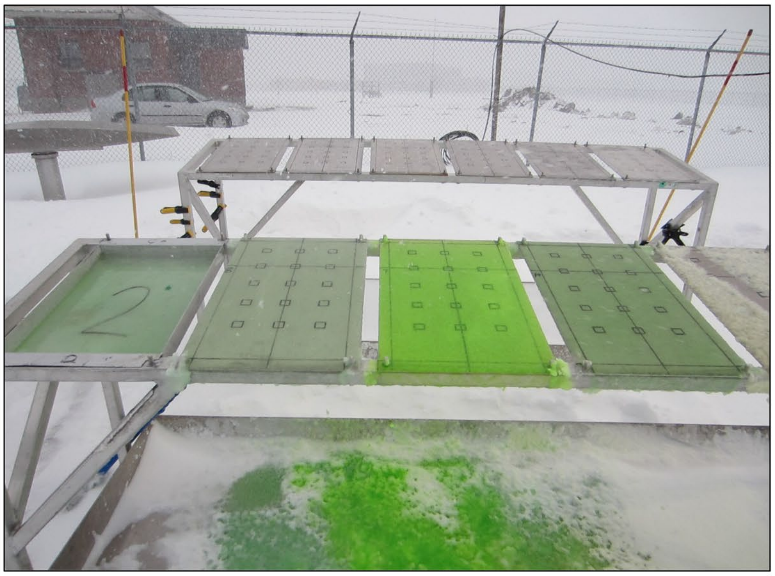


Photo 3.2: Cold-Soak / Leading Edge Thermal Equivalent Box

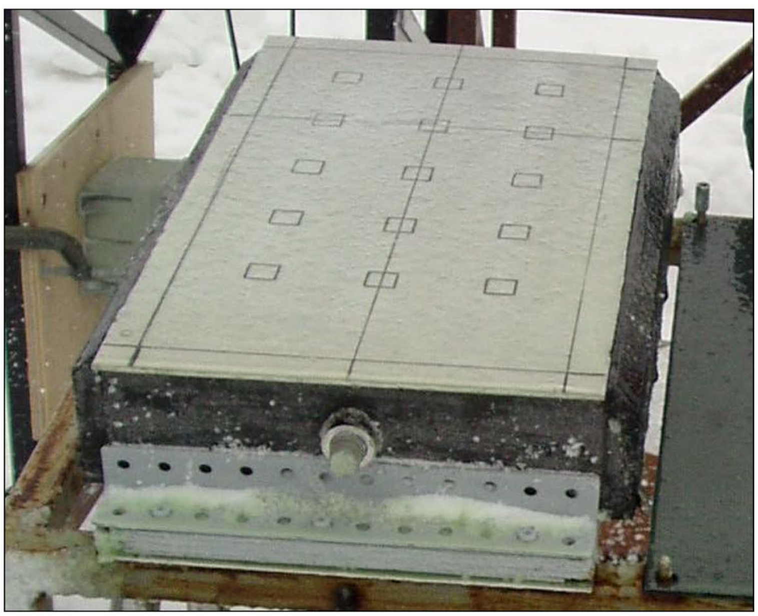


Photo 3.3: Frost Plate with Insulated Backing

Photo 3.4: Standard Plate Setup for Testing with Artificial Snow Machine

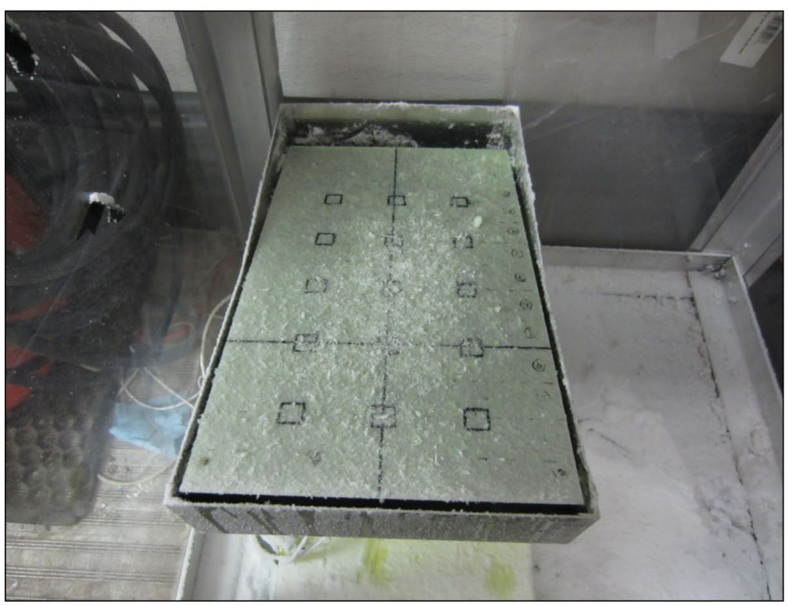


Photo 3.5: Collection Pans Used Indoors at the NRC

Photo 3.6: Sprayer Assembly

Photo 3.7: Sprayer Assembly in Use

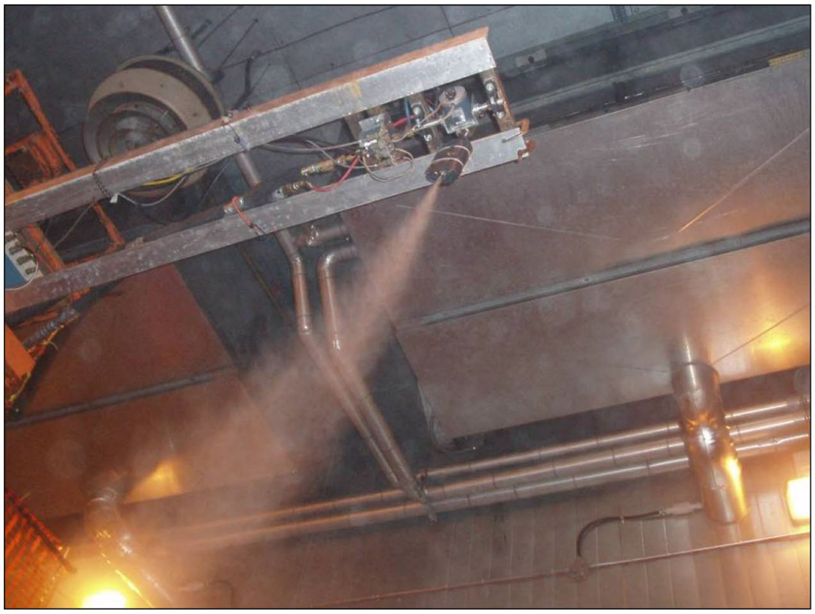
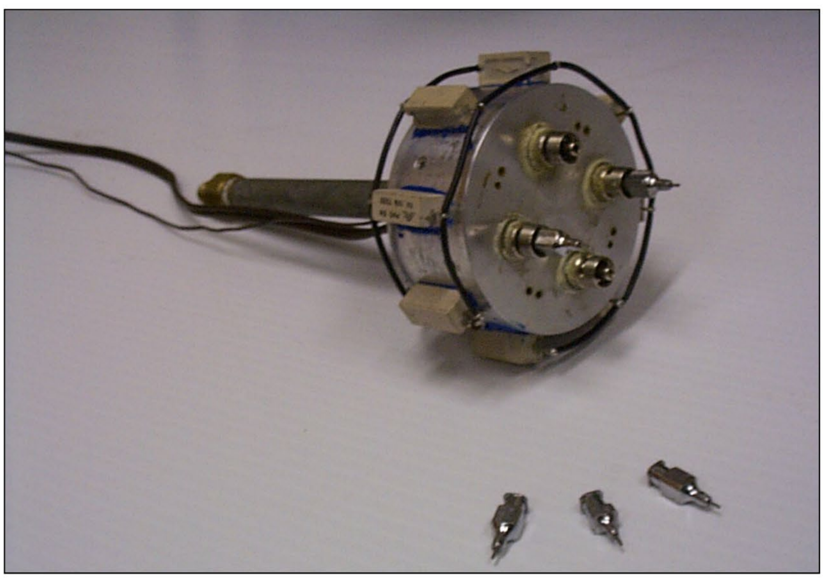


Photo 3.8: Sprayer Nozzle



4. TEST PROCEDURES

ARP5485 provides the standard procedure for endurance time testing of Type II, III, and IV fluids under natural and simulated precipitation conditions.

The procedure generally consists of pouring de/anti-icing fluids onto clean flat plates exposed to various winter precipitation conditions, and recording the elapsed time for the test to reach the defined end condition (see Subsection 4.5), when a specified degree of freezing occurs. The following subsections provide summaries of the test procedures followed for natural snow, natural frost, artificial snow, and simulated freezing precipitation testing.

4.1 Test Procedure – Natural Snow Tests

APS developed a specific procedure for Type II, III, and IV fluid testing in natural snow based on the requirements outlined in ARP5485. Key details of the procedure include:

- Tests are conducted on standard flat plates (see Subsection 3.3.1);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.2 Test Procedure – Natural Frost Tests

APS developed a specific procedure for Type II/III/IV testing in natural frost. Key details of the procedure include:

- Tests are conducted on frosticator plates (see Subsection 3.3.3);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.3 Test Procedure – Artificial Snow Tests

APS developed a specific procedure for testing in artificial snow based on the requirements outlined in ARP5485. Key details of the procedure include:

- Tests are conducted on a standard plate mounted on the snow machine scale (see Subsection 3.3.4);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.4 Test Procedure – Simulated Precipitation Tests

APS developed a specific procedure for Type II/III/IV testing in simulated precipitation based on the requirements outlined in ARP5485. Key details of the procedure include:

- Freezing fog, freezing drizzle, and light freezing rain tests are conducted on standard flat plates (see Subsection 3.3.1);
- Rain on cold-soaked surface tests are conducted on filled cold-soaked boxes (see Subsection 3.3.2);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.5 End Condition Definitions

Failure is called when 30 percent (1/3) of the plate or 5 cross-hairs are covered with frozen contamination. Appearance of this frozen contamination includes, but is not limited to:

a) Ice front;
b) Ice sheet;
c) Slush, in clusters or as a front;
d) Disseminated fine ice crystals;
e) Frost on surface;
f) Clear ice pieces partially or totally imbedded in fluid; and
g) Snow bridges on top of the fluid.

4.6 Precipitation Rate Measurement Procedures

The procedures for measuring and determining precipitation rates during simulated precipitation and natural precipitation conditions are provided below.

4.6.1 Simulated Precipitation Conditions

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

The pans are weighed prior to exposure to precipitation and the weights are recorded in a customized Excel spreadsheet by using the print function on the digital weigh scale. Prior to the start of the precipitation catch period, the exact time (hh:mm:ss) is recorded using a pre-programmed time macro in the Excel spreadsheet. The pans are re-weighed following this collection period and the precipitation rates over the area of the test stand are examined. If the rates are unacceptable, re-calibration of the water spray is necessary. If the rates are deemed to be acceptable, the pans are weighed and placed on the stand for a second collection period. After the second collection period has expired, the pans are again re-weighed and the rates computed.

Once two rates have been collected at each test location, the catch rates of the first and second collection are compared. If the average catch rate for any location is deemed to be acceptable for the test condition, then the pouring of fluids may begin at this location.

Rates are continuously monitored at a minimum of two locations during a test in order to ensure there are no significant rate fluctuations. Pans will be placed at these locations and be re-weighed at fixed intervals (15 minutes, typically) during the course of a test. If a rate fluctuation occurs, the test is stopped.

Following the failure of a test plate, a rate collection pan is weighed and placed at the plate location for a predetermined time interval. It is then re-weighed and placed again on the stand to collect a minimum of two additional rates at this location.

The rate of precipitation for any location on the stand is calculated by averaging the two rates collected prior to the test and the two rates collected following the test.

4.6.2 Natural Precipitation Conditions

Two rate collection pans per test stand are typically used to determine precipitation rates in natural conditions. Prior to the rate collection period, both pans are marked (upper and lower), and the inner bottom and sides of each pan are wetted with Type IV fluid to prevent blowing snow from escaping the pan. The wetted pans are then weighed to the nearest gram. The start time of the rate collection period is recorded (h/min/sec) using a customized Excel spreadsheet in which the weight is also recorded by pressing the print function on the digital weigh scale.

The pans are positioned in locations 6 and 7 and allowed to collect precipitation for 10-minute intervals in normal conditions and 5-minute intervals in periods of high precipitation rates and high winds. In frost the collection interval is half hour to one hour depending on the frost accretion intensity.

Prior to removal of the plate pans from the test stand for re-weighing, any accumulated precipitation on the lips and outer sides of each plate pan is carefully removed. The plate pans are then carried to the rate station for re-weighing. Upon entering the trailer, the exact time is noted. The new weights of the plate pans are recorded and the pans are brought back outside. This procedure is continued until the final plate on the test stand fails.

The rate for any HOT test in natural snow or frost is obtained by computing the time-weighted average of the rates collected in the upper and lower pans over the duration of the particular test.

An example of the rate calculation method for tests in natural conditions is displayed in Figure 4.1. Typically, two collections pans are used for each test. The start and end times of the test shown in Figure 4.1 are 10:15 and 10:45, respectively. Precipitation rates for one pan were collected at three periods during this test, indicated by t1, t2, and t3 (minutes). The calculated rates for each collection period are indicated by R1, R2, and R3 (g/dm²/h).

In order to calculate the average rate for this pan, the following formula is then used:

$$\frac{(R_1 \times t_1 + R_2 \times t_2 + R_3 \times t_3)}{t_1 + t_2 + t_3}$$

In the example shown in Figure 4.1, the rate is calculated as follows:

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

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

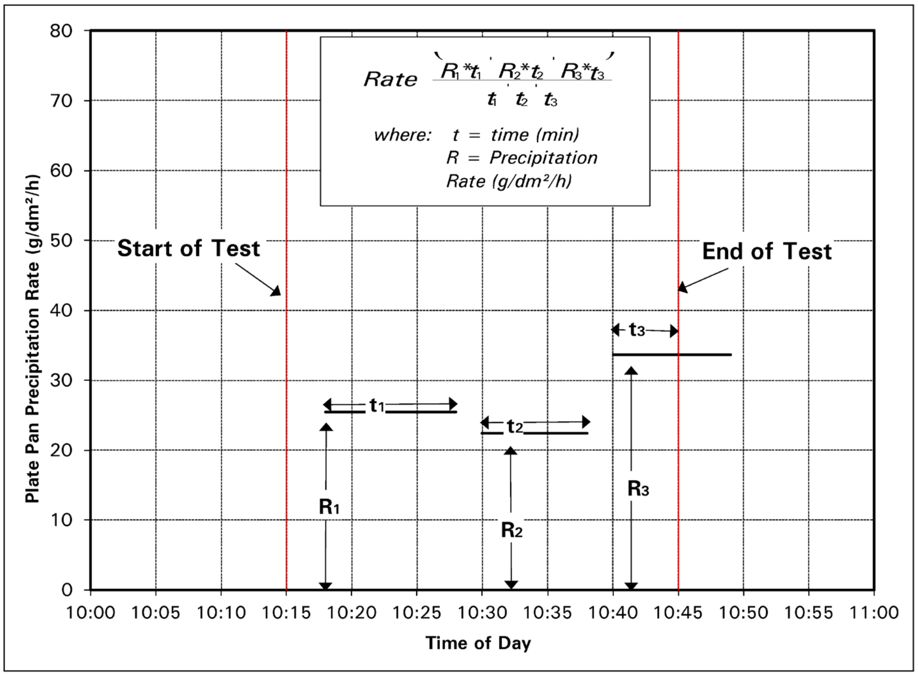


Figure 4.1: Calculation of Outdoor Precipitation Rate

5. TEST CONDITIONS

The conditions under which endurance time testing is conducted with Type II, III, and IV fluids are outlined in this section. Details are provided for precipitation rates, ambient temperatures, and droplet sizes.

5.1 Precipitation Rate Limits

Upper and lower precipitation rate limits are an important part of the test methodology for measuring fluid endurance times. Table 5.1 provides the meteorologically accepted definitions of weather phenomenon / precipitation types. It also includes the criteria used to determine precipitation intensity.

Table 5.1: Definition of Weather Phenomenon

Weather Phenomenon*	Definition*
FROST (No METAR code) **Note:** No Intensity is assigned to FROST.	Ice crystals that form from ice-saturated air at temperatures below 0°C (32°F) by direct sublimation on the ground or other exposed objects.
FREEZING FOG (FZFG) **Note:** No Intensity is assigned to FRZ FOG	A suspension of numerous minute water droplets which freezes upon impact with ground or other exposed objects, generally reducing the horizontal
SNOW (SN)	Precipitation of ice crystals, most of which are branched, star-shaped, or mixed with unbranched crystals. At temperatures higher than about -5°C
FRZING DRIZZLE (FZDZ)	Fairly uniform precipitation composed exclusively of fine drops [diameter less than 0.5 mm (0.02 in.)] very close together which freezes upon impact with
FREEZING RAIN (FZRA)	Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5
RAIN (RA)	Precipitation of liquid water particles either in the form of drops of more than 0.5 mm (0.02 in.) diameter or of smaller widely scattered drops.
SNOW PELLETS (GS) and/or SMALL HAIL	Precipitation of white and opaque grains of ice. These grains are spherical or sometimes conical; their diameter
SNOW GRAINS (SG)	Precipitation of very small white and opaque grains of ice. These grains are fairly flat or elongated; their diameter is
HAIL (GR)	Precipitation of small balls or pieces of ice with a diame-
ICE PELLETS (PE)	Precipitation of transparent (sleet or grains of ice), or translucent (small hail) pellets of ice, which are spherical or irregular, and which have a diameter of 5 mm (0.2 in.)

Intensity Criteria**

	Snow(SN),Pellets(GS),Grains(SG)		Ice Pellets (PE)
Estimated Intensity	**Horizontal Visibility (statute mile)**	**Liquid Equivalent Snow (SN) Intensity*****	**Definition and Horizontal Visibility**
Light (-)	If visibility is: **≥ 5/8 mi** (≥ 1.0 km)	**Trace to 0.05 in/hr** (≤ 1.0 mm/hr or 10 gr/dm²/hr)	Scattered pellets on the ground. Visibility not affected
Moderate	If visibility is: **< 5/8 to 5/16 mi** (< 1.0 to 0.5 km)	**> 0.05 to 0.10 in/hr** (> 1.0 to 2.5 mm/hr) (> 10.0 to 25.0 gr/dm²/hr)	Slow accumulation on the ground. Visibility reduced to less than 7 mi.
Heavy (+)	If visibility is: **< 5/16 mi** (< 0.5 km)	**More than 0.10 in/hr** (> 2.5 mm/hr or 25 gr/dm²/hr)	Rapid accumulation on the ground. Visibility reduced to less than 3 mi.

Note: Horizontal visibility is only an estimation of snow and freezing drizzle intensity. Measurements and observations have

	Drizzle Intensity (FZDZ)
Light(-)	Trace to 0.01 in/hr (0.254 mm/hr or 2.54 gr/dm²/hr)
Moderate	From 0.01 to 0.02 in/hr (2.54 to 5.08 gr/dm²/hr)
Heavy(+)	More than 0.02 in/hr (> 5.08 gr/dm²/hr) **Note:** Drizzle > 0.04 in/hr is usually in the form of rain.

		Rain (RA), Freezing Rain (FZRA), Ice Pellets (PE)
Light (-)	Measured Intensity	Up to 0.10 in/hr (2.5 mm/hr or 25 gr/dm²/hr) Maximum 0.01 inch in 6 minutes
	Estimated Intensity	From scattered drops that, regardless of duration, do not completely wet an
Moderate	Measured Intensity	0.11 in to 0.30 in/hr (7.6 mm/hr or 76 gr/dm²/hr) More than 0.01 to 0.03 inch in 6 minutes
	Estimated Intensity	Individual drops are not clearly identifiable; spray is observable just above
Heavy (+)	Measured Intensity	More than 0.30 in/hr (7.6 mm/hr or 76 gr/dm²/hr) More than 0.03 inch in 6 minutes
	Estimated Intensity	Rain seemingly falls in sheets; individual drops are not identifiable; heavy

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

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

Compiled by Jeff Cole and Roy Rasmussen of NCAR/RAP Sept 8, 1999 (Updated for METAR codes)

Table 5.1 was compiled by the National Centre for Atmospheric Research (NCAR) from the *World Meteorological Organization Guide to Meteorological Instruments and Methods of Observation* (1983) and from the *American Meteorological Society, Glossary of Meteorology WSOH # 7 Manual of Surface Weather Observations (MANOBS*) (3/94).

The precipitation rate limits established for Type II/III/IV endurance time testing are provided in ARP5485 and represented graphically in Figure 5.1. Subsections 5.1.1 to 5.1.5 provide detailed definitions and explanations of the precipitation types and rate boundaries used in Type II/III/IV endurance time testing. It should be noted that in many cases these limits are not the same as the meteorologically accepted definitions provided in Table 5.1.

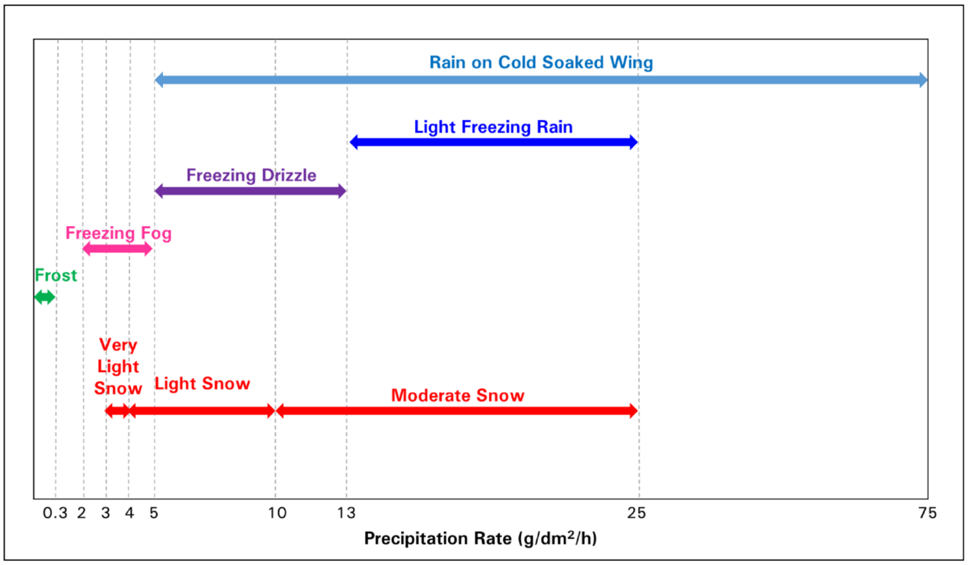


Figure 5.1: Precipitation Rate Limits Used in Endurance Time Testing

5.1.1 Freezing Fog

The precipitation rate limits for endurance time testing in freezing fog were set in 1997 at rates of 2 and 5 $g/dm^2/h$. These limits were determined with input from NRC meteorologists, who helped define an important parameter in the study of fog referred to as the *Liquid Water Content* (LWC). This quantity, expressed in density terms as the mass of water in grams contained in one cubic meter of air, can generally assume values in the range of 0.2 to 0.6 g/m^3.

5.1.2 Freezing Drizzle

The precipitation rate limits for endurance time testing in freezing drizzle are 5 and 13 g/dm^2/h. The upper limit in this range was adopted based on discussions with meteorological experts and aircraft operators on the SAE G-12 HOT Committee. This range corresponds to heavy drizzle and has been chosen to provide aircraft operators with a greater margin of safety.

5.1.3 Light Freezing Rain

The precipitation rate limits for endurance time testing in light freezing rain are 13 and 25 g/dm^2/h. This range corresponds to the category of light freezing rain and is the only freezing rain category considered, as operations in periods of moderate or heavy freezing rain are deemed unsafe.

5.1.4 Rain on a Cold-Soaked Surface

The precipitation rate limits for rain on cold-soaked surface are 5 and 75 g/dm^2/h. This range encompasses drizzle (5 to 13 g/dm^2/h), light rain (13 to 25 g/dm^2/h), and moderate rain (25 to 75 g/dm^2/h).

5.1.5 Snow

The precipitation rate limits used to determine HOTs for Type II/III/IV fluids in snow are 3, 4, 10, and 25 g/dm^2/h. These rate limits encompass very light, light, and moderate snow.

5.2 Ambient Temperatures in Type II/III/IV Endurance Time Testing

HOTs are provided for six temperature bands in Type II, III, and IV HOT tables. These bands cover temperatures from the fluid's lowest operational use temperature (LOUT) and warmer.

For Type II/IV fluids the temperature bands are:

- -3°C and above (rain on cold-soaked surface limited to +1°C);
- Below -3°C to -8°C;
- Below -8°C to -14°C (freezing drizzle/light freezing limited to -10°C);
- Below -14°C to -18°C;
- Below -18°C to -25°C; and
- Below -25°C to LOUT (for fluids with LOUTs below -25°C).

For Type III fluids the temperature bands are:

- -3°C and above (rain on cold-soaked surface limited to +1°C);
- Below -3°C to -10°C; and
- Below -10°C to LOUT.

For Type III fluids with extremely low LOUTs (below -29.5°C), the third temperature band may be limited to -25°C and a fourth temperature band (below -25°C to LOUT) may be added.

In natural snow and natural frost testing, endurance time testing is carried out under a range of temperatures. In simulated freezing precipitation and artificial snow testing, endurance time testing is typically conducted at the lower limit of each temperature band. At this time, testing is not conducted at -8°C. The temperatures at which testing is conducted for each condition are listed below:

- Freezing Fog: -3°C, -10°C (Type III) / -14°C (Type II/IV), -25°C, LOUT (if LOUT <-29.5°C);
- Freezing Drizzle: -3°C and -10°C;
- Light Freezing Rain: -3°C and -10°C;
- Rain on Cold-Soaked Surface: +1°C; and
- Artificial Snow: -3°C, -10°C (Type III) / -18°C (Type II/IV), -25°C, LOUT (if LOUT <-29.5°C).

5.3 Freezing Precipitation Droplet Sizes

Research has shown that median volume diameter (MVD) of rain droplets is related to rate of precipitation as follows:

- MVD = (precipitation rate/10) $^{0.23}$, where MVD is in mm and rate of precipitation is in g/dm²/h

The theoretical MVDs for rain at various rates of precipitation were determined based on this equation. These values are listed in Table 5.2 beside the experimental MVDs for each precipitation condition.

To determine whether droplets produced at the NRC resembled droplets from natural precipitation, a test was conducted during natural light freezing rain conditions in 1997-98 at the APS test site. The droplet sizes were compared to those obtained in simulated light freezing rain at the NRC. The results of these tests are shown below.

a) *For the outdoor test:*
Location: Montreal International Airport
Precipitation: Natural Light Freezing Rain
Precipitation Rate: 20 g/dm²/h
Calibrated MVD: 1.0 mm

b) *For the indoor test:*
Location: National Research Council CEF
Precipitation: Simulated Light Freezing Rain
Precipitation Rate: 25 g/dm²/h
Calibrated MVD: 1.0 mm

The MVD for both natural and simulated light freezing rain was 1 mm, indicating that the NRC produced droplets simulate natural precipitation.

As a result of this testing, the MVDs for freezing precipitation testing were established as follows:

- Freezing Fog, high precipitation rate (5 g/dm²/h): 30 μm
- Freezing Fog, low precipitation rate (2 g/dm²/h): 30 μm

- Freezing Drizzle, high precipitation rate (13 g/dm²/h): 350 μm
- Freezing Drizzle, low precipitation rate (5 g/dm²/h): 250 μm

- Light Freezing Rain, high precipitation rate (25 g/dm²/h): 1,000 μm
- Light Freezing Rain, low precipitation rate (13 g/dm²/h): 1,000 μm

- Rain on Cold-Soaked Surface, low precipitation rate (5 g/dm²/h): 250 μm
- Rain on Cold-Soaked Surface, high precipitation rate (75 g/dm²/h): 1,400 μm

Table 5.2: Theoretical and Experimental MVDs

Precipitation Condition	Experimental MVD (mm)	Theoretical MVD (mm)
Moderate Rain (High rate: 75 g/dm²/h)	1.4	1.6
Light Rain (Low rate: 13 g/dm²/h)	1.0	< 1.1
Light Rain (High rate: 25 g/dm²/h)	1.0	1.2
Drizzle (Low rate: 5 g/dm²/h)	0.25	< 0.5
Drizzle (High rate: 13 g/dm²/h)	0.35	< 0.5
Fog		< 0.1

5.4 Summary of Freezing Precipitation Test Conditions

The precipitation types/rates, ambient temperatures and droplet sizes for freezing precipitation testing with Type II/III/IV fluids were described in the previous subsections. In summary, freezing precipitation tests are carried out under each of the 16 weather conditions listed in Table 5.3.

Table 5.3: Summary of Freezing Precipitation Test Conditions

Precipitation Type	Ambient Temperature	Precipitation Rate (Droplet Size)
Freezing Fog	-3°C	2 $g/dm^2/h$ (30 μm)
		5 $g/dm^2/h$ (30 μm)
	-14°C (Type II/IV) -10°C (Type III)	2 $g/dm^2/h$ (30 μm)
		5 $g/dm^2/h$ (30 μm)
	-25°C	2 $g/dm^2/h$ (30 μm)
		5 $g/dm^2/h$ (30 μm)
	LOUT (if < -29°C)	2 $g/dm^2/h$ (30 μm)
		5 $g/dm^2/h$ (30 μm)
Freezing Drizzle	-3°C	5 $g/dm^2/h$ (250 μm)
		13 $g/dm^2/h$ (350 μm)
	-10°C	5 $g/dm^2/h$ (250 μm)
		13 $g/dm^2/h$ (350 μm)
Light Freezing Rain	-3°C	13 $g/dm^2/h$ (1,000 μm)
		25 $g/dm^2/h$ (1,000 μm)
	-10°C	13 $g/dm^2/h$ (1,000 μm)
		25 $g/dm^2/h$ (1,000 μm)
Rain on Cold-Soaked Surface	+1°C	5 $g/dm^2/h$ (250 μm)
		75 $g/dm^2/h$ (1,400 μm)

6. ANALYSIS METHODOLOGIES

A multi-variable regression procedure is used to derive fluid-specific HOTs for Type II/III/IV fluids. The procedure is based on the refinement of an equation for a curve which best represents the test data, and then solving that equation at the upper and lower limits established for the precipitation type. These precipitation rate limits, set by the SAE G-12 HOT Committee and detailed in ARP5485, were described in Subsection 5.1. This approach was developed in the winter of 1996-97 (see TC report, TP 13131E) and has since been used to derive fluid HOTs. There are some differences in the way the methodology is applied to freezing precipitation and natural snow data.

6.1 Freezing Precipitation Data

For each related freezing precipitation HOT table cell, four tests are conducted at the most restrictive (lowest) temperature in the temperature range for that cell: two tests at the low precipitation rate limit and two tests at the high precipitation rate limit (limits are detailed in Subsection 5.1). An exception to this is the "Below -3°C to -8°C" cell for Type II/IV fluids. No testing is conducted in this temperature range; this cell is instead populated with the same HOTs as the "Below -8°C to -14°C" cell.

The equation used to treat freezing precipitation data is:

- $t = 10^{I}R^{a}$, where

  t = Time (minutes)
  R = Rate of precipitation (g/dm²/h)
  I, a = coefficients determined from the regression.

The upper and lower HOT values for each cell are determined from the points at which the best-fit curve intersects the lower and upper precipitation limits, respectively. The calculated HOTs derived from this analysis are subject to the rounding and capping rules detailed in Subsection 6.4.

6.2 Natural Snow Data

As outside air temperature and precipitation rate cannot be controlled under natural test conditions, natural snow tests are carried out at a variety of temperatures and precipitation rates. An attempt is made to gather data under all temperatures and precipitation rates encompassed by the HOT tables.

The general form of the regression equation is modified for natural snow to incorporate the variable of temperature and also to prevent taking the log of a negative number as natural snow can occur at temperatures approaching 2°C. The equation used to treat natural snow data is:

- $t = 10^{I} R^{a} (2\text{-}T)^{b}$, where

  t = Time (minutes)
  R = Rate of precipitation (g/dm²/h)
  I, a, b = coefficients determined from the regression.

The upper and lower HOT values for each cell are determined from the points at which the best-fit curve intersects the lower and upper precipitation limits, using the most restrictive (lowest) temperature for that cell. The calculated HOTs derived from this analysis are subject to the rounding and capping rules detailed in Subsection 6.4.

The data included in a given snow HOT regression analysis is dependent on the temperatures for which the HOTs are being derived. For warm snow HOTs (-14°C and above), all data collected at temperatures of -16°C and warmer is included in the analysis. For cold snow HOTs (below -14°C), all data collected at temperatures of -14°C and colder is included in the analysis.

6.3 Natural Frost Data

Regression analysis is not used in the determination of frost HOTs. The current Type II/III/IV generic frost HOTs were determined based on several years of testing using all fluids which were commercially available at the time. A "minimum values" analysis methodology was used to determine appropriate HOTs from the test data.

The purpose of natural frost testing with new fluids is to verify the fluids can be used with the generic frost HOTs. The analysis methodology is to compare the frost test data collected with the new fluid to the current generic HOTs. If the test data provides HOTs equal to or greater than the generic HOTs then the generic HOTs have been validated for the new fluid.

As outside air temperature and precipitation rate can not be controlled under natural test conditions, natural frost tests are carried out at a variety of temperatures and precipitation rates.

For a given Type II/III/IV fluid, a minimum of two data points (with acceptable results) per dilution are required to consider the generic active frost HOTs validated. The desired data targets are six tests for a neat dilution, four tests for a 75/25 dilution, and two tests for a 50/50 dilution. If these desired data targets are not achieved for a given fluid in the year it is initially submitted for HOT testing, samples of the fluid will be retained and additional active frost tests will be run the following year. Samples are not to be retained for testing longer than one additional year.

6.4 Artificial Snow Data

6.4.1 Fluids without Fluid-Specific Snow HOTs Below -14°C

Type II and Type IV fluids that were submitted for endurance time testing in the winter of 2019-20 underwent testing in artificial snow at -18°C and -25°C. The purpose of the testing was to verify the fluids can be used with the generic very cold snow HOTs. Note that this testing was omitted for fluids with fluid-specific snow HOTs below -14°C.

The analysis methodology used to complete this verification was to compare the test data collected to a historical database of similar data. If the test data provided endurance times similar to those in the historical data set, then the generic HOTs were considered validated for the new fluid.

6.4.2 Snow HOTs at LOUT for Fluids with LOUT <-29°C

Type II and Type IV fluids with LOUTs below -29°C that were submitted for endurance time testing in the winter of 2019-20 underwent additional testing in artificial snow at -25°C and at their respective LOUTs. The purpose of this testing was to determine the appropriate snow HOTs for these fluids at their LOUT.

The testing and analysis protocol used to determine the HOTs at LOUT is as follows:

1. Artificial snow tests are run at -25°C and at the LOUT at the boundary rates for very light, light, and moderate snow as outlined in the HOT Guidelines (3, 4, 10, and 25 g/dm²/h, with two tests at each rate/temperature pairing);
2. The relative performance of the fluid at -25°C vs. the LOUT is determined by dividing the endurance times of the tests run at the LOUT by the endurance times of the tests run at -25°C for each of the boundary rates;
3. The resulting relative performance outputs are averaged;
4. The final average endurance ratio is reduced by a factor of two sigma in order to ensure the final output remains conservative; and
5. The reduced endurance time ratio is applied to the HOTs derived for -25°C from the natural snow data to obtain HOTs for the LOUT.

6.5 Rounding and Capping Protocols

Regression-generated HOTs are subject to the rounding and capping protocols detailed below.

6.5.1 Rounding Protocols

All HOTs are rounded to the nearest whole "5" minute, i.e. 55.1 to 57.4 minutes is rounded down to 55 minutes; 57.5 to 59.9 minutes is rounded up to 60 minutes. The only exceptions are:

- In cases where the regression-generated HOTs for Type II/IV fluids are below 10 minutes, the numbers are rounded down to the nearest whole minute as a precautionary measure (e.g. 9.6 minutes is rounded down to 9 minutes); and
- In cases where the regression-generated HOTs for Type III fluids are below 20 minutes, the numbers are rounded down to the nearest whole minute as a precautionary measure (e.g. 19.6 minutes is rounded down to 19 minutes).

6.5.2 Capping Protocols

All HOT values are capped at maximum values. The caps differ by precipitation type, and in the case of snow, by regulator. The caps are as follows:

- Freezing Fog HOT values are capped at 4 hours;
- Freezing Drizzle, Light Freezing Rain, Rain on Cold-Soaked Wing HOTs are capped at 2 hours; and
- Snow HOTs are capped at 2 hours by TC and 3 hours by the FAA.

6.6 Regression Example

Sample plots of **Log t** versus **Log R** are shown in Figure 6.1. The plots contain data for one Neat Type IV fluid, in one temperature range (-10°C), in light freezing rain conditions. The best-fit regression line is superimposed onto the plot and was obtained from the analysis using the lowest temperature in the temperature range from which the data were chosen.

The same data plotted on a linear scale (failure time **t** versus precipitation rate **R**) are shown in Figure 6.2. The curve, generated from the power law form of the equation using the coefficients determined from the fit, is superimposed onto the plot. The HOT range is determined from the intersections of the curve with the precipitation rate limits defined for light freezing rain.

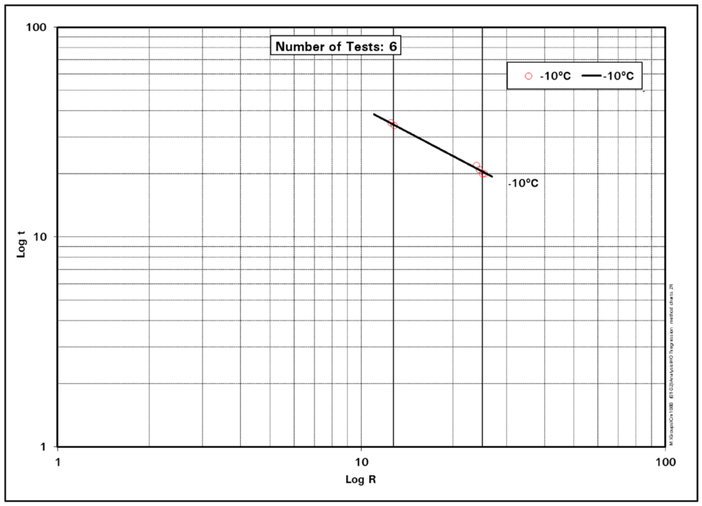


Figure 6.1: Regression Method on Log-Log Chart – Type IV Neat, Freezing Rain

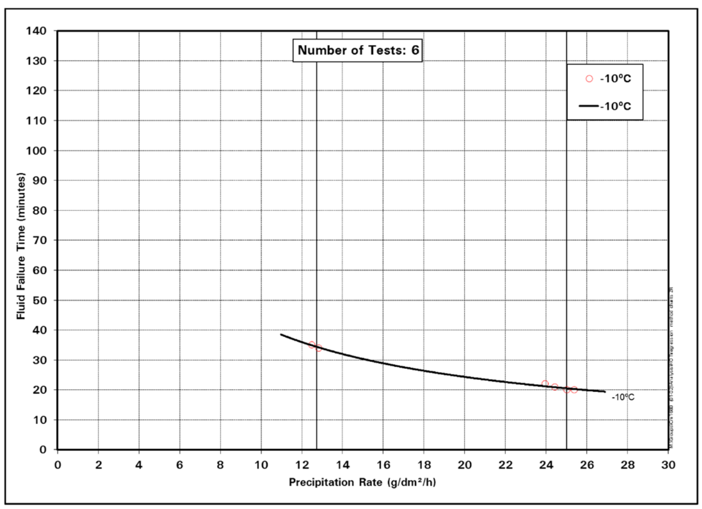


Figure 6.2: Regression Method on Standard Chart – Type IV Neat, Freezing Rain

The HOTs for this fluid at -10°C are 20 minutes at 13 g/dm^2/h and 35 minutes at 25 g/dm^2/h, establishing the HOT range for this particular fluid in the light freezing rain, neat fluid, below -3 to -10°C cell. This illustrates the general approach used in the determination of a fluid HOT range for any given cell in the HOT table.

6.7 Lowest and Highest Usable Precipitation Rates in Snow

A detailed analysis methodology was developed to determine if a snow data set is sufficient to determine HOTs for light and very light snow. Specifically, the analysis determines the lowest usable precipitation rate (LUPR) and also the highest usable precipitation rate (HUPR), which are the lowest and highest rates, respectively, at which the data set is considered robust.

6.7.1 Temperatures of -14°C and Above

A three-factor weighted analysis methodology is used to determine the LUPR and HUPR values for a snow data set at temperatures of -14°C and above. Table 6.1 lists the three factors and their weightings. Each data set is given a rating of 0, 10, 20, 30, or 40 for each factor. The factor rating system is shown in Table 6.2.

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/dm^2/h. HUPR scores are calculated for 25 and 50 g/dm^2/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.

6.7.2 Temperatures Below -14°C

The methodology described above for determining LUPR values at -14°C and above is also used for determining LUPR values below -14°C.

Moderate snow occurs rarely and heavy snow occurs very rarely at temperatures below -14°C. It is therefore not feasible to collect sufficient natural snow data to support use of the regression curve at high precipitation rates. At this time, regulators have elected to allow use of regression coefficients for temperatures below -14°C up to a rate of 25 g/dm^2/h. This is the default HUPR for all fluids below -14°C.

Table 6.1: 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 6.2: 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	≥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%

APPENDIX C

LOG OF TESTS – NATURAL SNOW CHARACTERIZATION 2018-19 AND 2019-20

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
1	20-Jan-19	EG3-1	Snow	PET	III	EG Type III	0:00:00	2:30:00	150.0	-21.2	6.7	
1	20-Jan-19	PG4-1	Snow	PET	IV	PG Type IV	0:00:00	0:31:00	31.0	-21.3	4.9	
2	20-Jan-19	EG3-2	Snow	PET	III	EG Type III	3:20:00	5:10:00	110.0	-19.4	7.6	
2	20-Jan-19	PG4-2	Snow	PET	IV	PG Type IV	3:20:00	3:45:00	25.0	-19.8	9.1	
3	23-Jan-19	EG3-3	Snow	PET	III	EG Type III	9:00:00	10:03:00	63.0	-11.9	6.3	
3	23-Jan-19	PG4-3	Snow	PET	IV	PG Type IV	9:00:00	10:16:00	76.0	-11.8	6.5	
4	23-Jan-19	EG3-4	Snow	PET	III	EG Type III	11:00:00	12:47:00	107.0	-10.6	3.1	
4	23-Jan-19	PG4-4	Snow	PET	IV	PG Type IV	11:00:00	14:26:00	206.0	-9.6	3.0	
5	23-Jan-19	EG3-5	Snow	PET	III	EG Type III	15:10:00	15:39:00	29.0	-8.6	27.3	
5	23-Jan-19	PG4-5	Snow	PET	IV	PG Type IV	15:10:00	15:36:00	26.0	-8.6	27.2	
6	29-Jan-19	EG3-6	Snow	PET	III	EG Type III	16:30:00	17:37:00	67.0	-10.4	4.8	
6	29-Jan-19	PG4-6	Snow	PET	IV	PG Type IV	16:30:00	17:45:00	75.0	-10.5	5.0	
7	29-Jan-19	EG3-7	Snow	PET	III	EG Type III	18:30:00	19:11:00	41.0	-10.8	10.5	
7	29-Jan-19	PG4-7	Snow	PET	IV	PG Type IV	18:30:00	19:14:00	44.0	-10.8	10.7	
8	29-Jan-19	EG3-8	Snow	PET	III	EG Type III	19:40:00	20:19:00	39.0	-10.7	11.7	
8	29-Jan-19	PG4-8	Snow	PET	IV	PG Type IV	19:40:00	20:23:00	43.0	-10.7	11.7	
9	29-Jan-19	EG3-9	Snow	PET	III	EG Type III	21:00:00	21:34:00	34.0	-9.8	12.8	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
9	29-Jan-19	PG4-9	Snow	PET	IV	PG Type IV	21:00:00	21:45:00	45.0	-9.8	12.1	
10	2-Feb-19	PG2-1	Snow	PET	II	PG Type II	10:30:00	12:41:10	131.2	-9.0	4.6	Old fluid batch
10	2-Feb-19	EG3-10	Snow	PET	III	EG Type III	10:30:00	11:51:10	81.2	-9.2	3.4	
10	2-Feb-19	PG4-10	Snow	PET	IV	PG Type IV	10:30:00	12:41:10	131.2	-9.0	4.6	
11	2-Feb-19	PG2-2	Snow	PET	II	PG Type II	13:20:00	15:20:20	120.3	-7.8	8.5	Old fluid batch
11	2-Feb-19	EG3-11	Snow	PET	III	EG Type III	13:20:00	14:03:15	43.3	-8.1	8.8	
11	2-Feb-19	PG4-11	Snow	PET	IV	PG Type IV	13:20:00	14:42:20	82.3	-8.0	9.2	
12	12-Feb-19	PG2-3	Snow	PET	II	PG Type II	17:00:00	18:35:30	95.5	-11.5	15.2	
12	12-Feb-19	EG3-12	Snow	PET	III	EG Type III	17:00:00	18:00:00	60.0	-11.6	14.5	
12	12-Feb-19	PG4-12	Snow	PET	IV	PG Type IV	17:00:00	17:35:30	35.5	-11.8	16.2	
13	12-Feb-19	PG2-4	Snow	PET	II	PG Type II	19:10:00	20:21:50	71.8	-9.8	16.9	
13	12-Feb-19	EG3-13	Snow	PET	III	EG Type III	19:10:00	19:54:50	44.8	-10.0	16.6	
13	12-Feb-19	PG4-13	Snow	PET	IV	PG Type IV	19:10:00	20:00:00	50.0	-10.0	16.9	
14	12-Feb-19	PG2-5	Snow	PET	II	PG Type II	21:00:00	21:43:30	43.5	-8.2	23.5	
14	12-Feb-19	EG3-14	Snow	PET	III	EG Type III	21:00:00	21:24:50	24.8	-8.5	23.9	
14	12-Feb-19	PG4-14	Snow	PET	IV	PG Type IV	21:00:00	21:42:30	42.5	-8.2	23.5	
15	12-Feb-19	PG2-6	Snow	PET	II	PG Type II	22:30:00	23:11:00	41.0	-6.5	32.1	
15	12-Feb-19	EG3-15	Snow	PET	III	EG Type III	22:30:00	22:59:40	29.7	-6.5	31.6	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
15	12-Feb-19	PG4-15	Snow	PET	IV	PG Type IV	22:30:00	23:07:00	37.0	-6.5	32.0	
16	13-Feb-19	PG2-7	Snow	PET	II	PG Type II	0:00:00	0:34:10	34.2	-7.2	38.3	
16	13-Feb-19	EG3-16	Snow	PET	III	EG Type III	0:00:00	0:27:30	27.5	-7.1	33.9	
16	13-Feb-19	PG4-16	Snow	PET	IV	PG Type IV	0:00:00	0:24:30	24.5	-7.1	32.6	
17	13-Feb-19	PG2-8	Snow	PET	II	PG Type II	1:20:00	1:58:40	38.7	-7.3	45.3	
17	13-Feb-19	EG3-17	Snow	PET	III	EG Type III	1:20:00	1:38:20	18.3	-7.4	54.9	
17	13-Feb-19	PG4-17	Snow	PET	IV	PG Type IV	1:20:00	1:46:05	26.1	-7.3	51.4	
18	13-Feb-19	PG2-9	Snow	PET	II	PG Type II	2:40:00	3:01:20	21.3	-7.3	58.4	
18	13-Feb-19	EG3-18	Snow	PET	III	EG Type III	2:40:00	2:55:45	15.8	-7.3	61.9	
18	13-Feb-19	PG4-18	Snow	PET	IV	PG Type IV	2:40:00	2:58:00	18.0	-7.3	60.9	
19	13-Feb-19	PG2-10	Snow	PET	II	PG Type II	4:00:00	4:34:25	34.4	-6.9	32.1	
19	13-Feb-19	EG3-19	Snow	PET	III	EG Type III	4:00:00	4:24:10	24.2	-7.0	32.7	
19	13-Feb-19	PG4-19	Snow	PET	IV	PG Type IV	4:00:00	4:30:15	30.3	-7.0	32.9	
20	21-Feb-19	PG2-11	Snow	PET	II	PG Type II	0:10:00	0:53:00	43.0	-5.9	20.2	
20	21-Feb-19	EG3-20	Snow	PET	III	EG Type III	0:10:00	0:40:00	30.0	-5.7	19.3	
20	21-Feb-19	PG4-20	Snow	PET	IV	PG Type IV	0:10:00	0:54:00	44.0	-5.9	20.2	
21	21-Feb-19	PG2-12	Snow	PET	II	PG Type II	1:20:00	1:36:00	16.0	-6.7	48.6	
21	21-Feb-19	EG3-21	Snow	PET	III	EG Type III	1:20:00	1:37:00	17.0	-6.7	48.4	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
21	21-Feb-19	PG4-21	Snow	PET	IV	PG Type IV	1:20:00	1:38:00	18.0	-6.8	48.0	
22	21-Feb-19	PG2-13	Snow	PET	II	PG Type II	2:20:00	2:55:00	35.0	-7.4	22.5	
22	21-Feb-19	EG3-22	Snow	PET	III	EG Type III	2:20:00	2:50:00	30.0	-7.4	21.8	
22	21-Feb-19	PG4-22	Snow	PET	IV	PG Type IV	2:20:00	2:56:00	36.0	-7.4	22.7	
23	21-Feb-19	PG2-14	Snow	PET	II	PG Type II	3:20:00	4:49:00	89.0	-7.1	9.1	
23	21-Feb-19	EG3-23	Snow	PET	III	EG Type III	3:20:00	4:12:30	52.5	-7.1	8.9	
23	21-Feb-19	PG4-23	Snow	PET	IV	PG Type IV	3:20:00	5:14:40	114.7	-7.1	8.8	
24	3-Mar-19	EG3-24	Snow	PET	III	EG Type III	22:30:00	1:01:20	152.0	-3.7	1.8	
25	10-Mar-19	PG2-15	Snow	PET	II	PG Type II	9:30:00	10:06:10	36.2	-1.8	36.7	
25	10-Mar-19	EG3-25	Snow	PET	III	EG Type III	9:30:00	9:44:00	14.0	-1.8	34.4	
25	10-Mar-19	PG4-24	Snow	PET	IV	PG Type IV	9:30:00	10:01:00	31.0	-1.8	36.5	
26	10-Mar-19	PG2-16	Snow	PET	II	PG Type II	10:30:00	11:09:15	39.3	-1.7	47.6	
26	10-Mar-19	EG3-26	Snow	PET	III	EG Type III	10:30:00	10:42:40	12.7	-1.7	56.0	
26	10-Mar-19	PG4-25	Snow	PET	IV	PG Type IV	10:30:00	11:00:30	30.5	-1.7	50.4	
27	10-Mar-19	PG2-17	Snow	PET	II	PG Type II	11:40:00	12:30:15	50.2	-1.3	31.4	
27	10-Mar-19	EG3-27	Snow	PET	III	EG Type III	11:40:00	12:09:45	29.7	-1.3	20.8	
27	10-Mar-19	PG4-26	Snow	PET	IV	PG Type IV	11:40:00	12:31:45	51.8	-1.3	31.8	
28	18-Dec-19	EG3-28	Snow	PET	III	EG Type III	14:40:00	15:30:30	50.5	-3.7	6.2	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
29	6-Jan-20	PG2-18	Snow	PET	II	PG Type II	11:40:00	15:41:25	241.4	-7.8	4.1	
29	6-Jan-20	EG3-29	Snow	PET	III	EG Type III	11:40:00	12:53:00	73.0	-8.1	3.3	
29	6-Jan-20	PG4-27	Snow	PET	IV	PG Type IV	11:40:00	14:11:38	151.6	-7.9	5.1	
30	16-Jan-20	PG2-19	Snow	PET	II	PG Type II	4:20:00	6:33:30	133.5	-1.7	8.2	
30	16-Jan-20	EG3-30	Snow	PET	III	EG Type III	4:20:00	4:56:15	36.3	-1.6	9.8	
30	16-Jan-20	PG4-28	Snow	PET	IV	PG Type IV	4:20:00	6:24:05	124.1	-1.6	8.3	
31	16-Jan-20	PG2-20	Snow	PET	II	PG Type II	6:50:00	9:45:33	175.6	-1.9	6.7	
31	16-Jan-20	EG3-31	Snow	PET	III	EG Type III	6:50:00	7:19:00	29.0	-1.8	12.2	
31	16-Jan-20	PG4-29	Snow	PET	IV	PG Type IV	6:50:00	9:08:50	138.8	-1.9	7.3	
32	18-Jan-20	PG2-21	Snow	PET	II	PG Type II	17:40:00	18:21:13	41.2	-15.1	11.5	
32	18-Jan-20	EG3-32	Snow	PET	III	EG Type III	17:40:00	18:17:00	37.0	-15.1	11.4	
32	18-Jan-20	PG4-30	Snow	PET	IV	PG Type IV	17:40:00	18:18:00	38.0	-15.1	11.4	
33	18-Jan-20	PG2-22	Snow	PET	II	PG Type II	19:00:00	19:19:30	19.5	-15.1	26.5	
33	18-Jan-20	EG3-33	Snow	PET	III	EG Type III	19:00:00	19:18:33	18.6	-15.1	26.2	
33	18-Jan-20	PG4-31	Snow	PET	IV	PG Type IV	19:00:00	19:16:45	16.7	-15.1	25.9	
34	18-Jan-20	PG2-23	Snow	PET	II	PG Type II	20:40:00	20:56:20	16.3	-15.0	33.1	
34	18-Jan-20	EG3-34	Snow	PET	III	EG Type III	20:40:00	20:54:45	14.8	-15.0	34.2	
34	18-Jan-20	PG4-32	Snow	PET	IV	PG Type IV	20:40:00	20:52:33	12.5	-15.0	36.0	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
35	18-Jan-20	PG2-24	Snow	PET	II	PG Type II	22:10:00	23:06:58	57.0	-14.8	6.3	
35	18-Jan-20	EG3-35	Snow	PET	III	EG Type III	22:10:00	23:05:40	55.7	-14.8	6.3	
35	18-Jan-20	PG4-33	Snow	PET	IV	PG Type IV	22:10:00	23:03:05	53.1	-14.8	6.2	
36	6-Feb-20	PG2-25	Snow	PET	II	PG Type II	7:00:00	12:31:30	331.5	-8.2	2.4	
36	6-Feb-20	EG3-36	Snow	PET	III	EG Type III	7:00:00	10:22:30	202.5	-8.0	1.2	
36	6-Feb-20	PG4-34	Snow	PET	IV	PG Type IV	7:00:00	12:10:00	310.0	-8.2	2.3	
37	6-Feb-20	EG3-37	Snow	PET	III	EG Type III	12:50:00	13:47:00	57.0	-8.2	4.7	
38	7-Feb-20	PG2-26	Snow	PET	II	PG Type II	6:40:00	7:27:47	47.8	-5.4	20.7	
38	7-Feb-20	EG3-38	Snow	PET	III	EG Type III	6:40:00	7:07:00	27.0	-5.4	13.4	
38	7-Feb-20	PG4-35	Snow	PET	IV	PG Type IV	6:40:00	7:26:27	46.5	-5.4	20.5	
39	7-Feb-20	PG2-27	Snow	PET	II	PG Type II	8:10:00	9:05:15	55.3	-5.6	19.7	
39	7-Feb-20	EG3-39	Snow	PET	III	EG Type III	8:10:00	8:34:10	24.2	-5.5	15.9	
39	7-Feb-20	PG4-36	Snow	PET	IV	PG Type IV	8:10:00	9:02:30	52.5	-5.6	19.2	
40	7-Feb-20	PG2-28	Snow	PET	II	PG Type II	10:50:00	12:02:32	72.5	-5.8	20.1	
40	7-Feb-20	EG3-40	Snow	PET	III	EG Type III	10:50:00	11:16:20	26.3	-5.6	14.2	
40	7-Feb-20	PG4-37	Snow	PET	IV	PG Type IV	10:50:00	11:49:00	59.0	-5.7	19.1	
41	7-Feb-20	PG2-29	Snow	PET	II	PG Type II	12:40:00	13:35:20	55.3	-6.1	36.0	
41	7-Feb-20	EG3-41	Snow	PET	III	EG Type III	12:40:00	12:59:25	19.4	-6.0	28.5	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
41	7-Feb-20	PG4-38	Snow	PET	IV	PG Type IV	12:40:00	13:24:28	44.5	-6.0	34.6	
42	7-Feb-20	PG2-30	Snow	PET	II	PG Type II	16:30:00	17:40:00	70.0	-7.8	16.8	
42	7-Feb-20	EG3-42	Snow	PET	III	EG Type III	16:30:00	16:50:57	20.9	-7.8	23.5	
42	7-Feb-20	PG4-39	Snow	PET	IV	PG Type IV	16:30:00	17:21:10	51.2	-7.8	19.7	
43	10-Feb-20	PG2-31	Snow	PET	II	PG Type II	0:20:00	1:39:45	79.8	-10.4	5.0	
43	10-Feb-20	EG3-43	Snow	PET	III	EG Type III	0:20:00	1:30:15	70.3	-10.4	4.1	
43	10-Feb-20	PG4-40	Snow	PET	IV	PG Type IV	0:20:00	1:36:45	76.8	-10.4	4.8	
44	10-Feb-20	PG2-32	Snow	PET	II	PG Type II	2:10:00	2:59:00	49.0	-9.9	13.2	
44	10-Feb-20	EG3-44	Snow	PET	III	EG Type III	2:10:00	2:41:00	31.0	-9.9	12.6	
44	10-Feb-20	PG4-41	Snow	PET	IV	PG Type IV	2:10:00	2:52:00	42.0	-9.9	12.8	
45	10-Feb-20	PG2-33	Snow	PET	II	PG Type II	3:30:00	4:13:00	43.0	-9.6	17.4	
45	10-Feb-20	EG3-45	Snow	PET	III	EG Type III	3:30:00	3:57:00	27.0	-9.6	16.5	
45	10-Feb-20	PG4-42	Snow	PET	IV	PG Type IV	3:30:00	4:00:05	30.1	-9.6	16.6	
46	18-Feb-20	PG2-34	Snow	PET	II	PG Type II	8:10:00	8:38:00	28.0	-12.0	22.0	
46	18-Feb-20	EG3-46	Snow	PET	III	EG Type III	8:10:00	8:34:00	24.0	-12.1	22.3	
46	18-Feb-20	PG4-43	Snow	PET	IV	PG Type IV	8:10:00	8:38:30	28.5	-12.0	22.0	
47	18-Feb-20	PG2-35	Snow	PET	II	PG Type II	9:30:00	10:00:30	30.5	-8.7	24.1	
47	18-Feb-20	EG3-47	Snow	PET	III	EG Type III	9:30:00	9:50:00	20.0	-8.7	22.0	

Log of Tests – Natural Snow Characterization 2018-19 and 2019-20 (cont'd)

RUN	DATE	TEST #	CONDITION	LOCATION	FLUID TYPE	FLUID	Start Time (Local)	Fail Time (Local)	ENDURANCE TIME (MIN)	OAT (°C)	PRECIP RATE (g/dm²/h)	Comments
47	18-Feb-20	PG4-44	Snow	PET	IV	PG Type IV	9:30:00	10:02:00	32.0	-8.7	24.4	
48	18-Feb-20	EG3-48	Snow	PET	III	EG Type III	11:50:00	14:22:12	152.2	-2.9	2.5	
49	26-Feb-20	PG2-36	Snow	PET	II	PG Type II	17:50:00	20:31:00	161.0	-0.3	8.7	
49	26-Feb-20	EG3-49	Snow	PET	III	EG Type III	17:50:00	19:17:30	87.5	-0.3	3.7	
49	26-Feb-20	PG4-45	Snow	PET	IV	PG Type IV	17:50:00	20:25:00	155.0	-0.3	8.3	
50	27-Feb-20	PG2-37	Snow	PET	II	PG Type II	10:20:00	11:13:20	53.3	0.4	46.9	
50	27-Feb-20	EG3-50	Snow	PET	III	EG Type III	10:20:00	10:31:45	11.8	0.6	48.3	
50	27-Feb-20	PG4-46	Snow	PET	IV	PG Type IV	10:20:00	10:58:30	38.5	0.5	49.9	
51	27-Feb-20	PG2-38	Snow	PET	II	PG Type II	12:40:00	14:55:30	135.5	-2.3	11.2	
51	27-Feb-20	EG3-51	Snow	PET	III	EG Type III	12:40:00	13:13:45	33.8	-1.4	11.8	
51	27-Feb-20	PG4-47	Snow	PET	IV	PG Type IV	12:40:00	14:30:00	110.0	-2.0	10.8	
52	27-Feb-20	PG2-39	Snow	PET	II	PG Type II	17:00:00	19:54:10	174.2	-4.5	6.4	
52	27-Feb-20	EG3-52	Snow	PET	III	EG Type III	17:00:00	17:40:25	40.4	-4.5	8.5	
52	27-Feb-20	PG4-48	Snow	PET	IV	PG Type IV	17:00:00	19:50:00	170.0	-4.5	5.5	

APPENDIX D

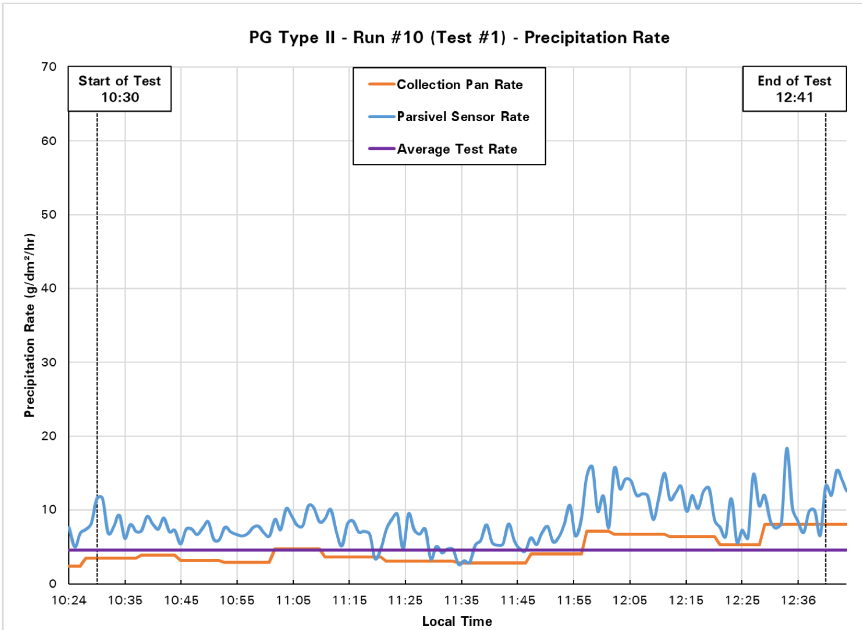
DATA PACKAGES – NATURAL SNOW CHARACTERIZATION
PG TYPE II RUNS

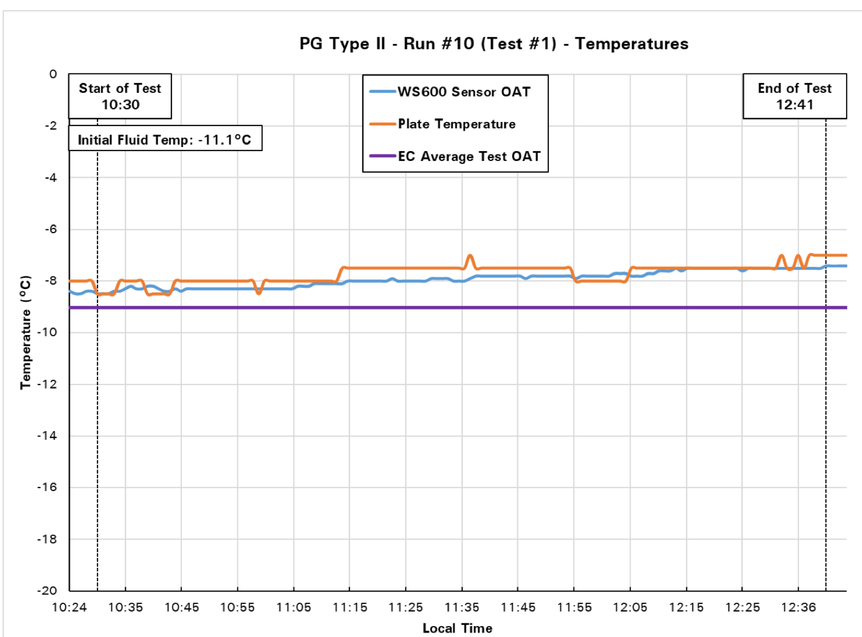
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

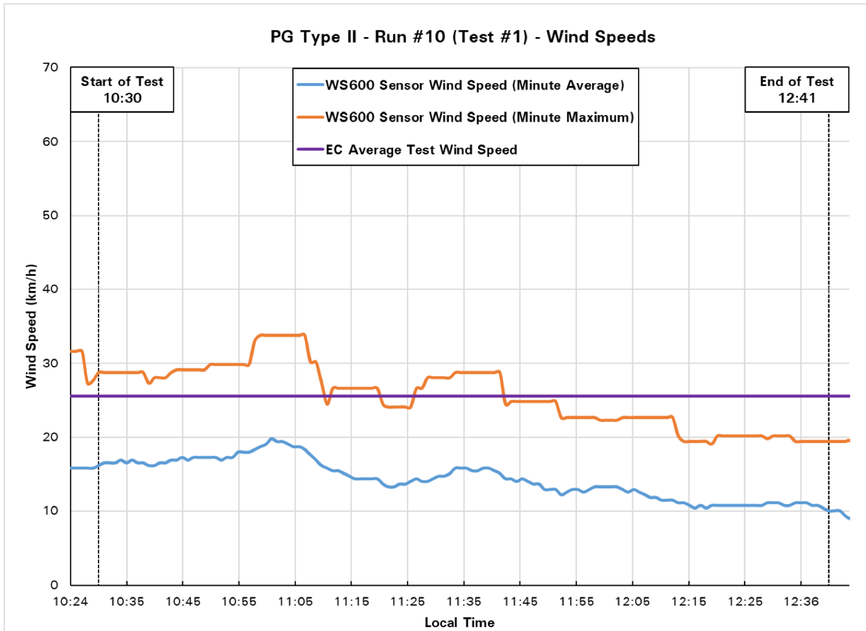
PG TYPE II
RUN #10 (TEST #1) – PG2-1

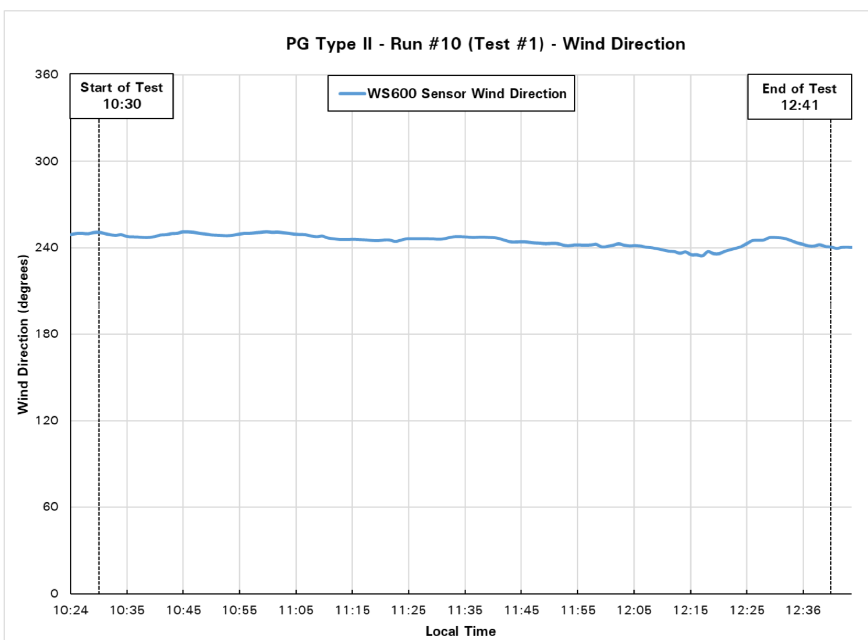
PG Type II – Run #10 (Test #1) – General Test Information

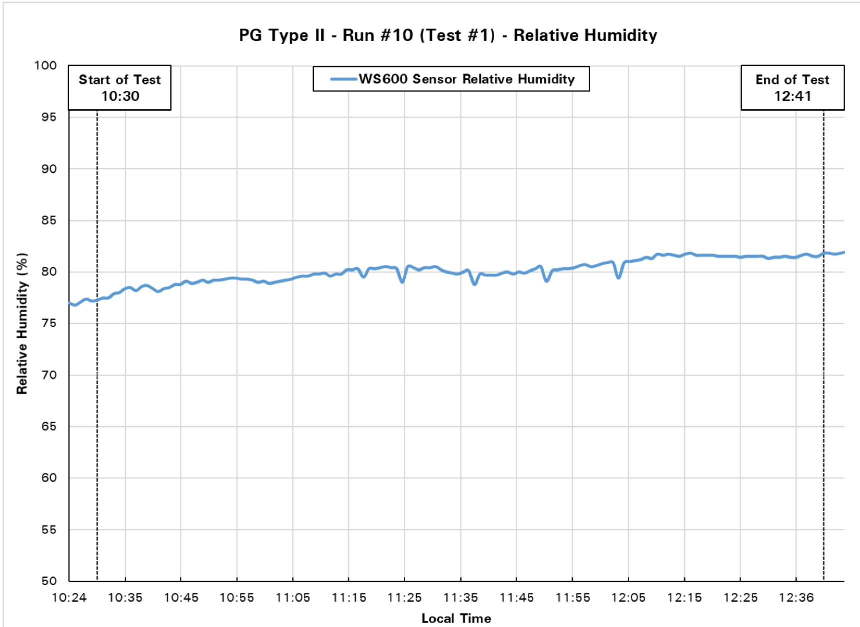
Test Number:	PG2-1
Date of Test:	February 2, 2019
Average OAT:	-9.0
Average Precipitation Rate:	4.58 g/dm²/h
Average Wind Speed:	25.6 km/h
Average Relative Humidity:	80.05%
Pour Time (Local):	10:30:00
Time of Fluid Failure (Local):	12:41:00
Fluid Brix at Failure:	14.0°
Endurance Time:	131.2 minutes
Expected Regression-Derived Endurance Time:	144.8 minutes
Difference (ET vs. Reg ET):	-13.6 minutes (-9.4%)


PG Type II - Run #10 (Test #1) - Precipitation Rate
Start of Test 10:30
End of Test 12:41
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

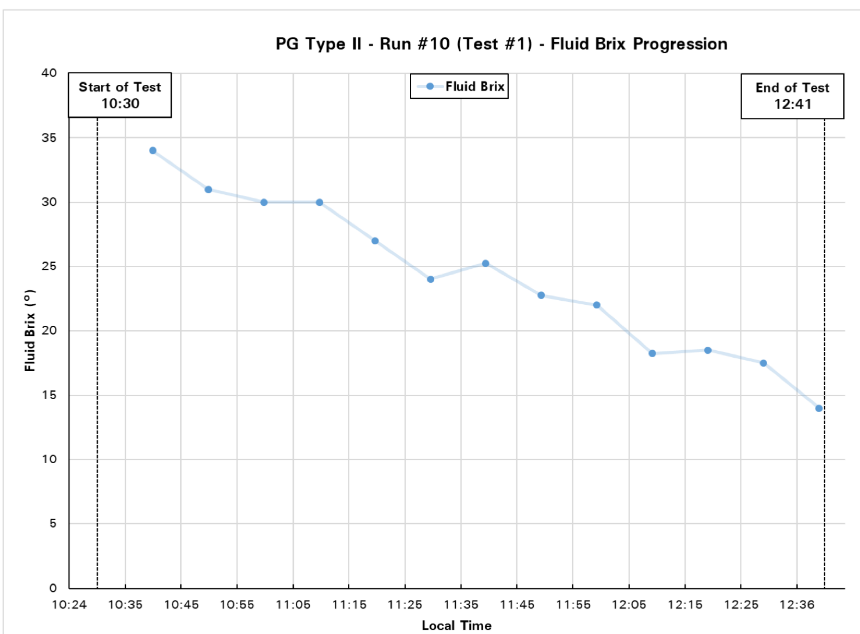

PG Type II - Run #10 (Test #1) - Temperatures
Start of Test 10:30
Initial Fluid Temp: -11.1°C
End of Test 12:41
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

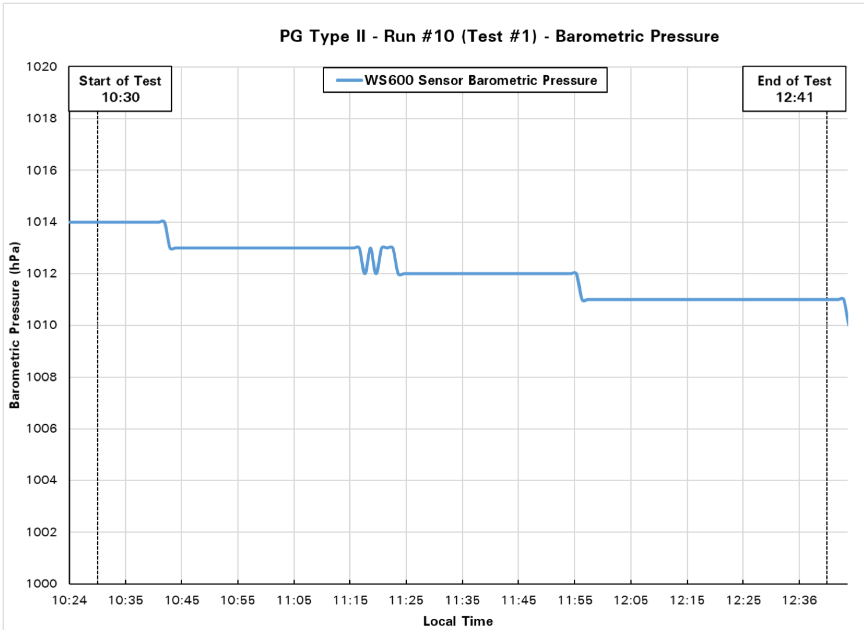

PG Type II - Run #10 (Test #1) - Wind Speeds
Start of Test 10:30
End of Test 12:41
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

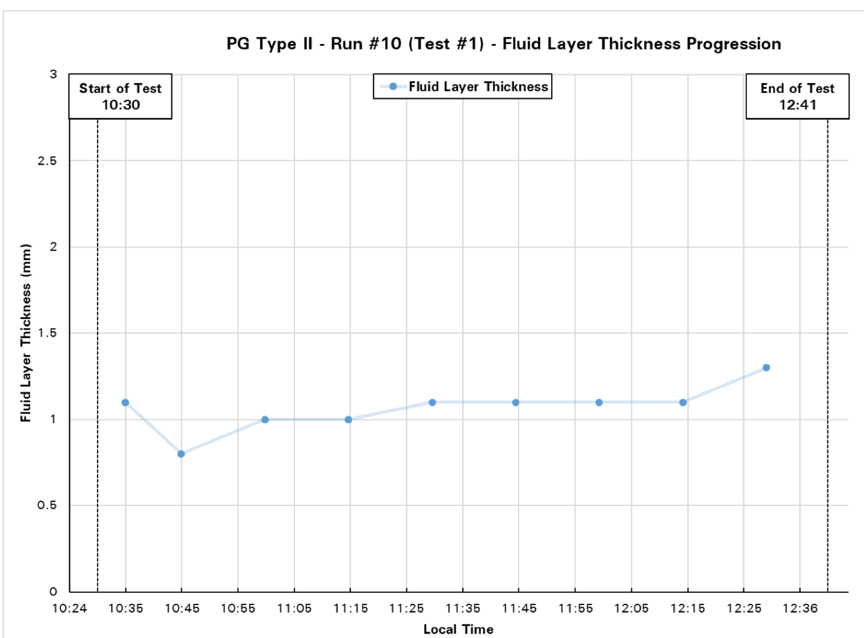

PG Type II - Run #10 (Test #1) - Wind Direction
Start of Test 10:30
WS600 Sensor Wind Direction
End of Test 12:41
Wind Direction (degrees)
0
60
120
180
240
300
360
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

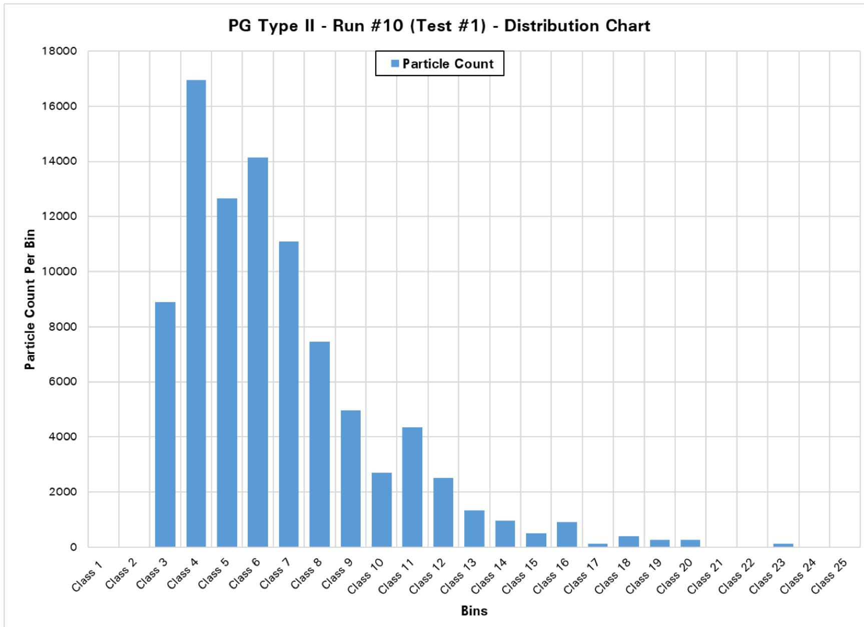


DATA PACKAGE – PG TYPE II – RUN 10 (TEST 1)

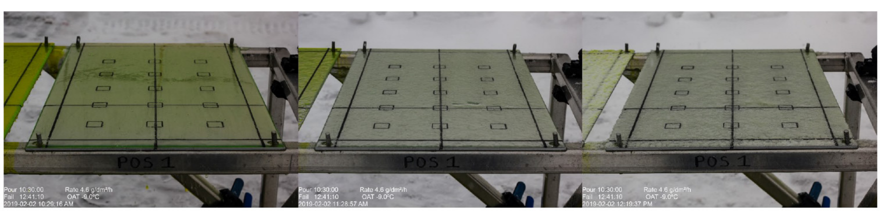



PG Type II - Run #10 (Test #1) - Barometric Pressure
Start of Test 10:30
WS600 Sensor Barometric Pressure
End of Test 12:41
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

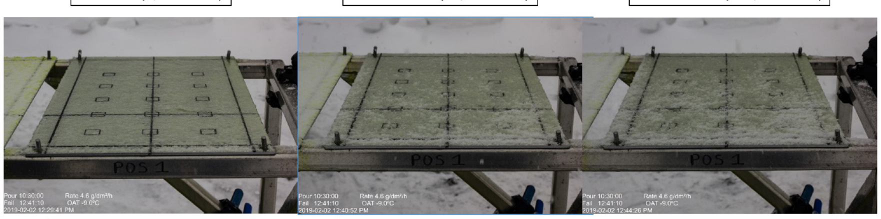

PG Type II - Run #10 (Test #1) - Fluid Layer Thickness Progression
Start of Test 10:30
Fluid Layer Thickness
End of Test 12:41
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time



Safewing MP II FLIGHT – Run 10 (Test 1) – Failure Progression Photos

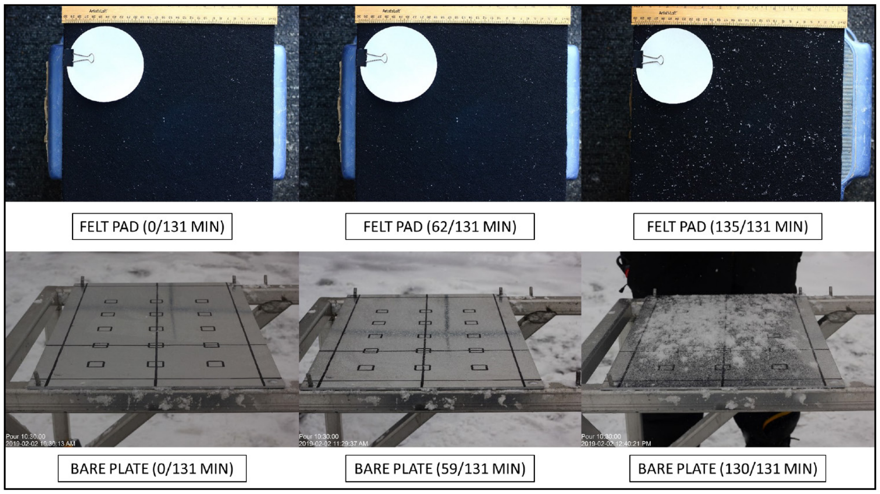


AT POUR (0/131 MIN) | PRE-FAILURE (58/131 MIN) | PRE-FAILURE (109/131 MIN)



PRE-FAILURE (119/131 MIN) | PRE-FAILURE (130/131 MIN) | POST-FAILURE (134/131 MIN)

Safewing MP II FLIGHT – Run 10 (Test 1) – Snow Characteristics Photos



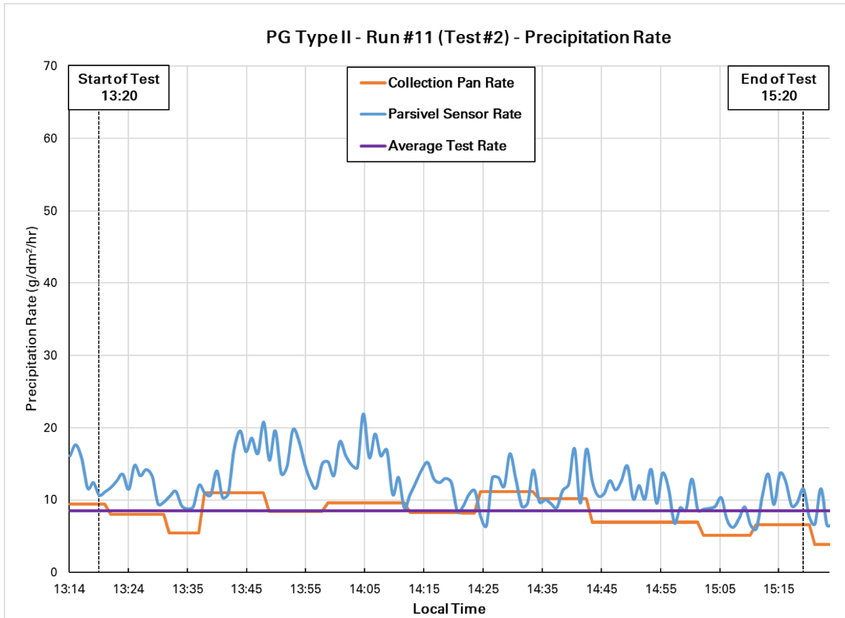
Final Bare Plate Contamination Thickness: **0.25mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

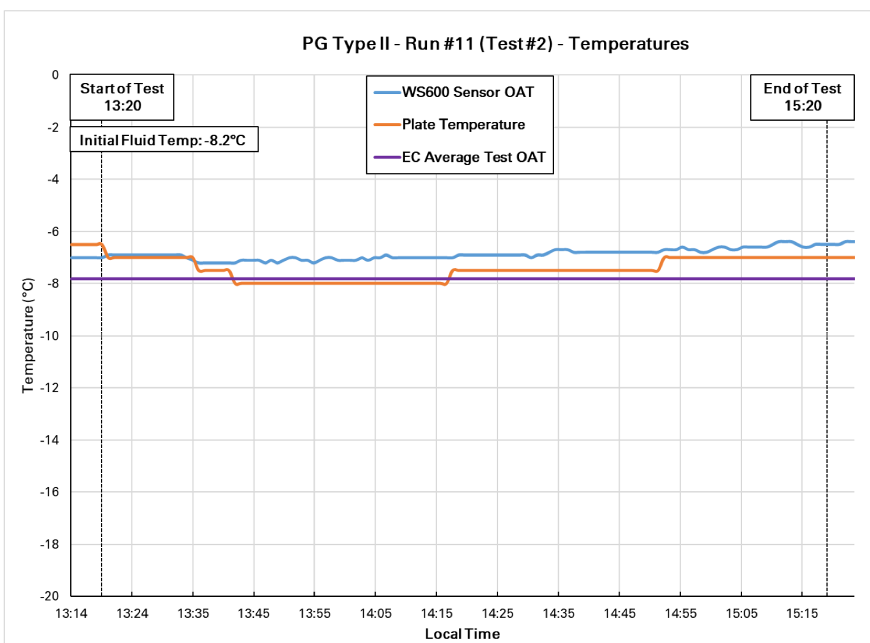
PG TYPE II
RUN #11 (TEST #2) - PG2-2

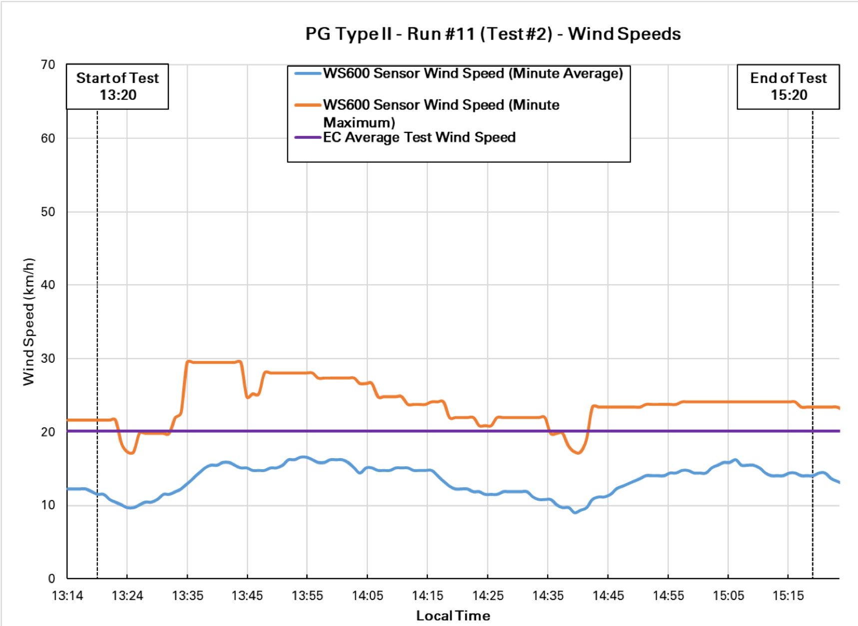
PG Type II – Run #11 (Test #2) – General Test Information

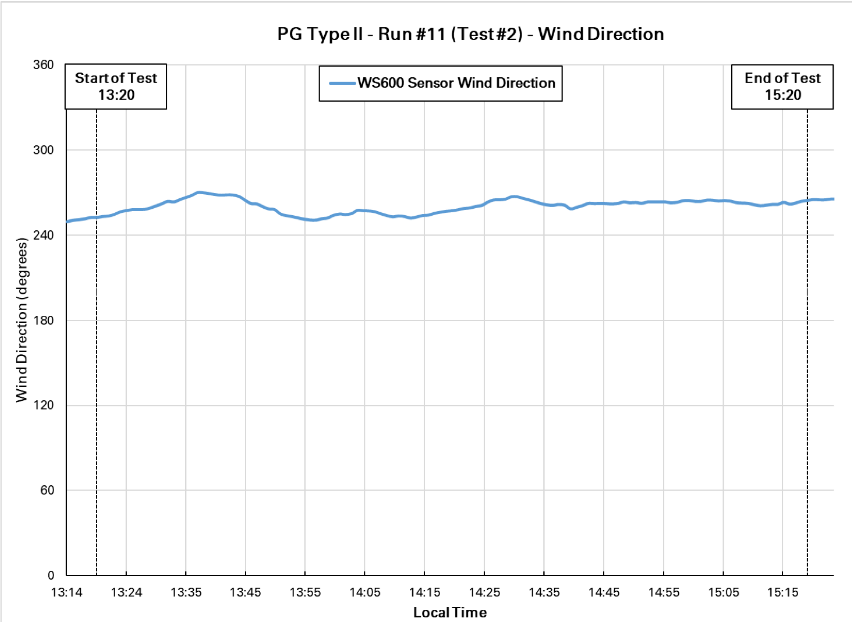
Test Number:	PG2-2
Date of Test:	February 2, 2019
Average OAT:	-7.8
Average Precipitation Rate:	8.5 g/dm²/h
Average Wind Speed:	20.1 km/h
Average Relative Humidity:	83%
Pour Time (Local):	13:20:00
Time of Fluid Failure (Local):	15:20:00
Fluid Brix at Failure:	13.5°
Endurance Time:	120.3 minutes
Expected Regression-Derived Endurance Time:	93.0 minutes
Difference (ET vs. Reg ET):	+27.4 minutes (+29.5%)

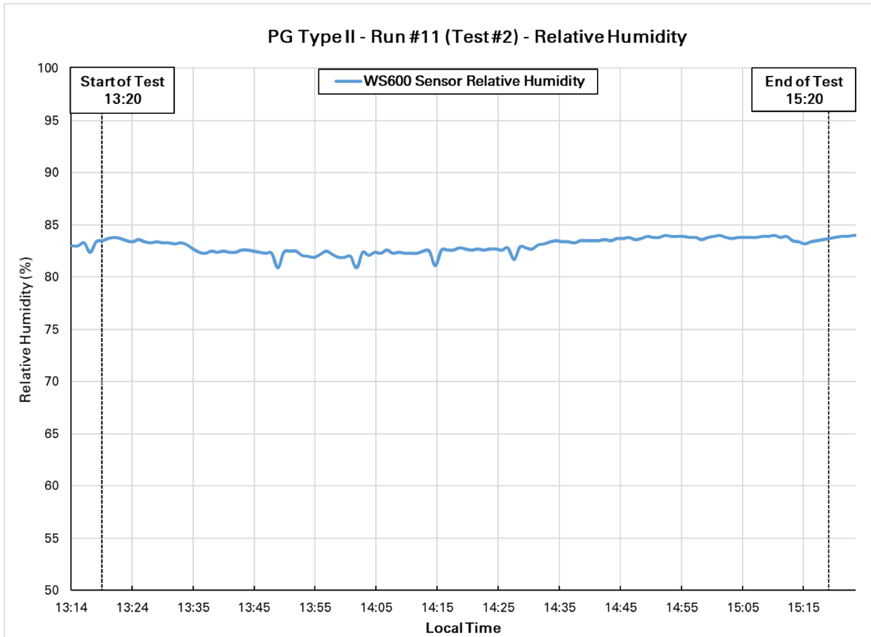


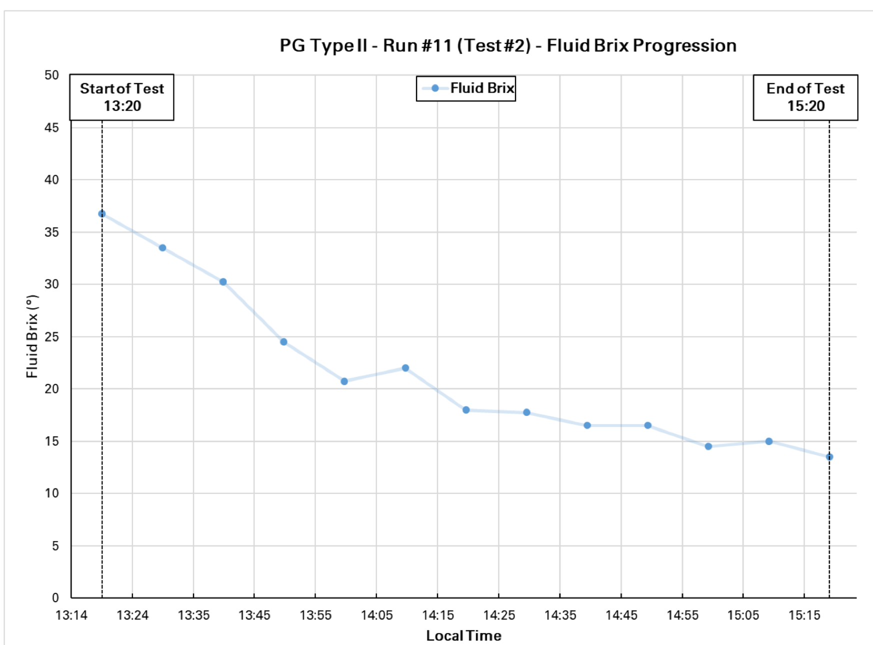
DATA PACKAGE – PG TYPE II – RUN 11 (TEST 2)

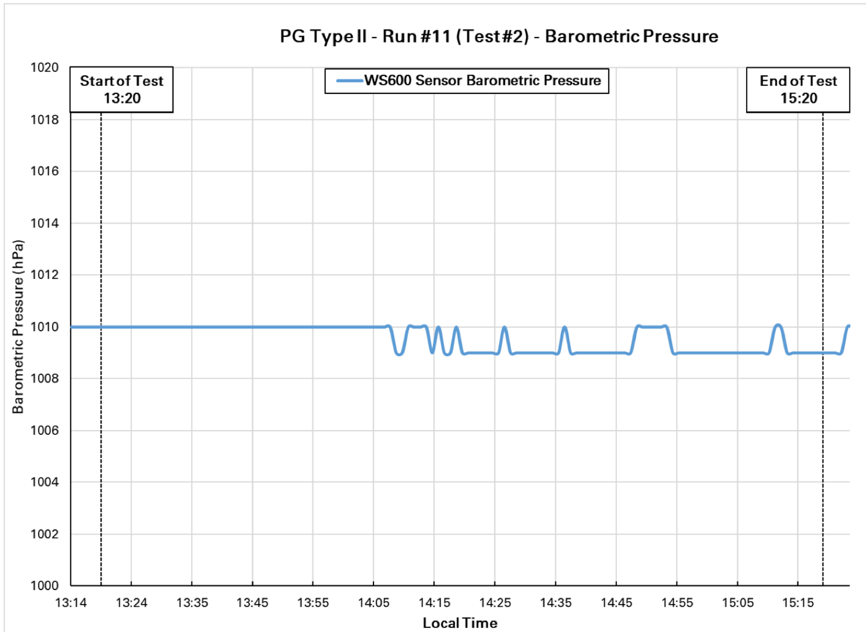


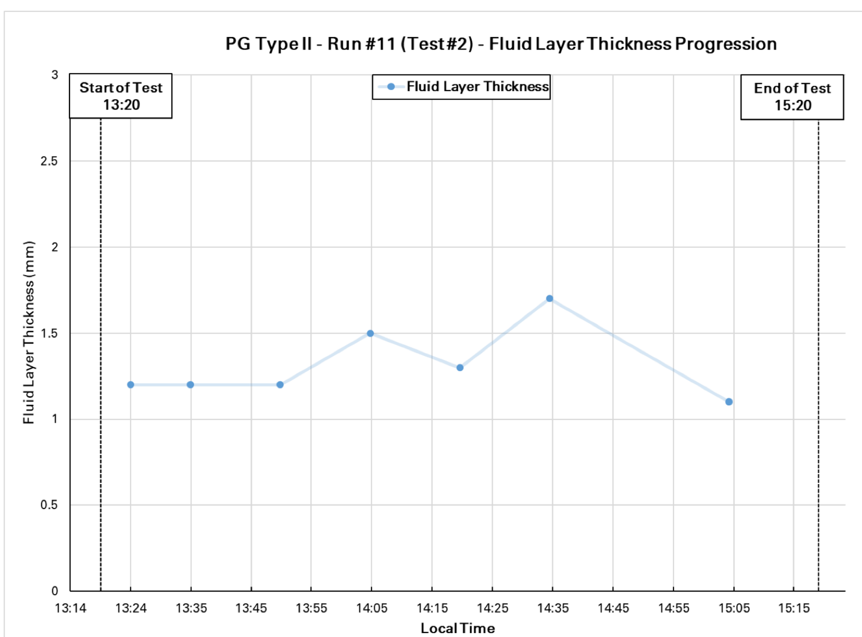

PG Type II - Run #11 (Test #2) - Wind Speeds
Start of Test 13:20
End of Test 15:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
15:05
15:15
Local Time

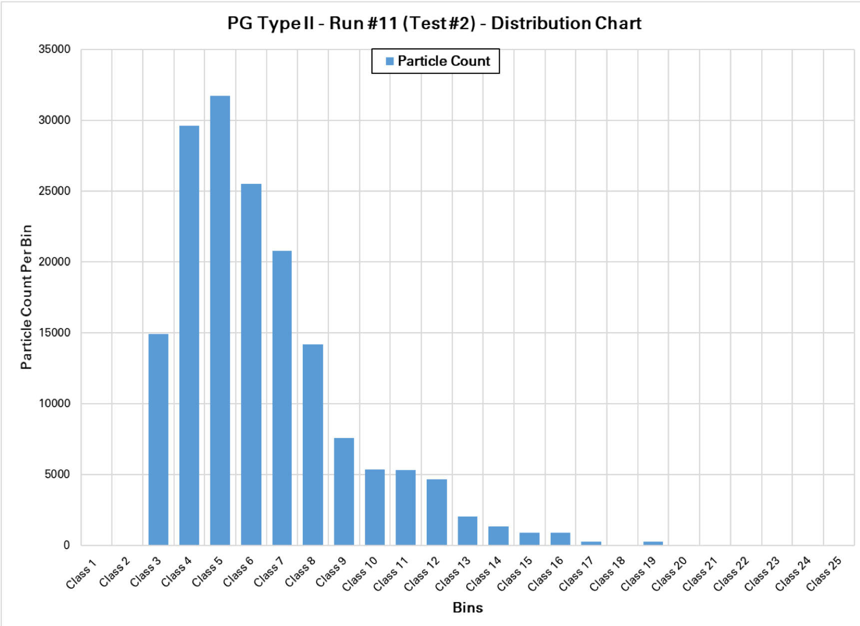

PG Type II - Run #11 (Test #2) - Wind Direction
Start of Test 13:20
End of Test 15:20
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
15:05
15:15
Local Time


PG Type II - Run #11 (Test #2) - Relative Humidity
Start of Test 13:20
WS600 Sensor Relative Humidity
End of Test 15:20
100
95
90
85
80
75
70
65
60
55
50
Relative Humidity (%)
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
15:05
15:15
Local Time

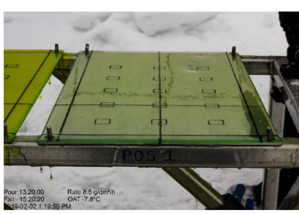

PG Type II - Run #11 (Test #2) - Fluid Brix Progression
Start of Test 13:20
Fluid Brix
End of Test 15:20
50
45
40
35
30
25
20
15
10
5
0
Fluid Brix (°)
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
15:05
15:15
Local Time


PG Type II - Run #11 (Test #2) - Barometric Pressure
Start of Test 13:20
WS600 Sensor Barometric Pressure
End of Test 15:20
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
13:14 13:24 13:35 13:45 13:55 14:05 14:15 14:25 14:35 14:45 14:55 15:05 15:15
Local Time

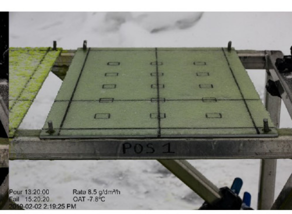

PG Type II - Run #11 (Test #2) - Fluid Layer Thickness Progression
Start of Test 13:20
Fluid Layer Thickness
End of Test 15:20
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
13:14 13:24 13:35 13:45 13:55 14:05 14:15 14:25 14:35 14:45 14:55 15:05 15:15
Local Time



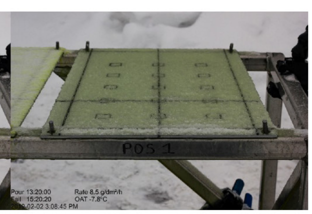
Safewing MP II FLIGHT – Run 11 (Test 2) – Failure Progression Photos



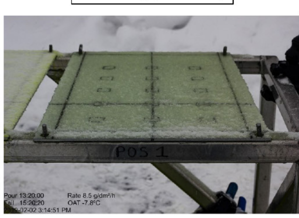
AT POUR (0/120 MIN)



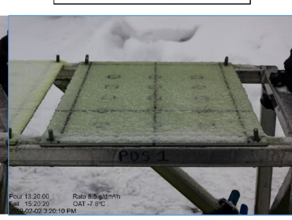
PRE-FAILURE (59/120 MIN)



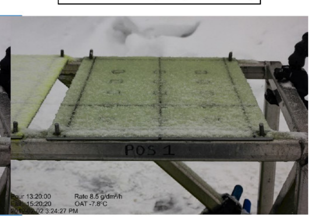
PRE-FAILURE (108/120 MIN)



PRE-FAILURE (114/120 MIN)

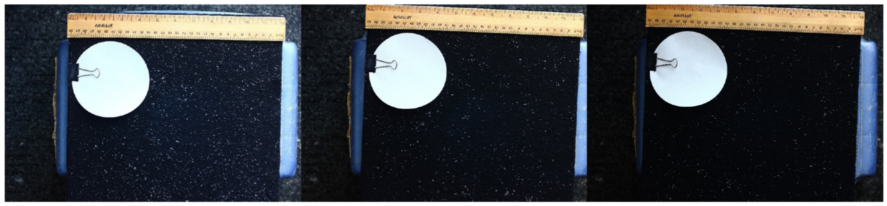


AT FAILURE (120/120 MIN)

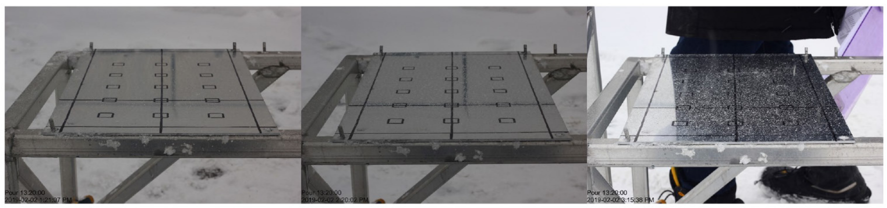


POST-FAILURE (124/120 MIN)

Safewing MP II FLIGHT – Run 11 (Test 2) – Snow Characteristics Photos



FELT PAD (3/120 MIN) | FELT PAD (63/120 MIN) | FELT PAD (122/120 MIN)



BARE PLATE (1/120 MIN) | BARE PLATE (60/120 MIN) | BARE PLATE (115/120 MIN)

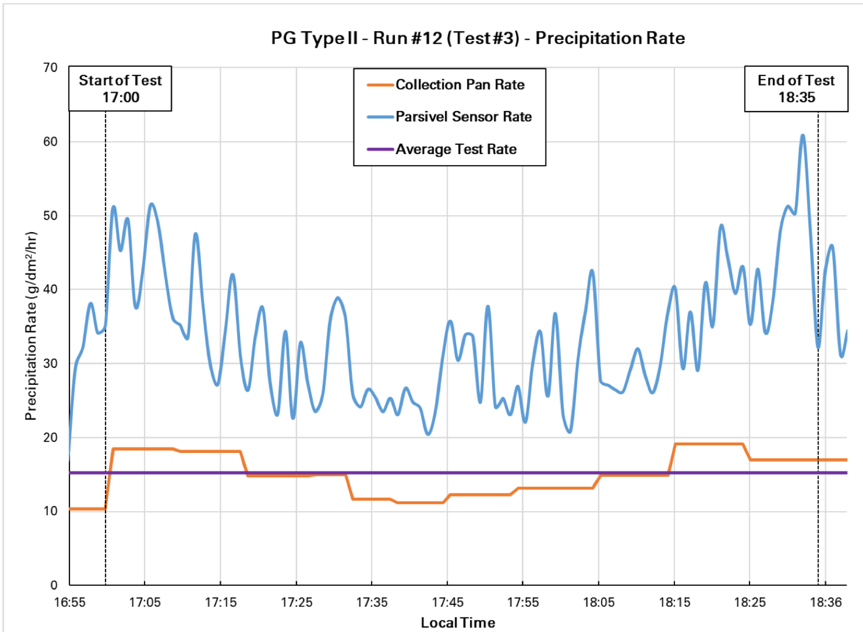
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

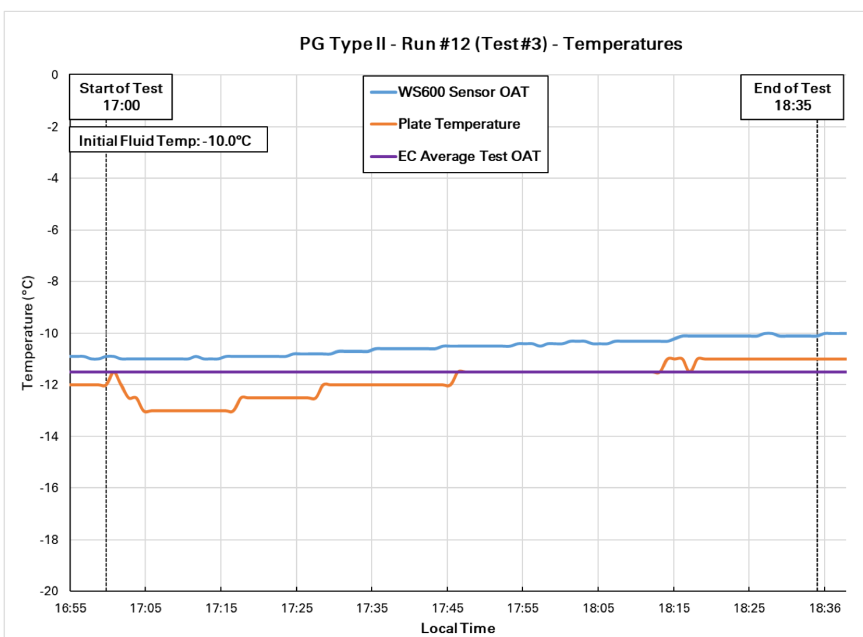
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

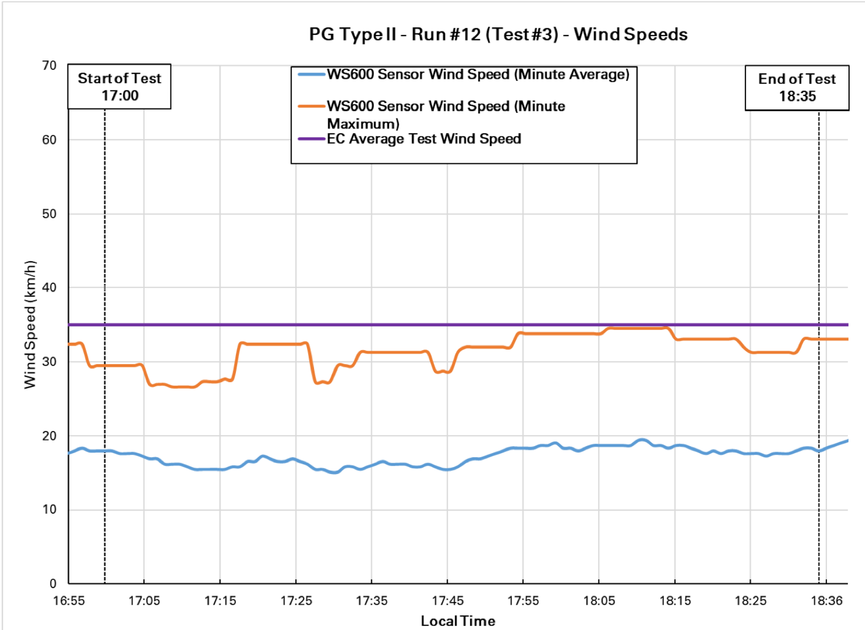
PG TYPE II
RUN #12 (TEST #3) – PG2-3

PG Type II – Run #12 (Test #3)– General Test Information

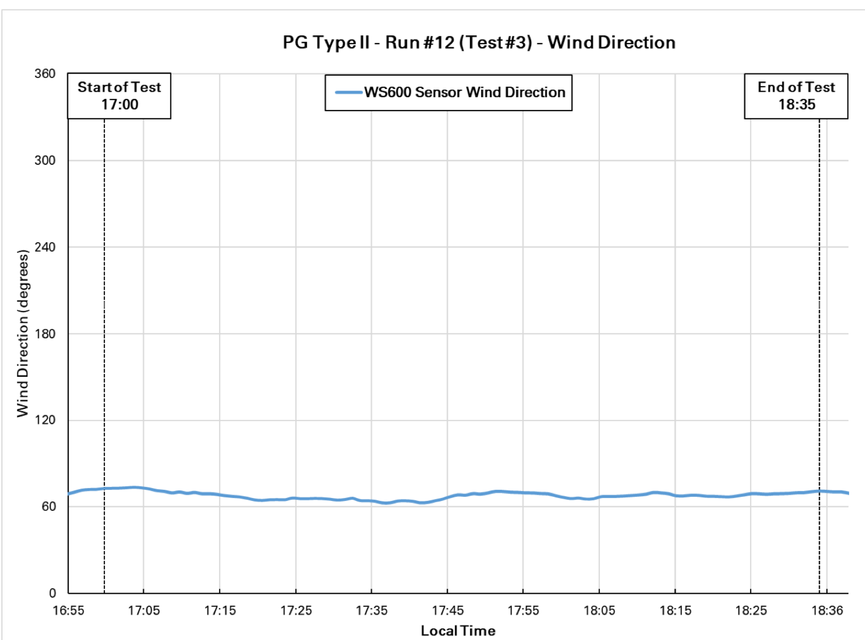
Test Number:	**PG2-3**
Date of Test:	**February 12, 2019**
Average OAT:	**-11.5**
Average Precipitation Rate:	**15.2 g/dm²/h**
Average Wind Speed:	**35 km/h**
Average Relative Humidity:	**78.96%**
Pour Time (Local):	**17:00:00**
Time of Fluid Failure (Local):	**18:35:00**
Fluid Brix at Failure:	**18°**
Endurance Time:	**95.5 minutes**
Expected Regression-Derived Endurance Time:	**49.0 minutes**
Difference (ET vs. Reg ET):	**+46.5 minutes (+94.9%)**

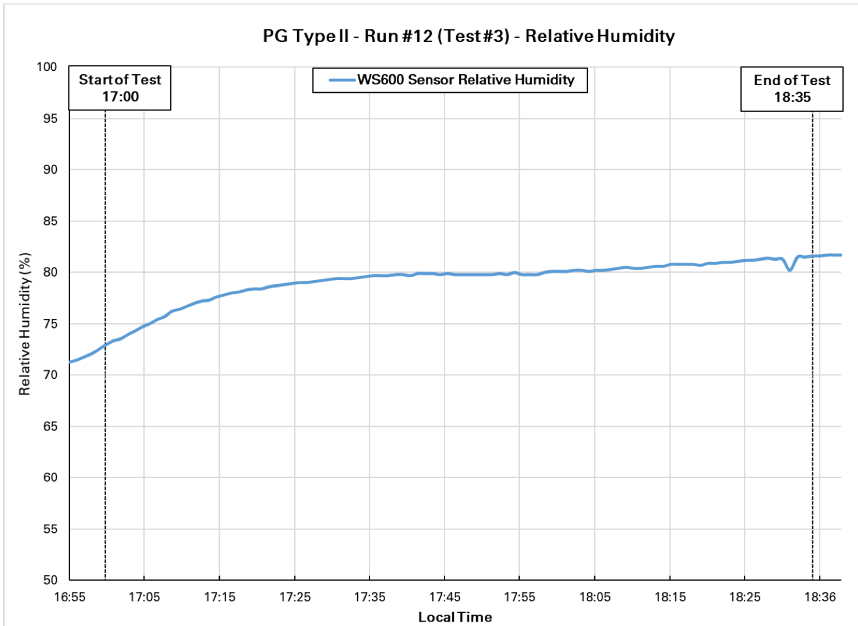

PG Type II - Run #12 (Test #3) - Precipitation Rate
Start of Test 17:00
End of Test 18:35
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:55
17:05
17:15
17:25
17:35
17:45
17:55
18:05
18:15
18:25
18:36
Local Time


PG Type II - Run #12 (Test #3) - Temperatures
Start of Test 17:00
Initial Fluid Temp: -10.0°C
End of Test 18:35
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:55
17:05
17:15
17:25
17:35
17:45
17:55
18:05
18:15
18:25
18:36
Local Time

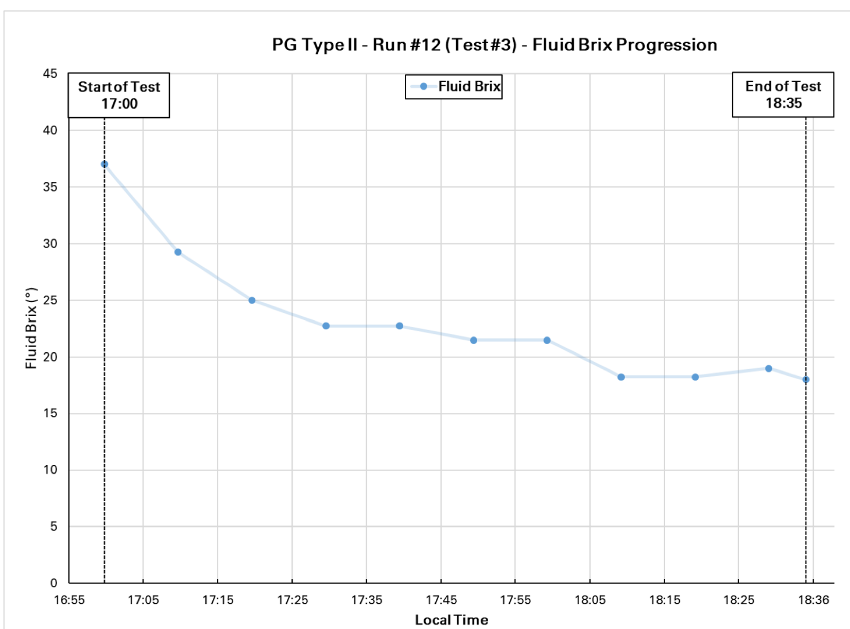


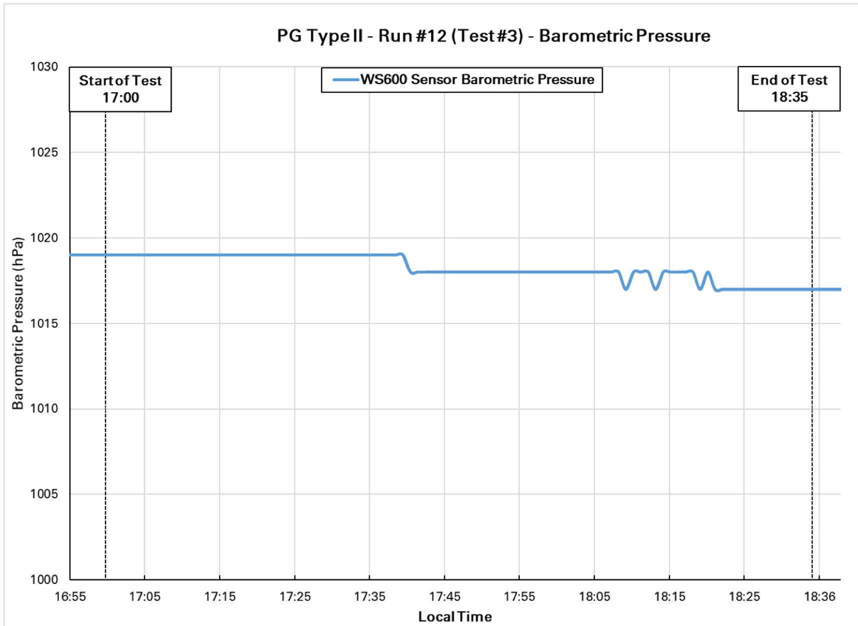
DATA PACKAGE – PG TYPE II – RUN 12 (TEST 3)

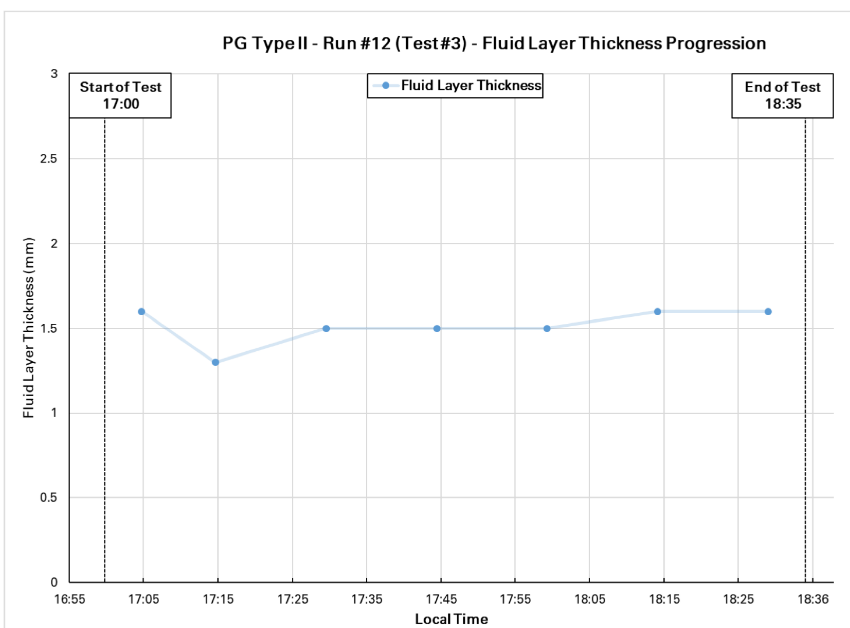


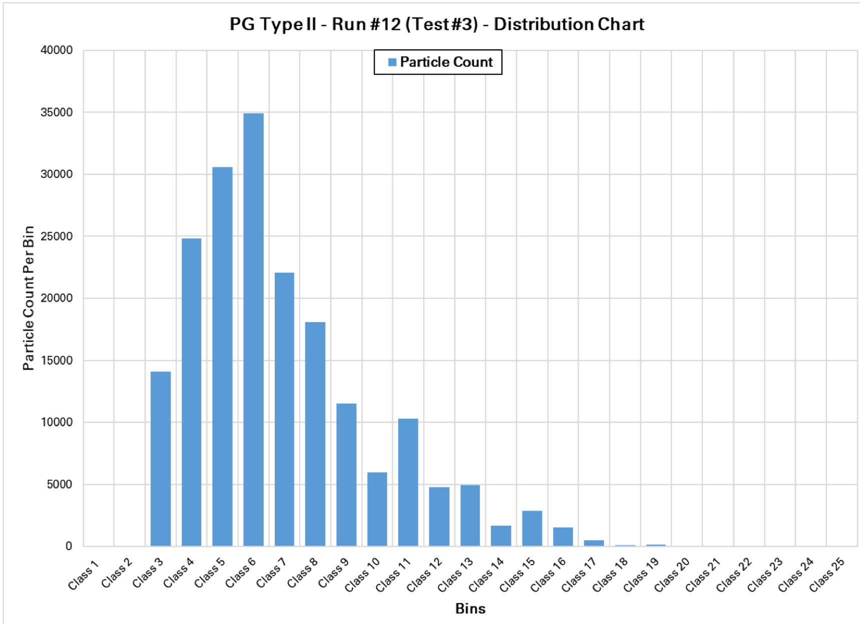


DATA PACKAGE – PG TYPE II – RUN 12 (TEST 3)



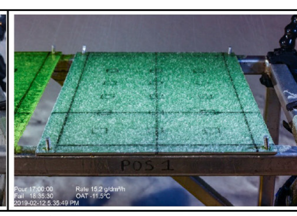

PG Type II - Run #12 (Test #3) - Barometric Pressure
Start of Test 17:00
WS600 Sensor Barometric Pressure
End of Test 18:35
Barometric Pressure (hPa)
1030
1025
1020
1015
1010
1005
1000
16:55
17:05
17:15
17:25
17:35
17:45
17:55
18:05
18:15
18:25
18:36
Local Time

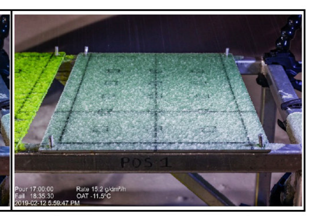

PG Type II - Run #12 (Test #3) - Fluid Layer Thickness Progression
Start of Test 17:00
Fluid Layer Thickness
End of Test 18:35
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:55
17:05
17:15
17:25
17:35
17:45
17:55
18:05
18:15
18:25
18:36
Local Time

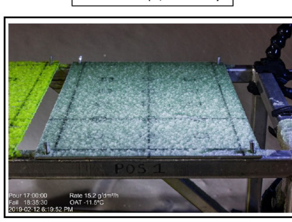


Safewing MP II FLIGHT – Run 12 (Test 3) – Failure Progression Photos


AT POUR (0/95 MIN)


PRE-FAILURE (35/95 MIN)

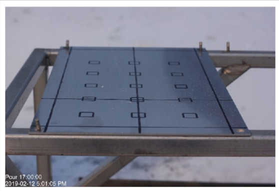
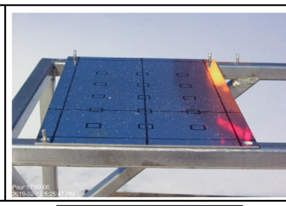
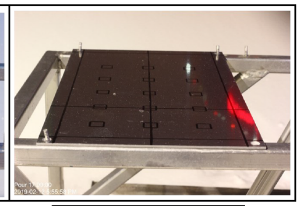

PRE-FAILURE (59/95 MIN)


PRE-FAILURE (79/95 MIN)


AT FAILURE (95/95 MIN)


POST-FAILURE (104/95 MIN)

Safewing MP II FLIGHT – Run 12 (Test 3) – Snow Characteristics Photos

No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (x/xx MIN)	FELT PAD (xx/xx MIN)	FELT PAD (xx/xx MIN)
		
BARE PLATE (1/95 MIN)	BARE PLATE 25/95 MIN)	BARE PLATE (55/95 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

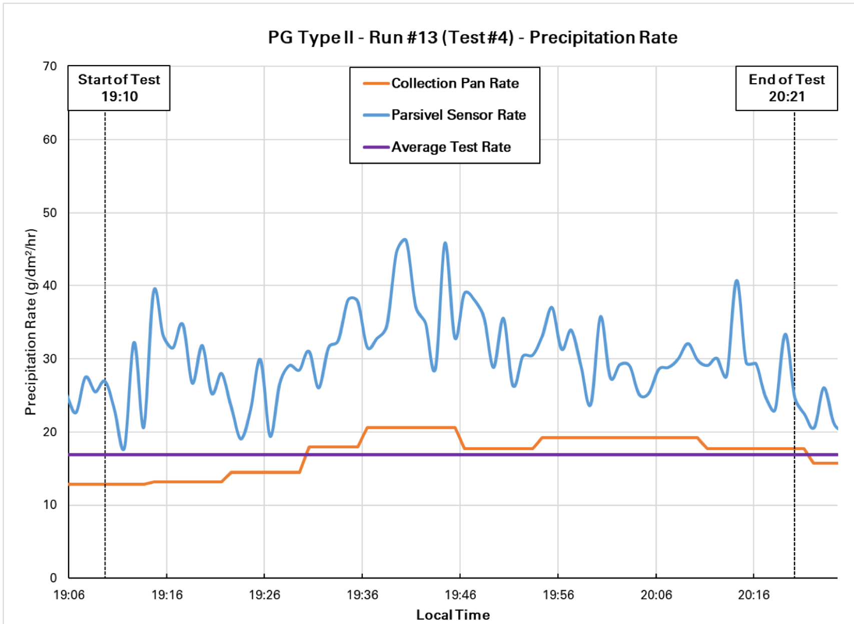
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #13 (TEST #4) – PG2-4

PG Type II – Run #13 (Test #4) – General Test Information

Test Number:	**PG2-4**
Date of Test:	**February 12, 2019**
Average OAT:	**-9.8**
Average Precipitation Rate:	**16.9 g/dm²/h**
Average Wind Speed:	**26.1 km/h**
Average Relative Humidity:	**83.2%**
Pour Time (Local):	**19:10:00**
Time of Fluid Failure (Local):	**20:21:00**
Fluid Brix at Failure:	**18.5°**
Endurance Time:	**71.8 minutes**
Expected Regression-Derived Endurance Time:	**48.1 minutes**
Difference (ET vs. Reg ET):	**+23.8 minutes (+49.4%)**

DATA PACKAGE – PG TYPE II – RUN 13 (TEST 4)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 13 - Test 4/Data Package - PG Type II - Run 13 - Test 4.docx
Final Version 1.0, February 2021

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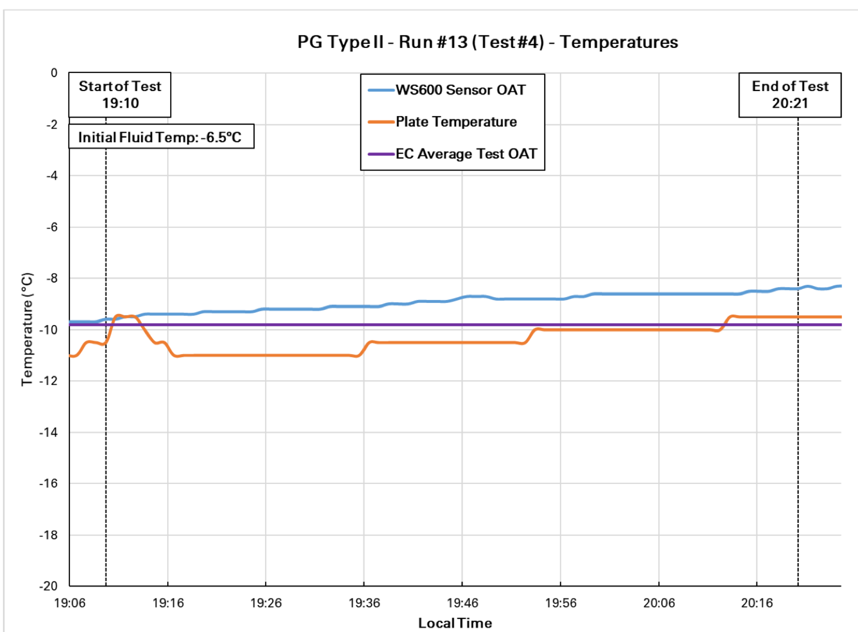
DATA PACKAGE – PG TYPE II – RUN 13 (TEST 4)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 13 - Test 4/Data Package - PG Type II - Run 13 - Test 4.docx
Final Version 1.0, February 2021

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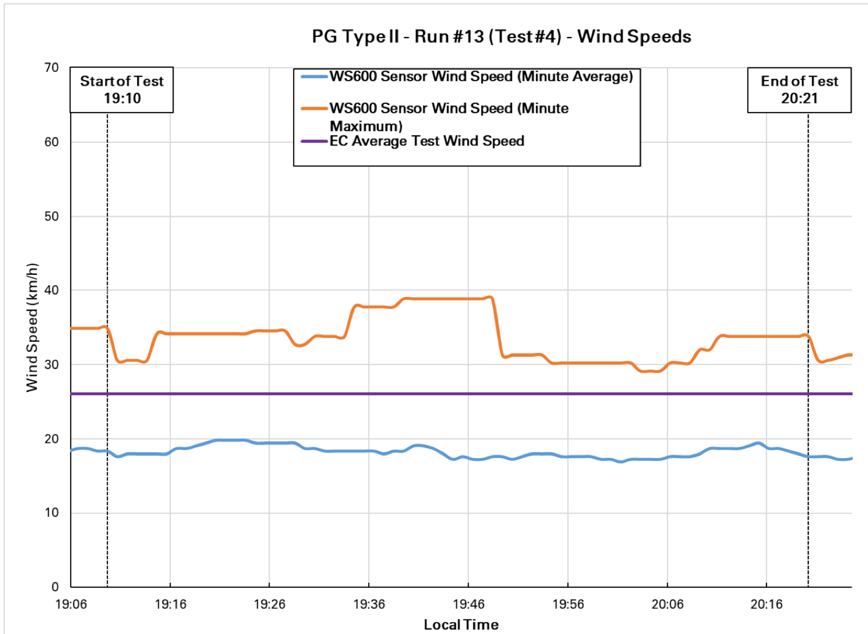
DATA PACKAGE – PG TYPE II – RUN 13 (TEST 4)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 13 - Test 4/Data Package - PG Type II - Run 13 - Test 4.docx
Final Version 1.0, February 2021

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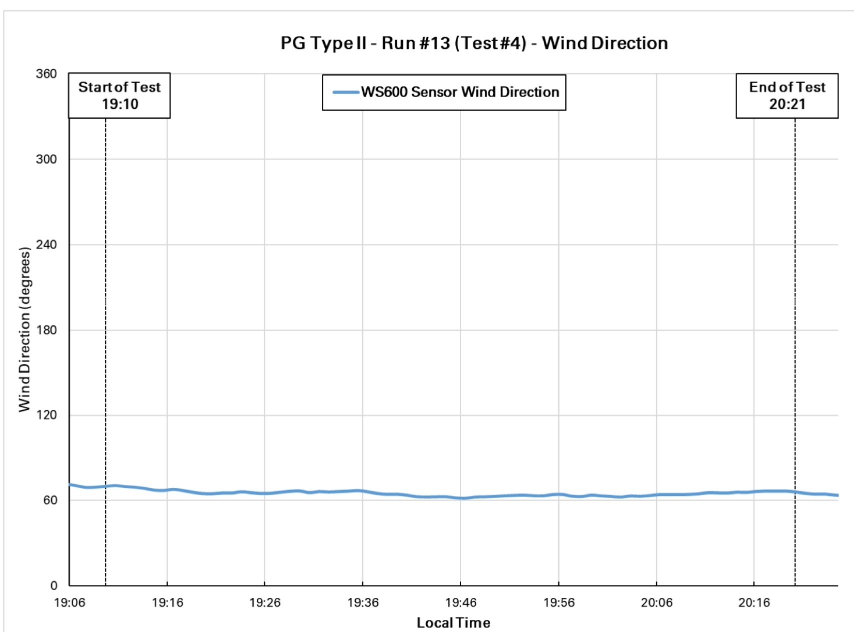
DATA PACKAGE – PG TYPE II – RUN 13 (TEST 4)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 13 - Test 4/Data Package - PG Type II - Run 13 - Test 4.docx
Final Version 1.0, February 2021

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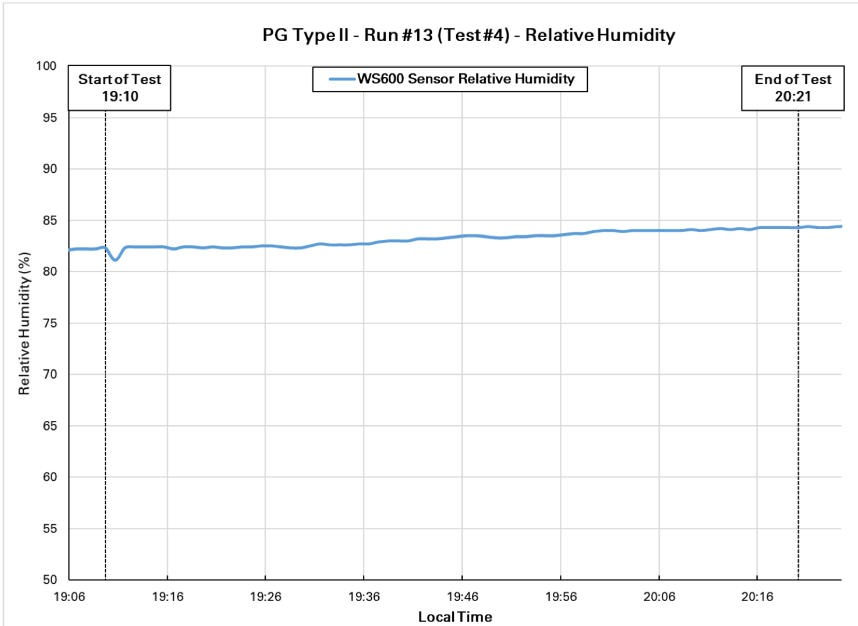
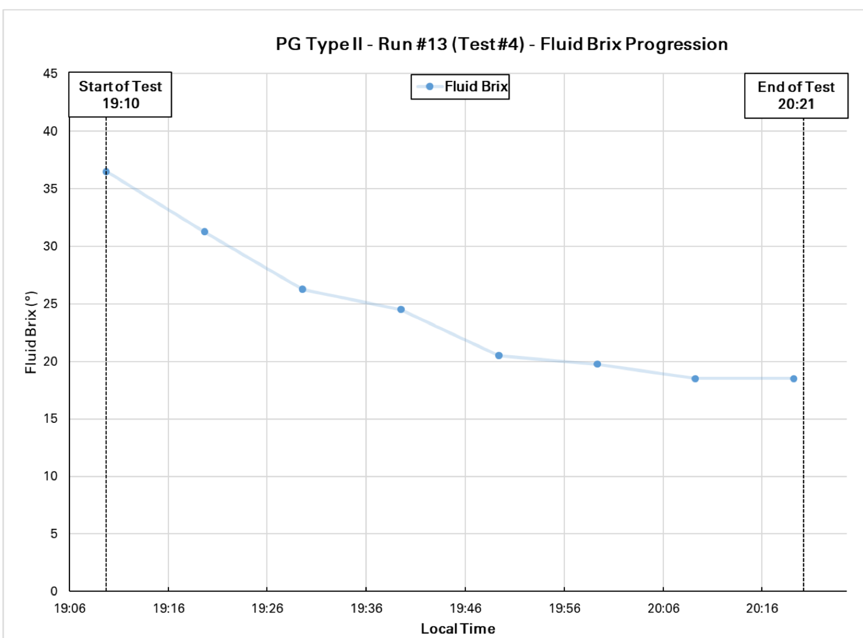
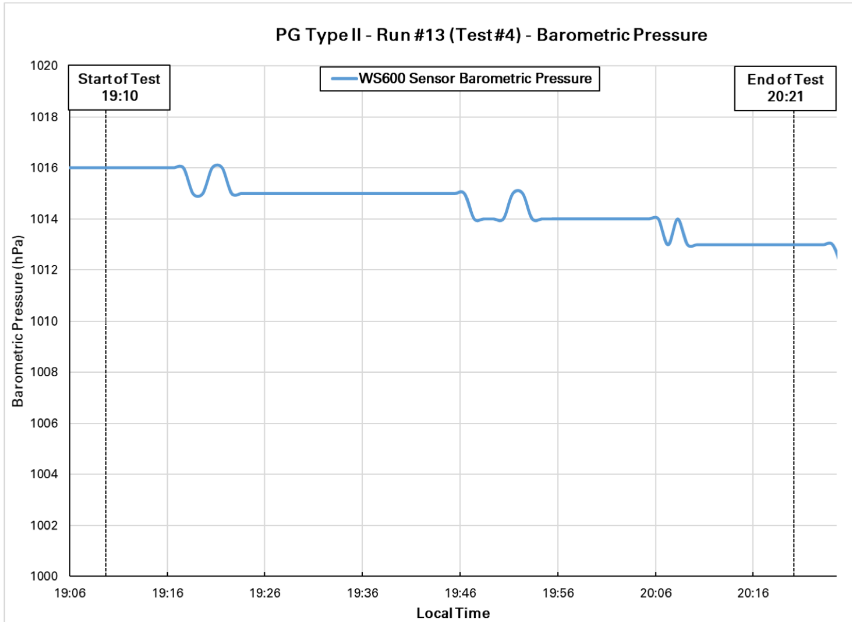
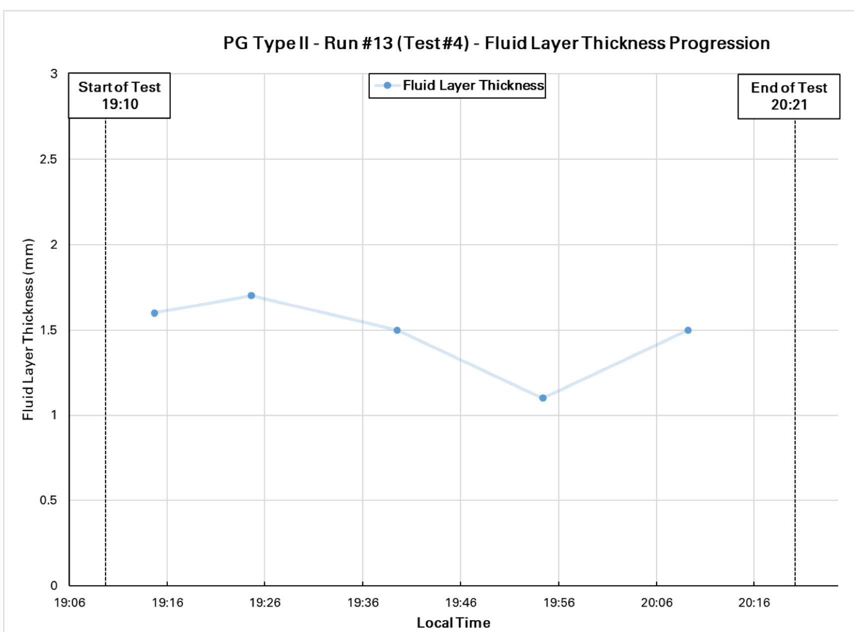


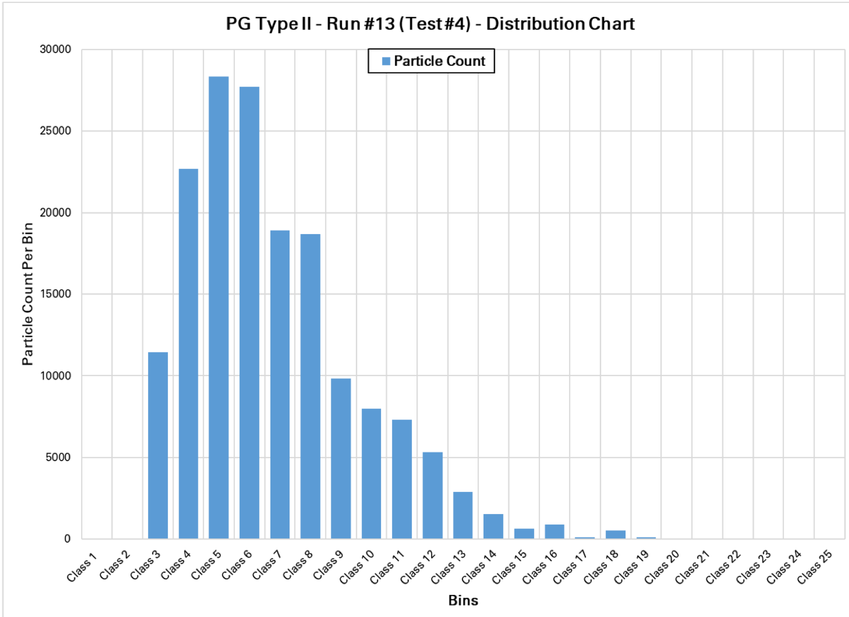
DATA PACKAGE – PG TYPE II – RUN 13 (TEST 4)



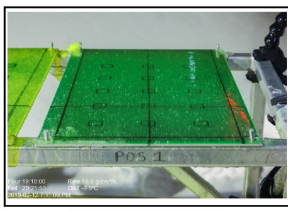


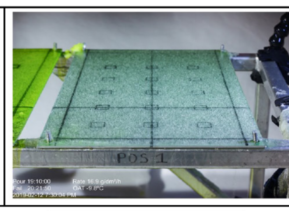
DATA PACKAGE – PG TYPE II – RUN 13 (TEST 4)

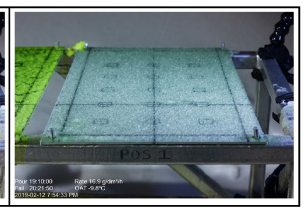


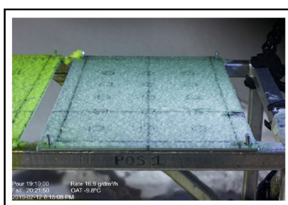


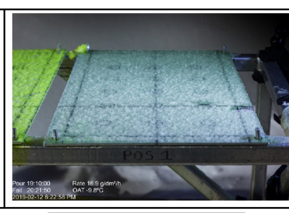
Safewing MP II FLIGHT – Run 13 (Test 4) – Failure Progression Photos

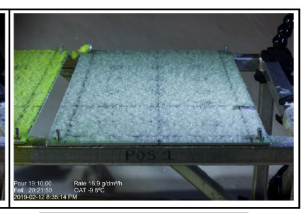

AT POUR (1/71 MIN)


PRE-FAILURE (20/71 MIN)

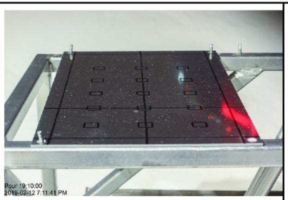
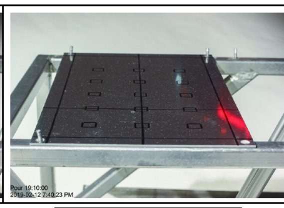
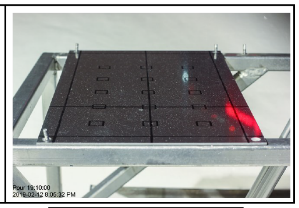

PRE-FAILURE (44/71 MIN)


PRE-FAILURE (65/71 MIN)


AT FAILURE (72/71 MIN)


POST-FAILURE (85/71 MIN)

Safewing MP II FLIGHT – Run 13 (Test 4) – Snow Characteristics Photos

No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (1/71 MIN)	BARE PLATE 30/71 MIN)	BARE PLATE (55/71 MIN)

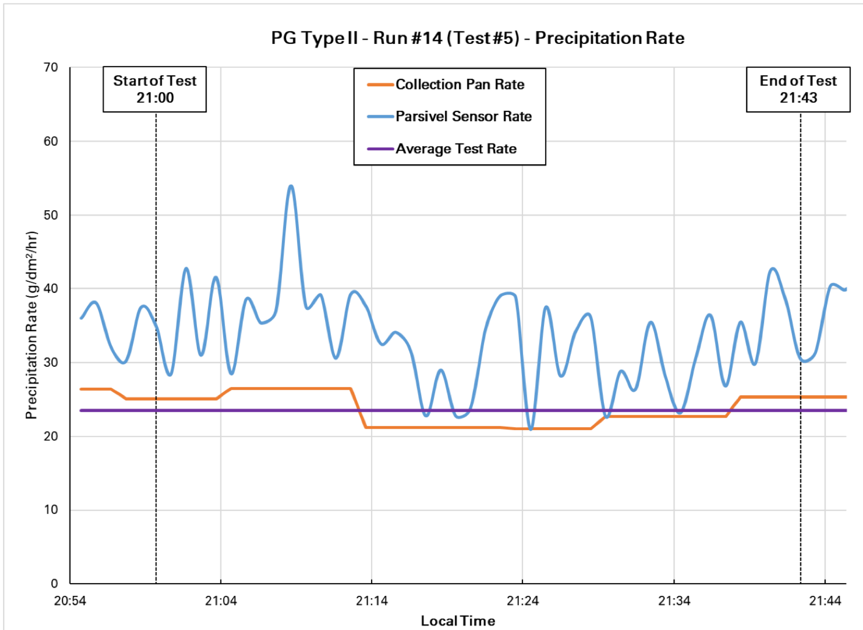
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

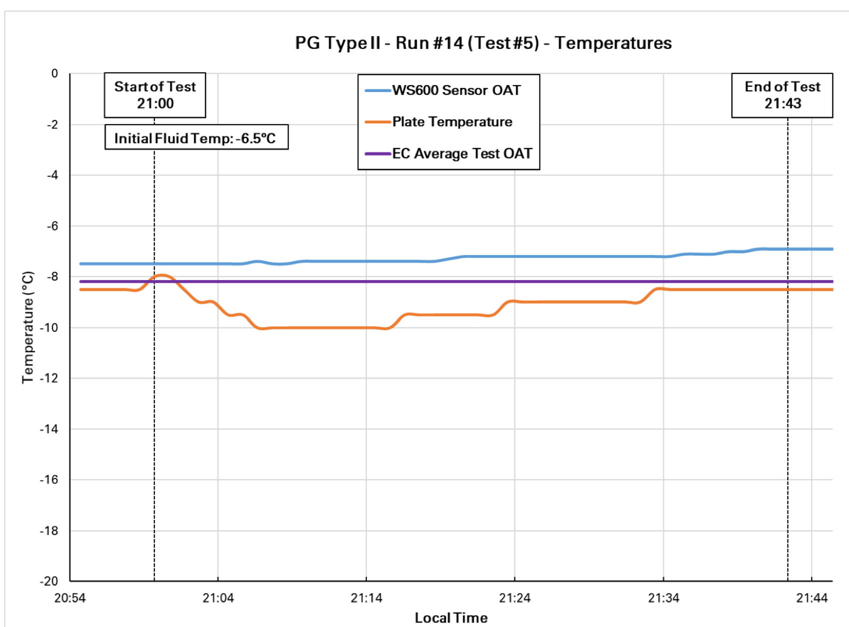
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

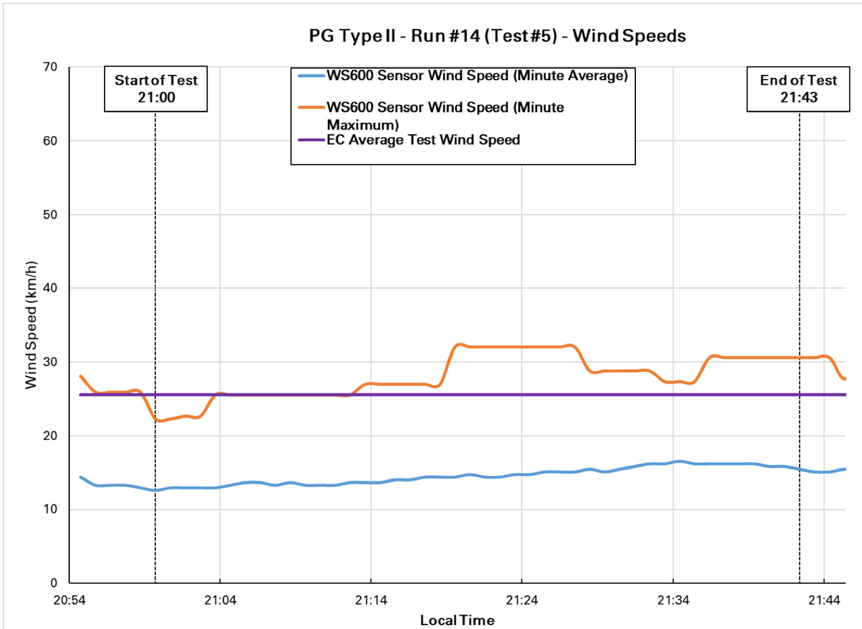
PG TYPE II
RUN #14 (TEST #5) – PG2-5

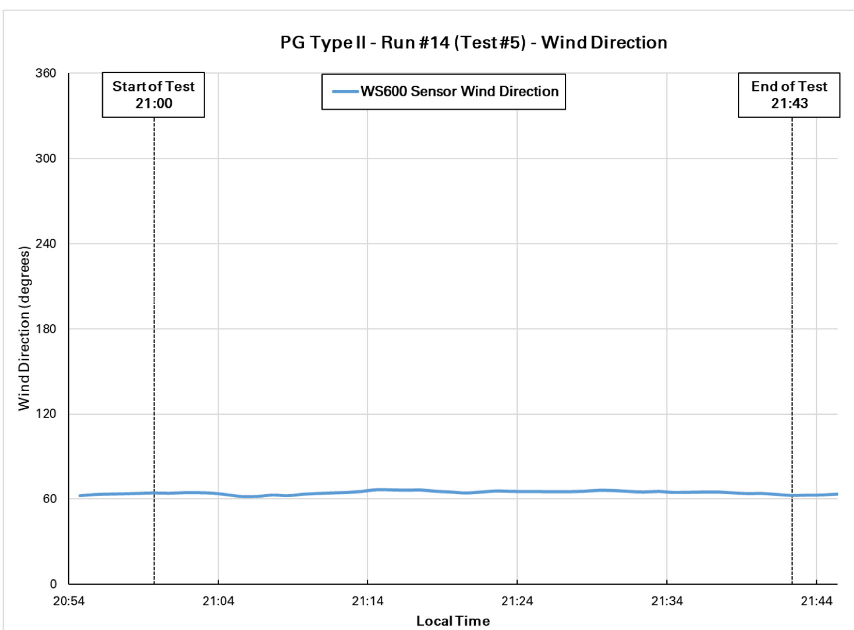
PG Type II – Run #14 (Test #5) – General Test Information

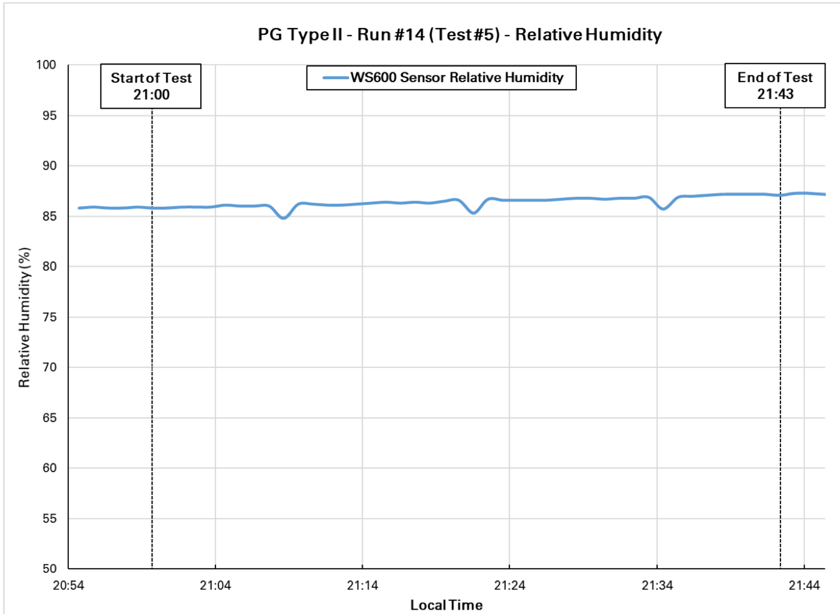
Test Number:	PG2-5
Date of Test:	February 12, 2019
Average OAT:	-8.2
Average Precipitation Rate:	23.5 g/dm²/h
Average Wind Speed:	25.6 km/h
Average Relative Humidity:	60.2%
Pour Time (Local):	21:00:00
Time of Fluid Failure (Local):	21:43:00
Fluid Brix at Failure:	17°
Endurance Time:	43.5 minutes
Expected Regression-Derived Endurance Time:	39.8 minutes
Difference (ET vs. Reg ET):	+3.7 minutes (+9.2%)

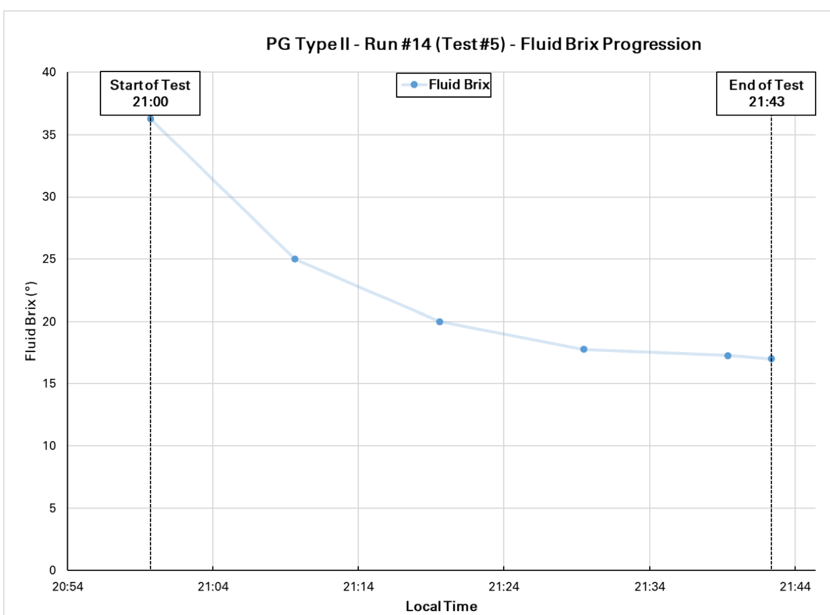

PG Type II - Run #14 (Test #5) - Precipitation Rate
Start of Test
21:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test
21:43
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
20:54
21:04
21:14
21:24
21:34
21:44
Local Time

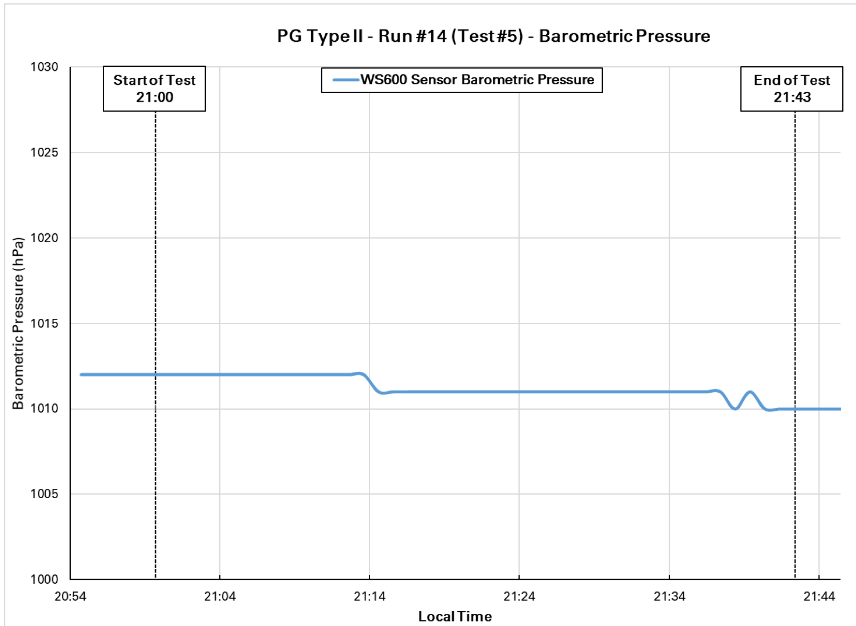

PG Type II - Run #14 (Test #5) - Temperatures
Start of Test
21:00
Initial Fluid Temp: -6.5°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test
21:43
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
20:54
21:04
21:14
21:24
21:34
21:44
Local Time

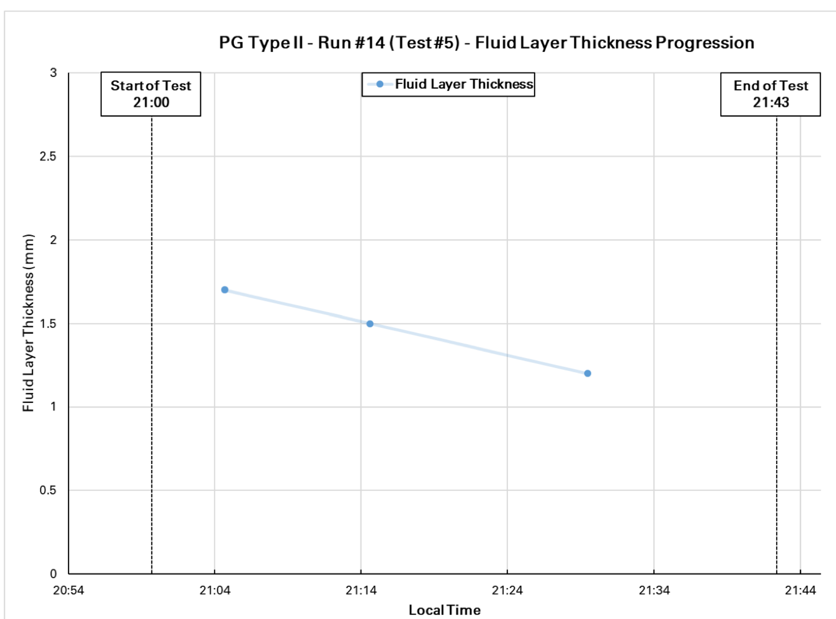

PG Type II - Run #14 (Test #5) - Wind Speeds
Start of Test 21:00
End of Test 21:43
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
20:54
21:04
21:14
21:24
21:34
21:44
Local Time


PG Type II - Run #14 (Test #5) - Wind Direction
Start of Test 21:00
WS600 Sensor Wind Direction
End of Test 21:43
Wind Direction (degrees)
360
300
240
180
120
60
0
20:54
21:04
21:14
21:24
21:34
21:44
Local Time

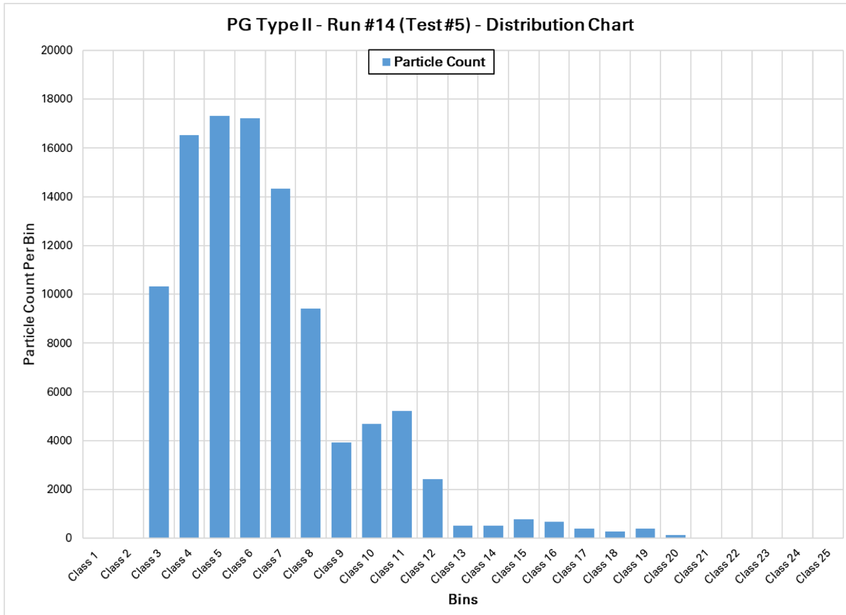

PG Type II - Run #14 (Test #5) - Relative Humidity
Start of Test 21:00
WS600 Sensor Relative Humidity
End of Test 21:43
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:54
21:04
21:14
21:24
21:34
21:44
Local Time


PG Type II - Run #14 (Test #5) - Fluid Brix Progression
Start of Test 21:00
Fluid Brix
End of Test 21:43
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:54
21:04
21:14
21:24
21:34
21:44
Local Time


PG Type II - Run #14 (Test #5) - Barometric Pressure
WS600 Sensor Barometric Pressure
Start of Test 21:00
End of Test 21:43
Barometric Pressure (hPa)
1030
1025
1020
1015
1010
1005
1000
20:54
21:04
21:14
21:24
21:34
21:44
Local Time


PG Type II - Run #14 (Test #5) - Fluid Layer Thickness Progression
Fluid Layer Thickness
Start of Test 21:00
End of Test 21:43
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
20:54
21:04
21:14
21:24
21:34
21:44
Local Time

DATA PACKAGE – PG TYPE II – RUN 14 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 14 - Test 5/Data Package - PG Type II - Run 14 - Test 5.docx
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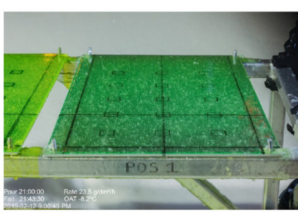
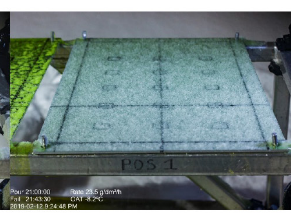
DATA PACKAGE – PG TYPE II – RUN 14 (TEST 5)

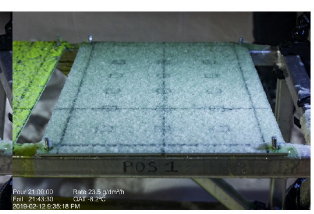
Safewing MP II FLIGHT – Run 14 (Test 5) – Failure Progression Photos



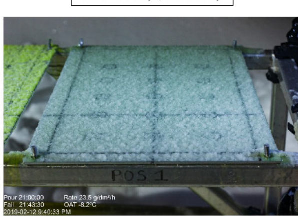
AT POUR (0/43 MIN)



PRE-FAILURE (24/43 MIN)

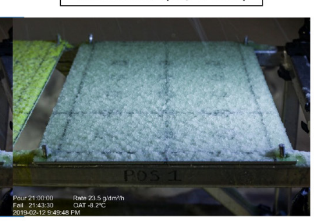


PRE-FAILURE (35/43 MIN)



PRE-FAILURE (40/43 MIN)

AT FAILURE (43/43 MIN)



POST-FAILURE (49/43 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 14 - Test 5/Data Package - PG Type II - Run 14 - Test 5.docx
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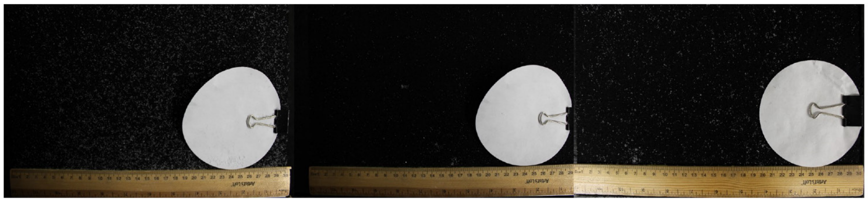
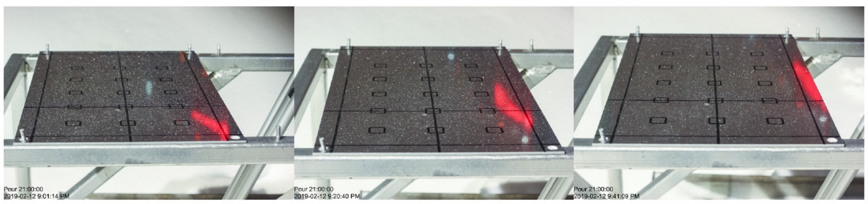
Safewing MP II FLIGHT – Run 14 (Test 5) – Snow Characteristics Photos



FELT PAD (1/43 MIN) | FELT PAD (20/43 MIN) | FELT PAD (40/43 MIN)



BARE PLATE (1/43 MIN) | BARE PLATE (20/43 MIN) | BARE PLATE (41/43 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

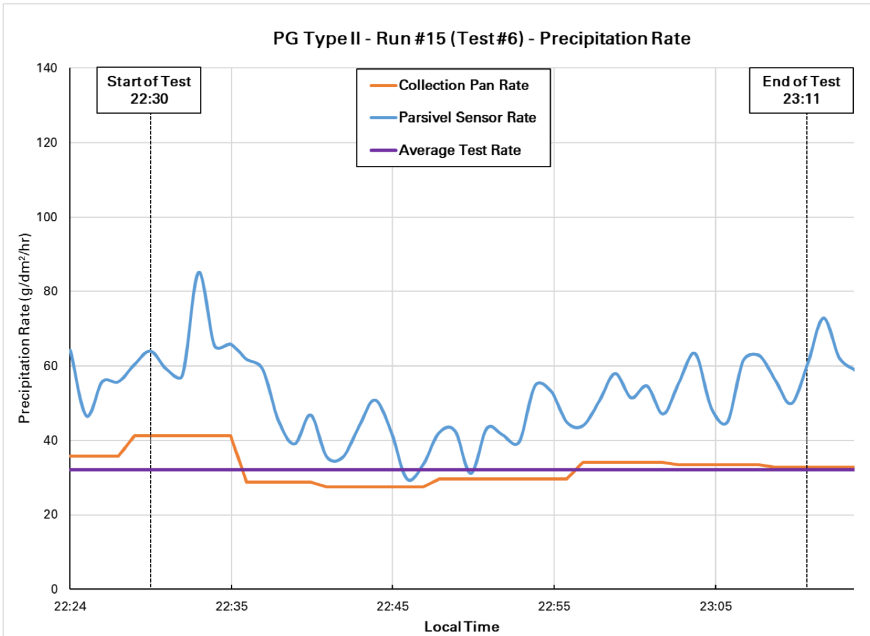
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #15 (TEST #6) - PG2-6

PG Type II – Run #15 (Test #6) – General Test Information

Test Number:	PG2-6
Date of Test:	February 12, 2019
Average OAT:	-6.5
Average Precipitation Rate:	32.1 g/dm²/h
Average Wind Speed:	23 km/h
Average Relative Humidity:	88.8%
Pour Time (Local):	22:30:00
Time of Fluid Failure (Local):	23:11:00
Fluid Brix at Failure:	14.25°
Endurance Time:	41.0 minutes
Expected Regression-Derived Endurance Time:	34.0 minutes
Difference (ET vs. Reg ET):	+7.0 minutes (+20.7%)

DATA PACKAGE – PG TYPE II – RUN 15 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 15 - Test 6/Data Package - PG Type II - Run 15 - Test 6.docx
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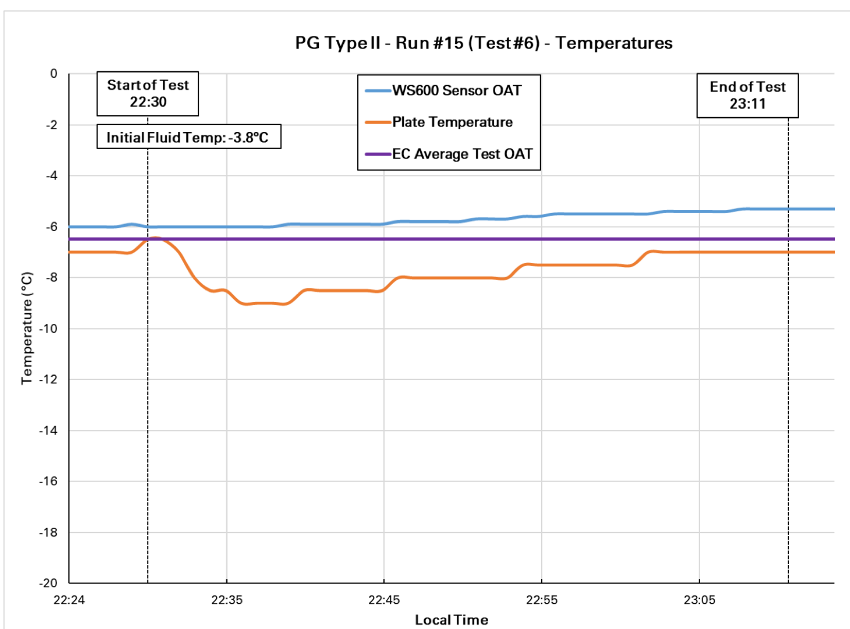
DATA PACKAGE – PG TYPE II – RUN 15 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 15 - Test 6/Data Package - PG Type II - Run 15 - Test 6.docx
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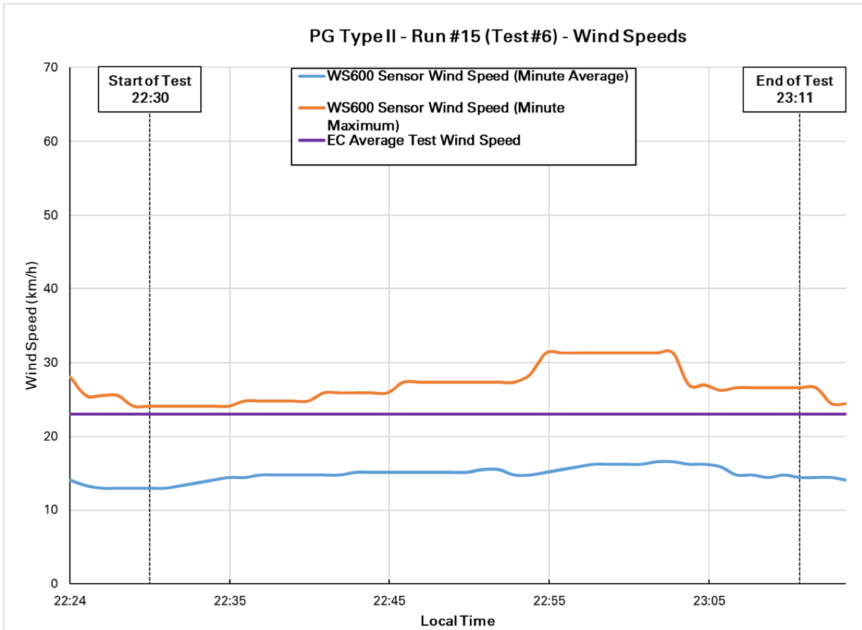
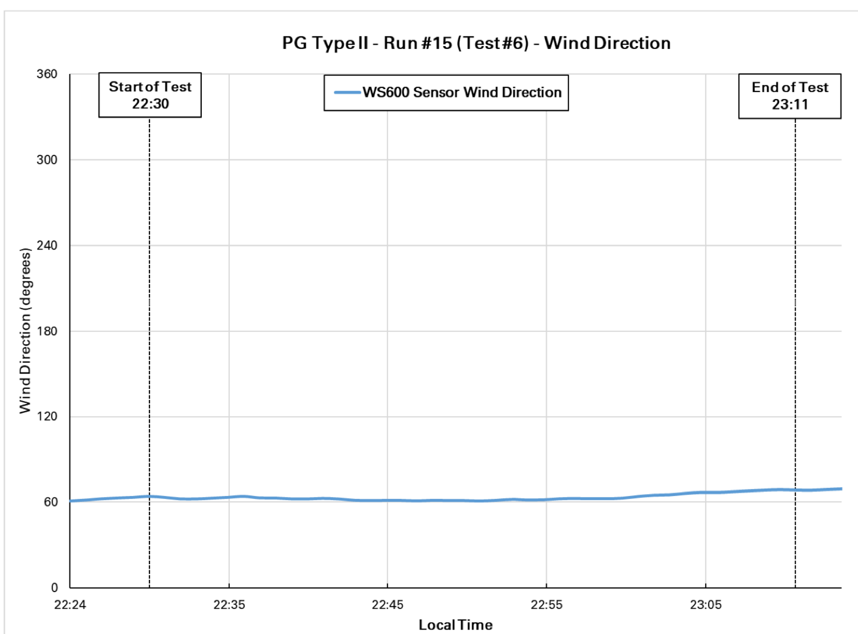
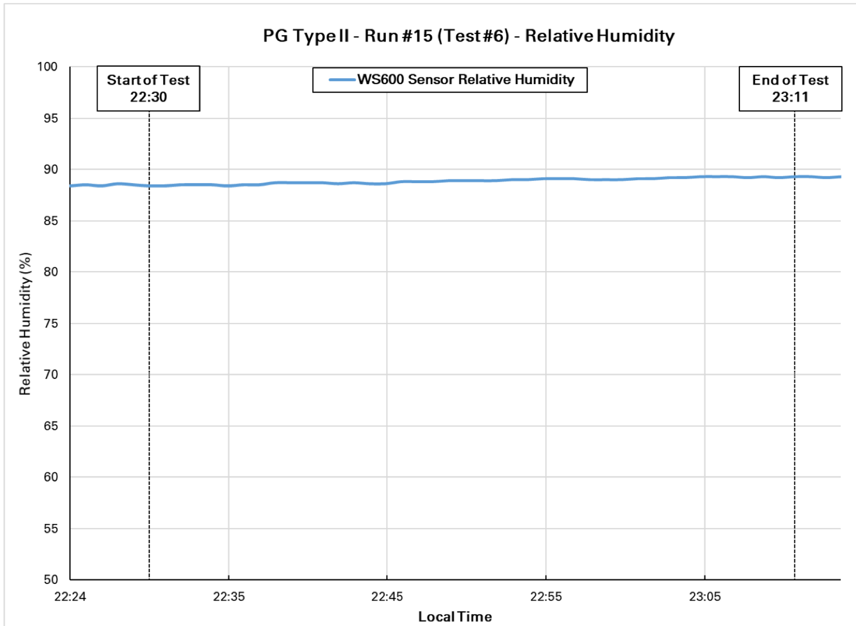

PG Type II - Run #15 (Test #6) - Wind Speeds
Start of Test 22:30
End of Test 23:11
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type II - Run #15 (Test #6) - Wind Direction
Start of Test 22:30
End of Test 23:11
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
22:24
22:35
22:45
22:55
23:05
Local Time

DATA PACKAGE – PG TYPE II – RUN 15 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 15 - Test 6/Data Package - PG Type II - Run 15 - Test 6.docx
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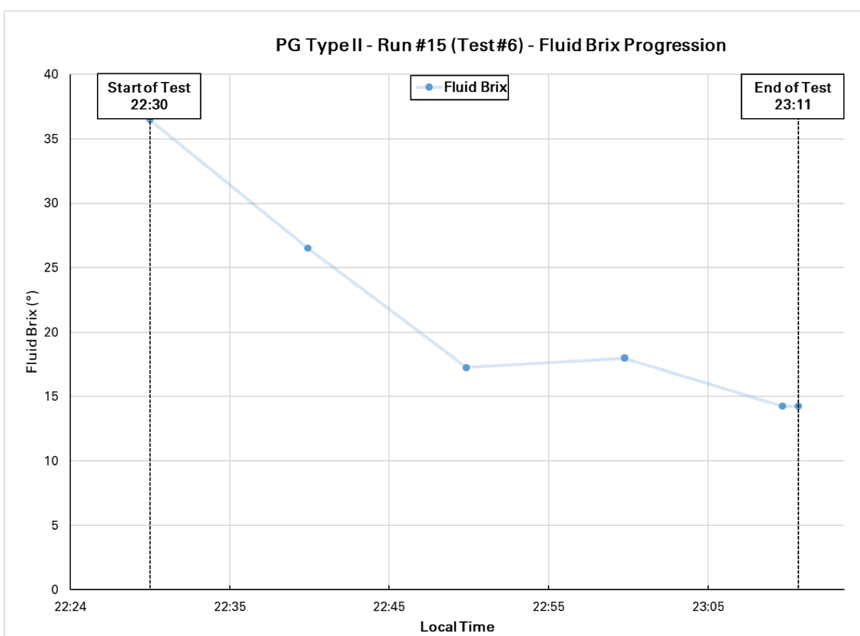
DATA PACKAGE – PG TYPE II – RUN 15 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 15 - Test 6/Data Package - PG Type II - Run 15 - Test 6.docx
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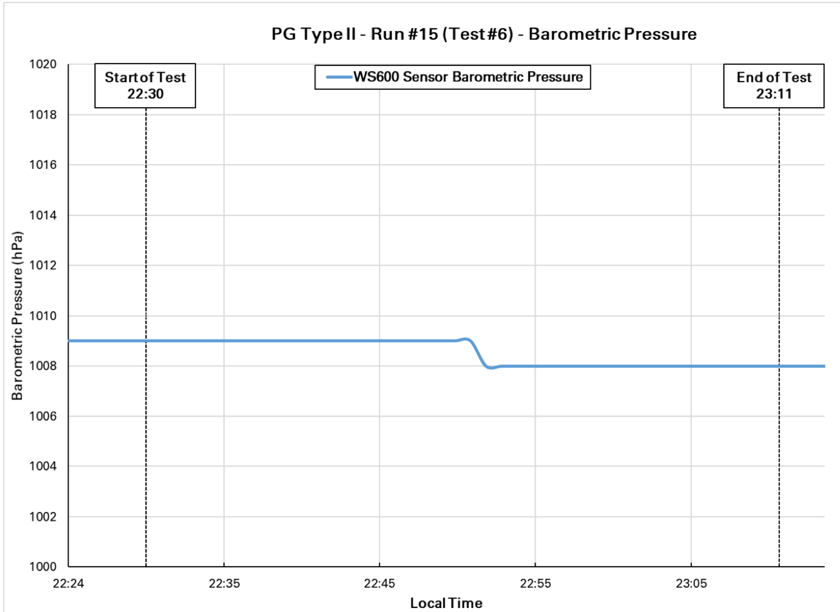
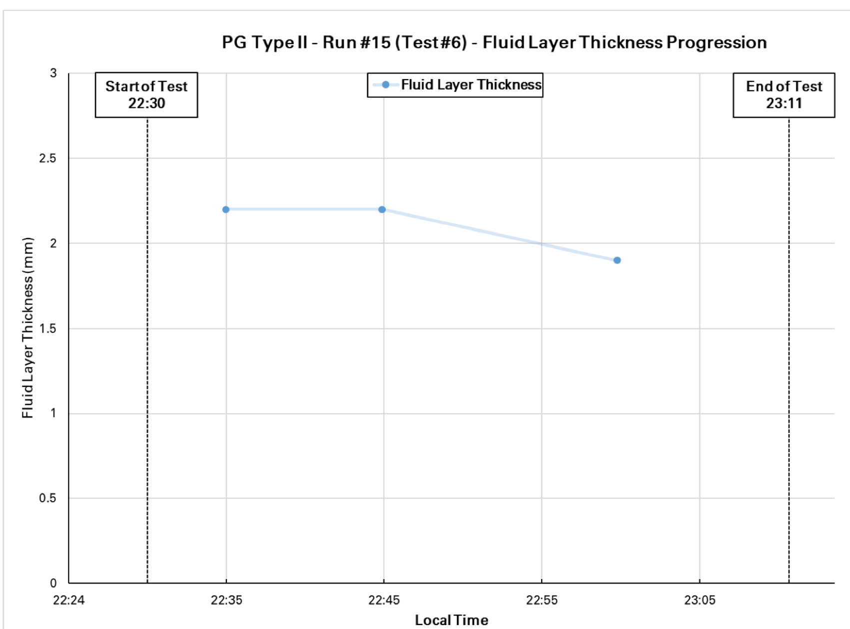
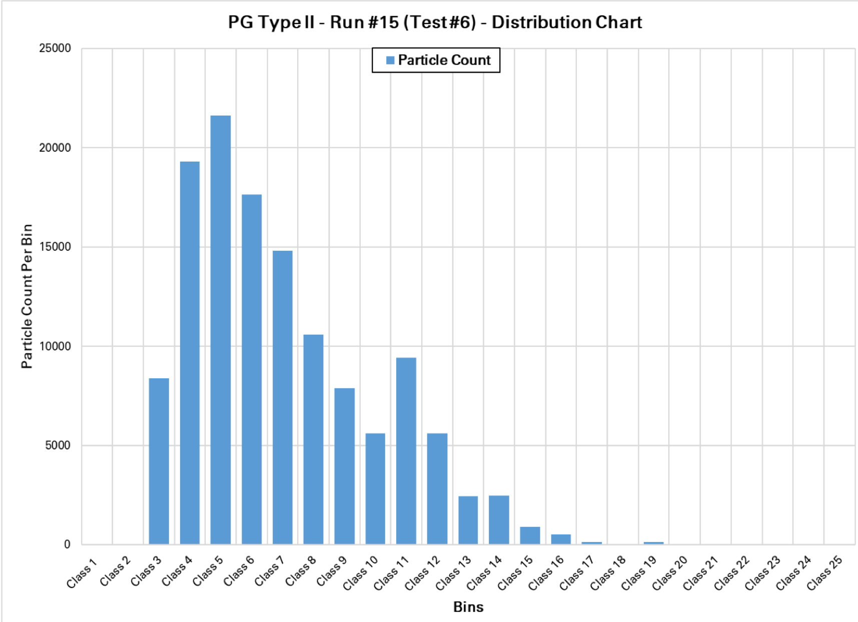
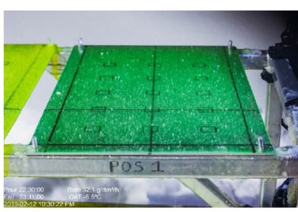

PG Type II - Run #15 (Test #6) - Barometric Pressure
Start of Test 22:30
WS600 Sensor Barometric Pressure
End of Test 23:11
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
22:24
22:35
22:45
22:55
23:05
Local Time

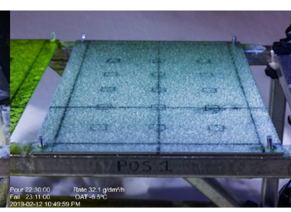

PG Type II - Run #15 (Test #6) - Fluid Layer Thickness Progression
Start of Test 22:30
Fluid Layer Thickness
End of Test 23:11
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
22:24
22:35
22:45
22:55
23:05
Local Time



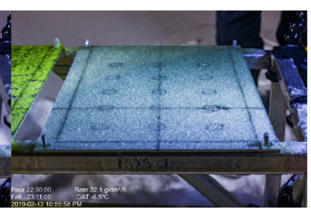
Safewing MP II FLIGHT – Run 15 (Test 6) – Failure Progression Photos



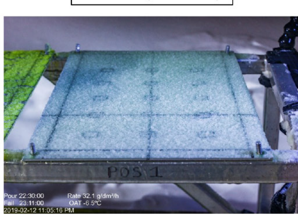
AT POUR (0/41 MIN)



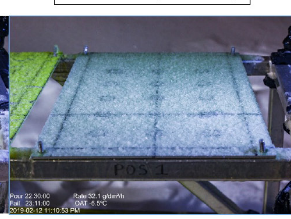
PRE-FAILURE (19/41 MIN)



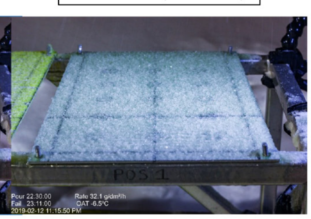
PRE-FAILURE (29/41 MIN)



PRE-FAILURE (35/41 MIN)

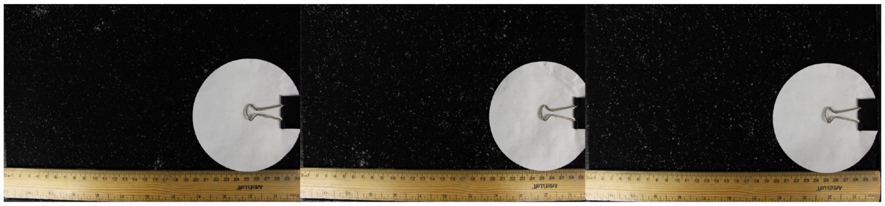


PRE-FAILURE (40/41 MIN)

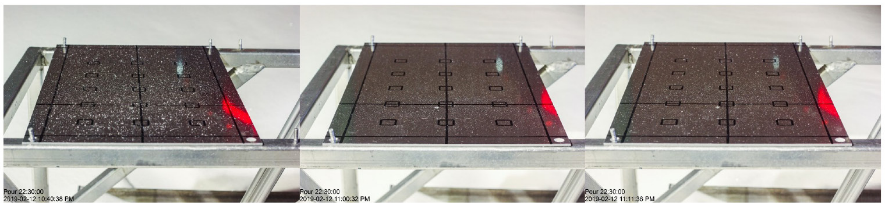


POST-FAILURE (45/41 MIN)

Safewing MP II FLIGHT – Run 15 (Test 6) – Snow Characteristics Photos



FELT PAD (0/41 MIN) | FELT PAD (10/41 MIN) | FELT PAD (20/41 MIN)



BARE PLATE (10/41 MIN) | BARE PLATE (20/41 MIN) | BARE PLATE (41/41 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

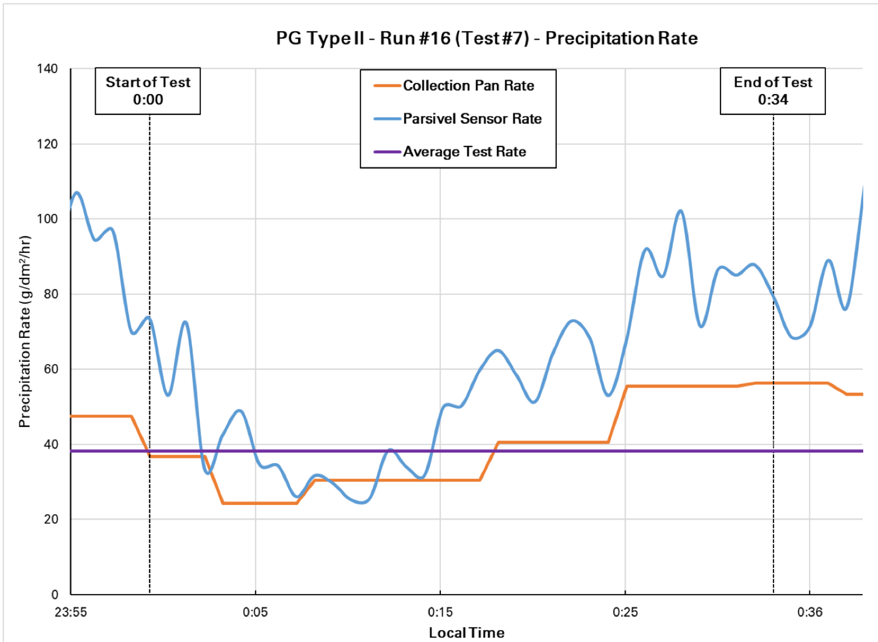
PG TYPE II
RUN #16 – (TEST #7) PG2-7

DATA PACKAGE – PG TYPE II – RUN 16 (TEST 7)

PG Type II – Run #16 (Test #7) – General Test Information

Test Number:	**PG2-7**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.2**
Average Precipitation Rate:	**38.3 g/dm²/h**
Average Wind Speed:	**32.4 km/h**
Average Relative Humidity:	**88.5%**
Pour Time (Local):	**0:00:00**
Time of Fluid Failure (Local):	**0:34:00**
Fluid Brix at Failure:	**18.5°**
Endurance Time:	**34 minutes**
Expected Regression-Derived Endurance Time:	**28.3 minutes**
Difference (ET vs. Reg ET):	**+5.9 minutes (+20.8%)**

DATA PACKAGE – PG TYPE II – RUN 16 (TEST 7)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 16 - Test 7/Data Package - PG Type II - Run 16 - Test 7.docx
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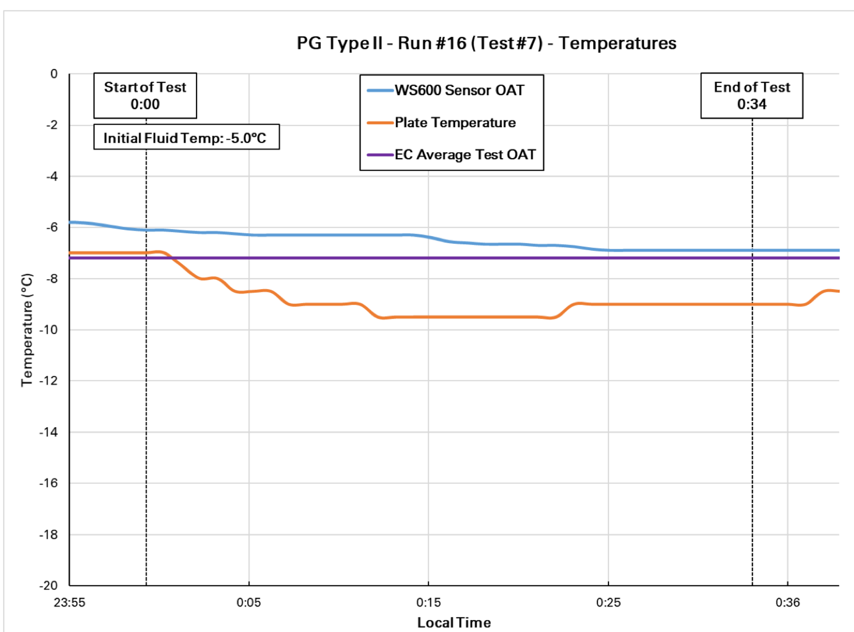
DATA PACKAGE – PG TYPE II – RUN 16 (TEST 7)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 16 - Test 7/Data Package - PG Type II - Run 16 - Test 7.docx
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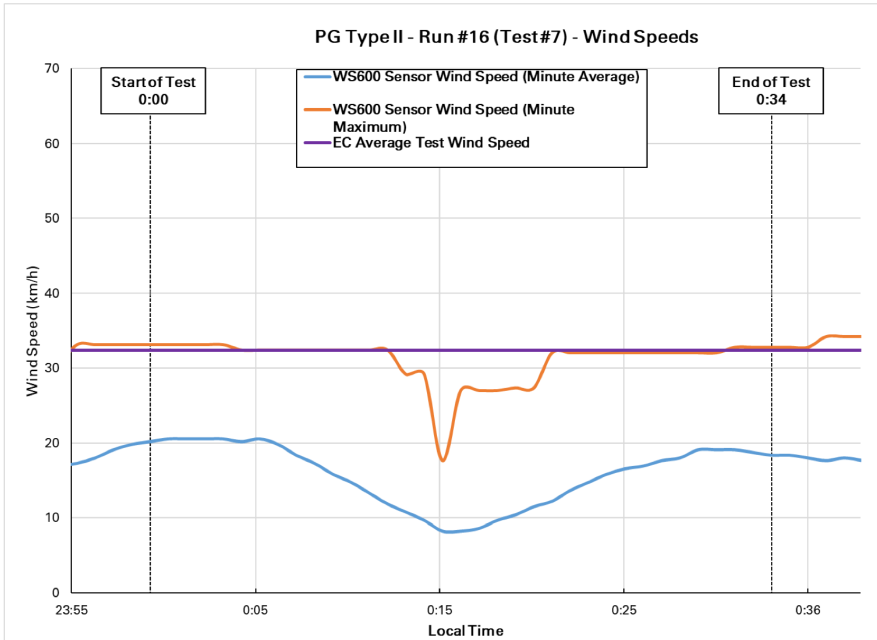
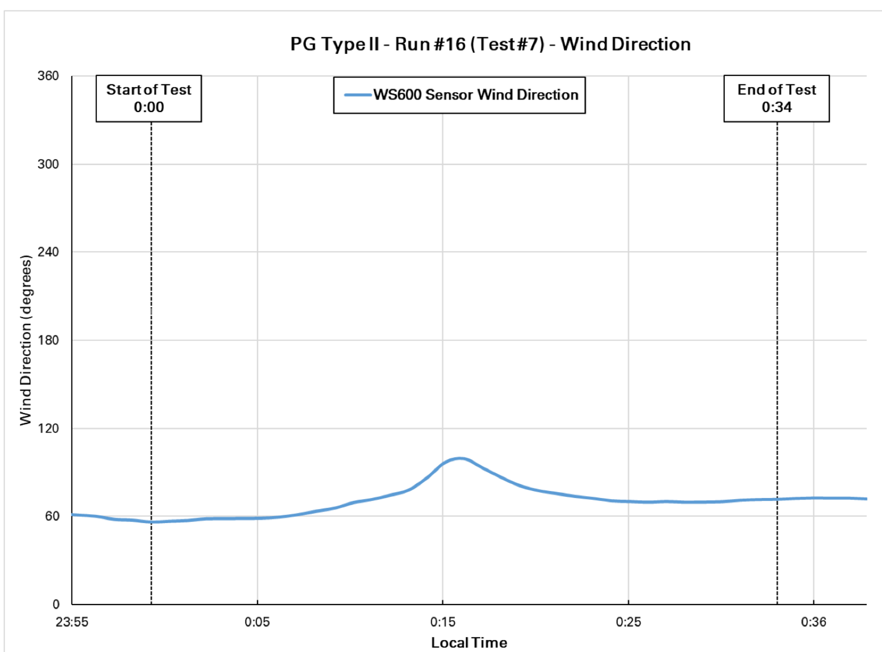
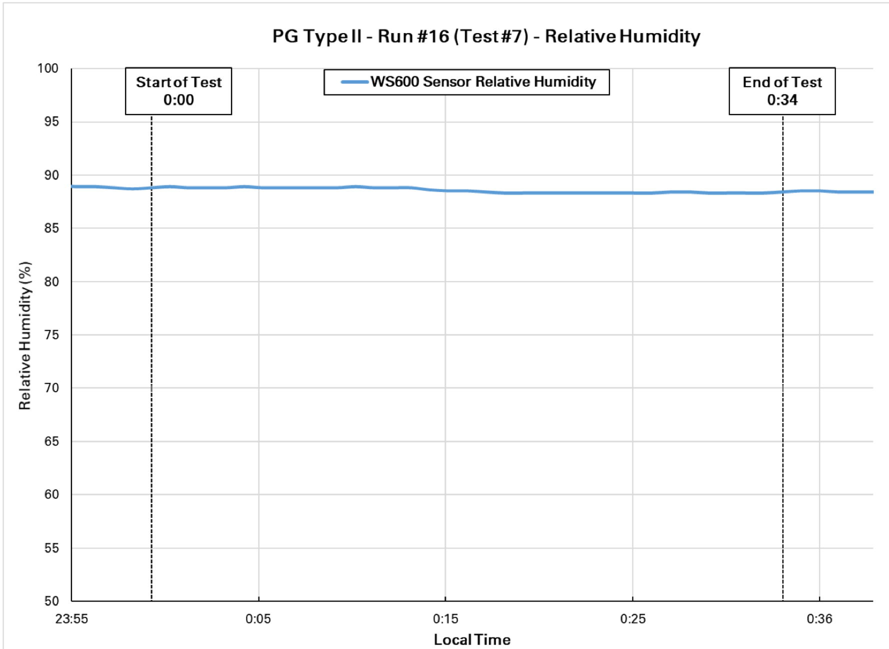


PG Type II - Run #16 (Test #7) - Wind Speeds
Start of Test 0:00
End of Test 0:34
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
23:55
0:05
0:15
0:25
0:36
Local Time



PG Type II - Run #16 (Test #7) - Wind Direction
Start of Test 0:00
WS600 Sensor Wind Direction
End of Test 0:34
Wind Direction (degrees)
360
300
240
180
120
60
0
23:55
0:05
0:15
0:25
0:36
Local Time

DATA PACKAGE – PG TYPE II – RUN 16 (TEST 7)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 16 - Test 7/Data Package - PG Type II - Run 16 - Test 7.docx
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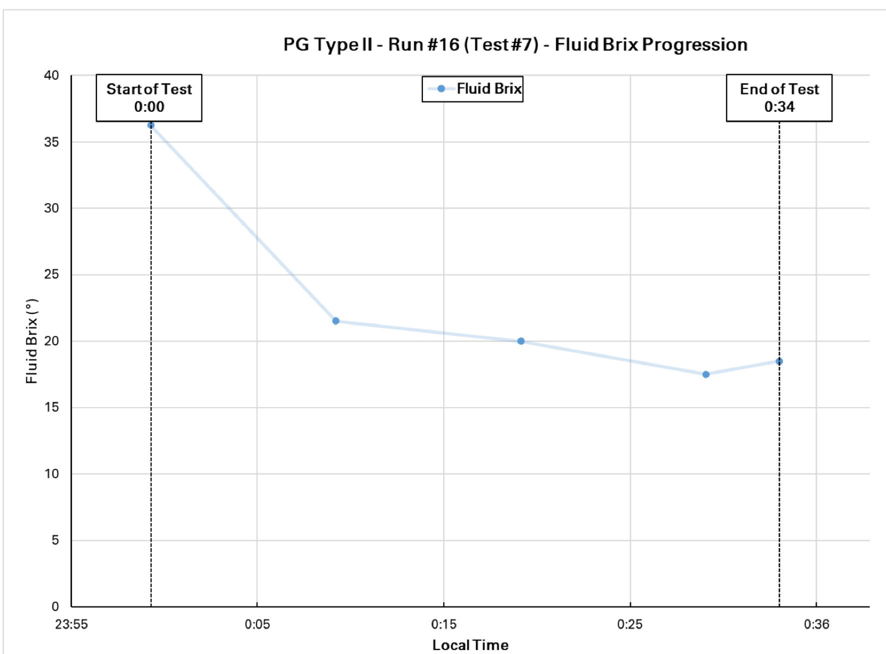
DATA PACKAGE – PG TYPE II – RUN 16 (TEST 7)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 16 - Test 7/Data Package - PG Type II - Run 16 - Test 7.docx
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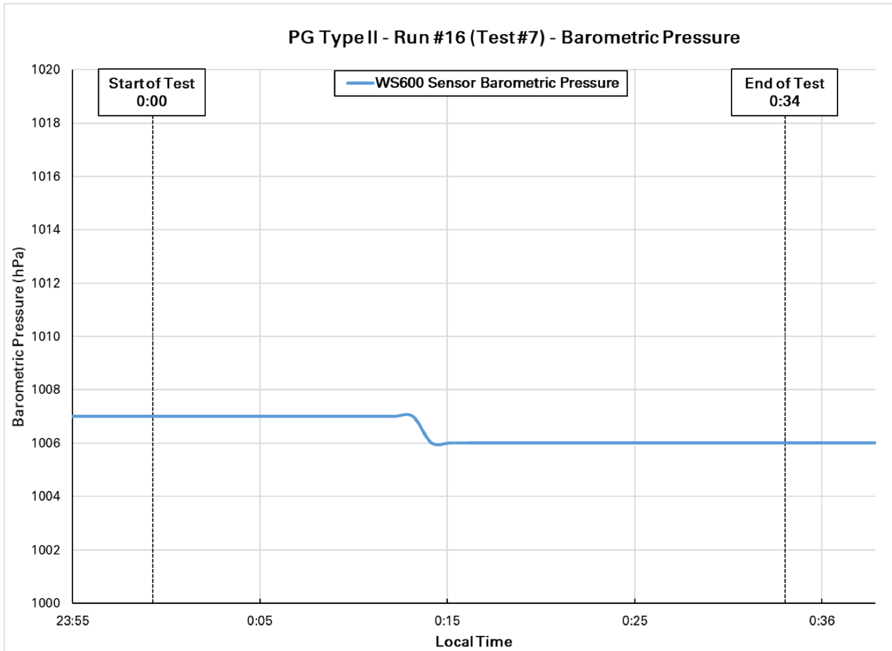
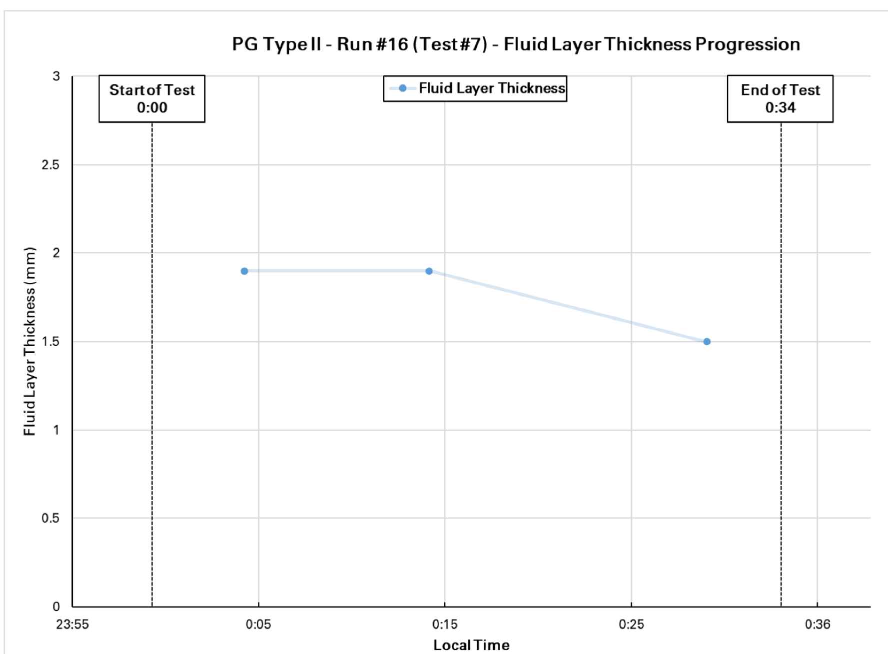
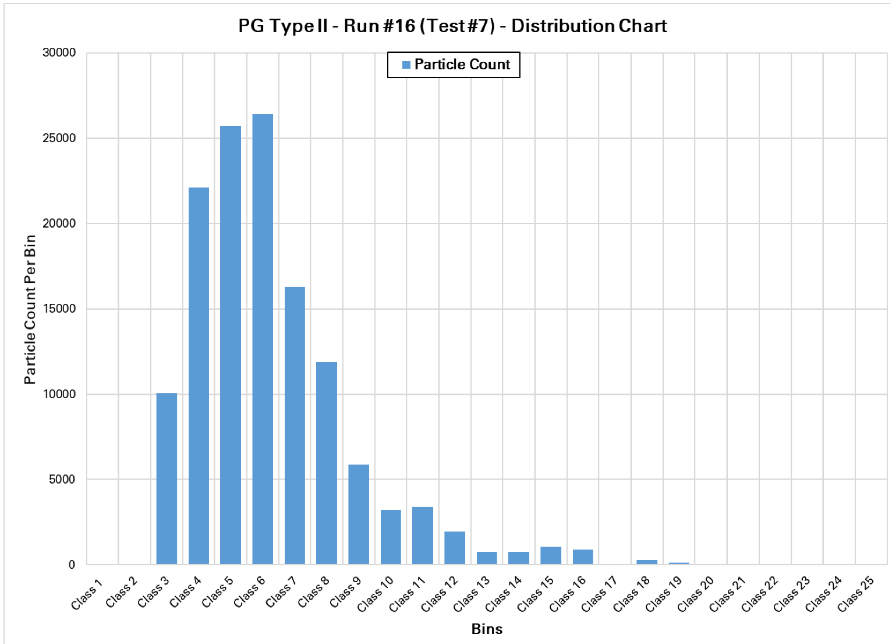
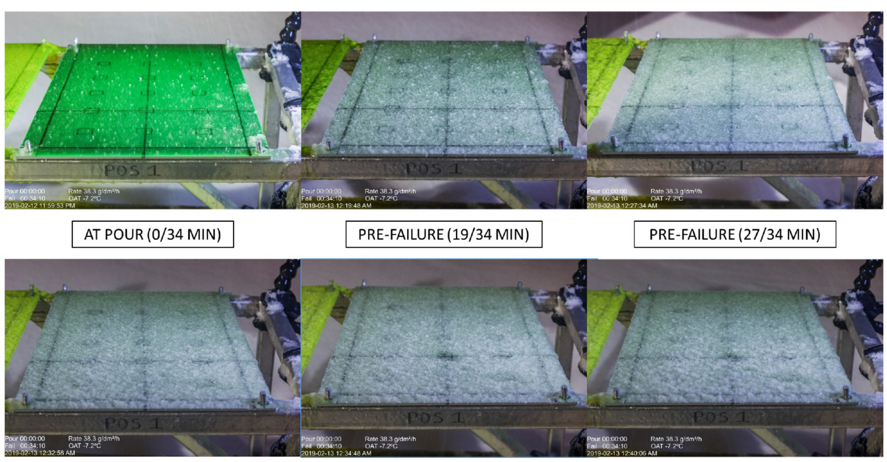


DATA PACKAGE – PG TYPE II – RUN 16 (TEST 7)





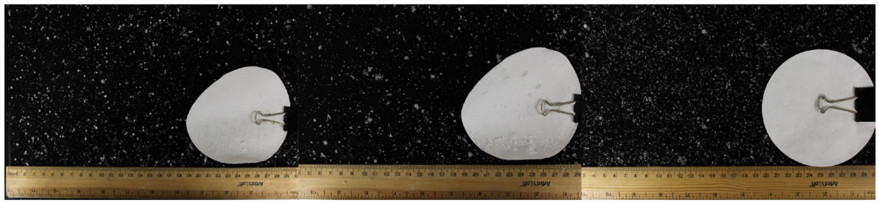
Safewing MP II FLIGHT – Run 16 (Test 7) – Failure Progression Photos



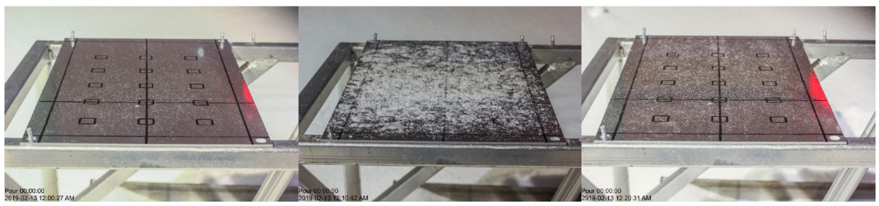
AT POUR (0/34 MIN) | PRE-FAILURE (19/34 MIN) | PRE-FAILURE (27/34 MIN)

PRE-FAILURE (32/34 MIN) | AT FAILURE (34/34 MIN) | POST-FAILURE (40/34 MIN)

Safewing MP II FLIGHT – Run 16 (Test 7) – Snow Characteristics Photos



FELT PAD (0/34 MIN) FELT PAD (19/34 MIN) FELT PAD (30/34 MIN)



BARE PLATE (0/34 MIN) BARE PLATE (10/34 MIN) BARE PLATE (20/34 MIN)

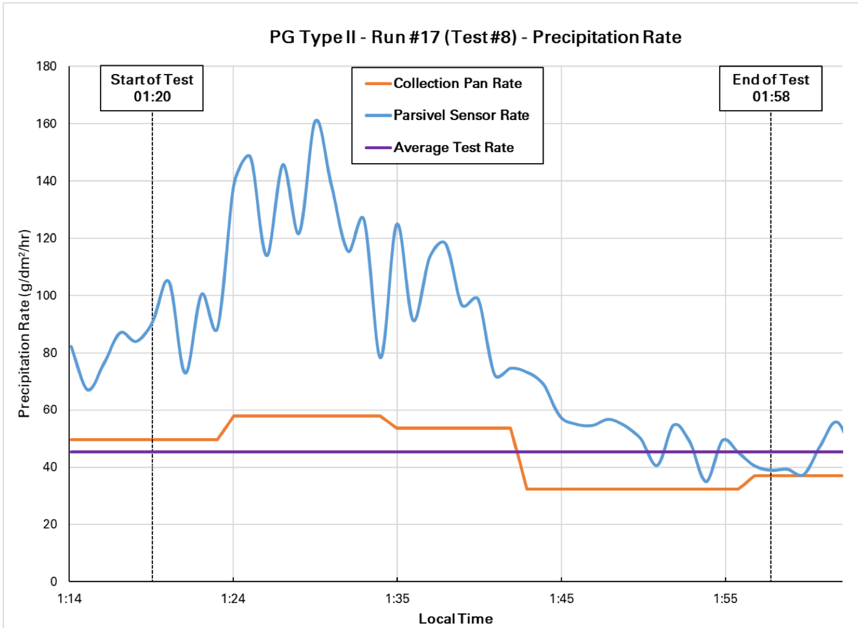
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

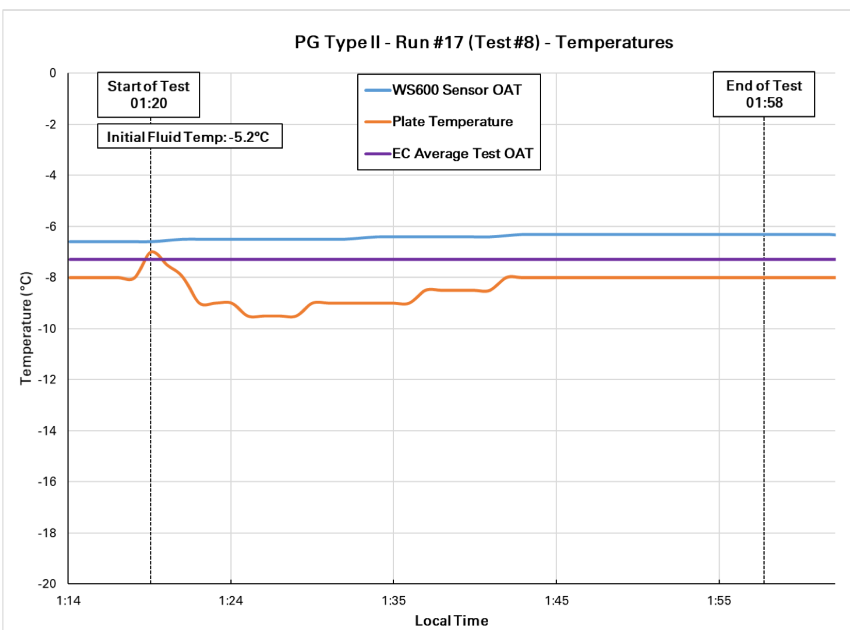
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

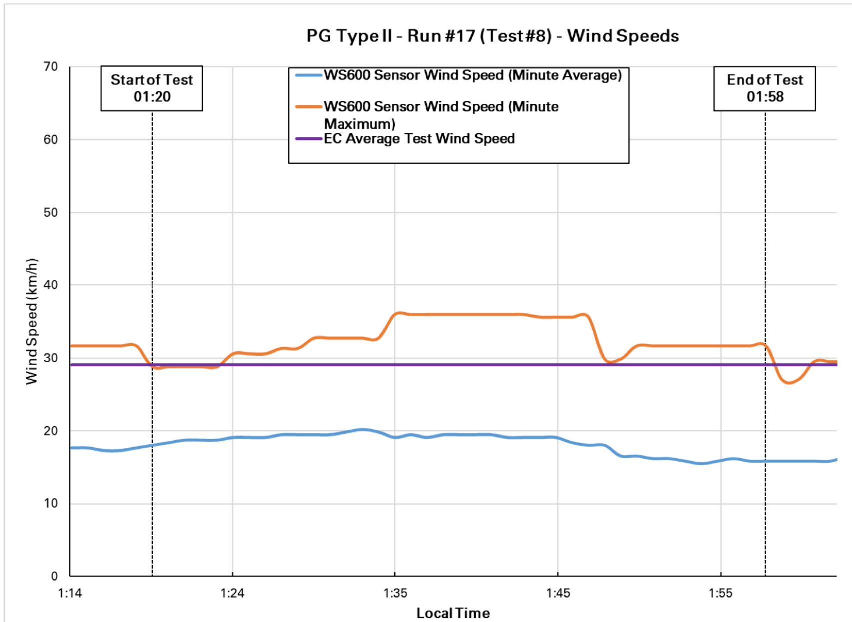
PG TYPE II
RUN #17 (TEST #8) – PG2-8

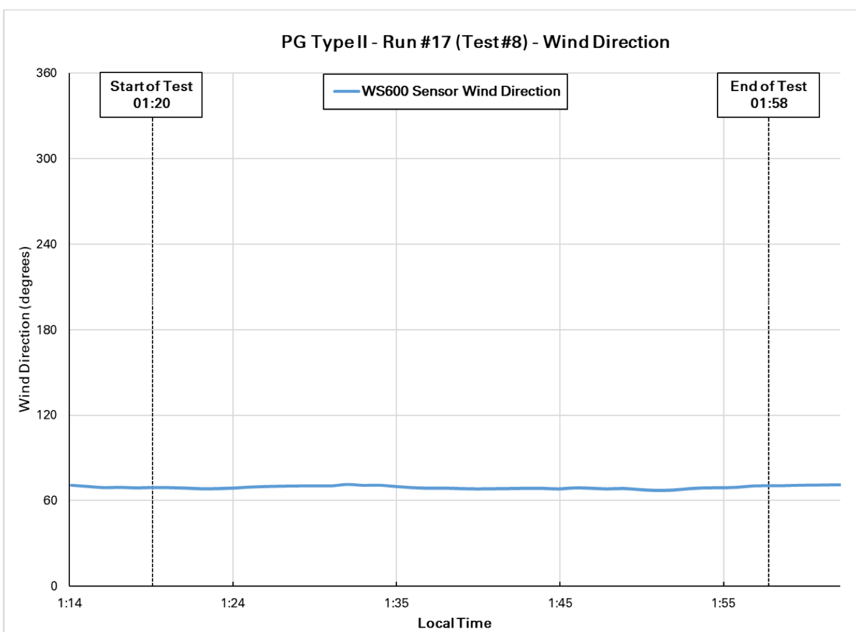
PG Type II – Run #17 (Test #8) – General Test Information

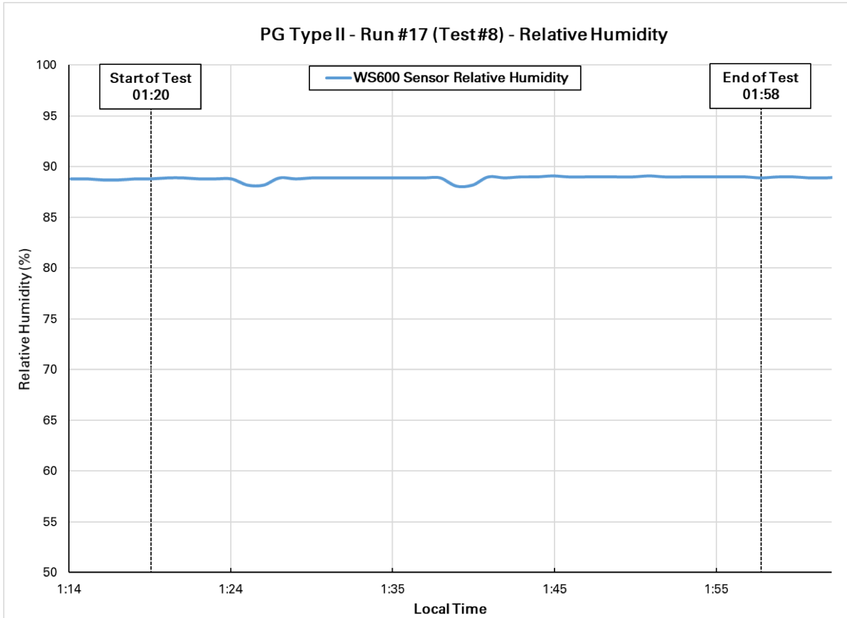
Test Number:	PG2-8
Date of Test:	February 13, 2019
Average OAT:	-7.3
Average Precipitation Rate:	45.3 g/dm²/h
Average Wind Speed:	29.1 km/h
Average Relative Humidity:	88.8%
Pour Time (Local):	01:20:00
Time of Fluid Failure (Local):	01:58:00
Fluid Brix at Failure:	14.5°
Endurance Time:	38.7 minutes
Expected Regression-Derived Endurance Time:	24.5 minutes
Difference (ET vs. Reg ET):	+14.2 minutes (+58.1%)

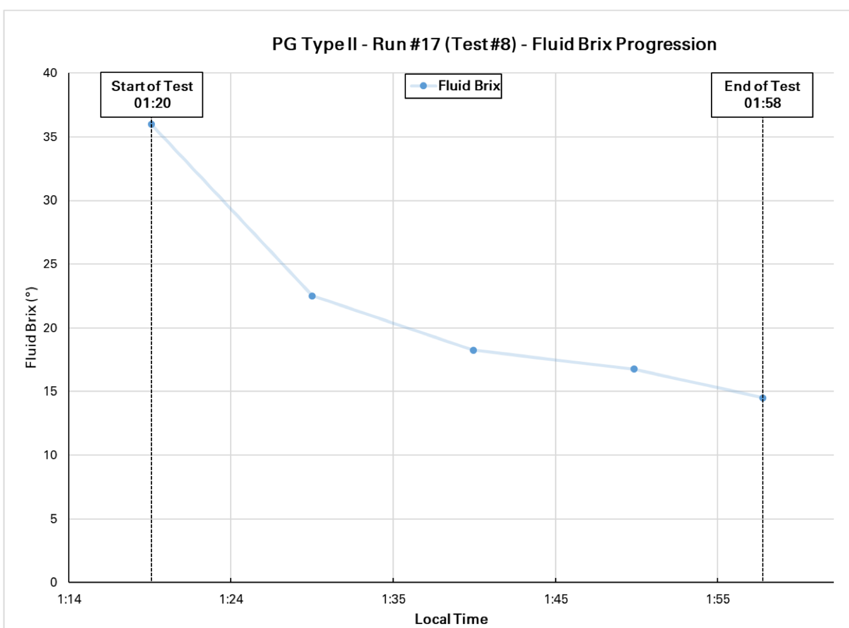

PG Type II - Run #17 (Test #8) - Precipitation Rate
Start of Test 01:20
End of Test 01:58
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
120
140
160
180
1:14
1:24
1:35
1:45
1:55
Local Time

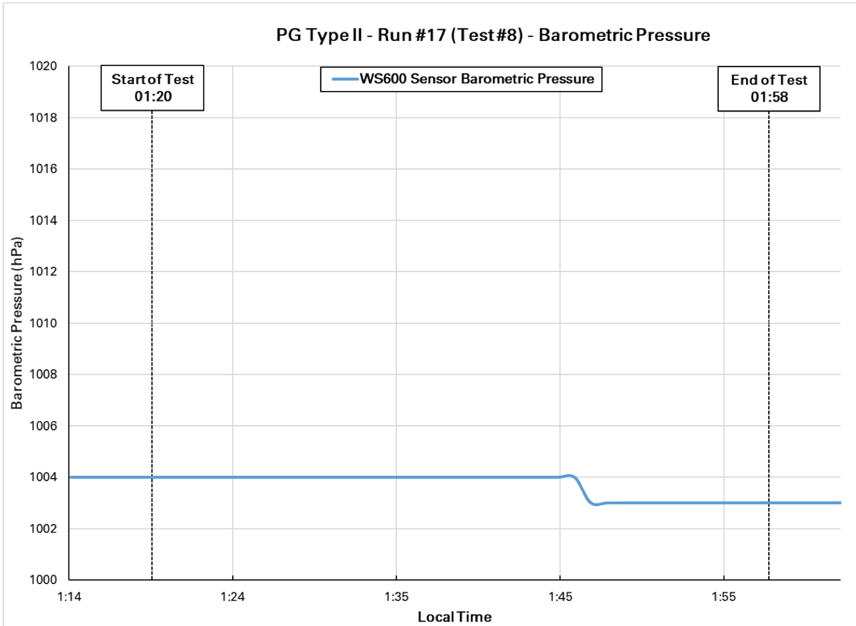

PG Type II - Run #17 (Test #8) - Temperatures
Start of Test 01:20
Initial Fluid Temp: -5.2°C
End of Test 01:58
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
1:14
1:24
1:35
1:45
1:55
Local Time

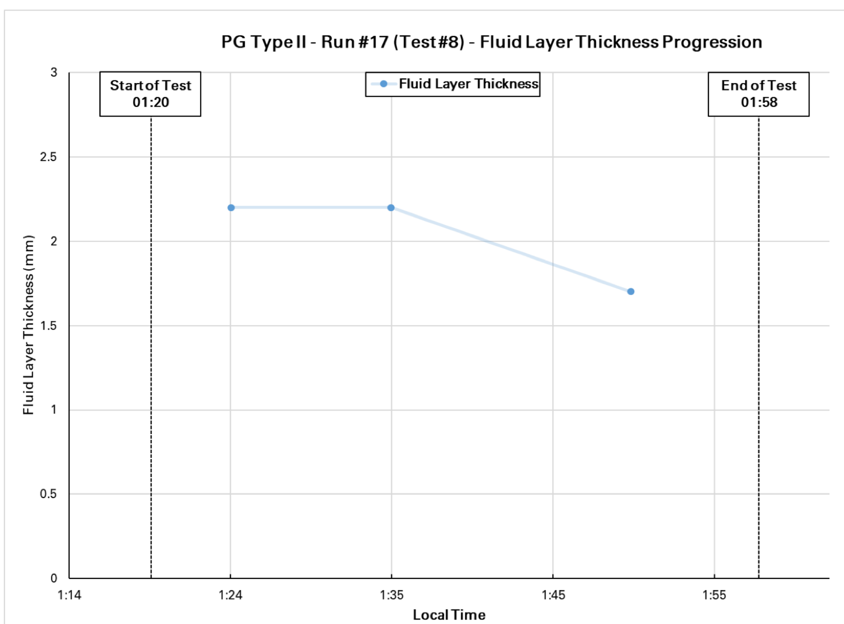

PG Type II - Run #17 (Test #8) - Wind Speeds
Start of Test 01:20
End of Test 01:58
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
1:14
1:24
1:35
1:45
1:55
Local Time

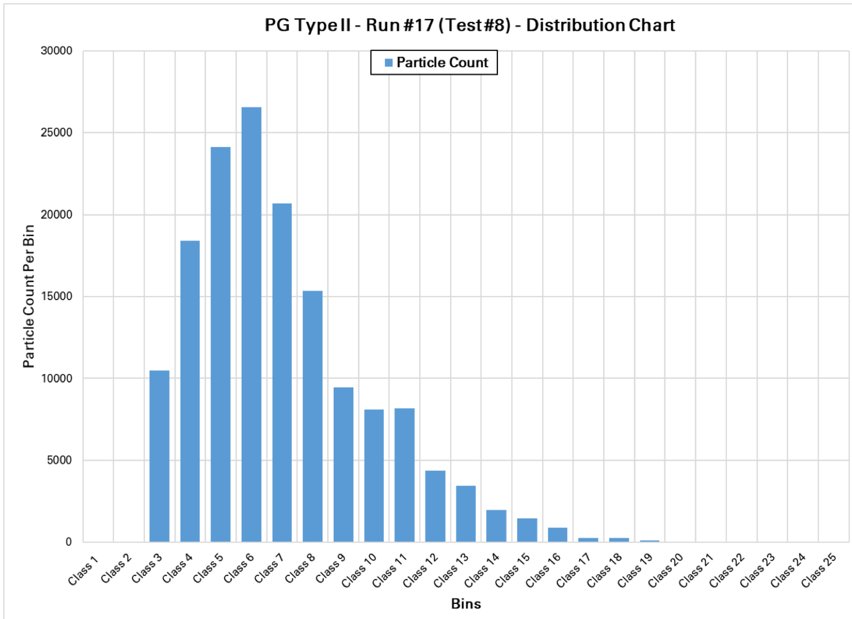

PG Type II - Run #17 (Test #8) - Wind Direction
Start of Test 01:20
End of Test 01:58
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
1:14
1:24
1:35
1:45
1:55
Local Time


PG Type II - Run #17 (Test #8) - Relative Humidity
Start of Test 01:20
WS600 Sensor Relative Humidity
End of Test 01:58
100
95
90
85
80
75
70
65
60
55
50
Relative Humidity (%)
1:14
1:24
1:35
1:45
1:55
Local Time

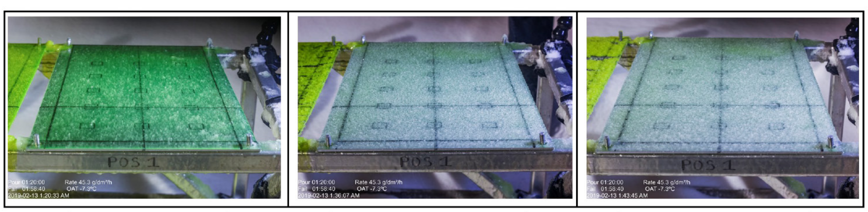

PG Type II - Run #17 (Test #8) - Fluid Brix Progression
Start of Test 01:20
Fluid Brix
End of Test 01:58
40
35
30
25
20
15
10
5
0
Fluid Brix (°)
1:14
1:24
1:35
1:45
1:55
Local Time


PG Type II - Run #17 (Test #8) - Barometric Pressure
Start of Test 01:20
WS600 Sensor Barometric Pressure
End of Test 01:58
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
Barometric Pressure (hPa)
1:14
1:24
1:35
1:45
1:55
Local Time

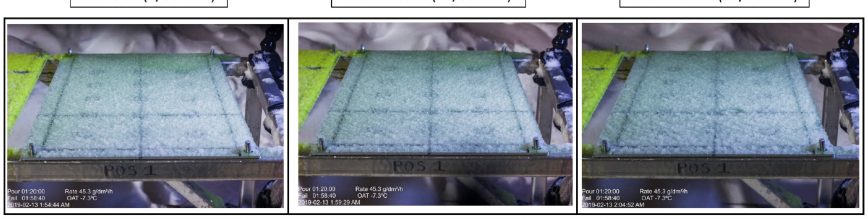

PG Type II - Run #17 (Test #8) - Fluid Layer Thickness Progression
Start of Test 01:20
Fluid Layer Thickness
End of Test 01:58
3
2.5
2
1.5
1
0.5
0
Fluid Layer Thickness (mm)
1:14
1:24
1:35
1:45
1:55
Local Time



Safewing MP II FLIGHT – Run 17 (Test 8) – Failure Progression Photos

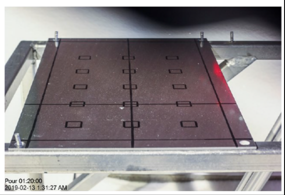


AT POUR (0/38 MIN) | PRE-FAILURE (16/38 MIN) | PRE-FAILURE (23/38 MIN)



PRE-FAILURE (34/38 MIN) | AT FAILURE (39/38 MIN) | POST-FAILURE (44/38 MIN)

Safewing MP II FLIGHT – Run 17 (Test 8) – Snow Characteristics Photos

No Felt Pad photo exists	No Felt Pad photo exists	No Felt Pad photo exists
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
	No Bare Plate photo exists	No Bare Plate photo exists
BARE PLATE (11/38 MIN)	BARE PLATE XX/XX MIN)	BARE PLATE (XX/XX MIN)

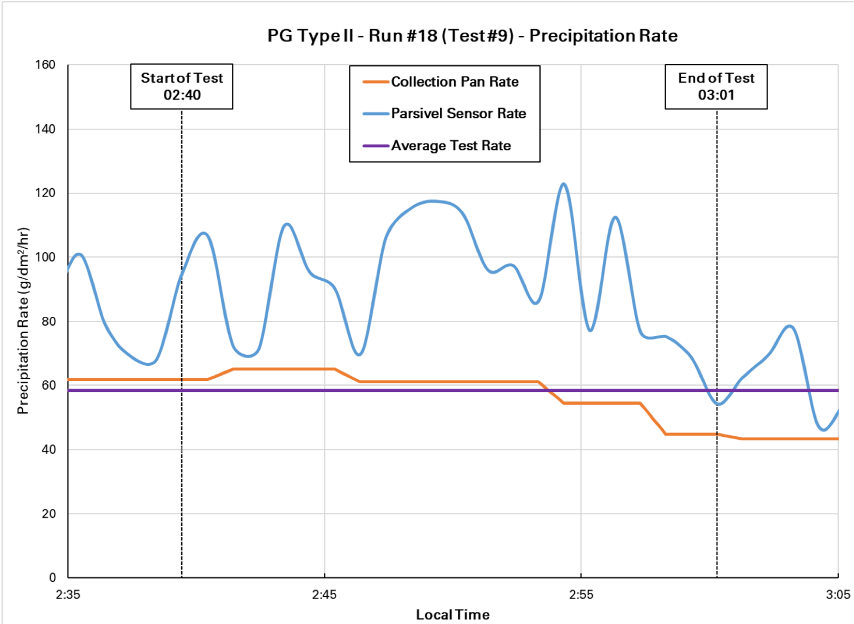
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

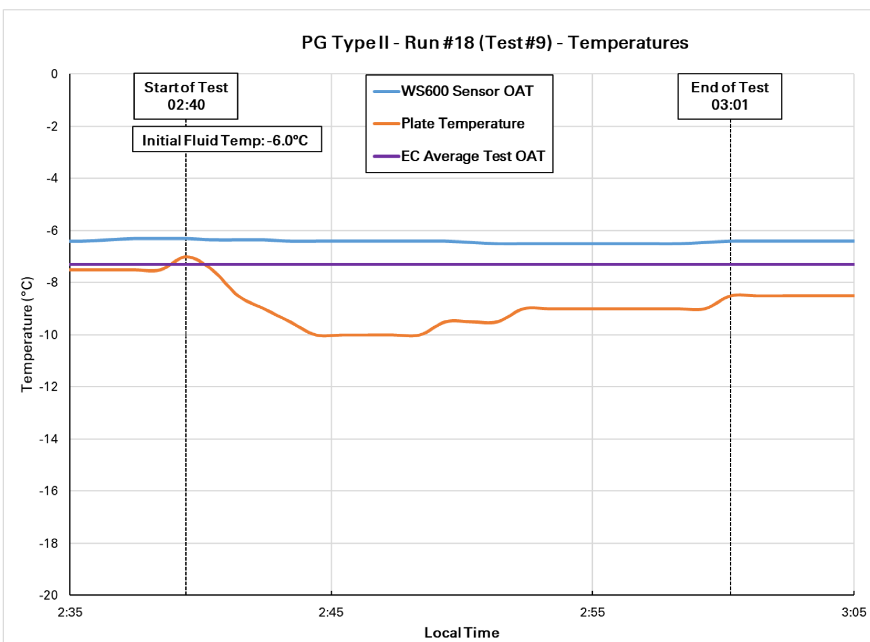
PG TYPE II
RUN #18 (TEST #9) – PG2-9

PG Type II – Run #18 (Test #9) – General Test Information

Test Number:	PG2-9
Date of Test:	February 13, 2019
Average OAT:	-7.3
Average Precipitation Rate:	58.4 g/dm²/h
Average Wind Speed:	26 km/h
Average Relative Humidity:	89.1%
Pour Time (Local):	02:40:00
Time of Fluid Failure (Local):	03:01:00
Fluid Brix at Failure:	18.75°
Endurance Time:	21.3 minutes
Expected Regression-Derived Endurance Time:	19.9 minutes
Difference (ET vs. Reg ET):	1.5 minutes (+7.4%)

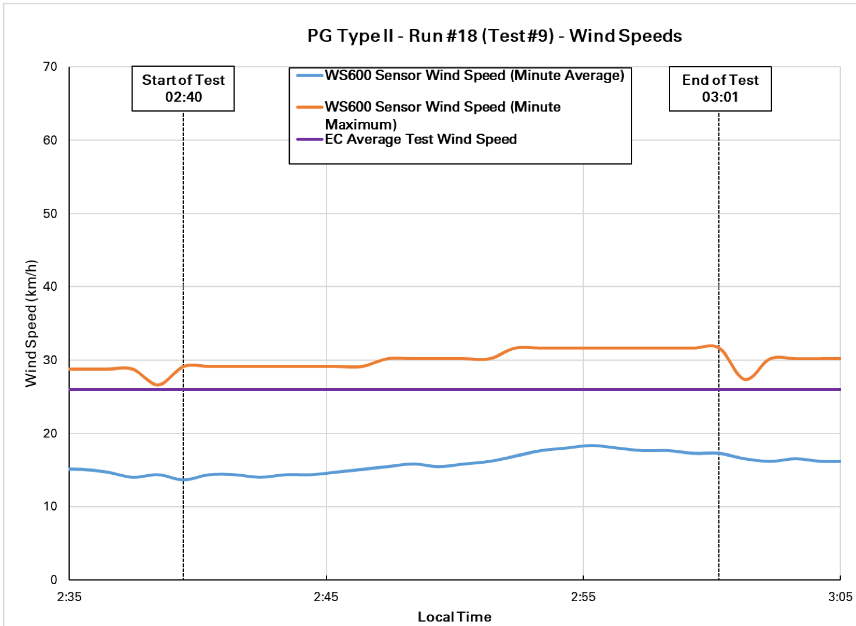


PG Type II - Run #18 (Test#9) - Precipitation Rate
Start of Test 02:40
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 03:01
Precipitation Rate (g/dm²/hr)
Local Time



PG Type II - Run #18 (Test#9) - Temperatures
Start of Test 02:40
Initial Fluid Temp: -6.0°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 03:01
Temperature (°C)
Local Time

DATA PACKAGE – PG TYPE II – RUN 18 (TEST 9)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 18 - Test 9/Data Package - PG Type II - Run 18 - Test 9.docx
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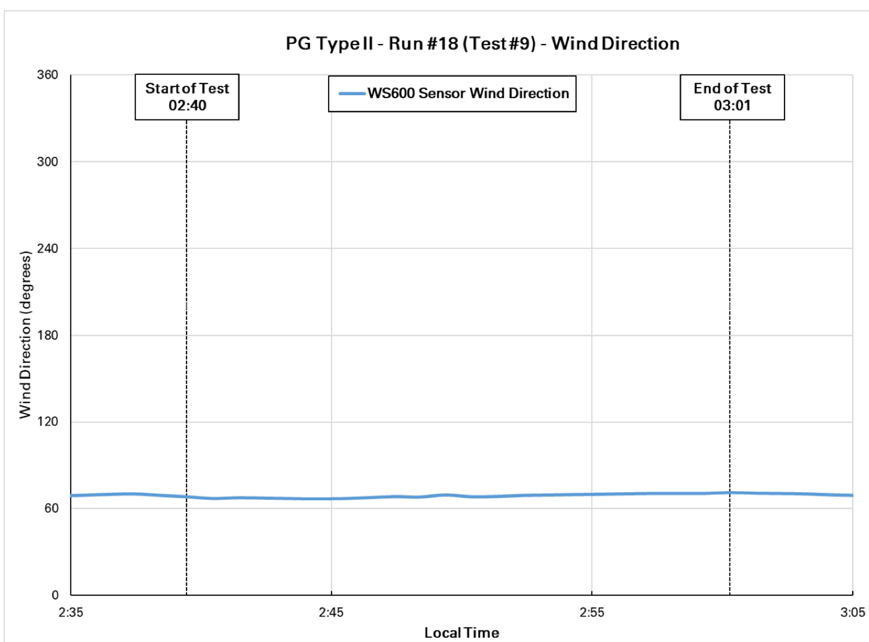
DATA PACKAGE – PG TYPE II – RUN 18 (TEST 9)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 18 - Test 9/Data Package - PG Type II - Run 18 - Test 9.docx
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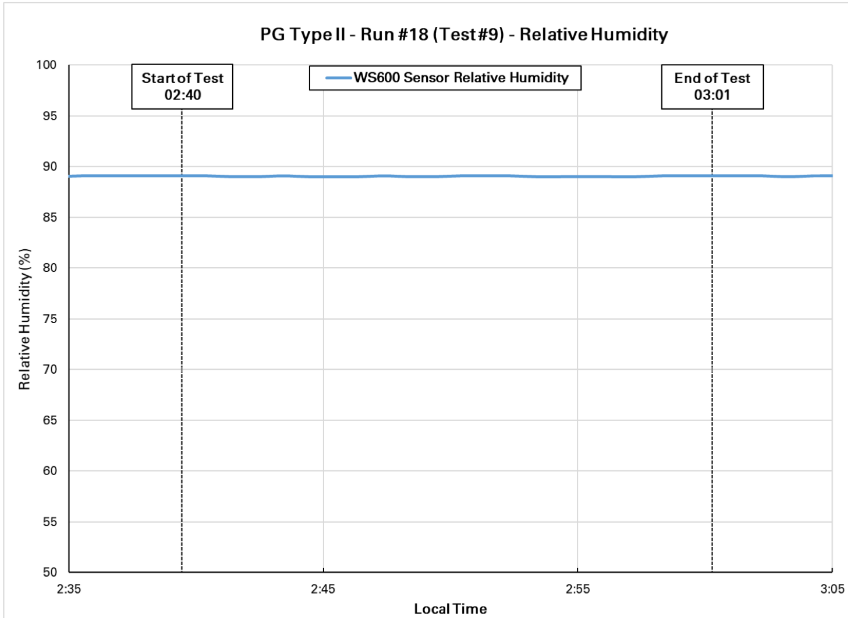
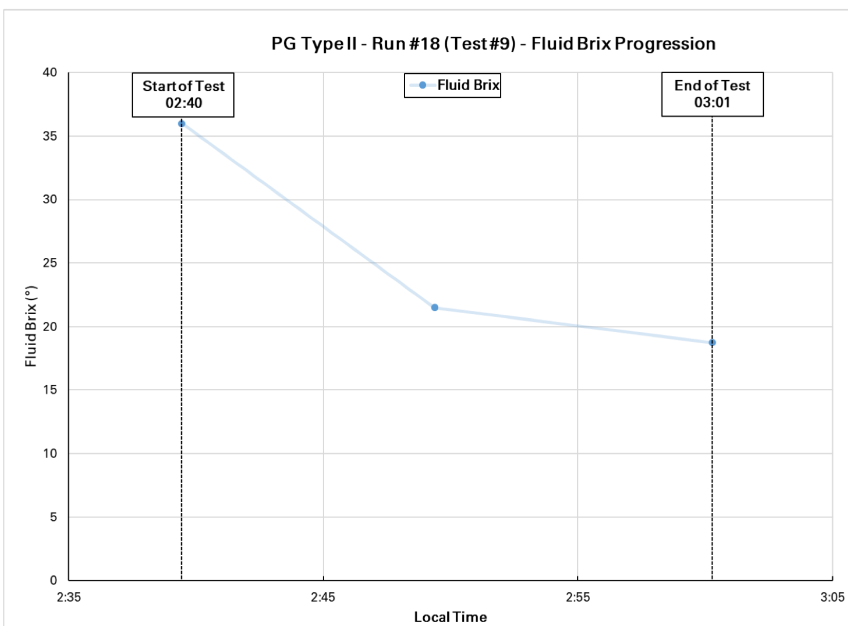
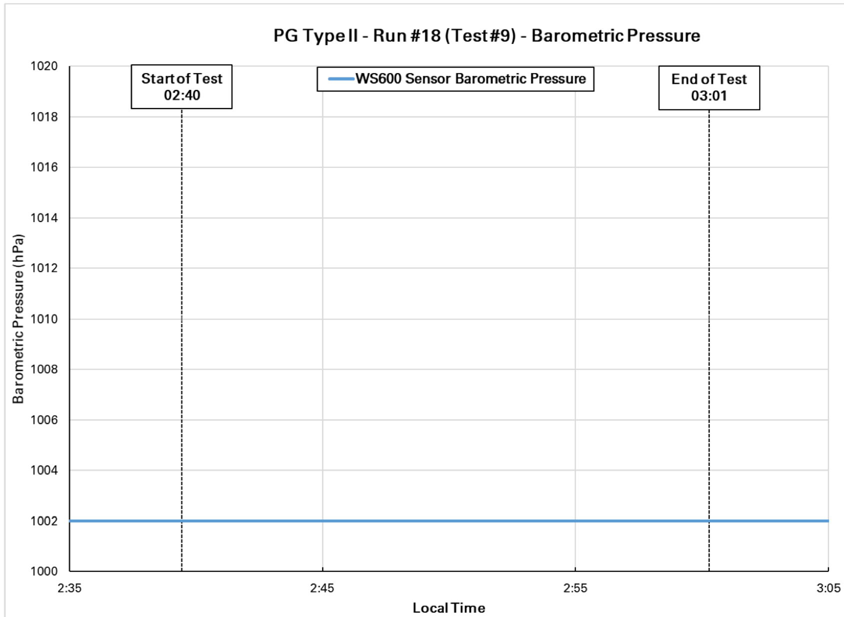

PG Type II - Run #18 (Test #9) - Relative Humidity
Start of Test 02:40
WS600 Sensor Relative Humidity
End of Test 03:01
100
95
90
85
80
75
70
65
60
55
50
Relative Humidity (%)
2:35
2:45
2:55
3:05
Local Time


PG Type II - Run #18 (Test #9) - Fluid Brix Progression
Start of Test 02:40
Fluid Brix
End of Test 03:01
40
35
30
25
20
15
10
5
0
Fluid Brix (°)
2:35
2:45
2:55
3:05
Local Time

DATA PACKAGE – PG TYPE II – RUN 18 (TEST 9)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 18 - Test 9/Data Package - PG Type II - Run 18 - Test 9.docx
Final Version 1.0, February 2021

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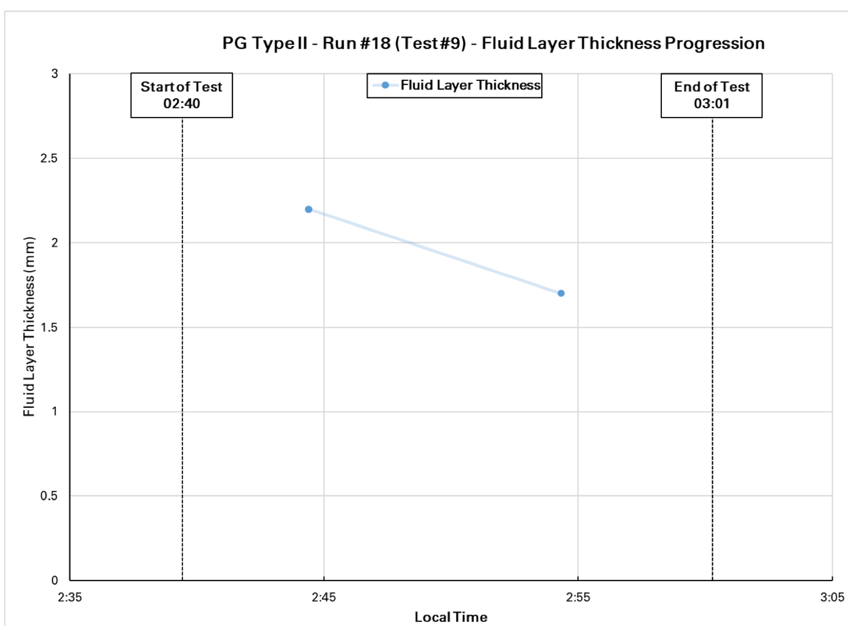
DATA PACKAGE – PG TYPE II – RUN 18 (TEST 9)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 18 - Test 9/Data Package - PG Type II - Run 18 - Test 9.docx
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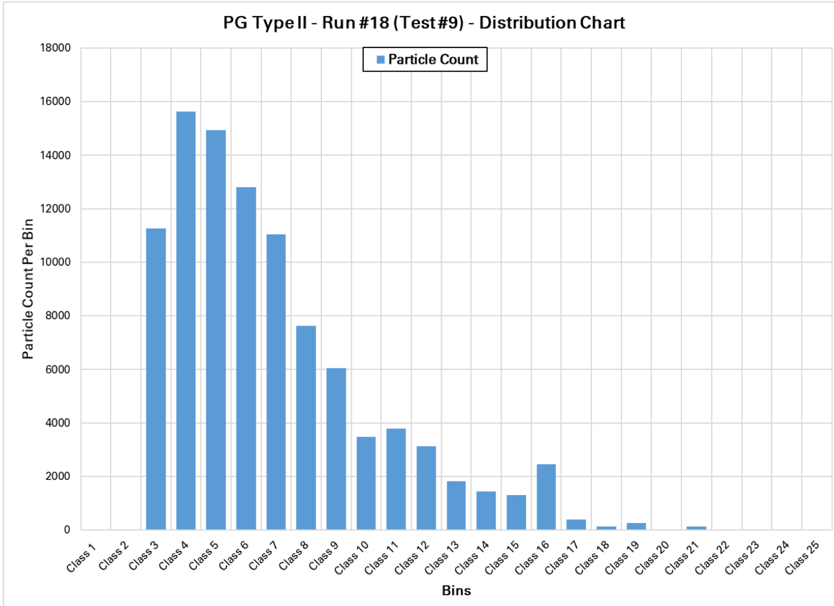
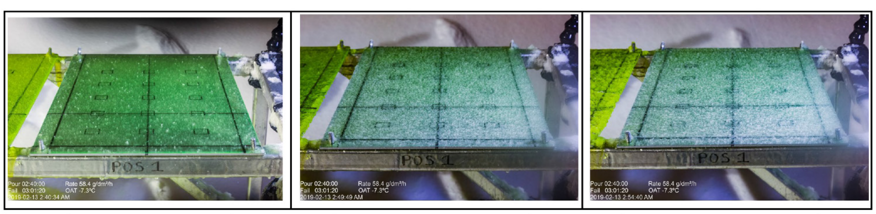
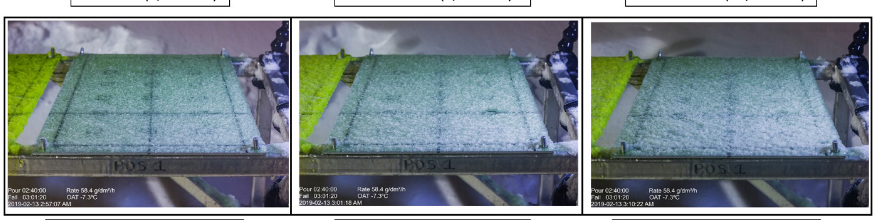


Safewing MP II FLIGHT – Run 18 (Test 9) – Failure Progression Photos



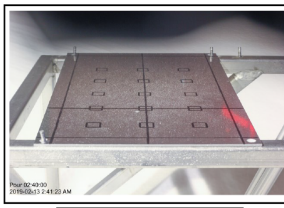
AT POUR (0/21 MIN) | PRE-FAILURE (9/21 MIN) | PRE-FAILURE (14/21 MIN)



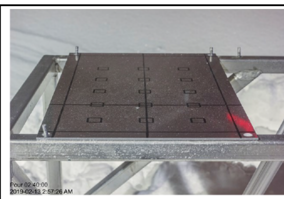
PRE-FAILURE (17/21 MIN) | AT FAILURE (21/21 MIN) | POST-FAILURE (30/21 MIN)

Safewing MP II FLIGHT – Run 18 (Test 9) – Snow Characteristics Photos

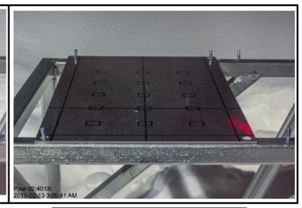
No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)



BARE PLATE (1/21 MIN)



BARE PLATE 17/21 MIN)



BARE PLATE (25/21 MIN)

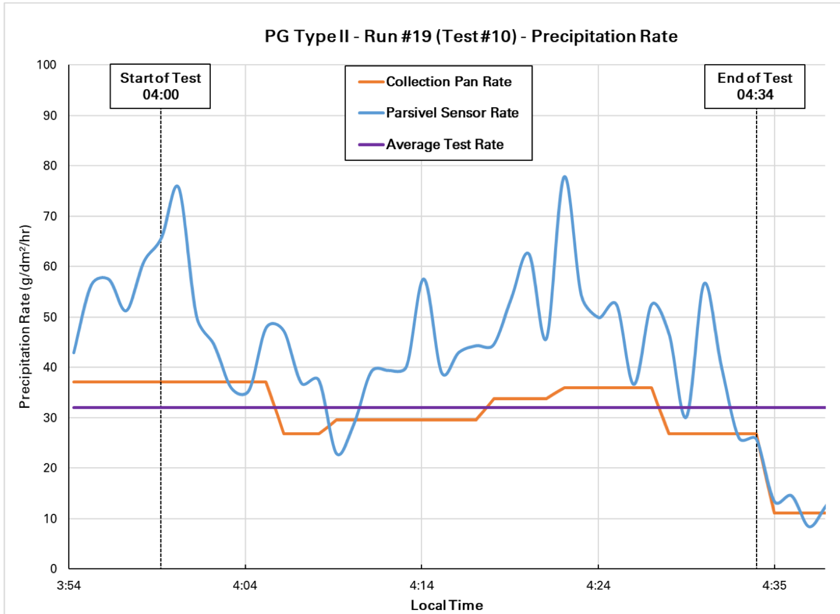
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

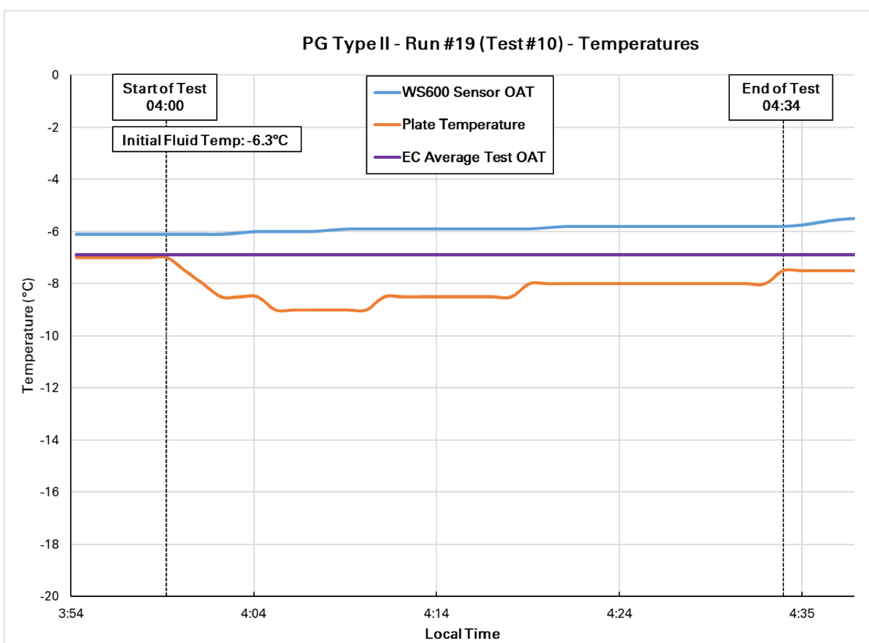
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #19 (TEST #10) PG2-10

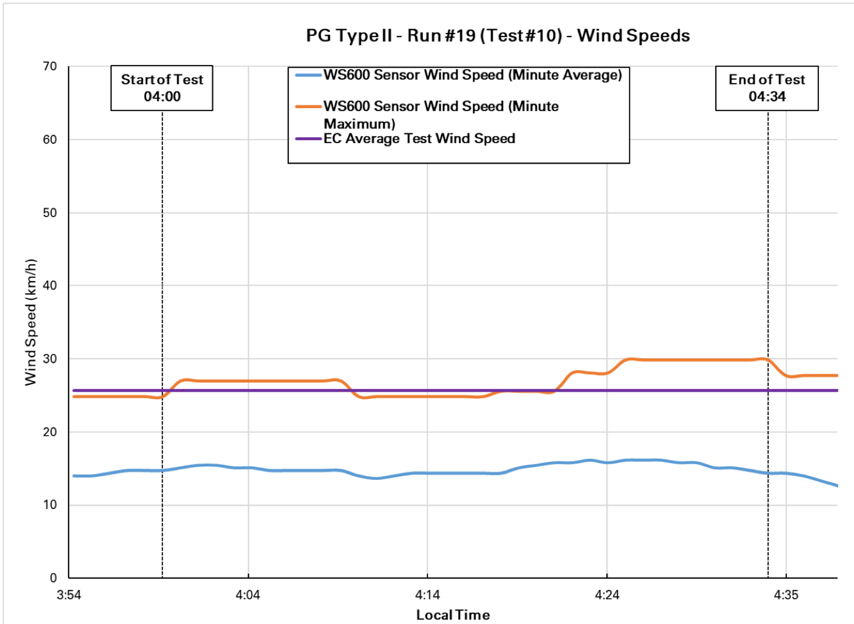
PG Type II – Run #19 (Test #10) – General Test Information

Test Number:	**PG2-10**
Date of Test:	**February 13, 2019**
Average OAT:	**-6.9**
Average Precipitation Rate:	**32.1 g/dm²/h**
Average Wind Speed:	**25.7 km/h**
Average Relative Humidity:	**89.5%**
Pour Time (Local):	**04:00:00**
Time of Fluid Failure (Local):	**04:34:00**
Fluid Brix at Failure:	**15.75°**
Endurance Time:	**34 minutes**
Expected Regression-Derived Endurance Time:	**33.1 minutes**
Difference (ET vs. Reg ET):	**+1.3 minutes (+4%)**


PG Type II - Run #19 (Test #10) - Precipitation Rate
Start of Test 04:00
End of Test 04:34
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
100
90
80
70
60
50
40
30
20
10
0
3:54
4:04
4:14
4:24
4:35
Local Time


PG Type II - Run #19 (Test #10) - Temperatures
Start of Test 04:00
Initial Fluid Temp: -6.3°C
End of Test 04:34
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:54
4:04
4:14
4:24
4:35
Local Time

DATA PACKAGE – PG TYPE II – RUN 19 (TEST 10)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 19 - Test 10/Data Package - PG Type II - Run 19 - Test 10.docx
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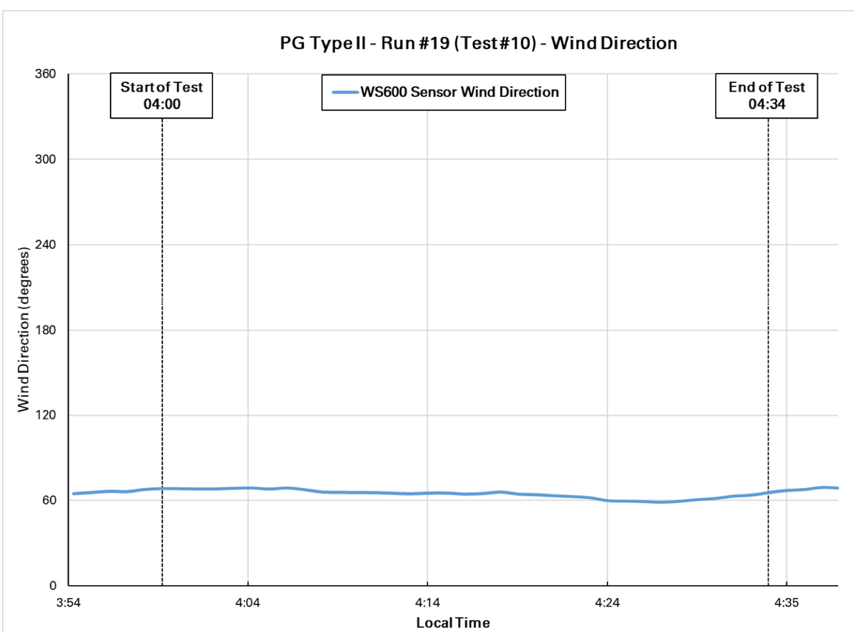
DATA PACKAGE – PG TYPE II – RUN 19 (TEST 10)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 19 - Test 10/Data Package - PG Type II - Run 19 - Test 10.docx
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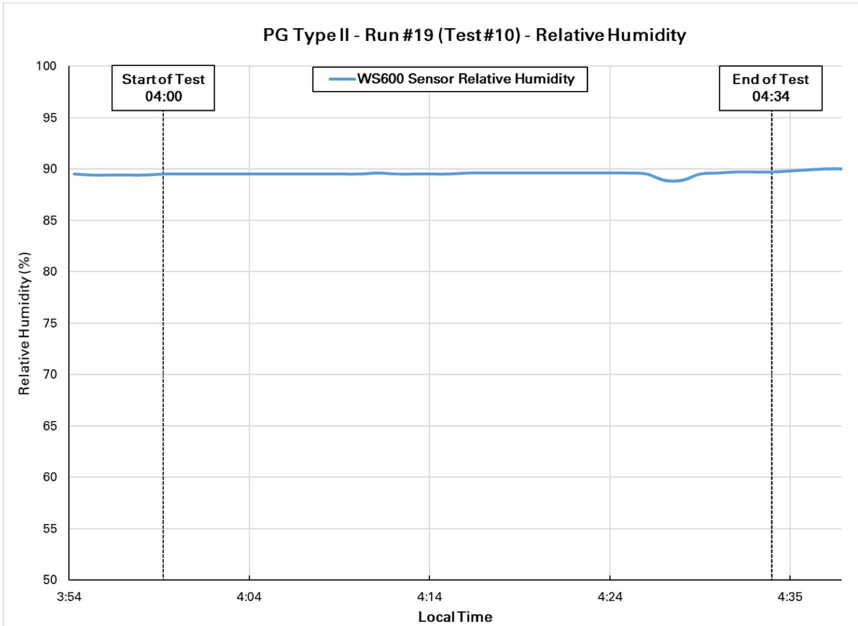
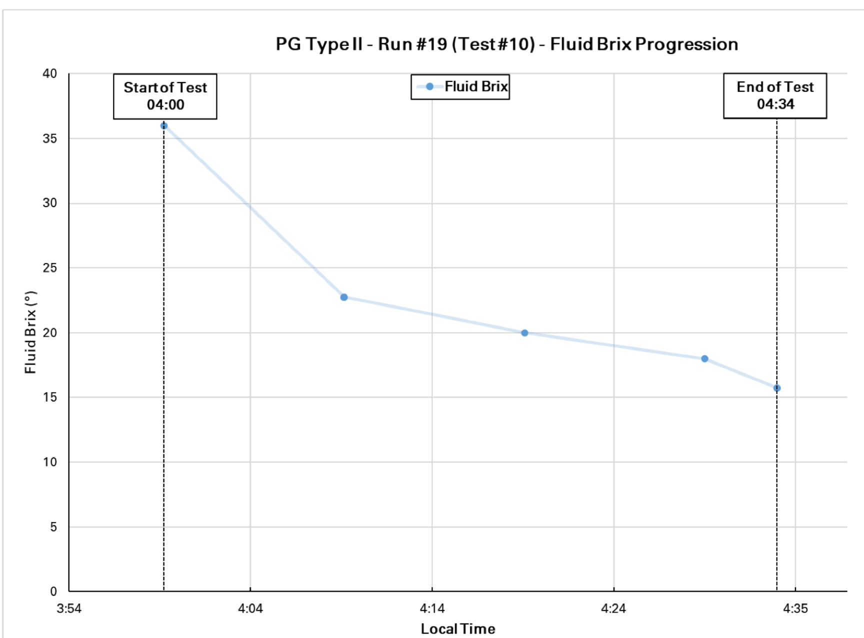
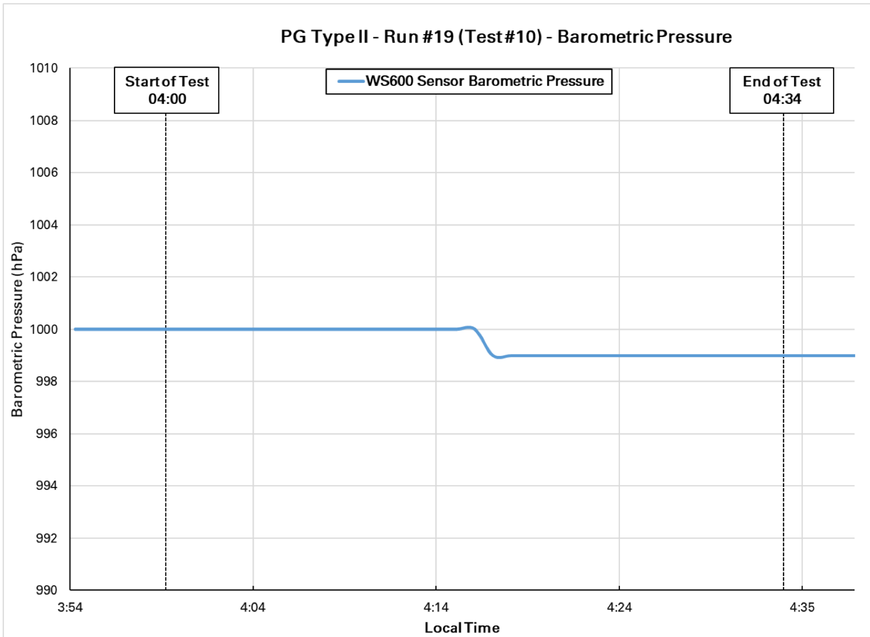
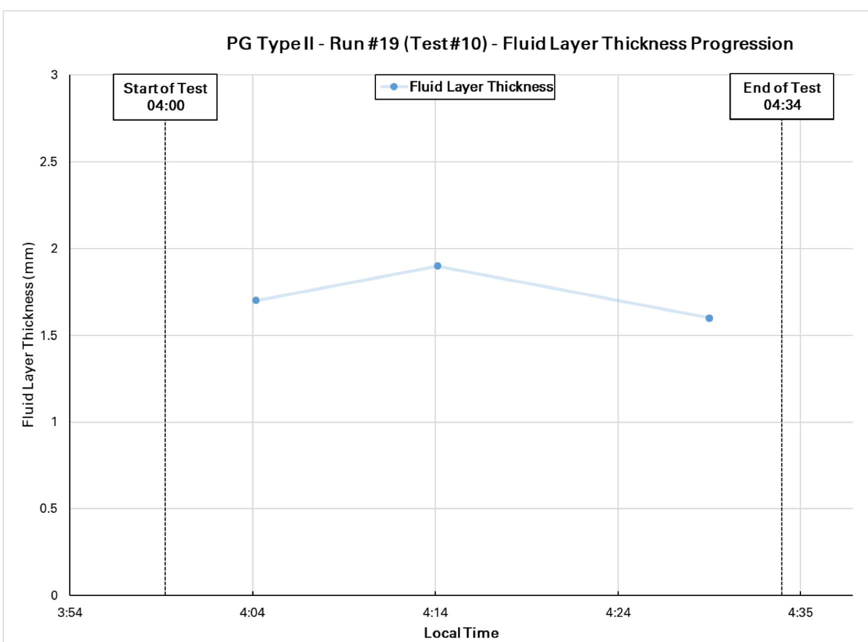


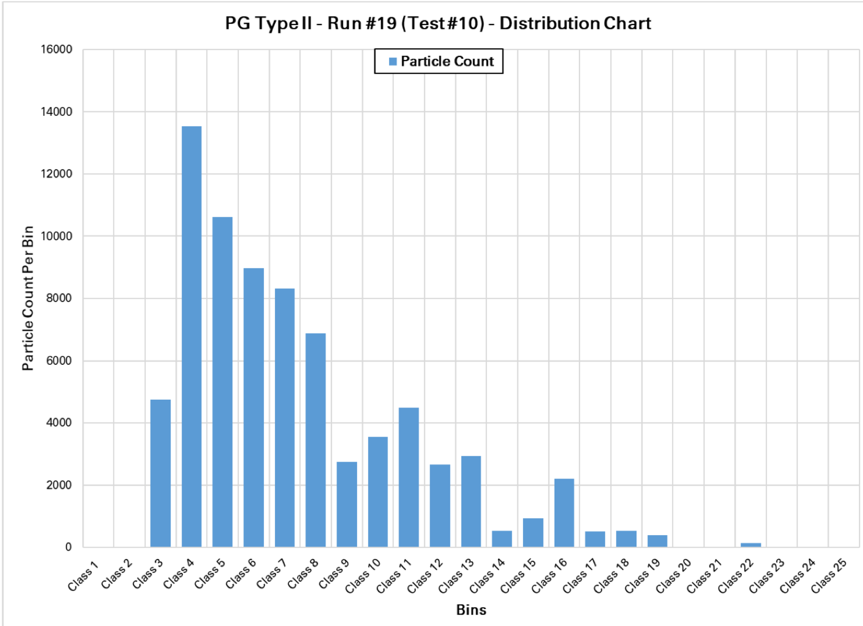
DATA PACKAGE – PG TYPE II – RUN 19 (TEST 10)



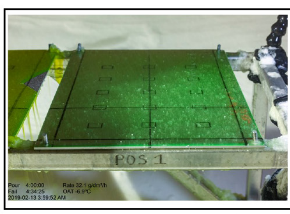


DATA PACKAGE – PG TYPE II – RUN 19 (TEST 10)

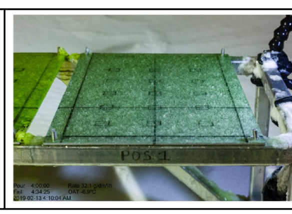




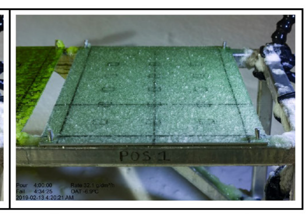
Safewing MP II FLIGHT – Run 19 (Test 10) – Failure Progression Photos



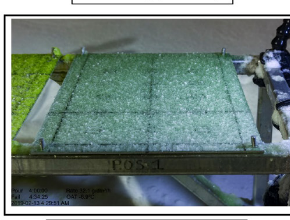
AT POUR (0/34 MIN)



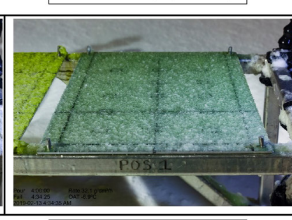
PRE-FAILURE (10/34 MIN)



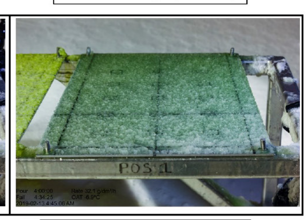
PRE-FAILURE (20/34 MIN)



PRE-FAILURE (29/34 MIN)

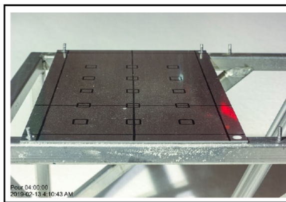
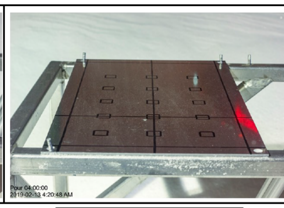
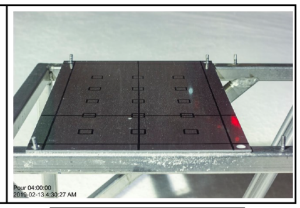


AT FAILURE (34/34 MIN)



POST-FAILURE (45/34 MIN)

Safewing MP II FLIGHT – Run 19 (Test 10) – Snow Characteristics Photos

No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (10/34 MIN)	BARE PLATE 20/34 MIN)	BARE PLATE (30/34 MIN)

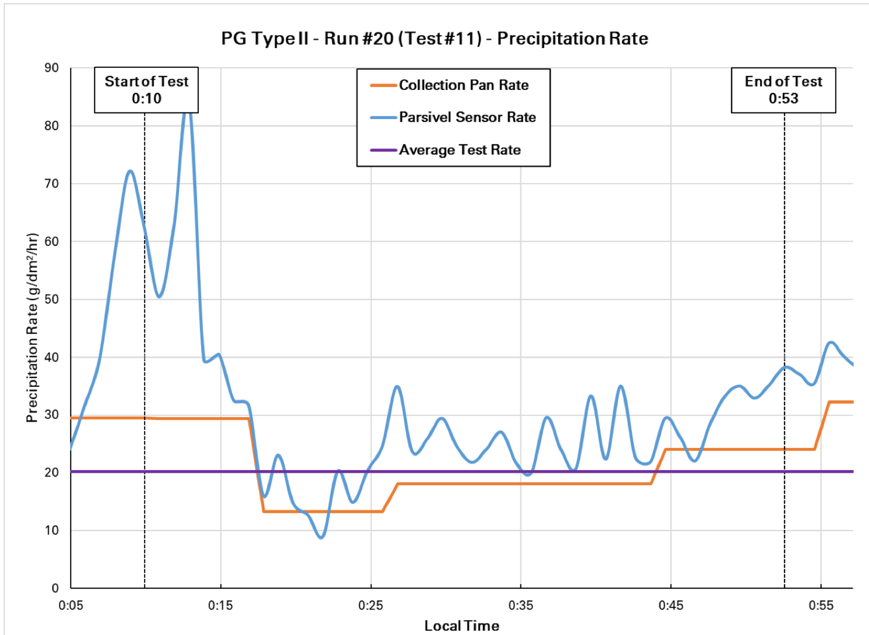
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

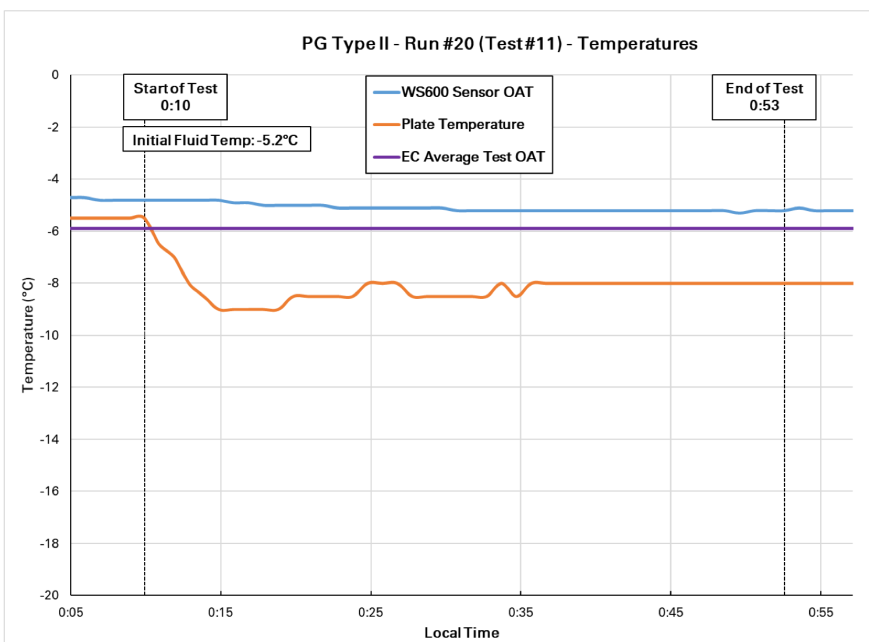
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

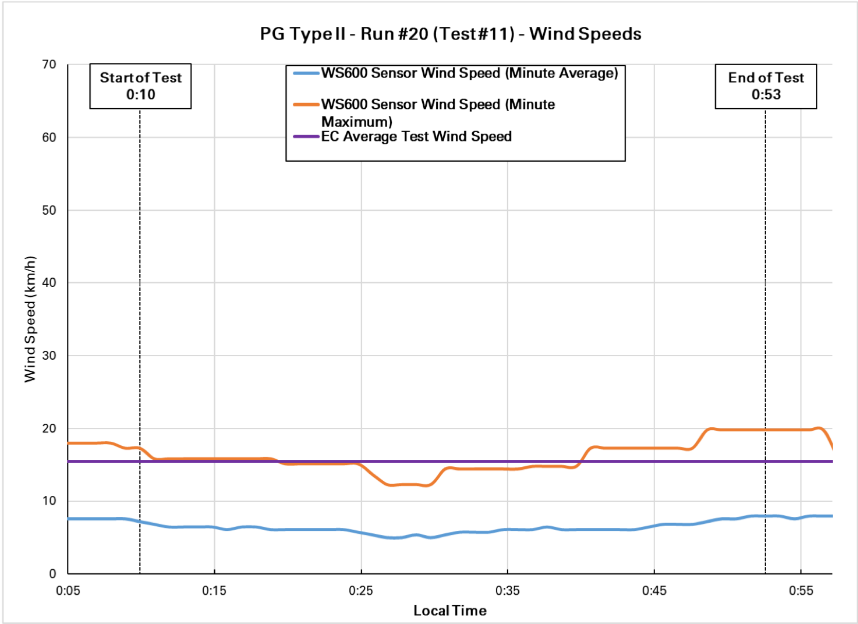
PG TYPE II
RUN #20 (TEST #11) PG2-11

PG Type II – Run #20 (Test #11) – General Test Information

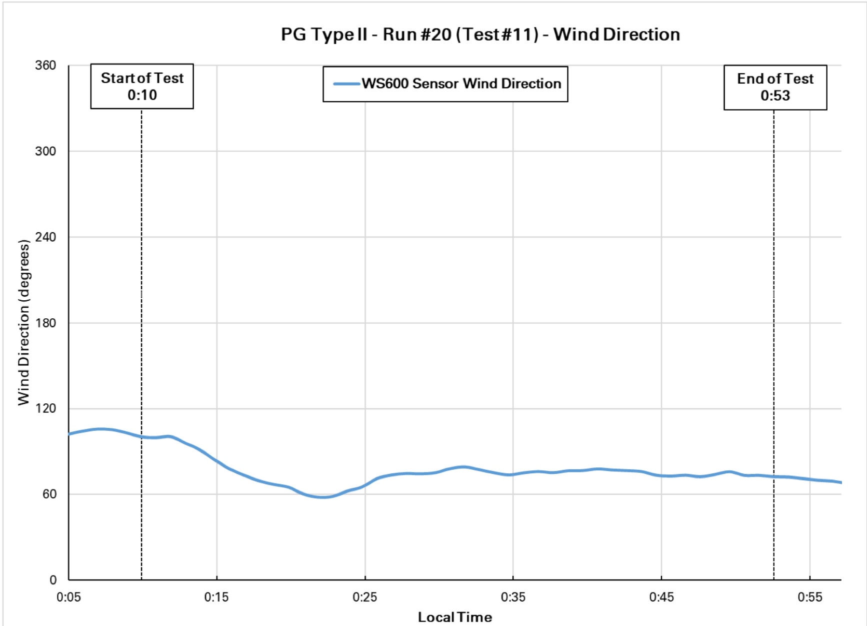
Test Number:	**PG2-11**
Date of Test:	**February 21, 2019**
Average OAT:	**-5.9**
Average Precipitation Rate:	**20.2 g/dm²/h**
Average Wind Speed:	**15.5 km/h**
Average Relative Humidity:	**85.1%**
Pour Time (Local):	**00:10:00**
Time of Fluid Failure (Local):	**00:53:00**
Fluid Brix at Failure:	**14°**
Endurance Time:	**43 minutes**
Expected Regression-Derived Endurance Time:	**51.7 minutes**
Difference (ET vs. Reg ET):	**-8.7 minutes (-16.8%)**

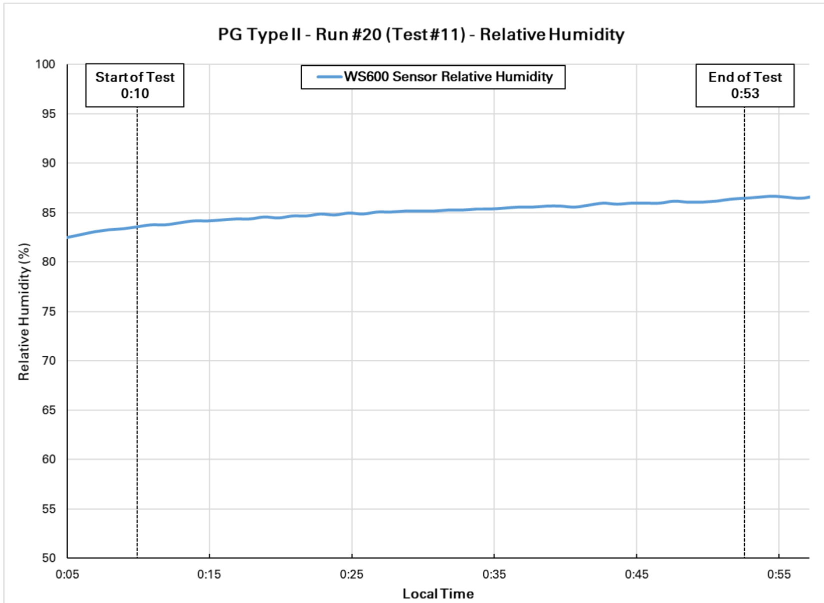

PG Type II - Run #20 (Test #11) - Precipitation Rate
Start of Test 0:10
End of Test 0:53
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
Local Time
0:05
0:15
0:25
0:35
0:45
0:55

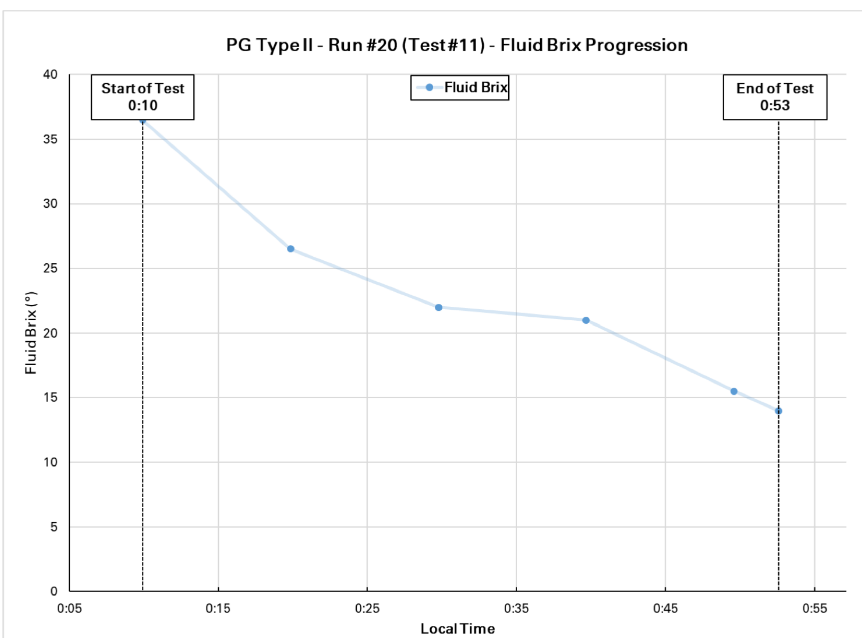

PG Type II - Run #20 (Test #11) - Temperatures
Start of Test 0:10
Initial Fluid Temp: -5.2°C
End of Test 0:53
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
Local Time
0:05
0:15
0:25
0:35
0:45
0:55

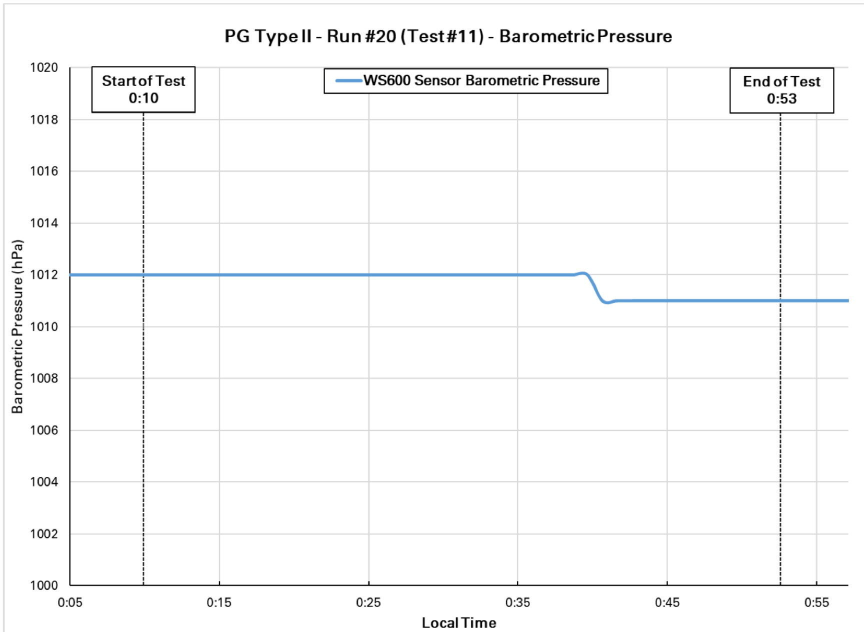


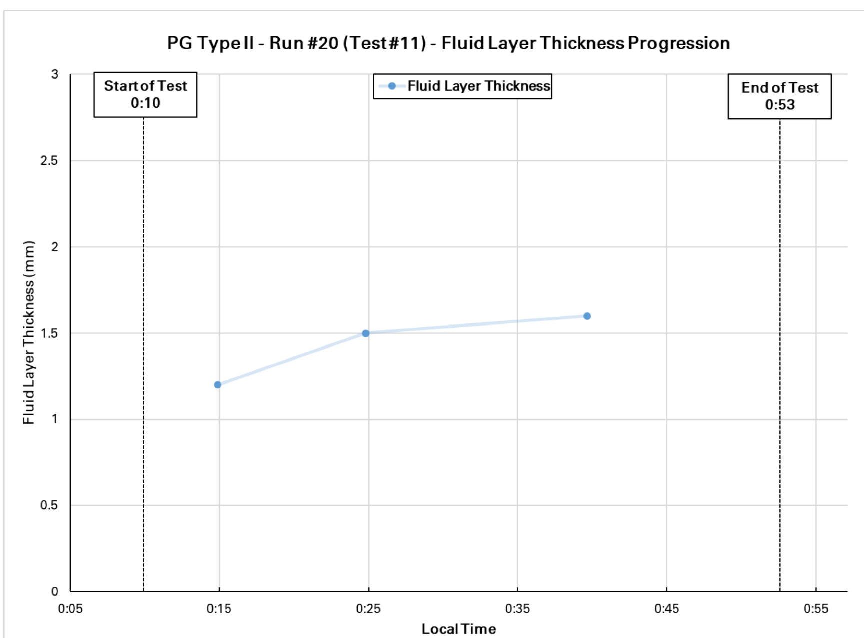
DATA PACKAGE – PG TYPE II – RUN 20 (TEST 11)

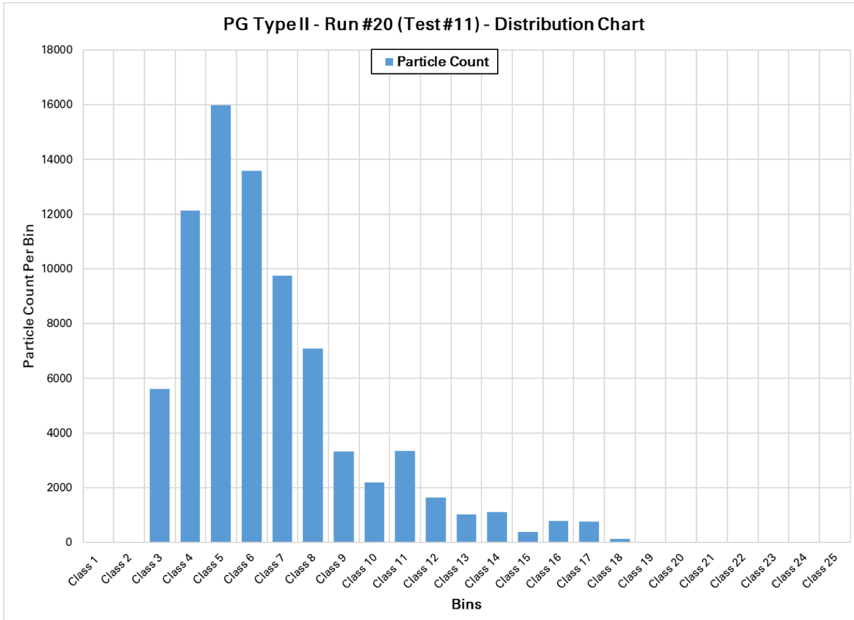



PG Type II - Run #20 (Test #11) - Relative Humidity
Start of Test 0:10
WS600 Sensor Relative Humidity
End of Test 0:53
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
0:05
0:15
0:25
0:35
0:45
0:55
Local Time

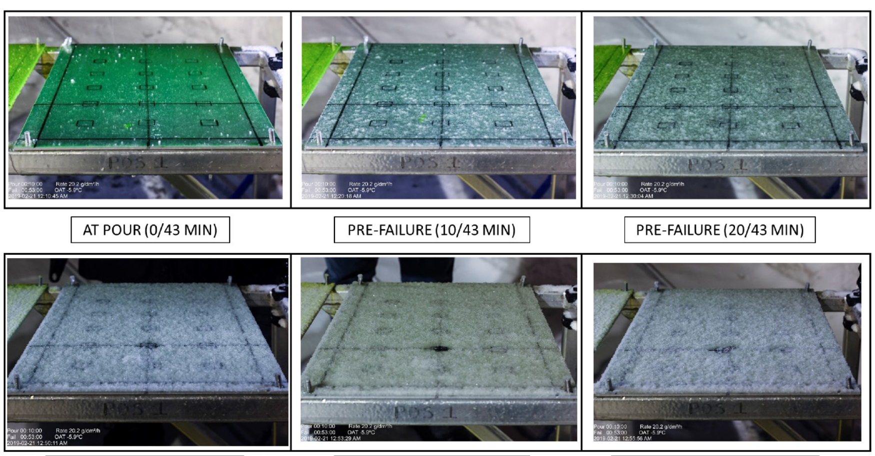

PG Type II - Run #20 (Test #11) - Fluid Brix Progression
Start of Test 0:10
Fluid Brix
End of Test 0:53
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
0:05
0:15
0:25
0:35
0:45
0:55
Local Time


PG Type II - Run #20 (Test #11) - Barometric Pressure
Start of Test 0:10
WS600 Sensor Barometric Pressure
End of Test 0:53
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
0:05
0:15
0:25
0:35
0:45
0:55
Local Time


PG Type II - Run #20 (Test #11) - Fluid Layer Thickness Progression
Start of Test 0:10
Fluid Layer Thickness
End of Test 0:53
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
0:05
0:15
0:25
0:35
0:45
0:55
Local Time



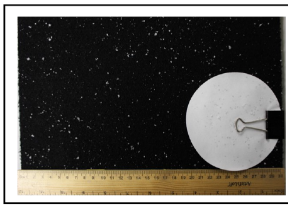
Safewing MP II FLIGHT – Run 20 (Test 11) – Failure Progression Photos



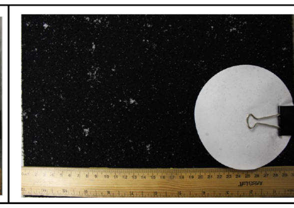
AT POUR (0/43 MIN) | PRE-FAILURE (10/43 MIN) | PRE-FAILURE (20/43 MIN)

PRE-FAILURE (40/43 MIN) | AT FAILURE (43/43 MIN) | POST-FAILURE (45/43 MIN)

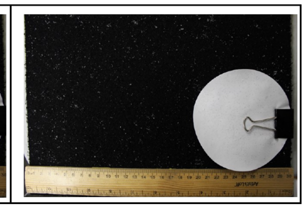
Safewing MP II FLIGHT – Run 20 (Test 11) – Snow Characteristics Photos



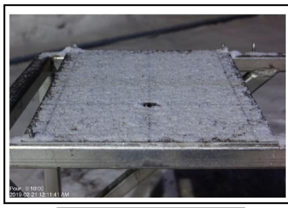
FELT PAD (0/43 MIN)



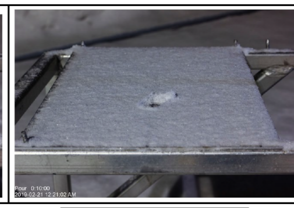
FELT PAD (19/43 MIN)



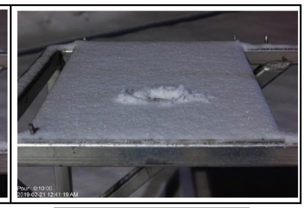
FELT PAD (39/43 MIN)



BARE PLATE (1/43 MIN)



BARE PLATE 11/43 MIN)



BARE PLATE (31/43 MIN)

Final Bare Plate Contamination Thickness: **1.25 mm**

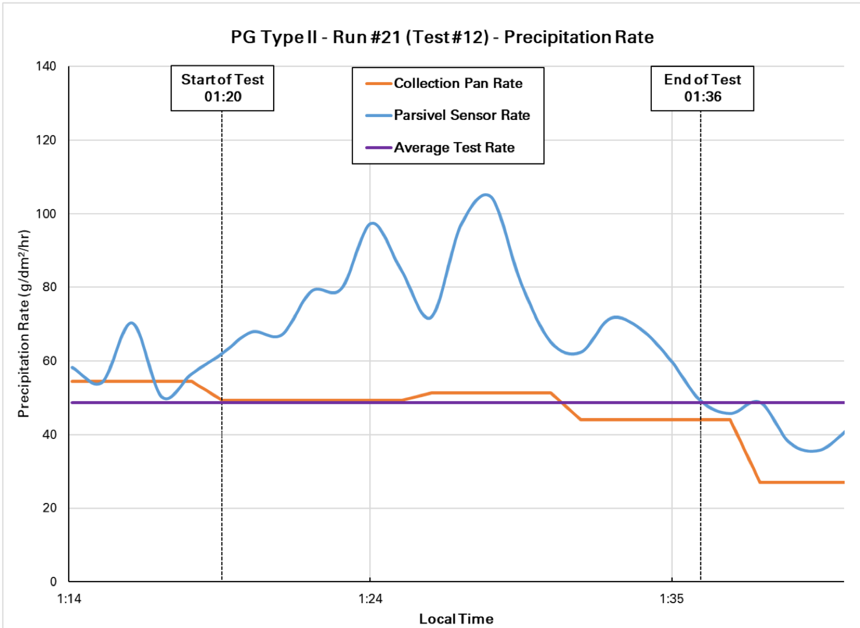
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #21 (TEST #12) - PG2-12

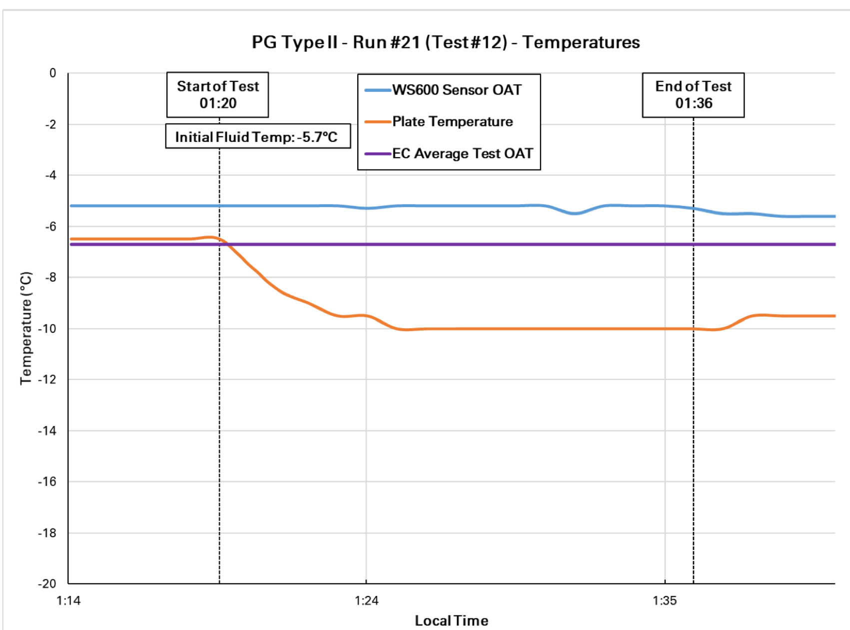
DATA PACKAGE – PG TYPE II – RUN 21 (TEST 12)

PG Type II – Run #21 (Test #12) – General Test Information

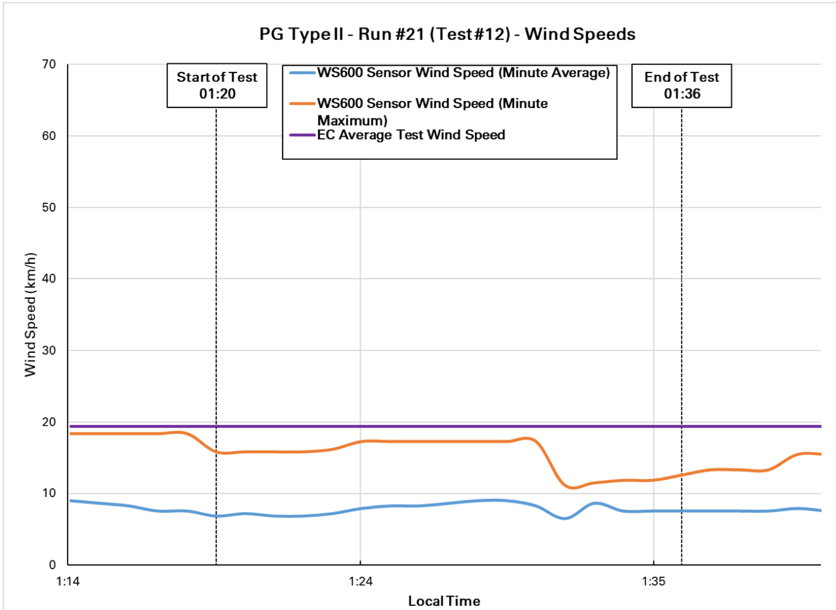
Test Number:	PG2-12
Date of Test:	February 21, 2019
Average OAT:	-6.7
Average Precipitation Rate:	48.6 g/dm²/h
Average Wind Speed:	19.4 km/h
Average Relative Humidity:	87.7%
Pour Time (Local):	01:20:00
Time of Fluid Failure (Local):	01:36:00
Fluid Brix at Failure:	17.5°
Endurance Time:	16 minutes
Expected Regression-Derived Endurance Time:	23.9 minutes
Difference (ET vs. Reg ET):	-7.9 minutes (-33.1%)



DATA PACKAGE – PG TYPE II – RUN 21 (TEST 12)



DATA PACKAGE – PG TYPE II – RUN 21 (TEST 12)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 21 - Test 12/Data Package - PG Type II - Run 21 - Test 12.docx
Final Version 1.0, February 2021

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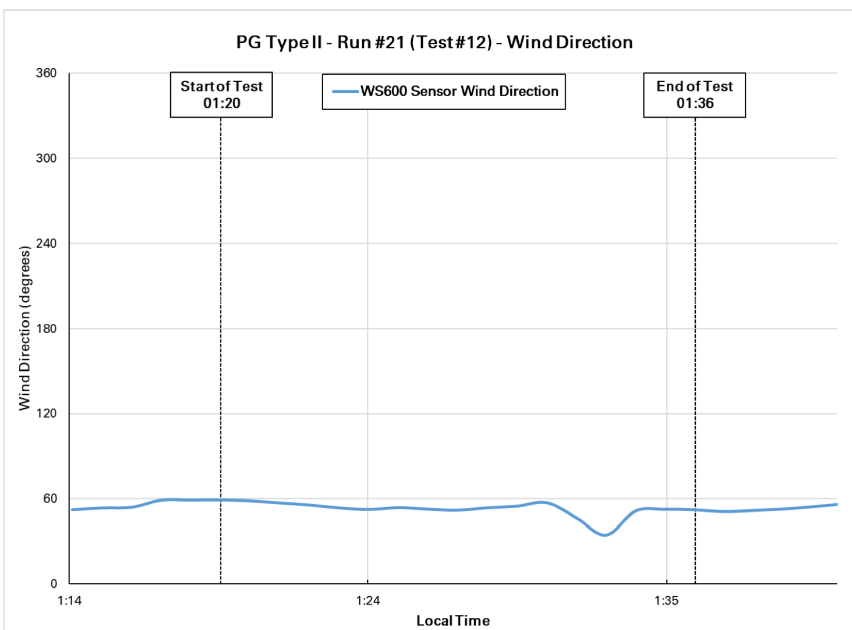
DATA PACKAGE – PG TYPE II – RUN 21 (TEST 12)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 21 - Test 12/Data Package - PG Type II - Run 21 - Test 12.docx
Final Version 1.0, February 2021

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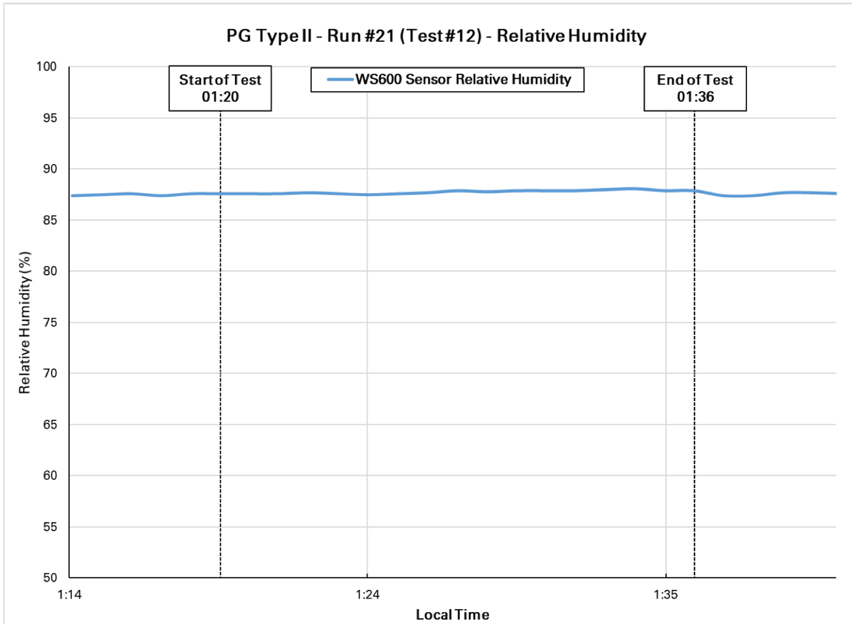
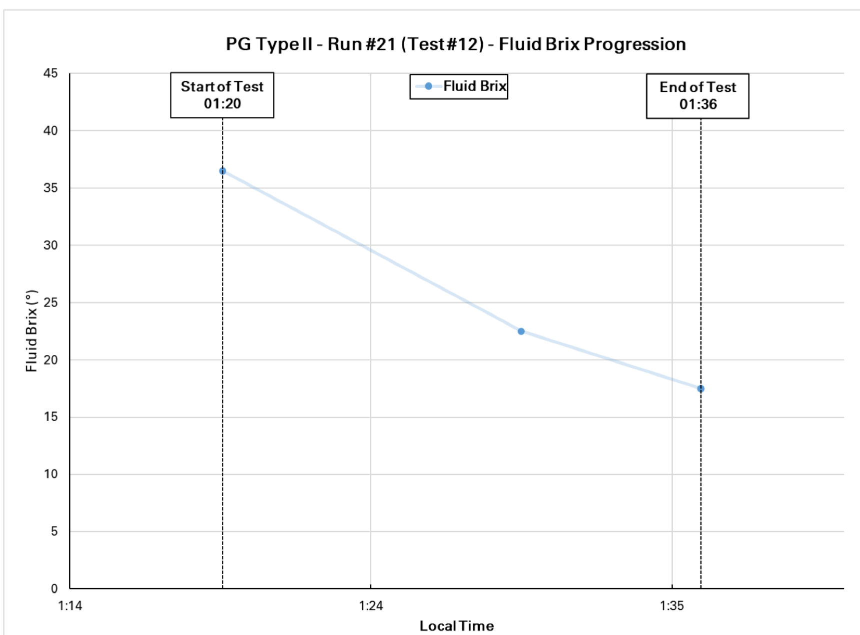
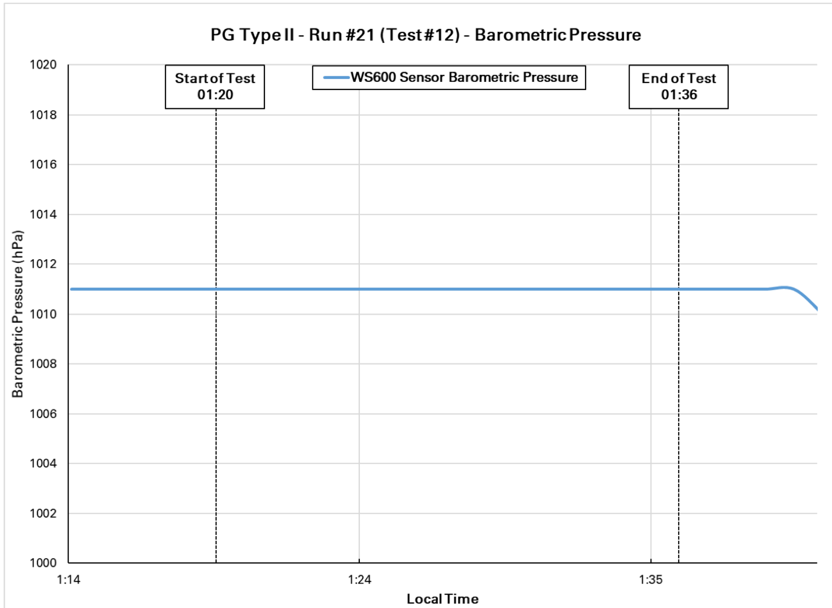
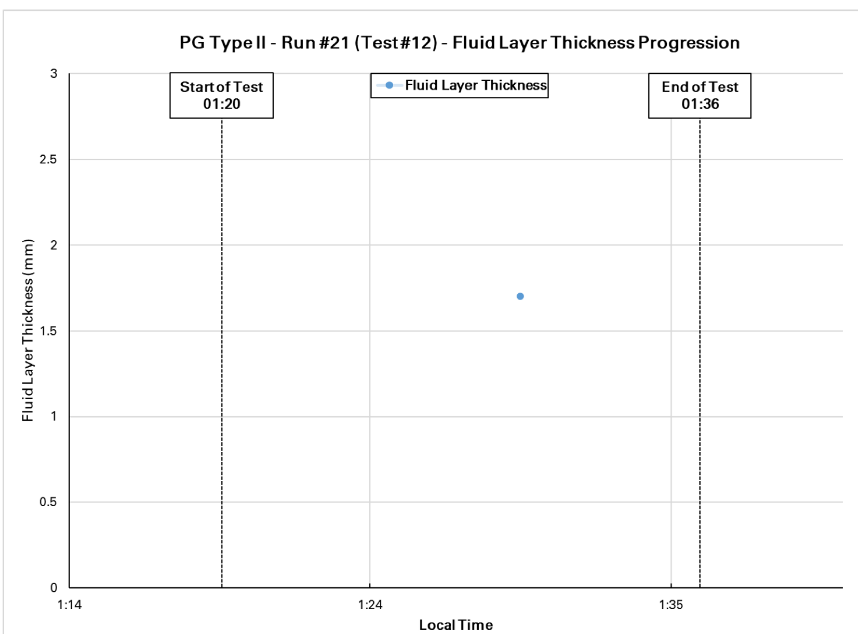
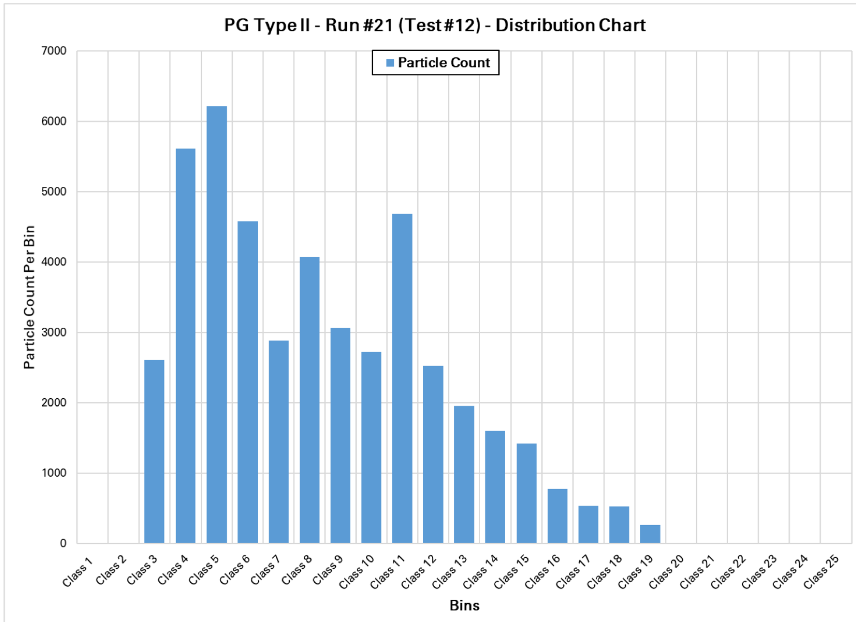

PG Type II - Run #21 (Test #12) - Relative Humidity
Start of Test 01:20
WS600 Sensor Relative Humidity
End of Test 01:36
100
95
90
85
80
75
70
65
60
55
50
Relative Humidity (%)
1:14
1:24
1:35
Local Time

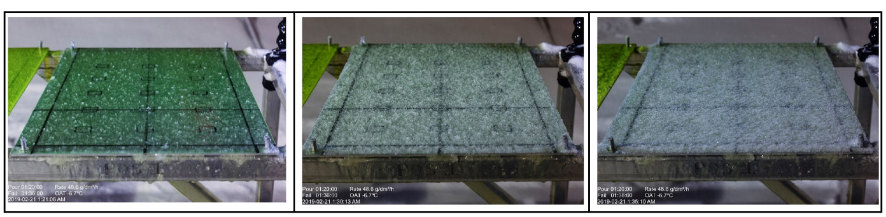

PG Type II - Run #21 (Test #12) - Fluid Brix Progression
Start of Test 01:20
Fluid Brix
End of Test 01:36
45
40
35
30
25
20
15
10
5
0
Fluid Brix (°)
1:14
1:24
1:35
Local Time


PG Type II - Run #21 (Test #12) - Barometric Pressure
Start of Test 01:20
WS600 Sensor Barometric Pressure
End of Test 01:36
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
Barometric Pressure (hPa)
1:14
1:24
1:35
Local Time

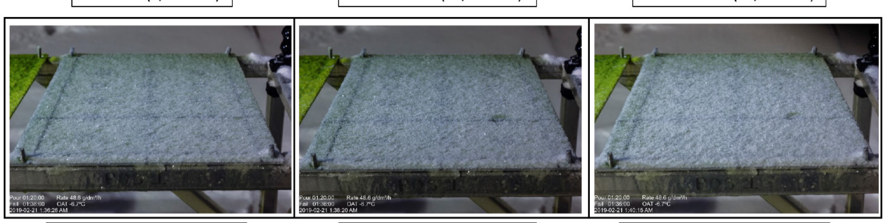

PG Type II - Run #21 (Test #12) - Fluid Layer Thickness Progression
Start of Test 01:20
Fluid Layer Thickness
End of Test 01:36
3
2.5
2
1.5
1
0.5
0
Fluid Layer Thickness (mm)
1:14
1:24
1:35
Local Time



Safewing MP II FLIGHT – Run 21 (Test 12) – Failure Progression Photos

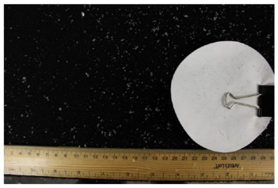


AT POUR (1/16 MIN) | PRE-FAILURE (10/16 MIN) | PRE-FAILURE (15/16 MIN)

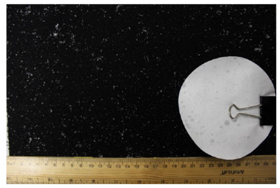


AT FAILURE (16/16 MIN) | POST-FAILURE (18/16 MIN) | POST-FAILURE (20/16 MIN)

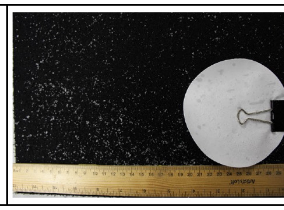
Safewing MP II FLIGHT – Run 21 (Test 12) – Snow Characteristics Photos



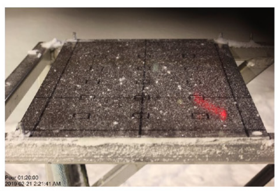
FELT PAD (0/16 MIN)



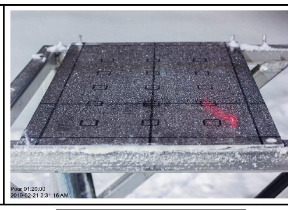
FELT PAD (4/16 MIN)



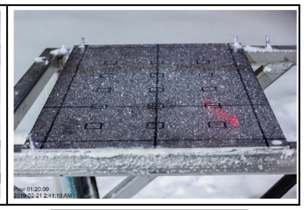
FELT PAD (10/16 MIN)



BARE PLATE (1/16 MIN)



BARE PLATE 11/16 MIN)



BARE PLATE (21/16 MIN)

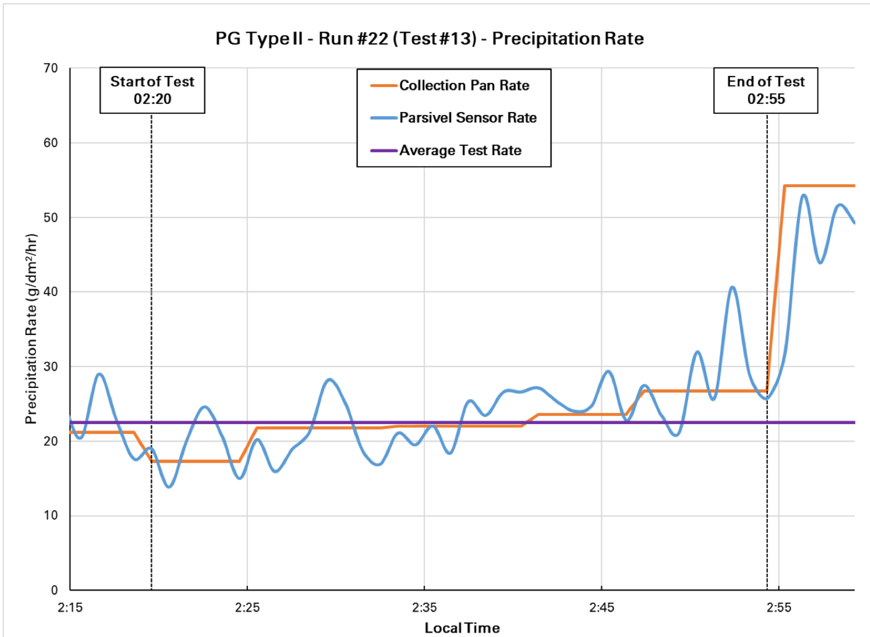
Final Bare Plate Contamination Thickness: **0.6mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

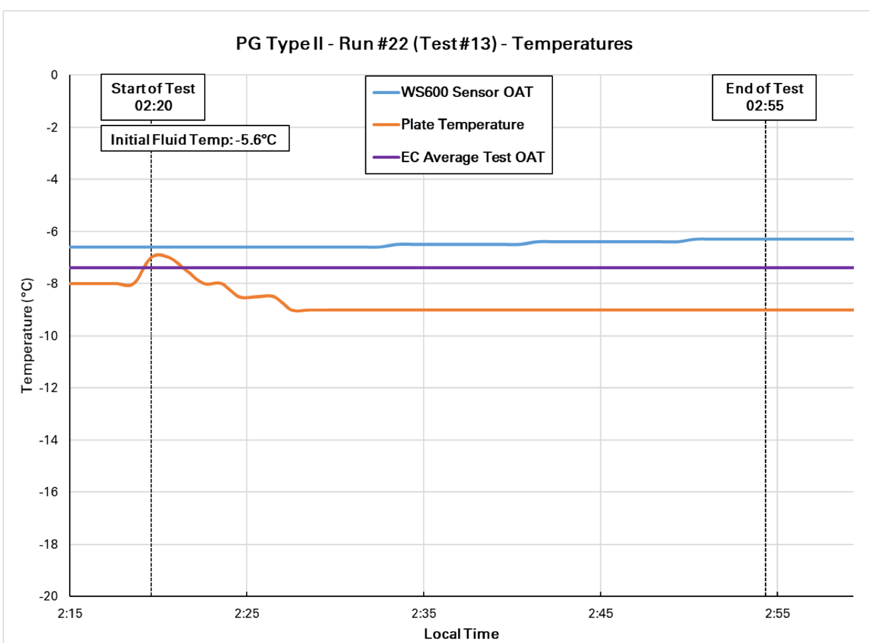
PG TYPE II
RUN #22 (TEST #13) – PG2-13

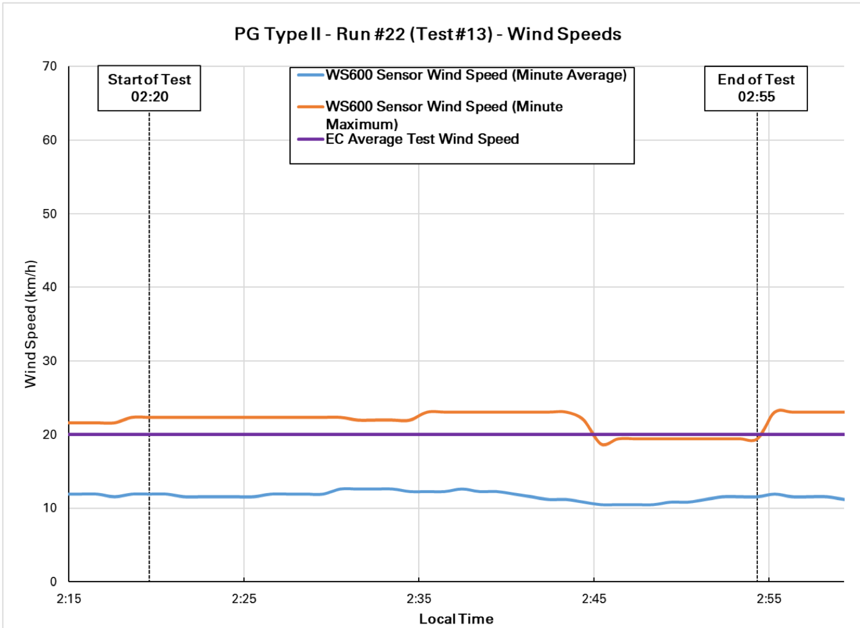
PG Type II – Run #22 (Test #13) – General Test Information

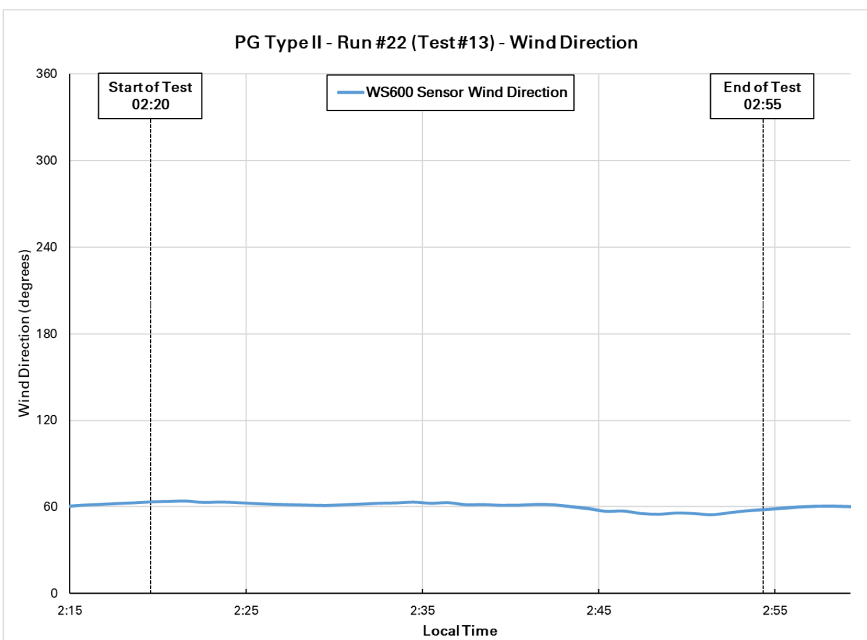
Test Number:	**PG2-13**
Date of Test:	**February 21, 2019**
Average OAT:	**-7.4**
Average Precipitation Rate:	**22.5 g/dm²/h**
Average Wind Speed:	**20 km/h**
Average Relative Humidity:	**87.6%**
Pour Time (Local):	**02:20:00**
Time of Fluid Failure (Local):	**02:55:00**
Fluid Brix at Failure:	**17.5°**
Endurance Time:	**35 minutes**
Expected Regression-Derived Endurance Time:	**43.1 minutes**
Difference (ET vs. Reg ET):	**-8.1 minutes (-18.8%)**

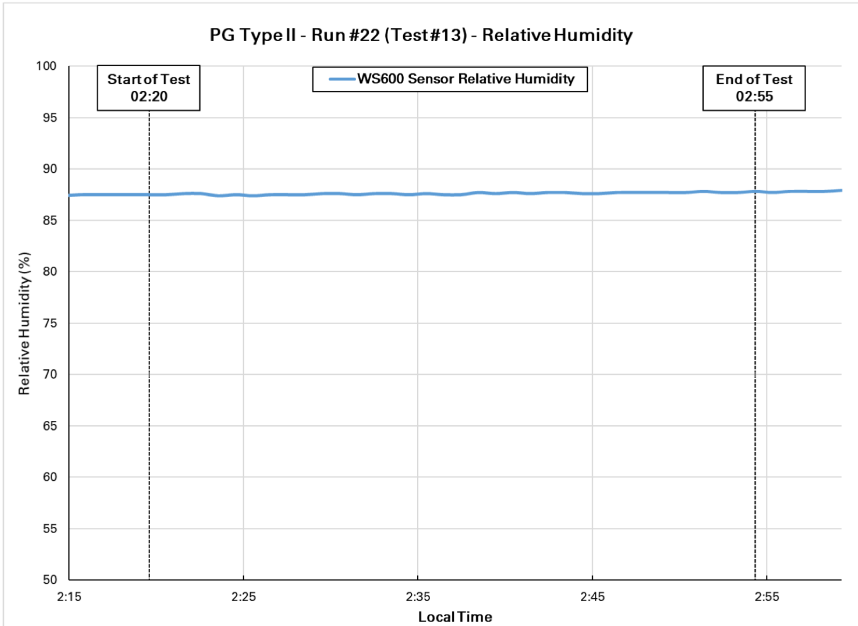


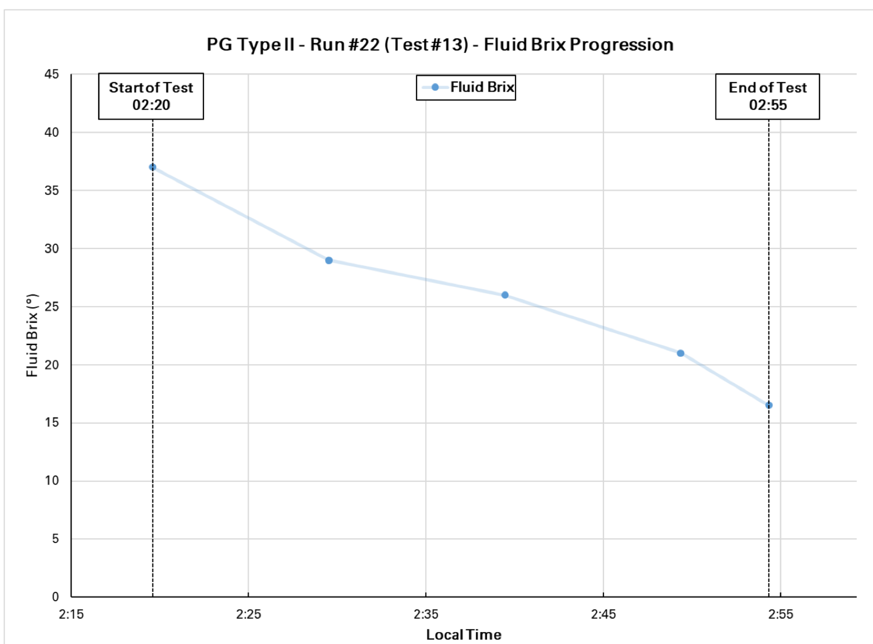
DATA PACKAGE – PG TYPE II – RUN 22 (TEST 13)

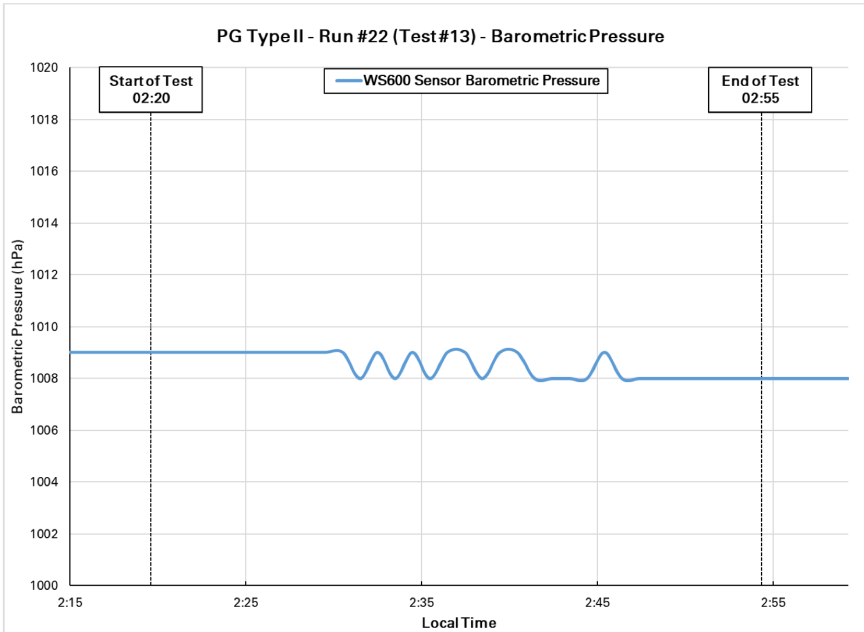


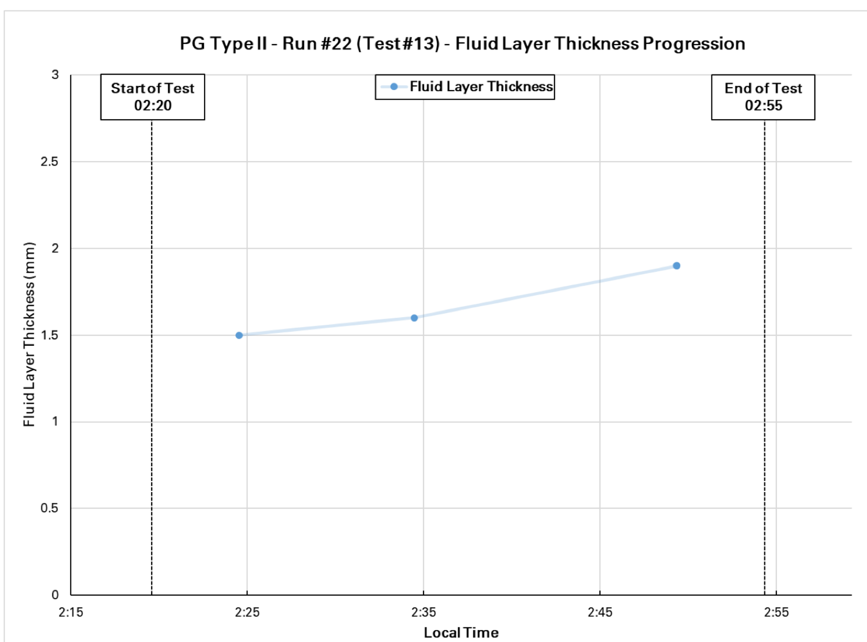

PG Type II - Run #22 (Test #13) - Wind Speeds
Start of Test
02:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test
02:55
Wind Speed (km/h)
0
10
20
30
40
50
60
70
2:15
2:25
2:35
2:45
2:55
Local Time

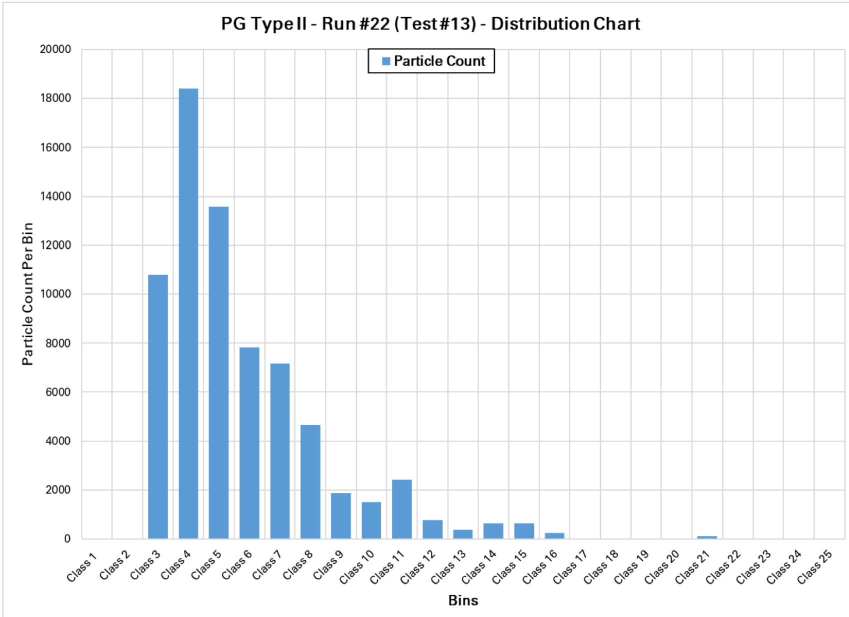

PG Type II - Run #22 (Test #13) - Wind Direction
Start of Test
02:20
WS600 Sensor Wind Direction
End of Test
02:55
Wind Direction (degrees)
0
60
120
180
240
300
360
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type II - Run #22 (Test #13) - Relative Humidity
Start of Test 02:20
WS600 Sensor Relative Humidity
End of Test 02:55
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type II - Run #22 (Test #13) - Fluid Brix Progression
Start of Test 02:20
Fluid Brix
End of Test 02:55
Fluid Brix (°)
45
40
35
30
25
20
15
10
5
0
2:15
2:25
2:35
2:45
2:55
Local Time

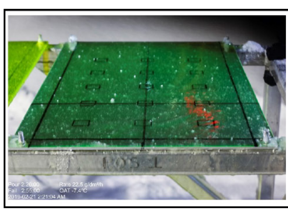

PG Type II - Run #22 (Test #13) - Barometric Pressure
Start of Test 02:20
WS600 Sensor Barometric Pressure
End of Test 02:55
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type II - Run #22 (Test #13) - Fluid Layer Thickness Progression
Start of Test 02:20
Fluid Layer Thickness
End of Test 02:55
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
2:15
2:25
2:35
2:45
2:55
Local Time

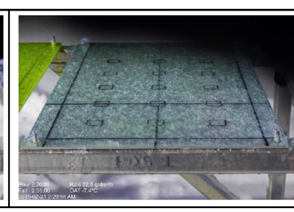


DATA PACKAGE – PG TYPE II – RUN 22 (TEST 13)

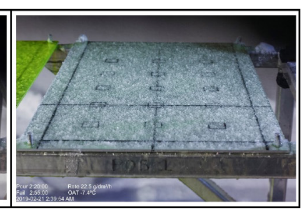
Safewing MP II FLIGHT – Run 22 (Test 13) – Failure Progression Photos



AT POUR (1/35 MIN)

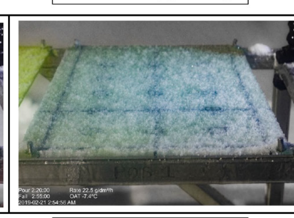


PRE-FAILURE (9/35 MIN)



PRE-FAILURE (19/35 MIN)

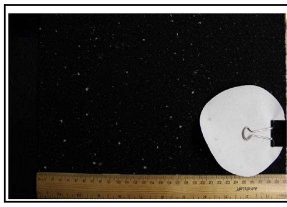
PRE-FAILURE (29/35 MIN)



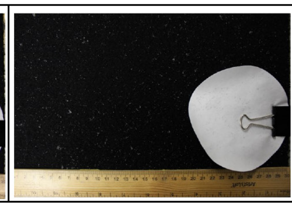
AT FAILURE (35/35 MIN)

POST-FAILURE (40/35 MIN)

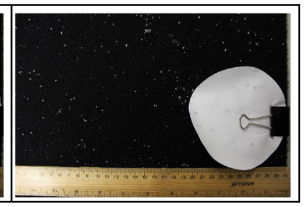
Safewing MP II FLIGHT – Run 22 (Test 13) – Snow Characteristics Photos



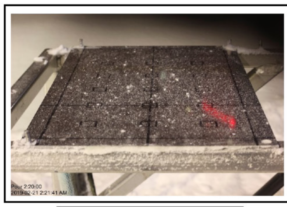
FELT PAD (0/35 MIN)



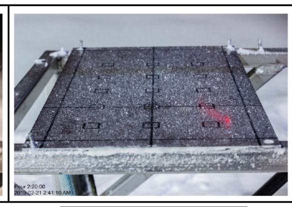
FELT PAD (9/35 MIN)



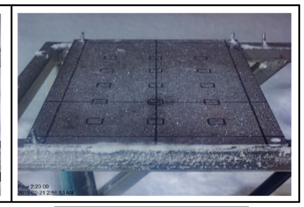
FELT PAD (30/35 MIN)



BARE PLATE (1/35 MIN)



BARE PLATE (21/35 MIN)



BARE PLATE (36/35 MIN)

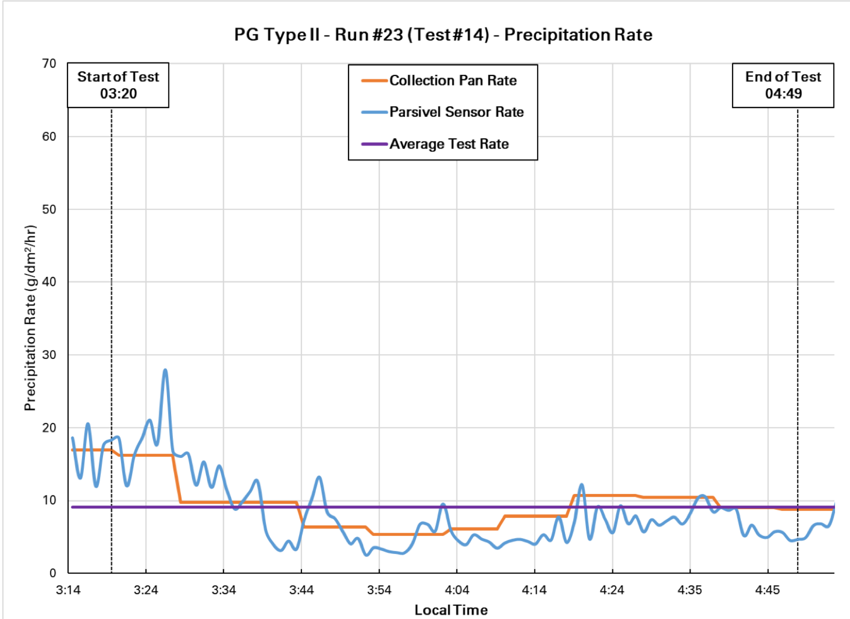
Final Bare Plate Contamination Thickness: **0.4mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

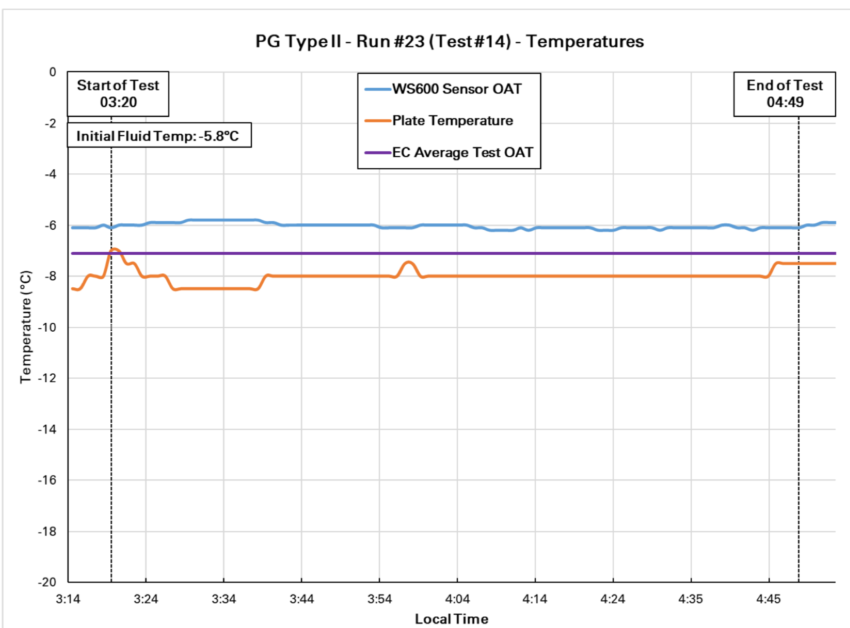
PG TYPE II
RUN #23 – (TEST #14) PG2-14

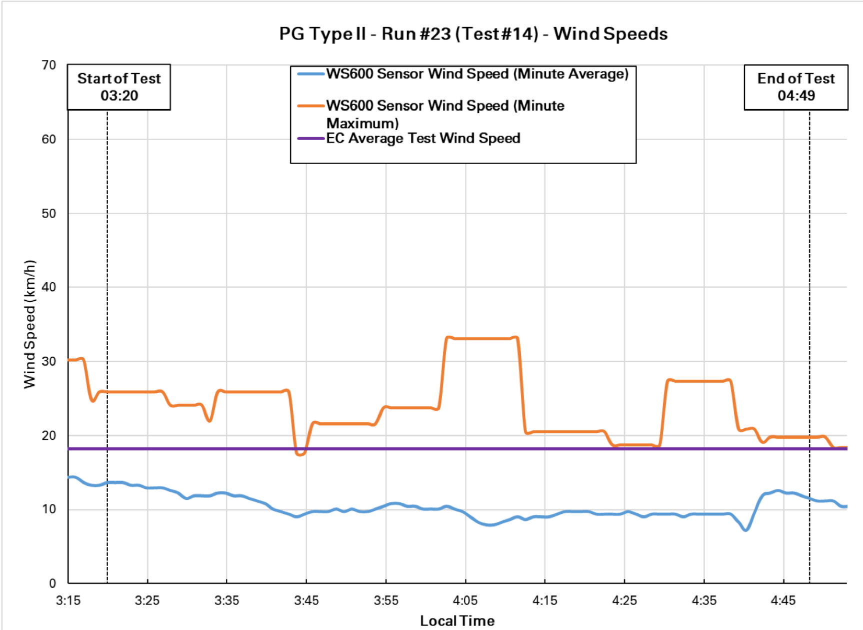
PG Type II – Run #23 (Test #14) – General Test Information

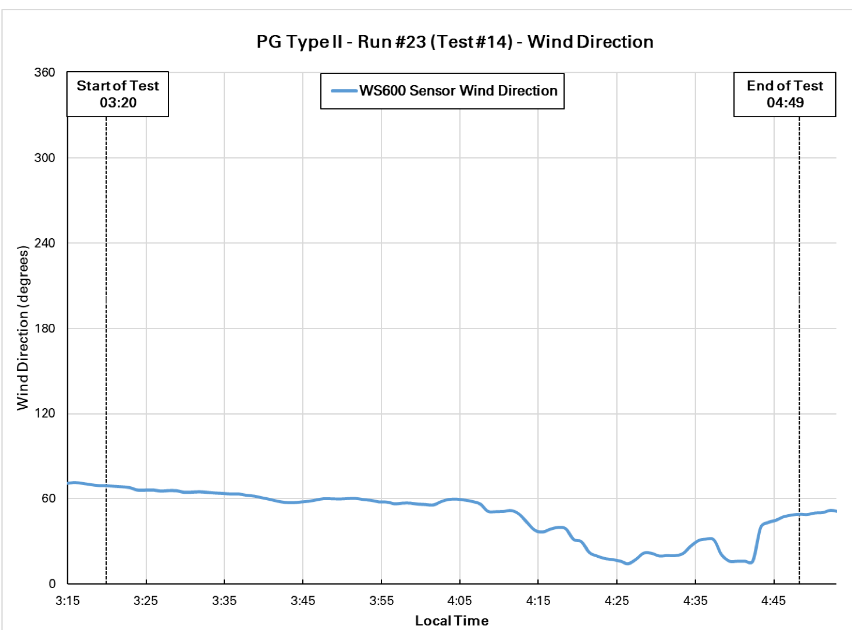
Test Number:	PG2-14
Date of Test:	February 21, 2019
Average OAT:	-7.1
Average Precipitation Rate:	9.1 g/dm²/h
Average Wind Speed:	18.2 km/h
Average Relative Humidity:	87.8%
Pour Time (Local):	03:20:00
Time of Fluid Failure (Local):	04:49:00
Fluid Brix at Failure:	17.25°
Endurance Time:	89 minutes
Expected Regression-Derived Endurance Time:	91.6 minutes
Difference (ET vs. Reg ET):	-2.6 minutes (-2.9%)

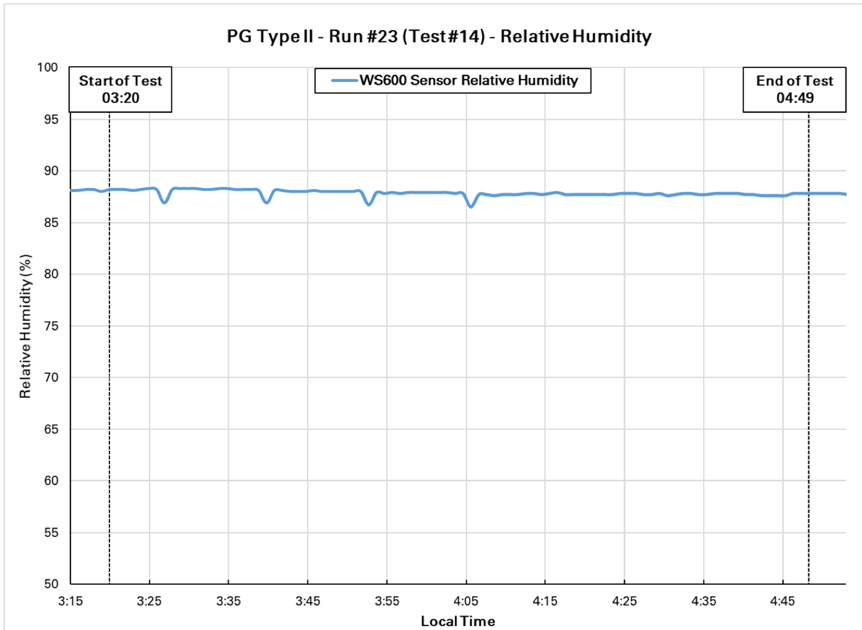


DATA PACKAGE – PG TYPE II – RUN 23 (TEST 14)

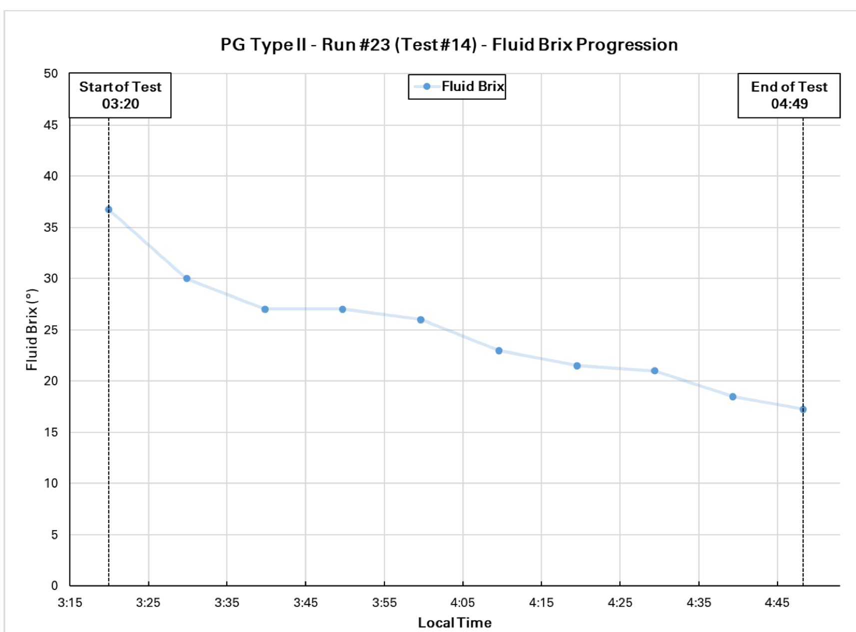



PG Type II - Run #23 (Test #14) - Wind Speeds
Start of Test 03:20
End of Test 04:49
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45

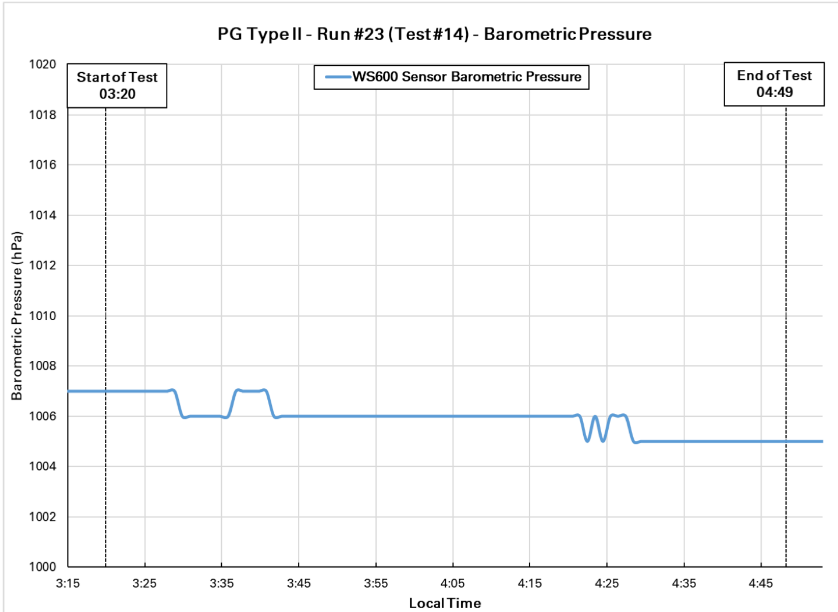

PG Type II - Run #23 (Test #14) - Wind Direction
Start of Test 03:20
WS600 Sensor Wind Direction
End of Test 04:49
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45

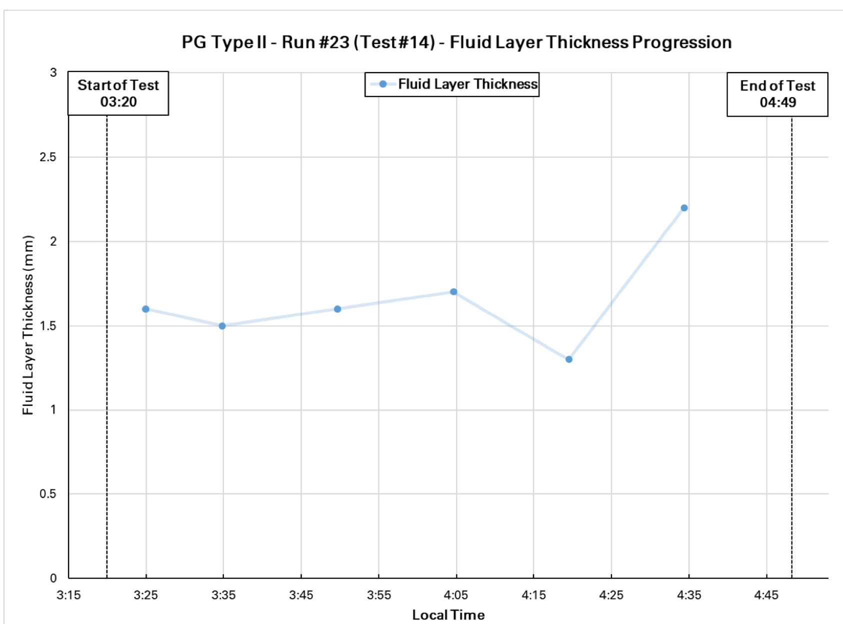


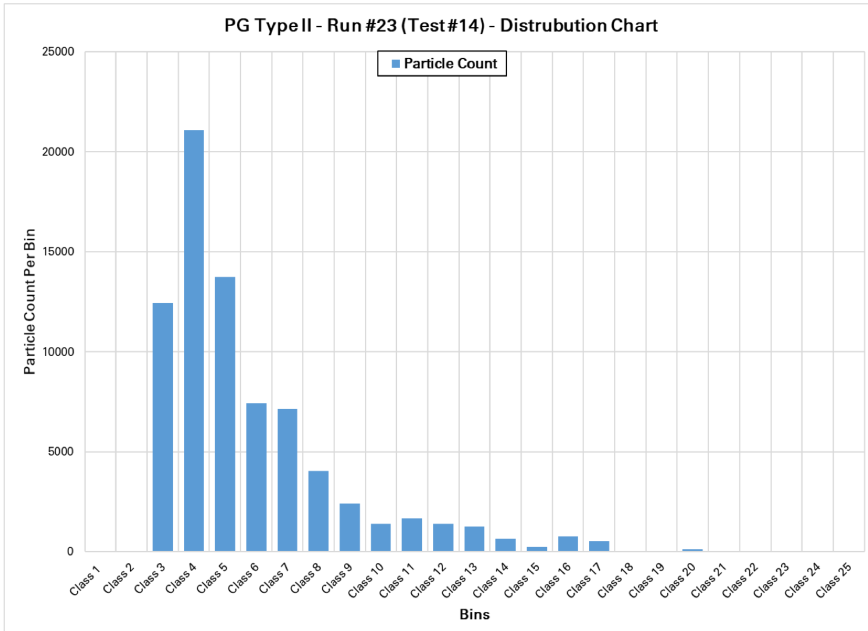
PG Type II - Run #23 (Test #14) - Relative Humidity
Start of Test 03:20
WS600 Sensor Relative Humidity
End of Test 04:49
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
Local Time



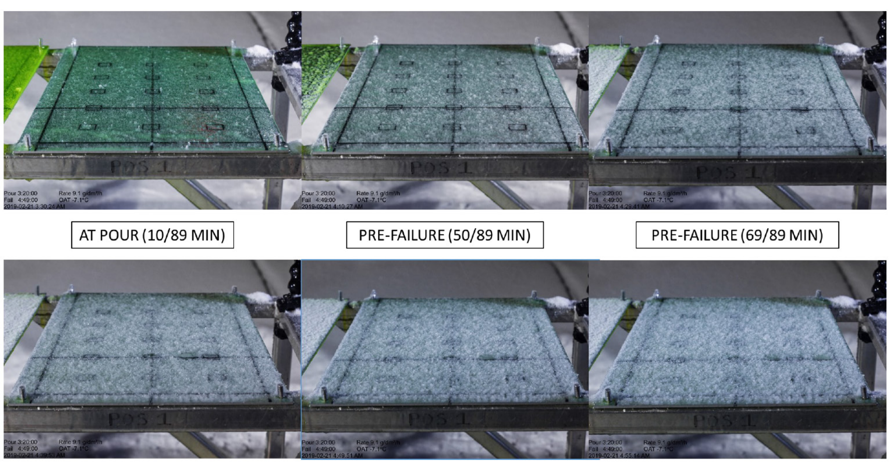
PG Type II - Run #23 (Test #14) - Fluid Brix Progression
Start of Test 03:20
Fluid Brix
End of Test 04:49
Fluid Brix (°)
50
45
40
35
30
25
20
15
10
5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
Local Time


PG Type II - Run #23 (Test #14) - Barometric Pressure
Start of Test 03:20
WS600 Sensor Barometric Pressure
End of Test 04:49
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
Local Time


PG Type II - Run #23 (Test #14) - Fluid Layer Thickness Progression
Start of Test 03:20
Fluid Layer Thickness
End of Test 04:49
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
Local Time



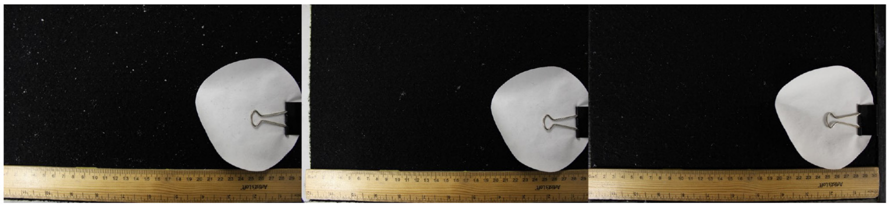
Safewing MP II FLIGHT – Run 23 (Test 14) – Failure Progression Photos



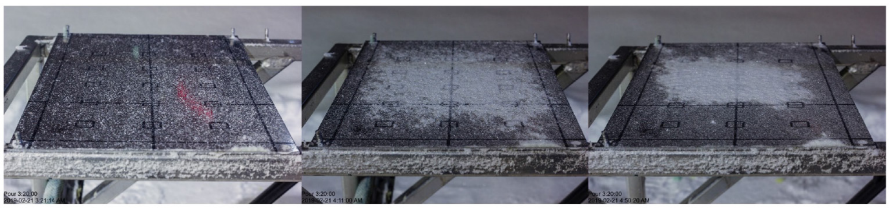
AT POUR (10/89 MIN) | PRE-FAILURE (50/89 MIN) | PRE-FAILURE (69/89 MIN)

PRE-FAILURE (79/89 MIN) | AT FAILURE (89/89 MIN) | POST-FAILURE (95/89 MIN)

Safewing MP II FLIGHT – Run 23 (Test 14) – Snow Characteristics Photos



FELT PAD (0/89 MIN) | FELT PAD (50/89 MIN) | FELT PAD (90/89 MIN)



BARE PLATE (1/89 MIN) | BARE PLATE (51/89 MIN) | BARE PLATE (90/89 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

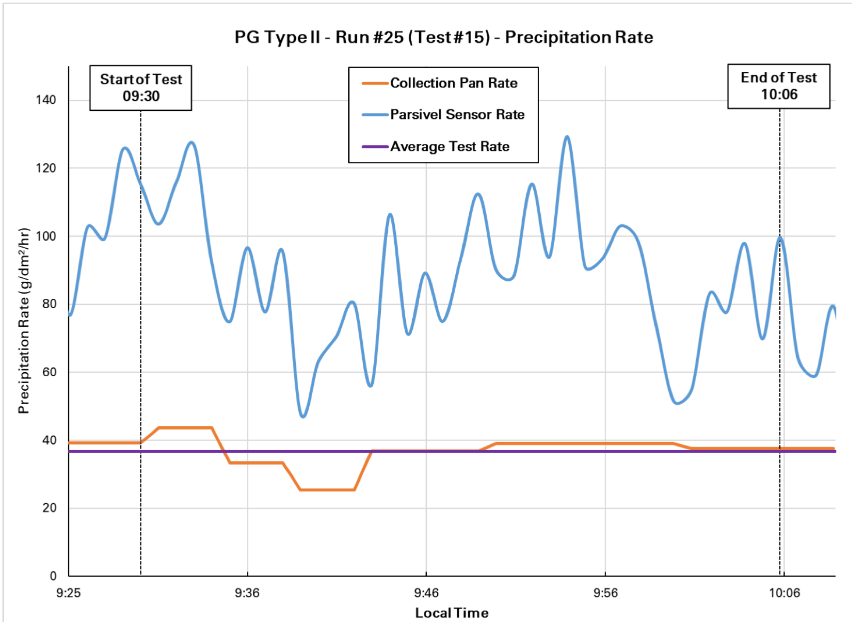
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #25 (TEST #15) –PG2-15

PG Type II – Run #25 (Test #15) – General Test Information

Test Number:	**PG2-15**
Date of Test:	**March 10, 2019**
Average OAT:	**-1.8**
Average Precipitation Rate:	**36.7 g/dm²/h**
Average Wind Speed:	**24 km/h**
Average Relative Humidity:	**91.8%**
Pour Time (Local):	**09:30:00**
Time of Fluid Failure (Local):	**10:06:00**
Fluid Brix at Failure:	**9.75°**
Endurance Time:	**36 minutes**
Expected Regression-Derived Endurance Time:	**46.5 minutes**
Difference (ET vs. Reg ET):	**-10.4 minutes (-22.3%)**

DATA PACKAGE – PG TYPE II – RUN 25 (TEST 15)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 25 - Test 15/Data Package - PG Type II - Run 25 - Test 15.docx
Final Version 1.0, February 2021

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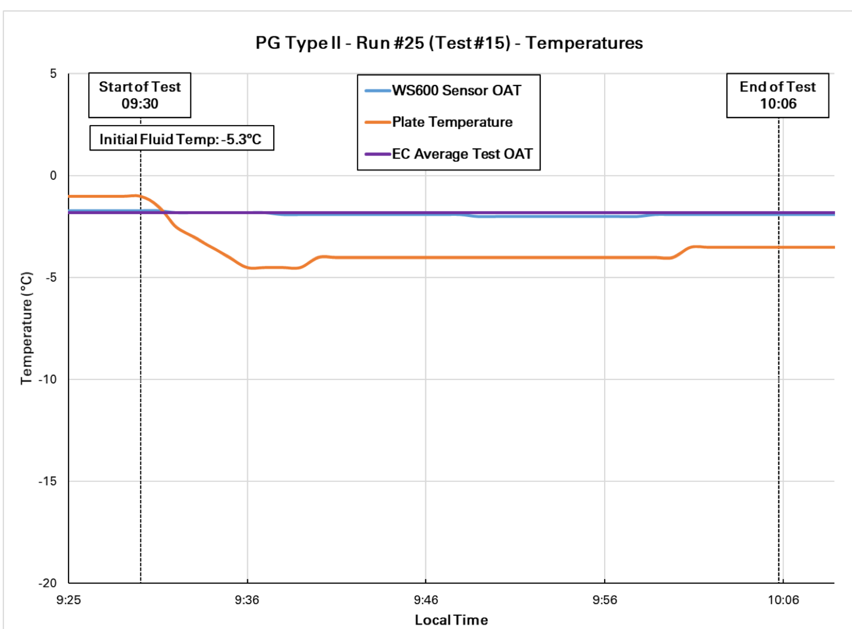
DATA PACKAGE – PG TYPE II – RUN 25 (TEST 15)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 25 - Test 15/Data Package - PG Type II - Run 25 - Test 15.docx
Final Version 1.0, February 2021

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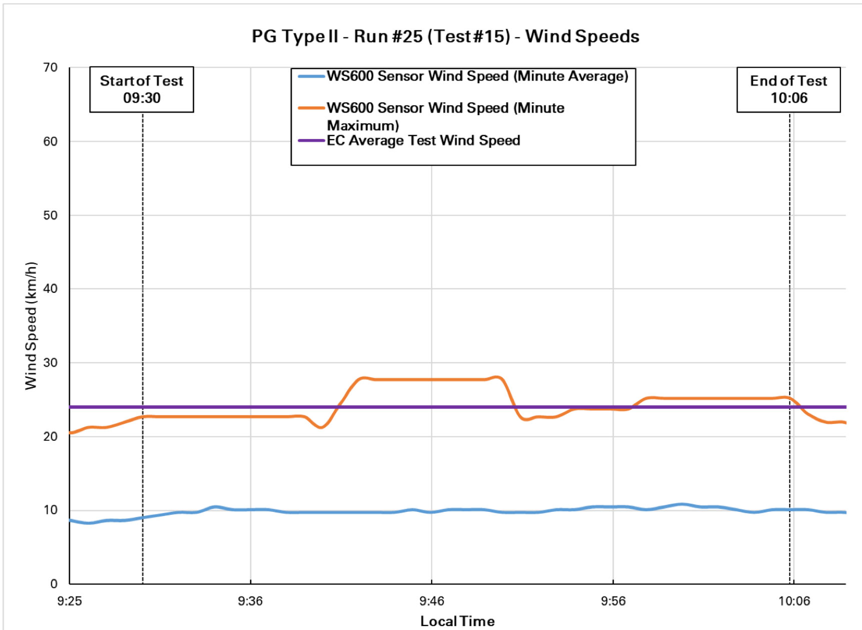
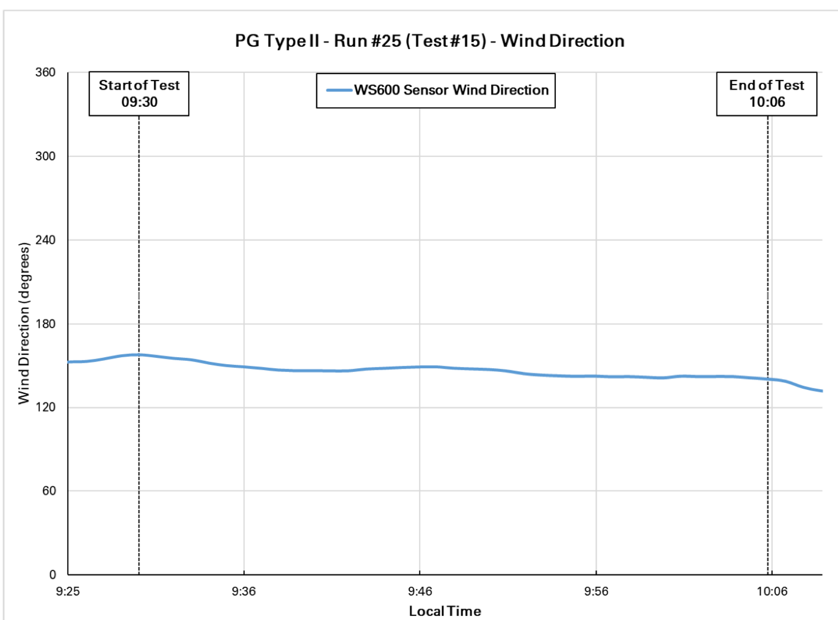
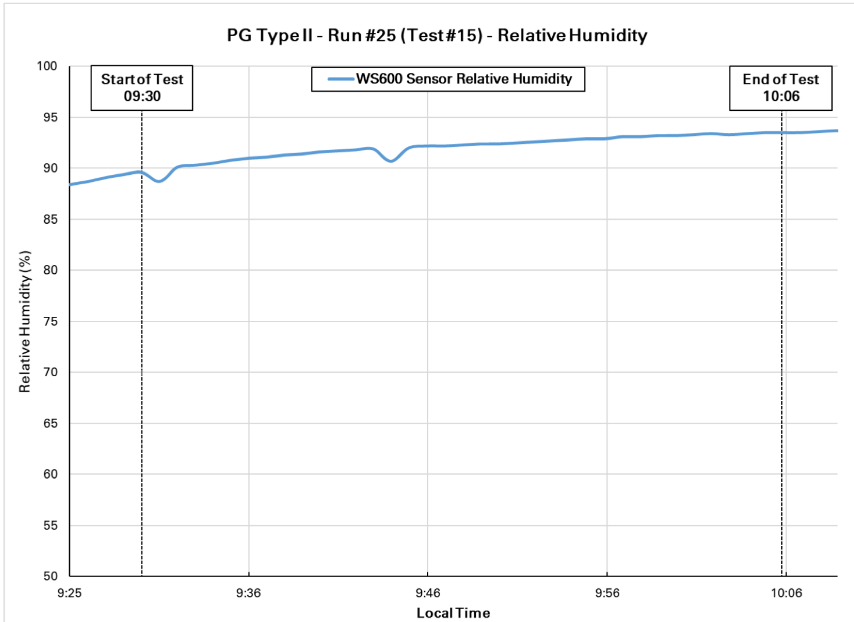
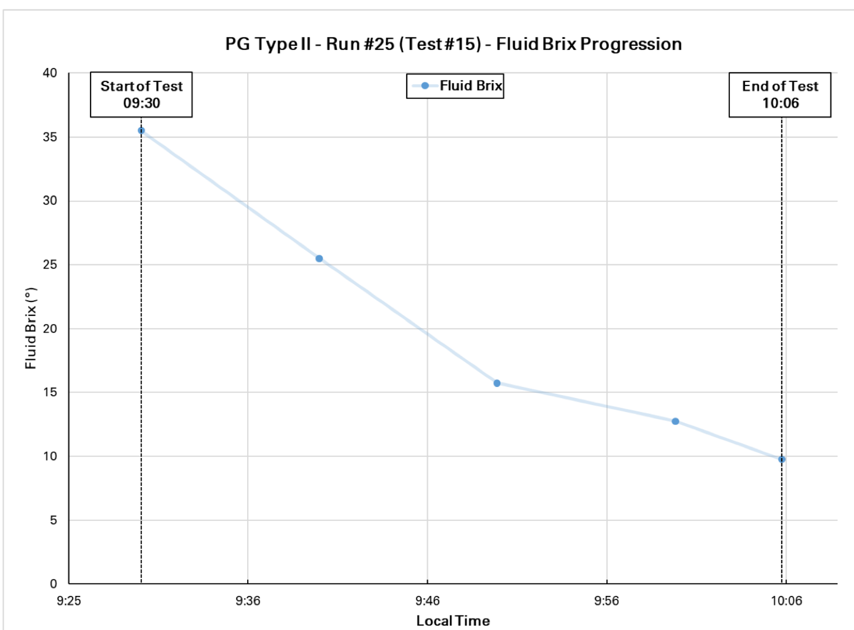
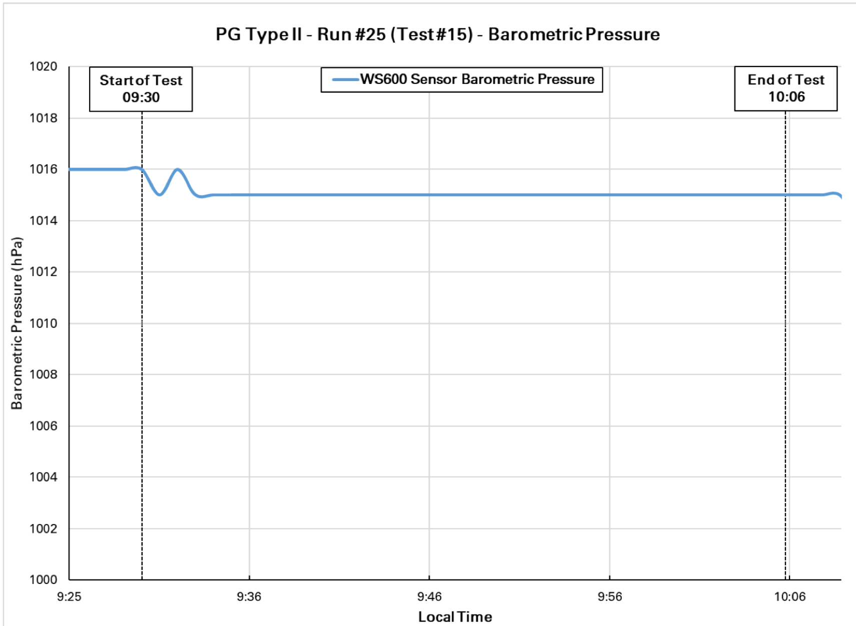

PG Type II - Run #25 (Test #15) - Wind Speeds
Start of Test 09:30
End of Test 10:06
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
9:25
9:36
9:46
9:56
10:06
Local Time

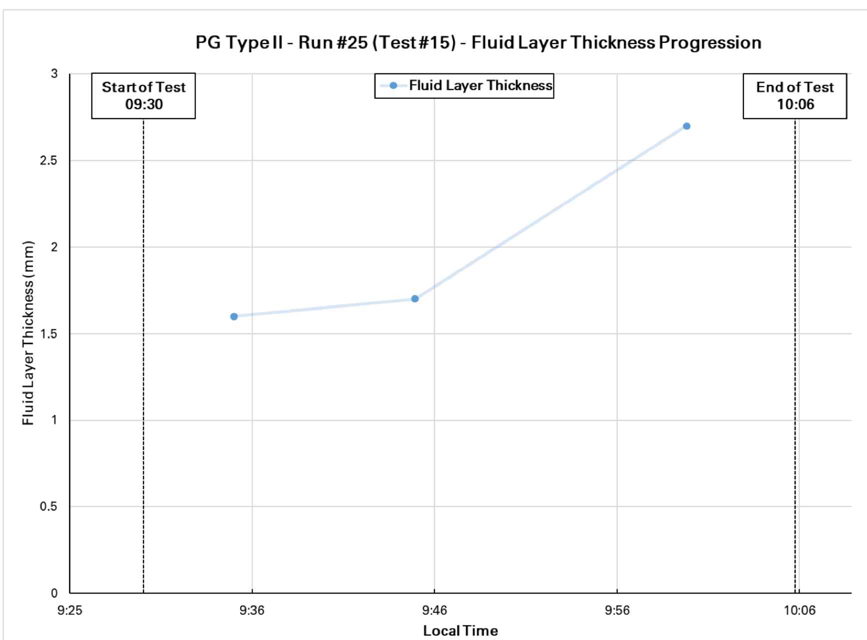

PG Type II - Run #25 (Test #15) - Wind Direction
Start of Test 09:30
End of Test 10:06
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
9:25
9:36
9:46
9:56
10:06
Local Time

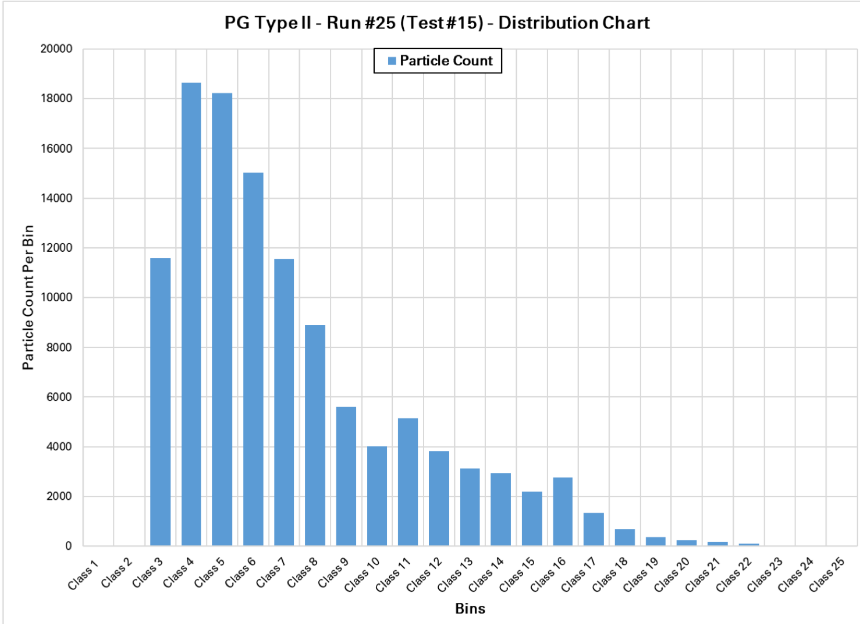


DATA PACKAGE – PG TYPE II – RUN 25 (TEST 15)

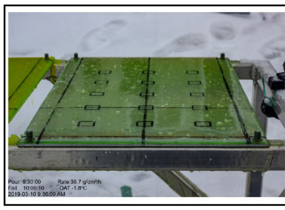


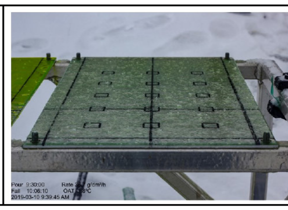

PG Type II - Run #25 (Test #15) - Barometric Pressure
Start of Test 09:30
WS600 Sensor Barometric Pressure
End of Test 10:06
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
9:25
9:36
9:46
9:56
10:06
Local Time

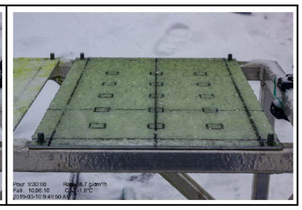

PG Type II - Run #25 (Test #15) - Fluid Layer Thickness Progression
Start of Test 09:30
Fluid Layer Thickness
End of Test 10:06
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
9:25
9:36
9:46
9:56
10:06
Local Time

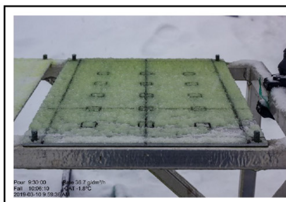


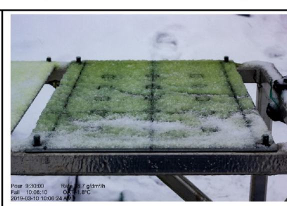
Safewing MP II FLIGHT – Run 25 (Test 15) – Failure Progression Photos

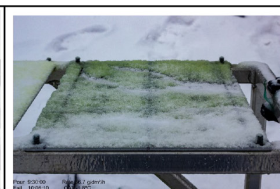

AT POUR (0/36 MIN)


PRE-FAILURE (10/36 MIN)

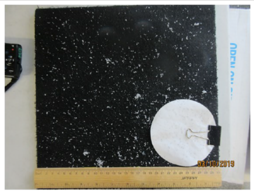
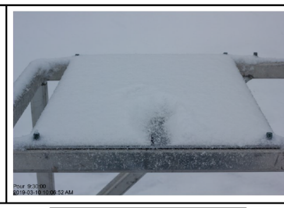

PRE-FAILURE (19/36 MIN)


PRE-FAILURE (30/36 MIN)


AT FAILURE (36/36 MIN)


POST-FAILURE (44/36 MIN)

Safewing MP II FLIGHT – Run 25 (Test 15) – Snow Characteristics Photos

	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (1/36 MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (1/36 MIN)	BARE PLATE 21/36 MIN)	BARE PLATE (36/36 MIN)

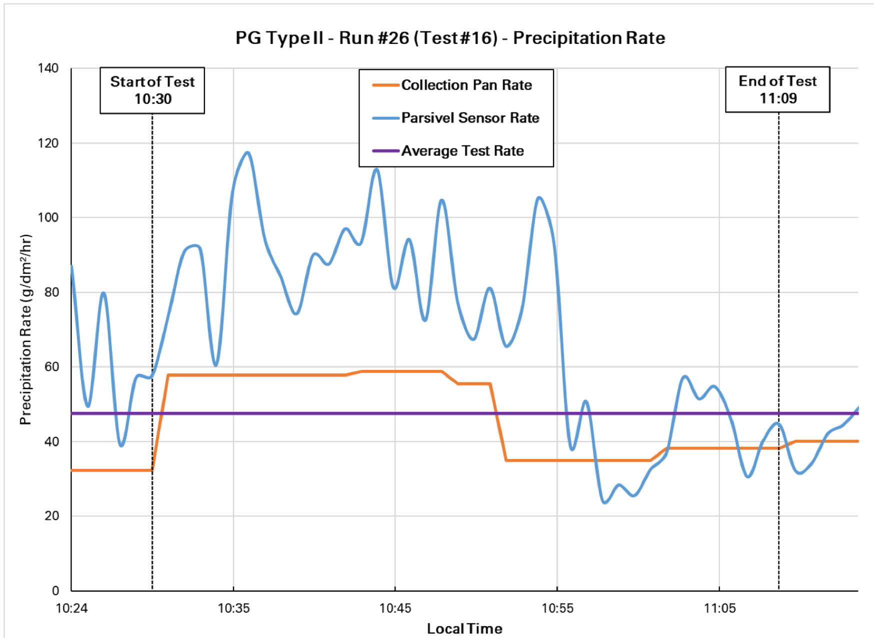
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

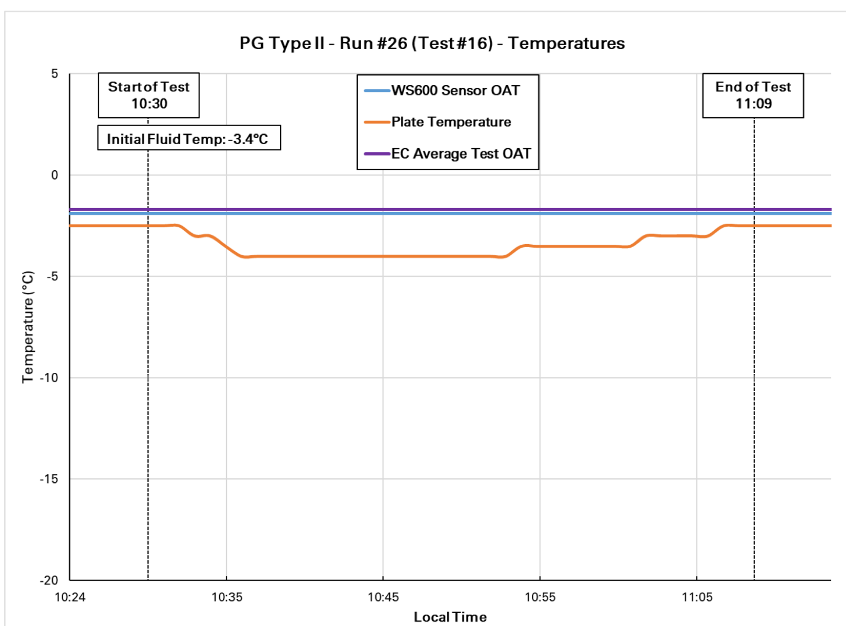
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

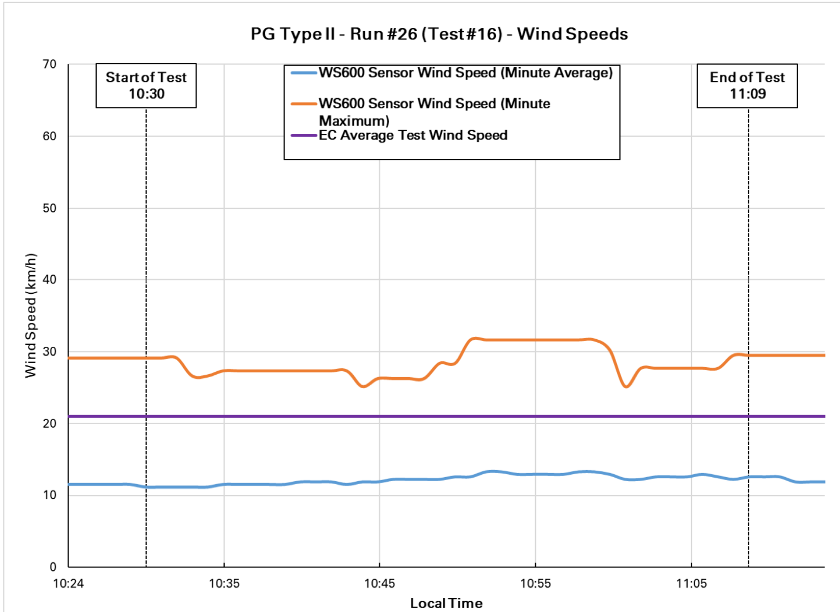
PG TYPE II
RUN #26 (TEST #16) – PG2-16

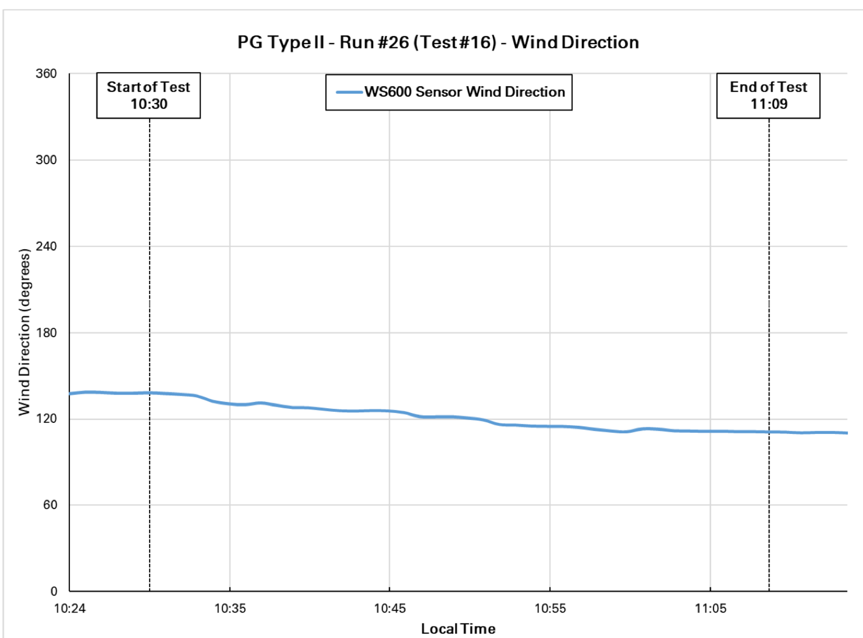
PG Type II – Run #26 (Test #16) – General Test Information

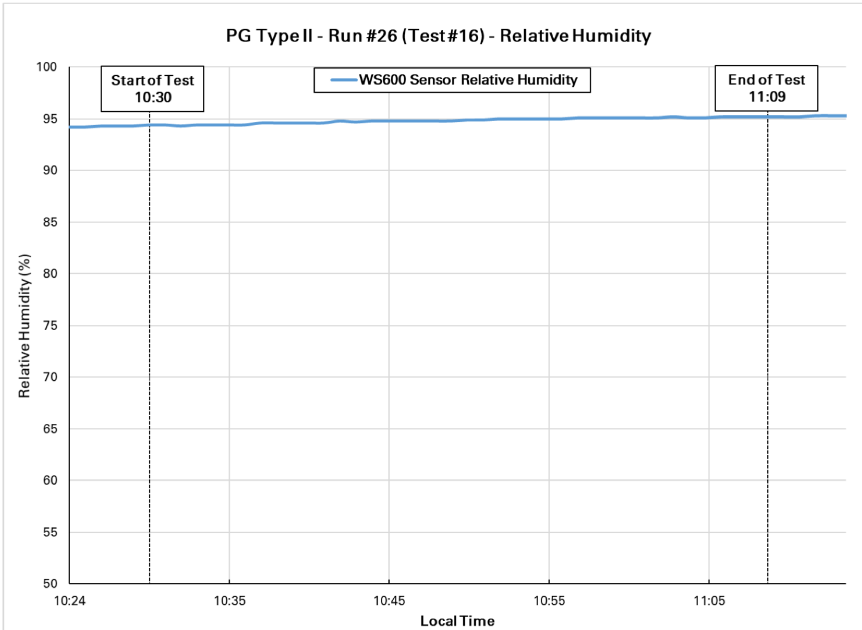
Test Number:	**PG2-16**
Date of Test:	**March 10, 2019**
Average OAT:	**-1.7**
Average Precipitation Rate:	**47.6 g/dm²/h**
Average Wind Speed:	**21 km/h**
Average Relative Humidity:	**94.8%**
Pour Time (Local):	**10:30:00**
Time of Fluid Failure (Local):	**11:09:00**
Fluid Brix at Failure:	**10.25°**
Endurance Time:	**39 minutes**
Expected Regression-Derived Endurance Time:	**38.2 minutes**
Difference (ET vs. Reg ET):	**+1.1 minutes (+2.8%)**

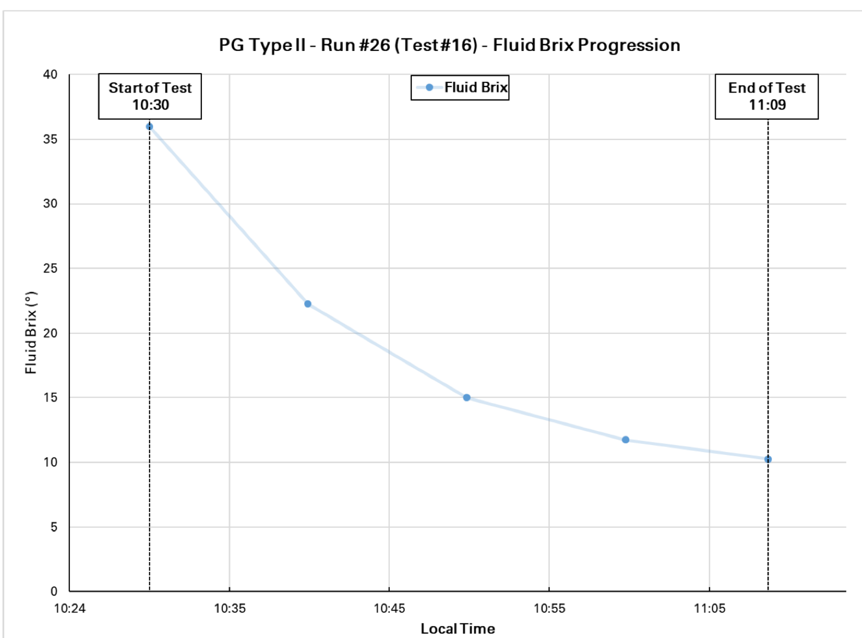

PG Type II - Run #26 (Test #16) - Precipitation Rate
Start of Test 10:30
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 11:09
Precipitation Rate (g/dm²/hr)
140
120
100
80
60
40
20
0
10:24
10:35
10:45
10:55
11:05
Local Time

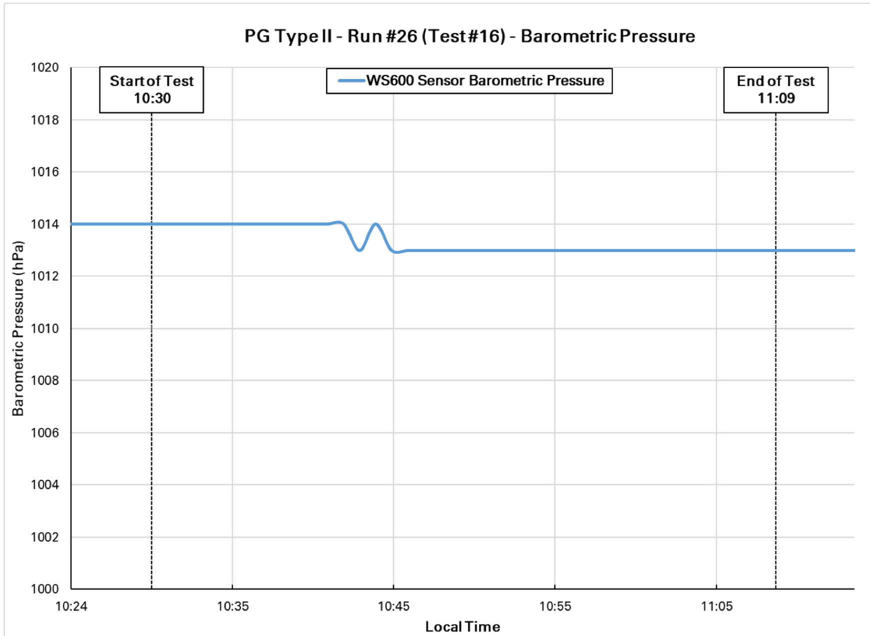

PG Type II - Run #26 (Test #16) - Temperatures
Start of Test 10:30
Initial Fluid Temp: -3.4°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 11:09
Temperature (°C)
5
0
-5
-10
-15
-20
10:24
10:35
10:45
10:55
11:05
Local Time

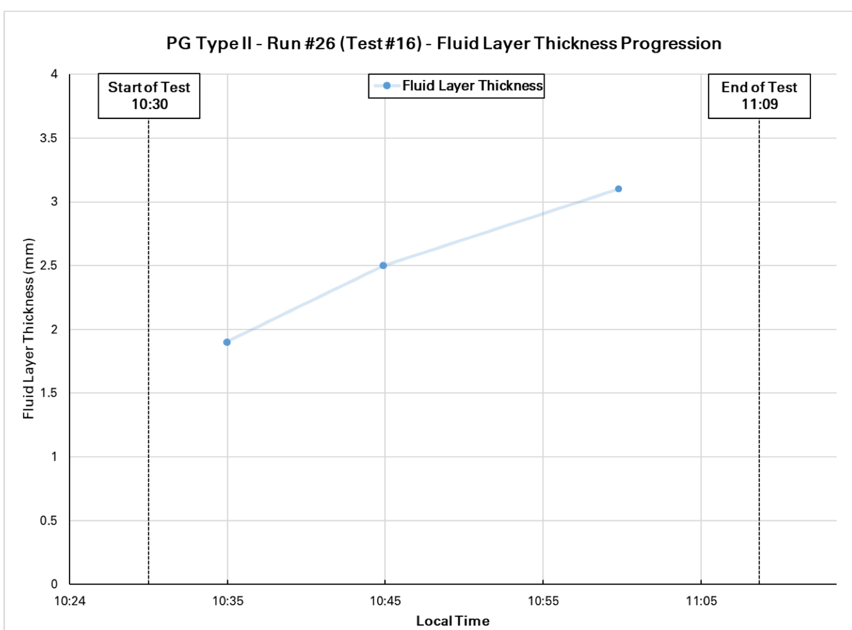

PG Type II - Run #26 (Test #16) - Wind Speeds
Start of Test 10:30
End of Test 11:09
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
10:24
10:35
10:45
10:55
11:05
Local Time

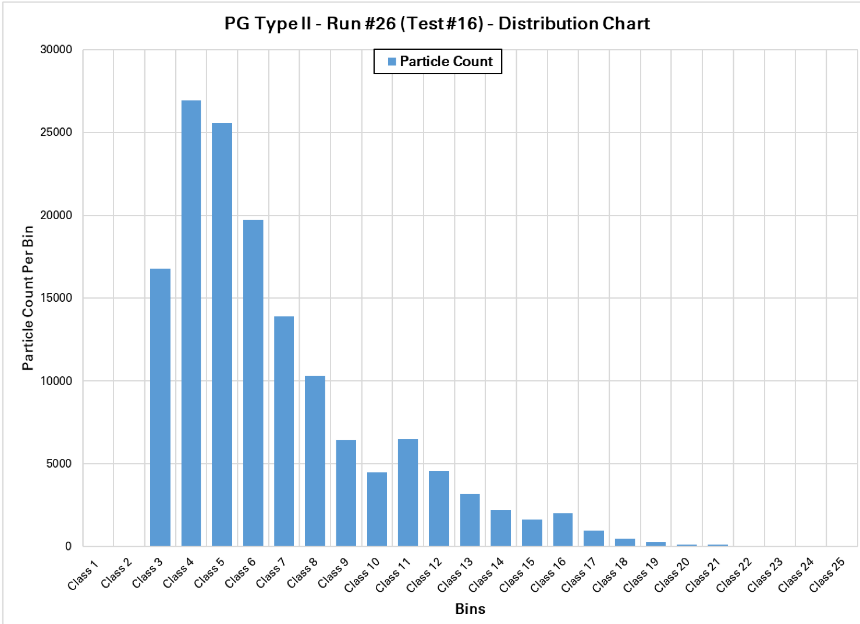

PG Type II - Run #26 (Test #16) - Wind Direction
Start of Test 10:30
End of Test 11:09
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
10:24
10:35
10:45
10:55
11:05
Local Time


PG Type II - Run #26 (Test #16) - Relative Humidity
Start of Test 10:30
WS600 Sensor Relative Humidity
End of Test 11:09
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:24
10:35
10:45
10:55
11:05
Local Time

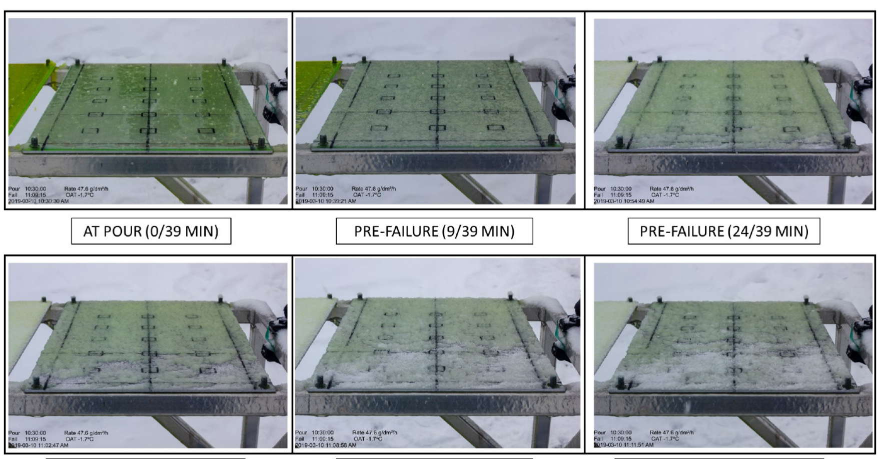

PG Type II - Run #26 (Test #16) - Fluid Brix Progression
Start of Test 10:30
Fluid Brix
End of Test 11:09
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:24
10:35
10:45
10:55
11:05
Local Time


PG Type II - Run #26 (Test #16) - Barometric Pressure
Start of Test 10:30
WS600 Sensor Barometric Pressure
End of Test 11:09
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:24
10:35
10:45
10:55
11:05
Local Time


PG Type II - Run #26 (Test #16) - Fluid Layer Thickness Progression
Start of Test 10:30
Fluid Layer Thickness
End of Test 11:09
Fluid Layer Thickness (mm)
4
3.5
3
2.5
2
1.5
1
0.5
0
10:24
10:35
10:45
10:55
11:05
Local Time



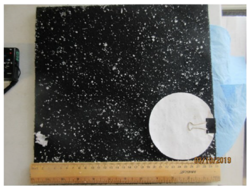
Safewing MP II FLIGHT – Run 26 (Test 16) – Failure Progression Photos



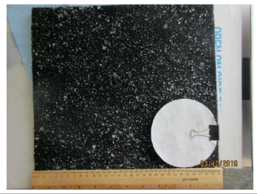
AT POUR (0/39 MIN) | PRE-FAILURE (9/39 MIN) | PRE-FAILURE (24/39 MIN)

PRE-FAILURE (32/39 MIN) | AT FAILURE (39/39 MIN) | POST-FAILURE (41/39 MIN)

Safewing MP II FLIGHT – Run 26 (Test 16) – Snow Characteristics Photos



FELT PAD (1/39 MIN)

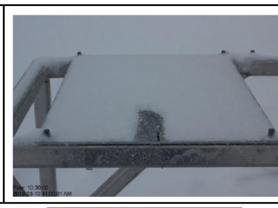


FELT PAD (21/39 MIN)

FELT PAD (37/39 MIN)

BARE PLATE (1/39 MIN)

BARE PLATE 20/39 MIN)



BARE PLATE (30/39 MIN)

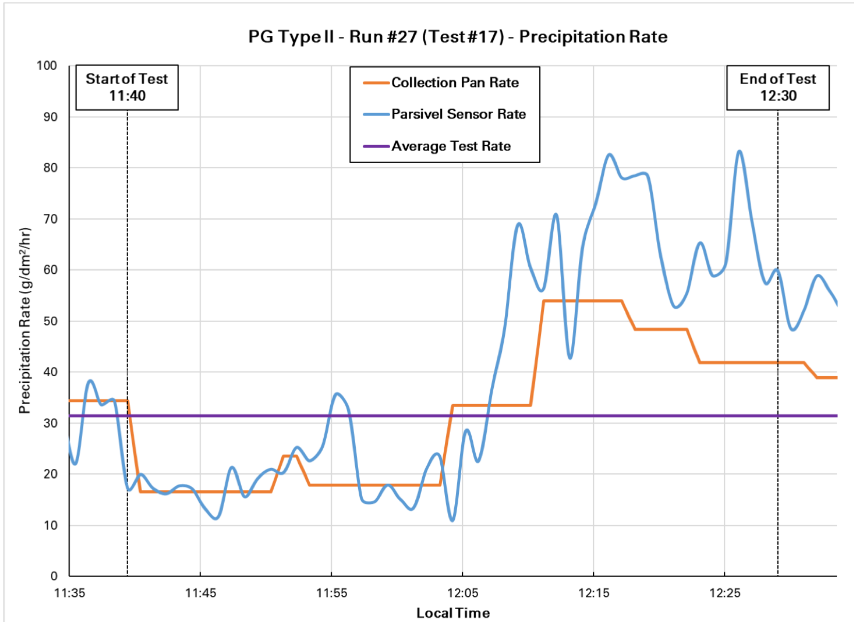
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

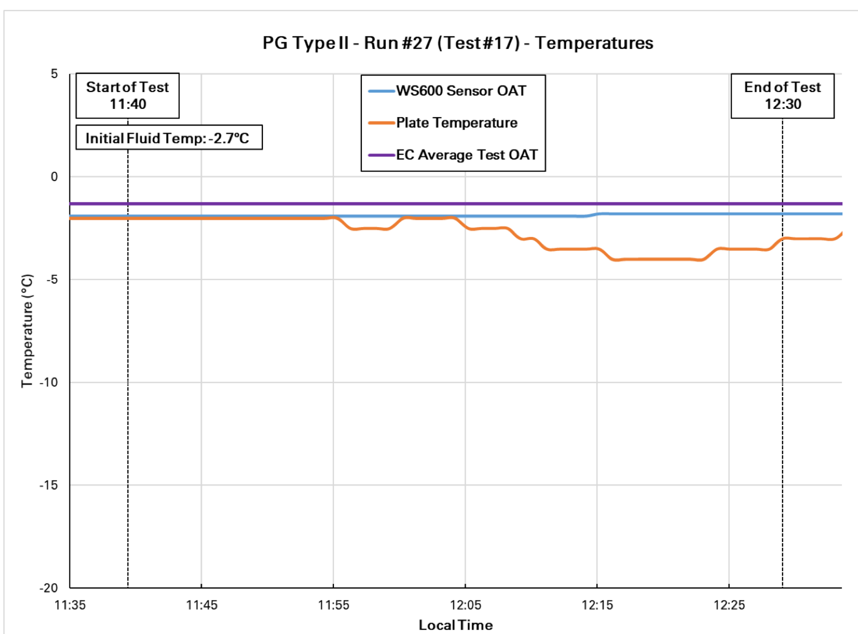
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

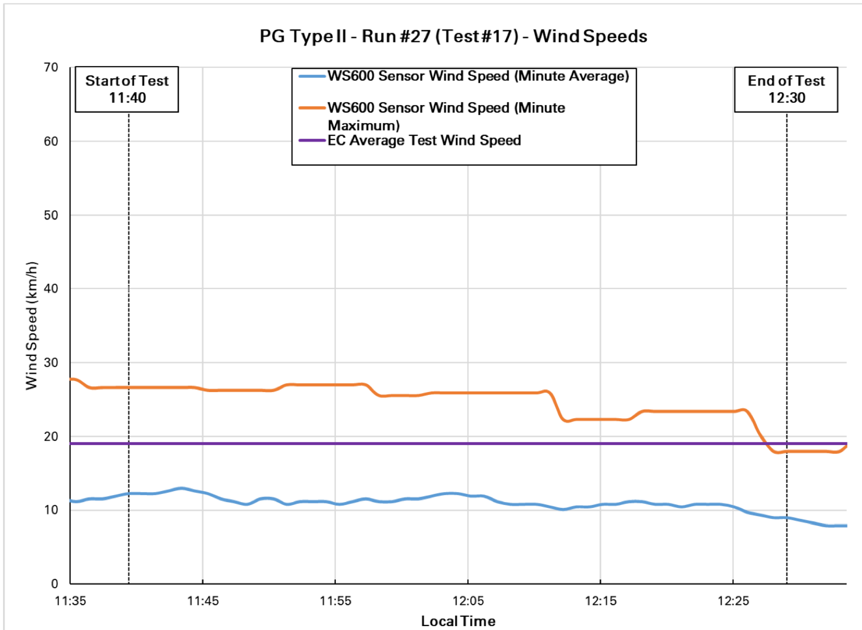
PG TYPE II
RUN #27 (TEST #17) - PG2-17

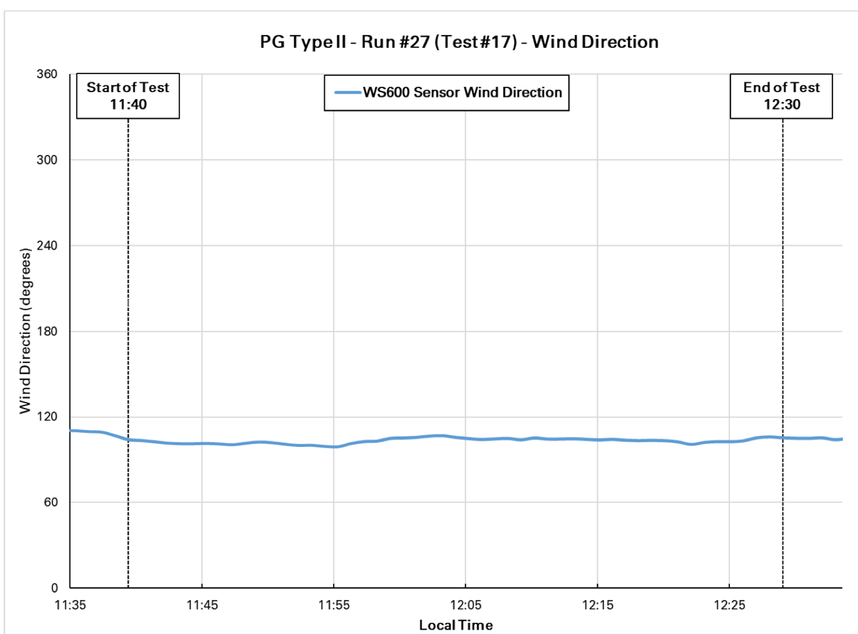
PG Type II – Run #27 (Test #17) – General Test Information

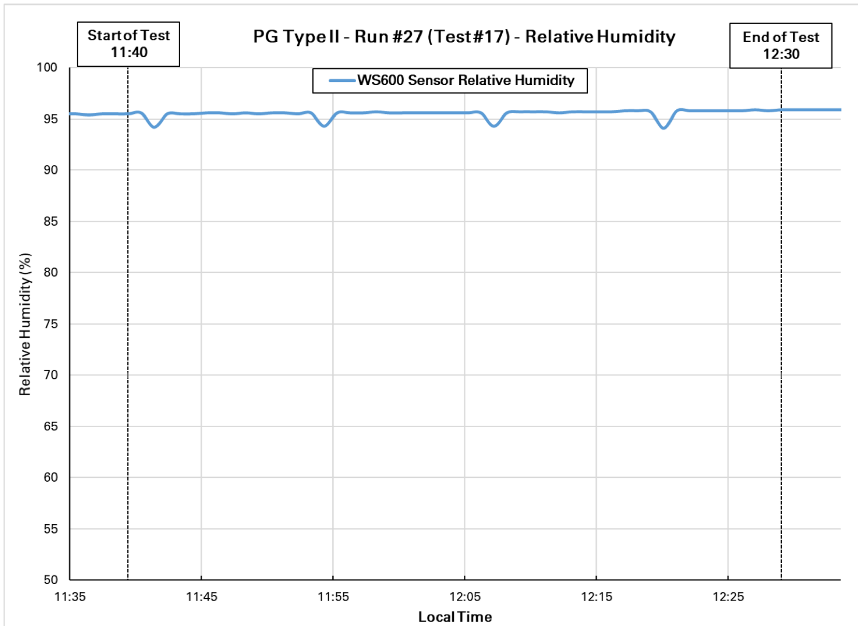
Test Number:	PG2-17
Date of Test:	March 10, 2019
Average OAT:	-1.3
Average Precipitation Rate:	31.4 g/dm²/h
Average Wind Speed:	19 km/h
Average Relative Humidity:	95.6%
Pour Time (Local):	11:40:00
Time of Fluid Failure (Local):	12:30:00
Fluid Brix at Failure:	12.25°
Endurance Time:	50 minutes
Expected Regression-Derived Endurance Time:	56.9 minutes
Difference (ET vs. Reg ET):	-6.7 minutes (-11.7%)

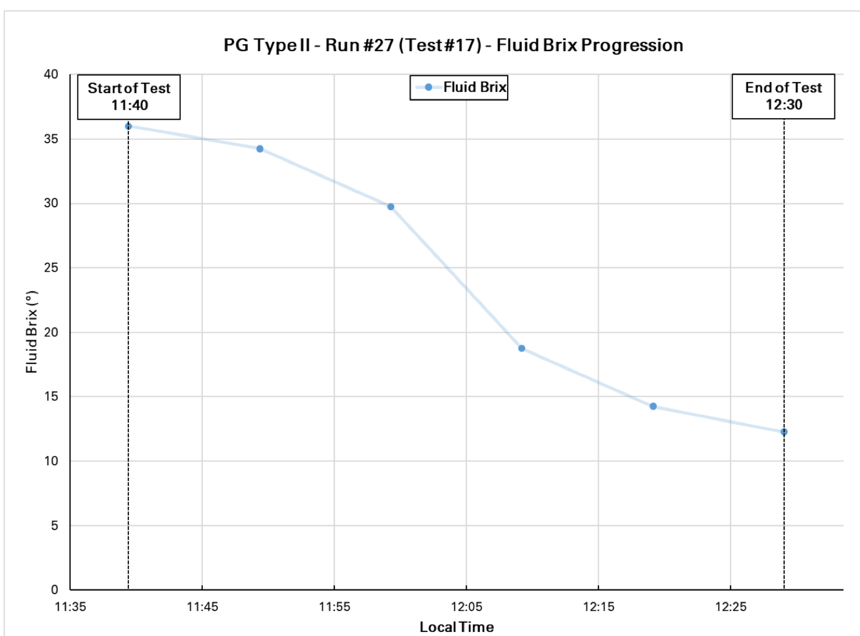

PG Type II - Run #27 (Test #17) - Precipitation Rate
Start of Test
11:40
End of Test
12:30
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
100
90
80
70
60
50
40
30
20
10
0
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

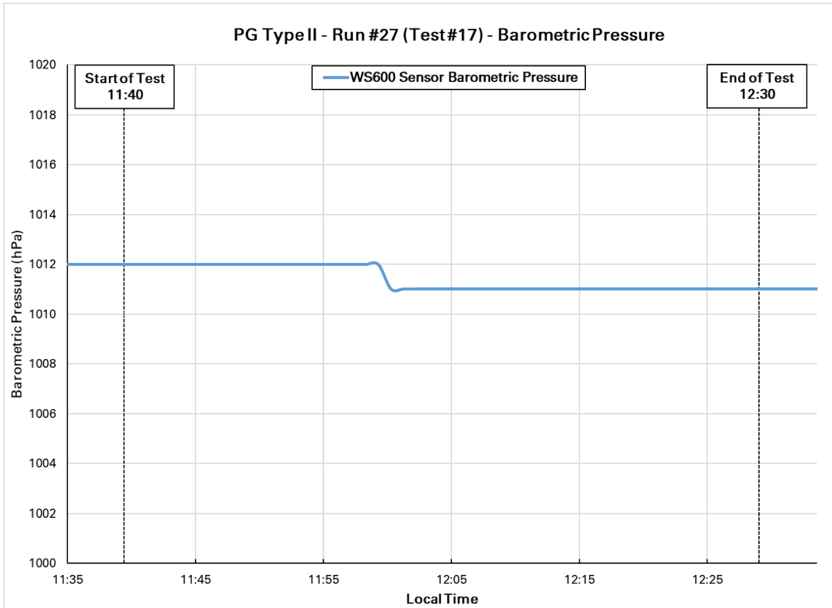

PG Type II - Run #27 (Test #17) - Temperatures
Start of Test
11:40
Initial Fluid Temp: -2.7°C
End of Test
12:30
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
0
-5
-10
-15
-20
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

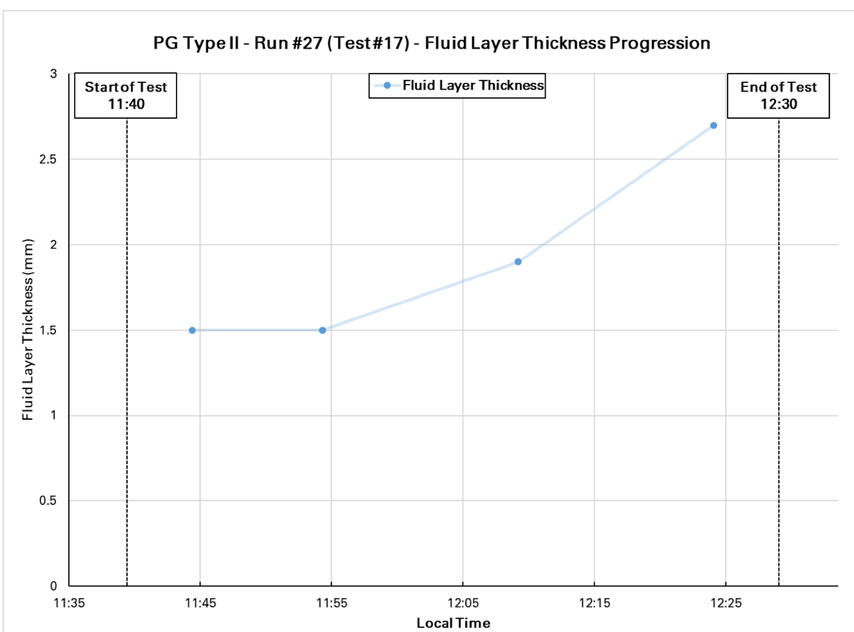

PG Type II - Run #27 (Test #17) - Wind Speeds
Start of Test 11:40
End of Test 12:30
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

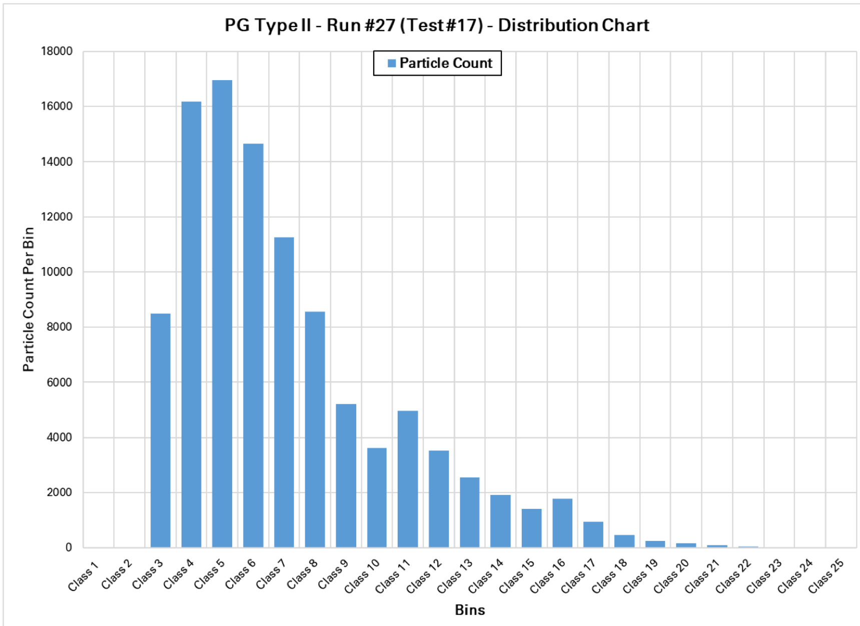

PG Type II - Run #27 (Test #17) - Wind Direction
Start of Test 11:40
End of Test 12:30
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
11:35
11:45
11:55
12:05
12:15
12:25
Local Time


PG Type II - Run #27 (Test #17) - Relative Humidity
Start of Test 11:40
End of Test 12:30
WS600 Sensor Relative Humidity
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

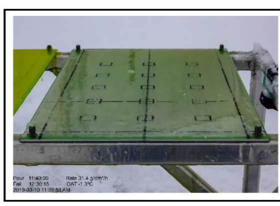

PG Type II - Run #27 (Test #17) - Fluid Brix Progression
Start of Test 11:40
Fluid Brix
End of Test 12:30
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

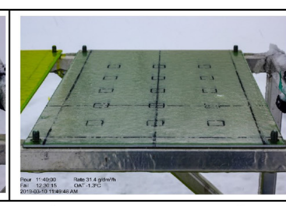

PG Type II - Run #27 (Test #17) - Barometric Pressure
Start of Test 11:40
WS600 Sensor Barometric Pressure
End of Test 12:30
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

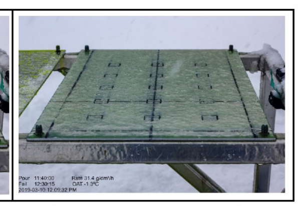

PG Type II - Run #27 (Test #17) - Fluid Layer Thickness Progression
Start of Test 11:40
Fluid Layer Thickness
End of Test 12:30
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

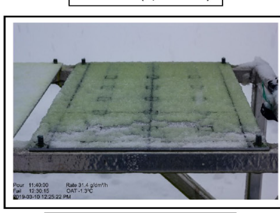


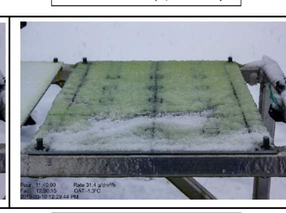
Safewing MP II FLIGHT – Run 27 (Test 17) – Failure Progression Photos

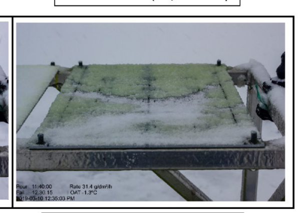

AT POUR (0/50 MIN)


PRE-FAILURE (9/50 MIN)

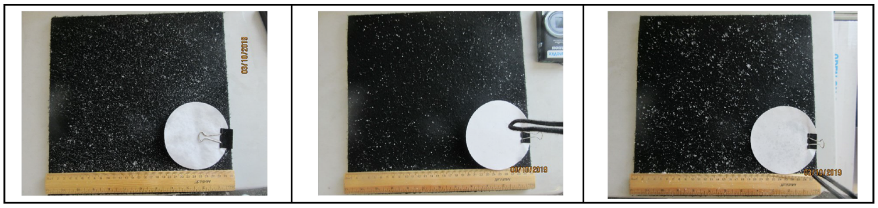

PRE-FAILURE (29/50 MIN)


PRE-FAILURE (45/50 MIN)

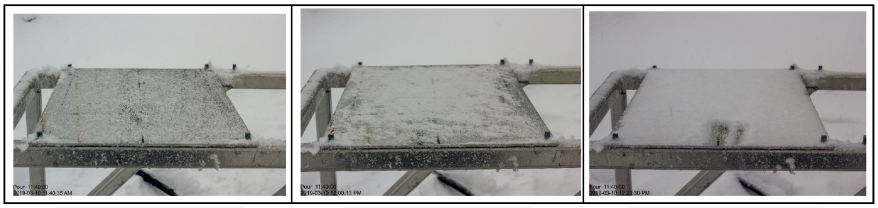

AT FAILURE (50/50 MIN)


POST-FAILURE (55/50 MIN)

Safewing MP II FLIGHT – Run 27 (Test 17) – Snow Characteristics Photos



FELT PAD (1/50 MIN) | FELT PAD (21/50 MIN) | FELT PAD (41/50 MIN)



BARE PLATE (0/50 MIN) | BARE PLATE 20/50 MIN) | BARE PLATE (40/50 MIN)

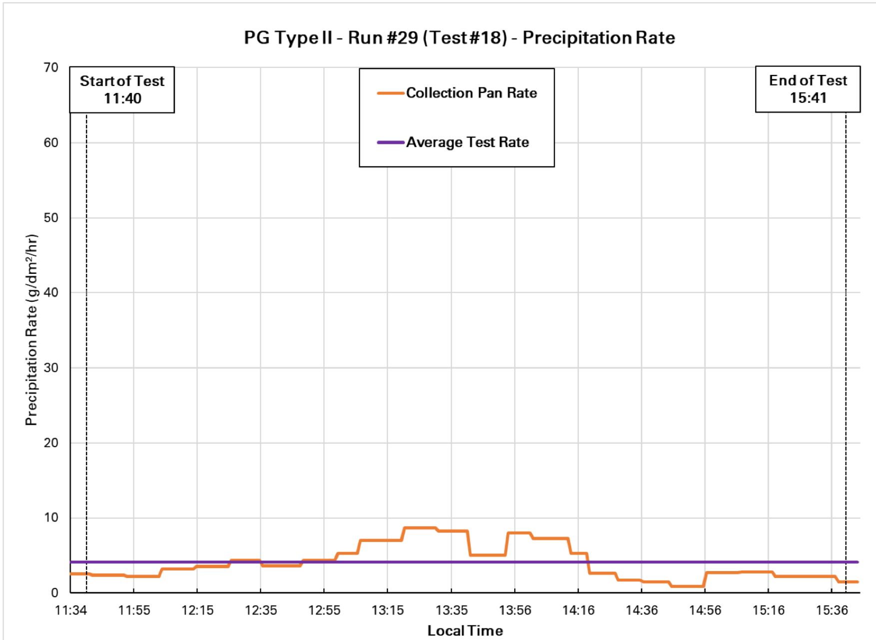
Final Bare Plate Contamination Thickness: **Not taken**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

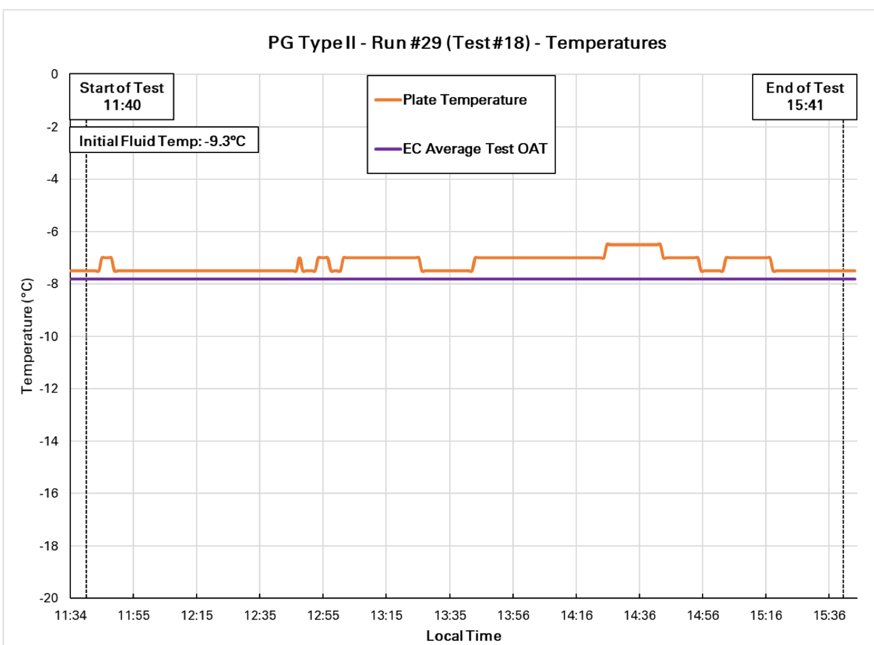
PG TYPE II
RUN #29 (TEST #18) – PG2-18

PG Type II – Run #28 (Test #18) – General Test Information

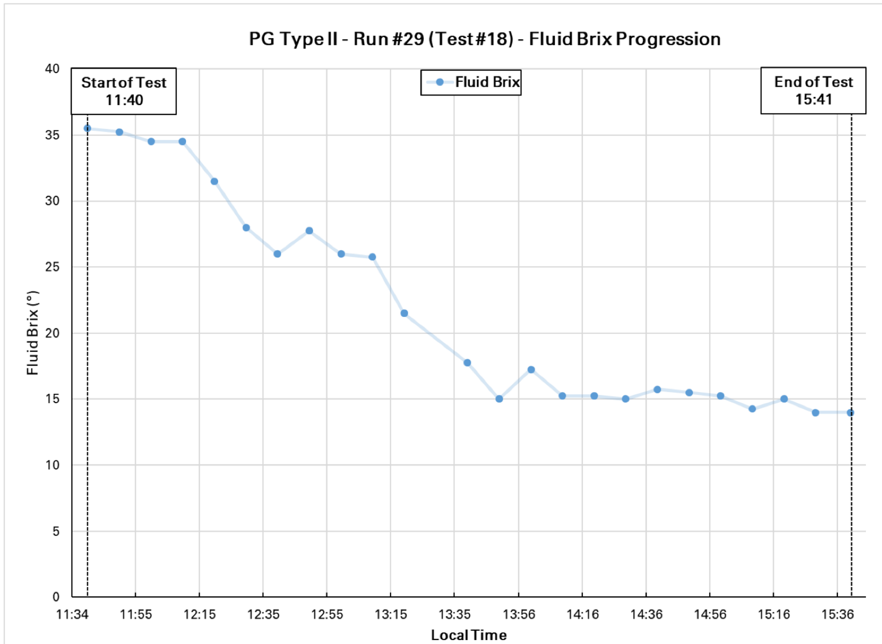
Test Number:	**PG2-18**
Date of Test:	**January 6, 2020**
Average OAT:	**-7.8**
Average Precipitation Rate:	**4.1 g/dm²/h**
Average Wind Speed:	**17.5 km/h**
Average Relative Humidity:	**Not Available**
Pour Time (Local):	**11:40:00**
Time of Fluid Failure (Local):	**15:41:00**
Fluid Brix at Failure:	**14.0°**
Endurance Time:	**241 minutes**
Expected Regression-Derived Endurance Time:	**168.2 minutes**
Difference (ET vs. Reg ET):	**+73.2 minutes (+43.5%)**



DATA PACKAGE – PG TYPE II – RUN 29 (TEST 18)



DATA PACKAGE – PG TYPE II – RUN 29 (TEST 18)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 29 - Test 18/Data Package - PG Type II - Run 29 - Test 18.docx
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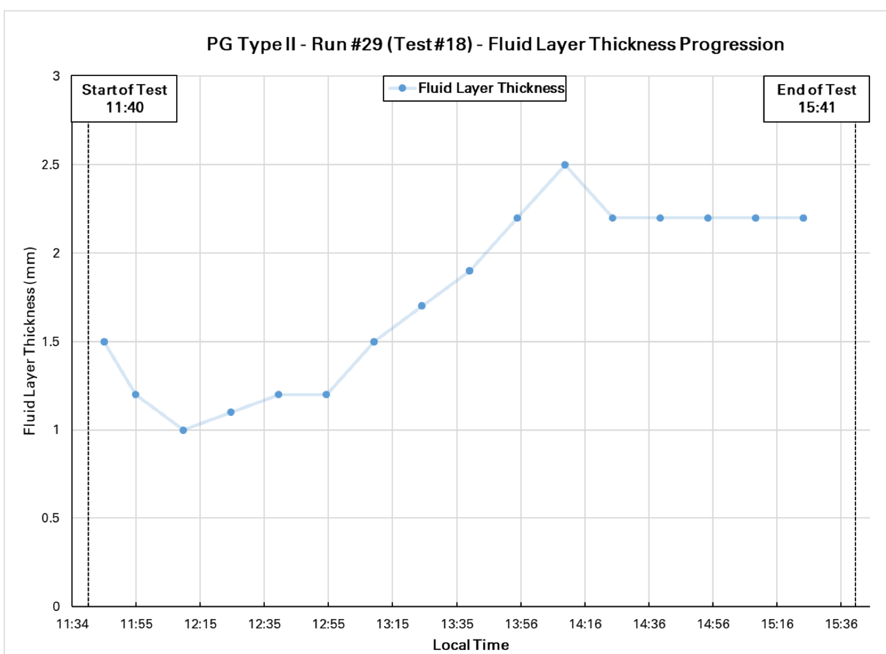
DATA PACKAGE – PG TYPE II – RUN 29 (TEST 18)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 29 - Test 18/Data Package - PG Type II - Run 29 - Test 18.docx
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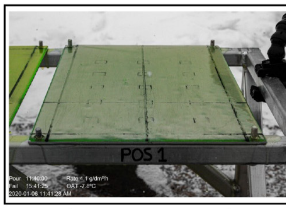
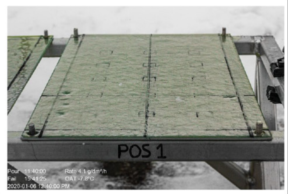
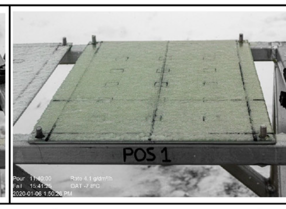
Safewing MP II Flight – Run 29 (Test 18) – Failure Progression Photos



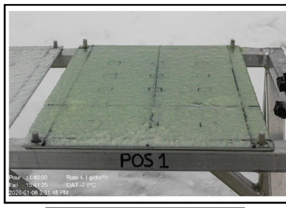
AT POUR (0/241 MIN)



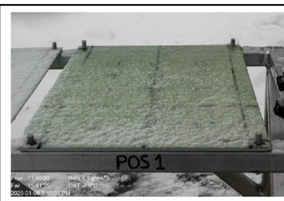
PRE-FAILURE (60/241 MIN)



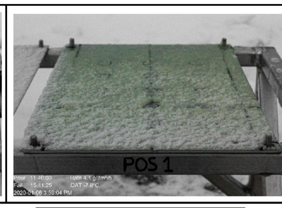
PRE-FAILURE (130/241 MIN)



PRE-FAILURE (201/241 MIN)

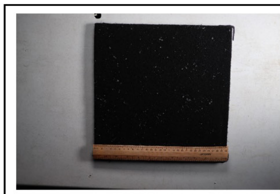


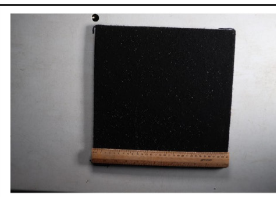
AT FAILURE (241/241 MIN)

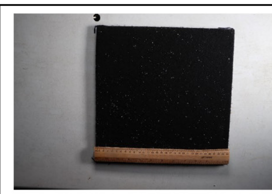


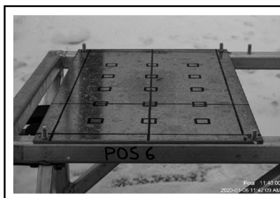
POST-FAILURE (259/241 MIN)

Safewing MP II Flight – Run 29 (Test 18) – Snow Characteristics Photos

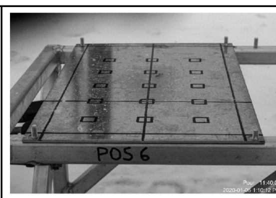

FELT PAD (2/241 MIN)


FELT PAD (173/241 MIN)

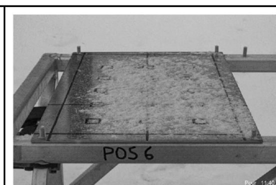

FELT PAD (240/241 MIN)



BARE PLATE (2/241 MIN)



BARE PLATE (90/241 MIN)



BARE PLATE (259/241 MIN)

Final Bare Plate Contamination Thickness: **Nil (0 mm)**

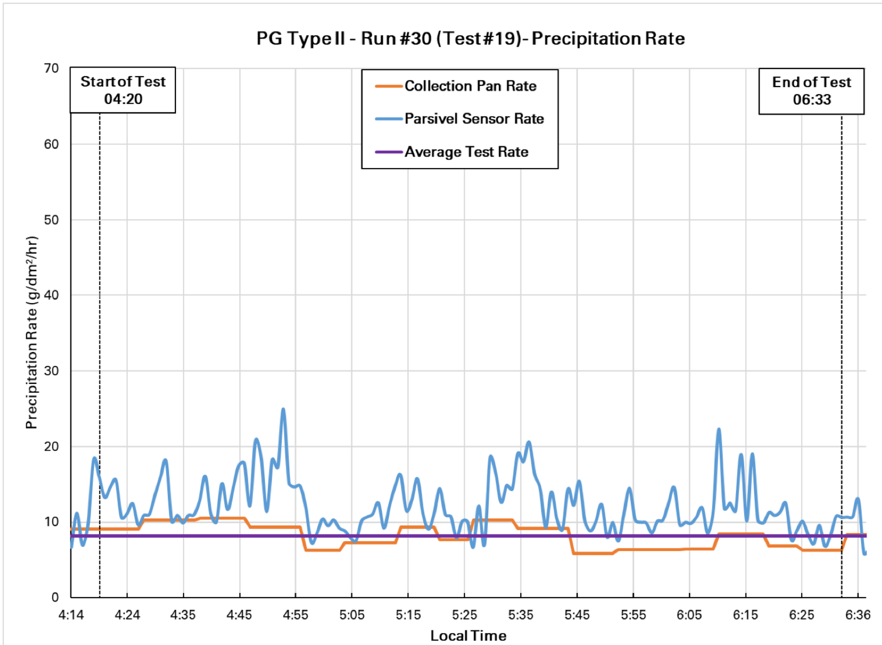
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #30 (TEST #19) – PG2-19

PG Type II – Run #30 (Test #19) – General Test Information

Test Number:	PG2-19
Date of Test:	January 16, 2020
Average OAT:	-1.7
Average Precipitation Rate:	8.2 g/dm²/h
Average Wind Speed:	13.2 km/h
Average Relative Humidity:	90.6%
Pour Time (Local):	04:20:00
Time of Fluid Failure (Local):	06:33:00
Fluid Brix at Failure:	6°
Endurance Time:	133 minutes
Expected Regression-Derived Endurance Time:	162 minutes
Difference (ET vs. Reg ET):	- 28.5 minutes (- 17.6%)

DATA PACKAGE – PG TYPE II – RUN 30 (TEST 19)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 30 - Test 19/Data Package - PG Type II - Run 30 - Test 19.docx
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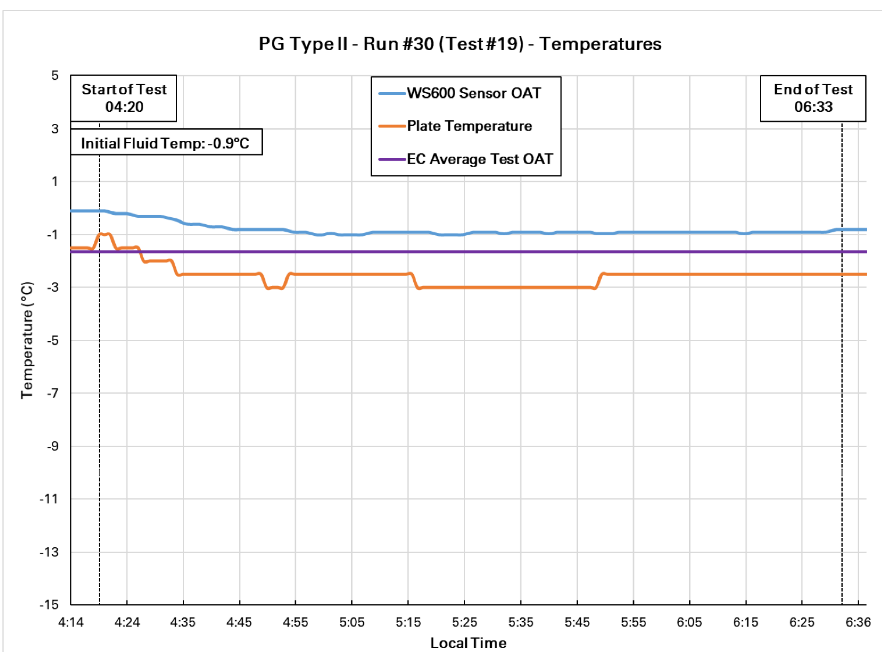
DATA PACKAGE – PG TYPE II – RUN 30 (TEST 19)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 30 - Test 19/Data Package - PG Type II - Run 30 - Test 19.docx
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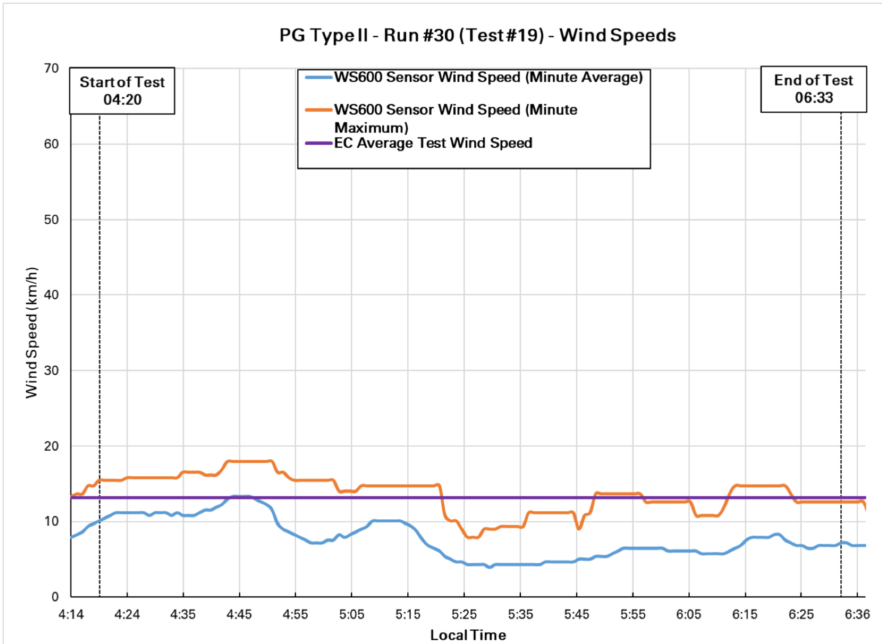
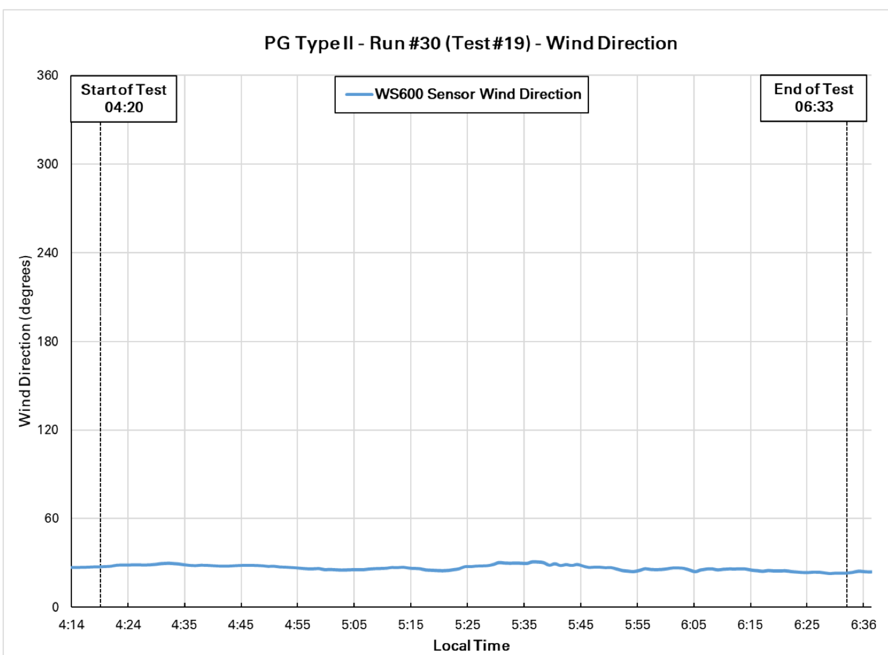
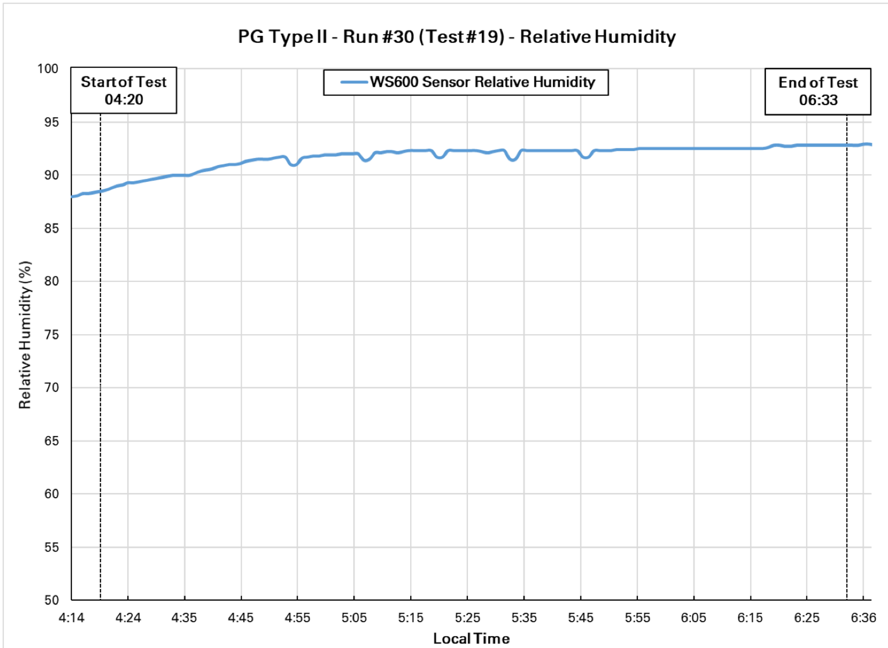


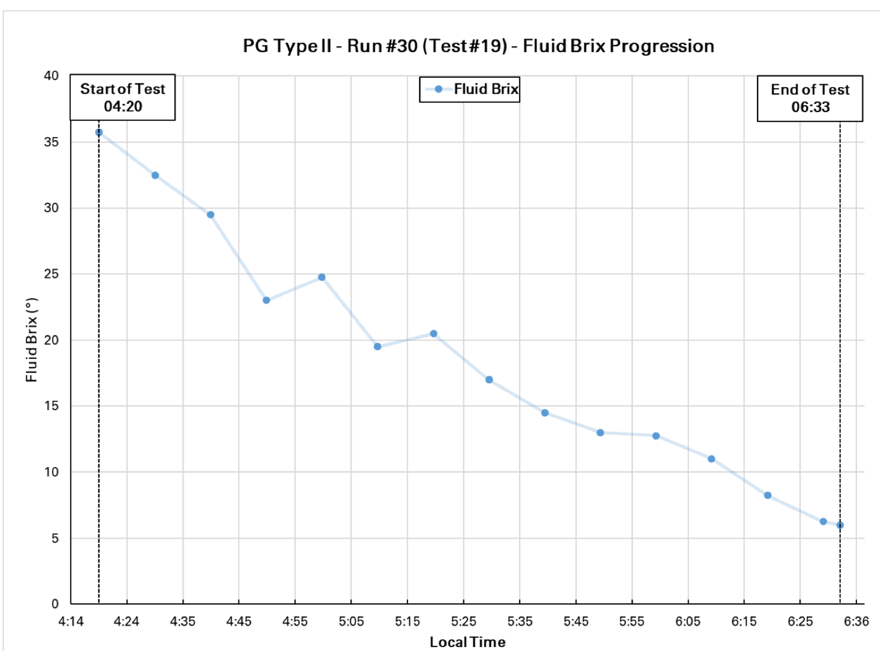
PG Type II - Run #30 (Test #19) - Wind Speeds
Start of Test 04:20
End of Test 06:33
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
6:36



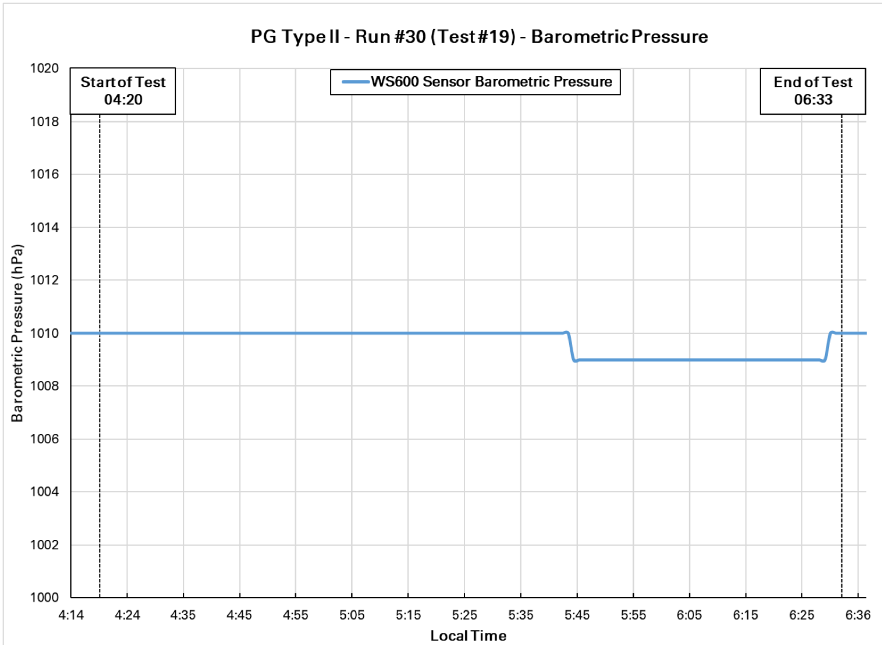
PG Type II - Run #30 (Test #19) - Wind Direction
Start of Test 04:20
End of Test 06:33
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
6:36

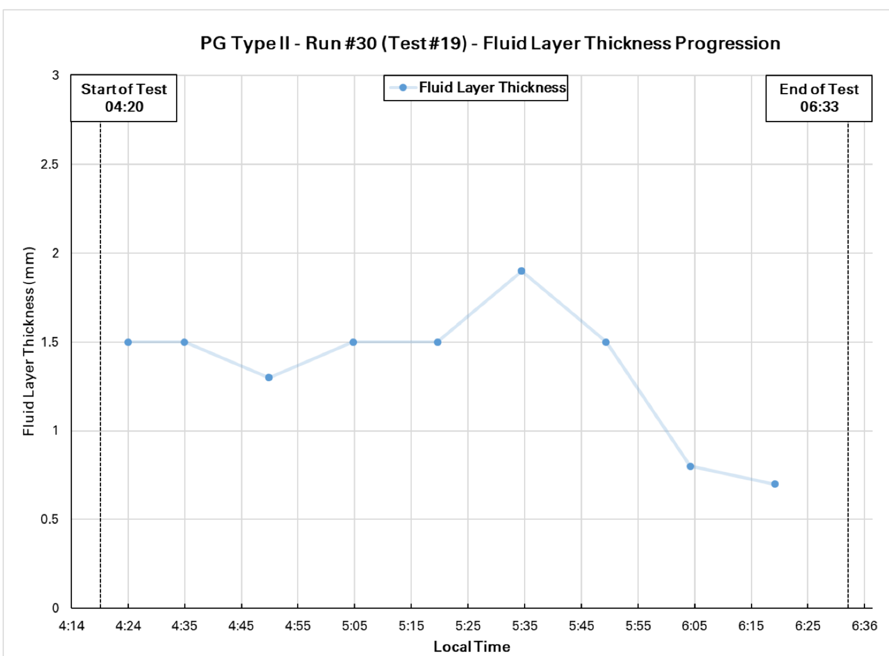


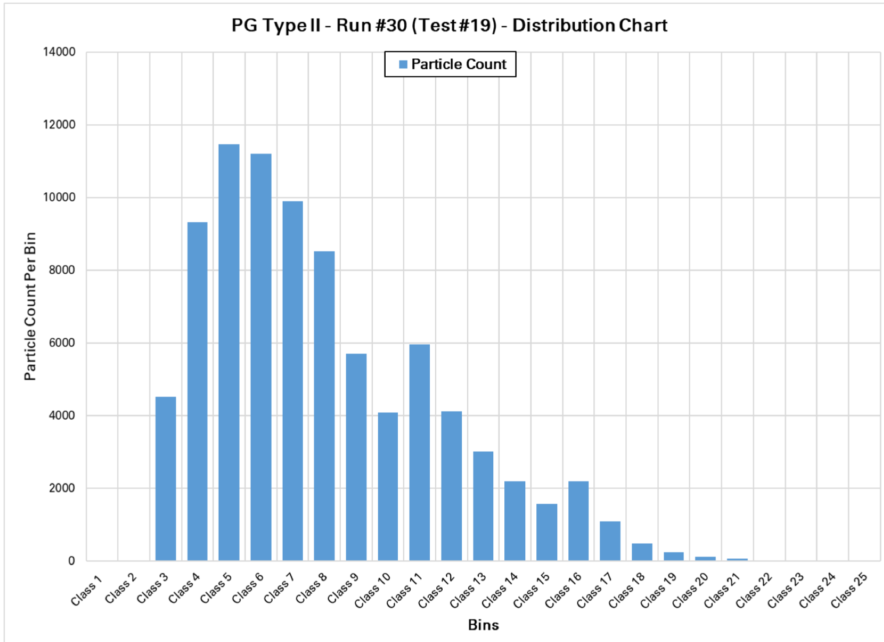
PG Type II - Run #30 (Test #19) - Relative Humidity
Start of Test 04:20
WS600 Sensor Relative Humidity
End of Test 06:33
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
6:36
Local Time



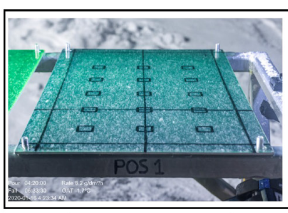
PG Type II - Run #30 (Test #19) - Fluid Brix Progression
Start of Test 04:20
Fluid Brix
End of Test 06:33
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
6:36
Local Time


PG Type II - Run #30 (Test #19) - Barometric Pressure
WS600 Sensor Barometric Pressure
Start of Test 04:20
End of Test 06:33
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
6:36
Local Time

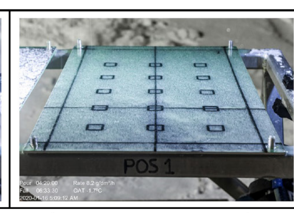

PG Type II - Run #30 (Test #19) - Fluid Layer Thickness Progression
Fluid Layer Thickness
Start of Test 04:20
End of Test 06:33
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
6:36
Local Time



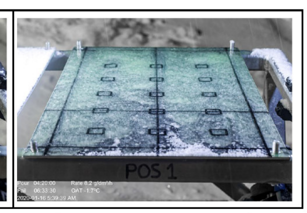
Safewing MP II Flight – Run 30 (Test 19) – Failure Progression Photos



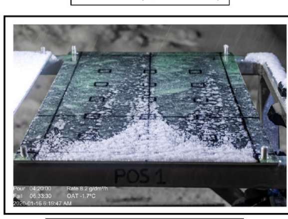
AT POUR (3/133 MIN)



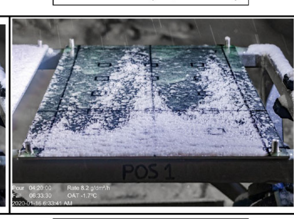
PRE-FAILURE (49/133 MIN)



PRE-FAILURE (79/133 MIN)



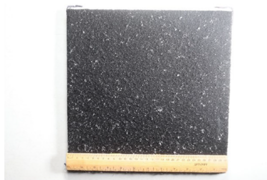
PRE-FAILURE (119/133 MIN)



AT FAILURE (133/133 MIN)

POST-FAILURE (140/133 MIN)

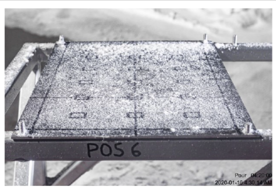
Safewing MP II Flight – Run 30 (Test 19) – Snow Characteristics Photos



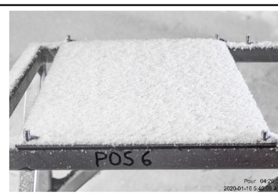
FELT PAD (5/133 MIN)

FELT PAD (70/133 MIN)

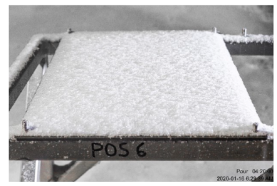
FELT PAD (130/133 MIN)



BARE PLATE (10/133 MIN)



BARE PLATE (80/133 MIN)



BARE PLATE (129/133 MIN)

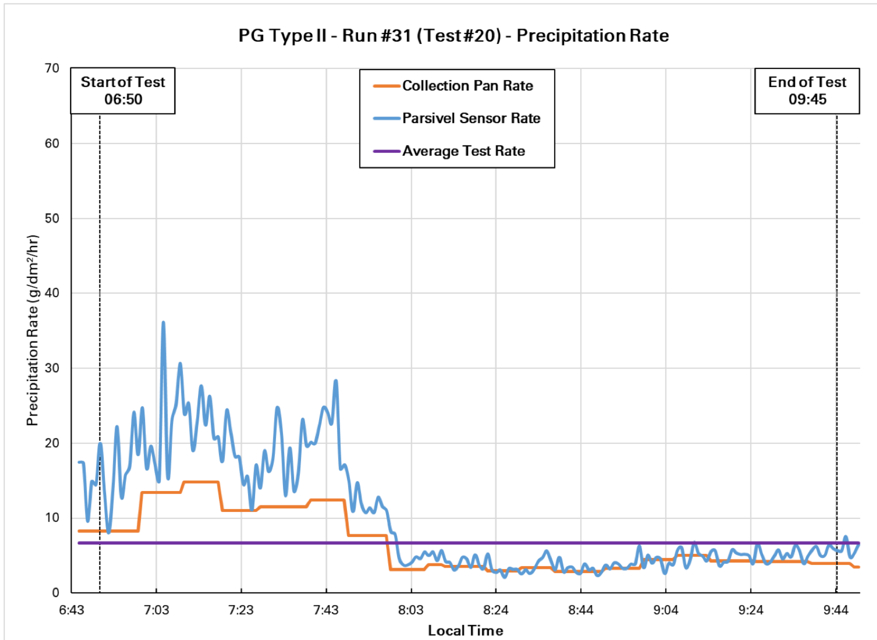
Final Bare Plate Contamination Thickness: **1.25 mm**

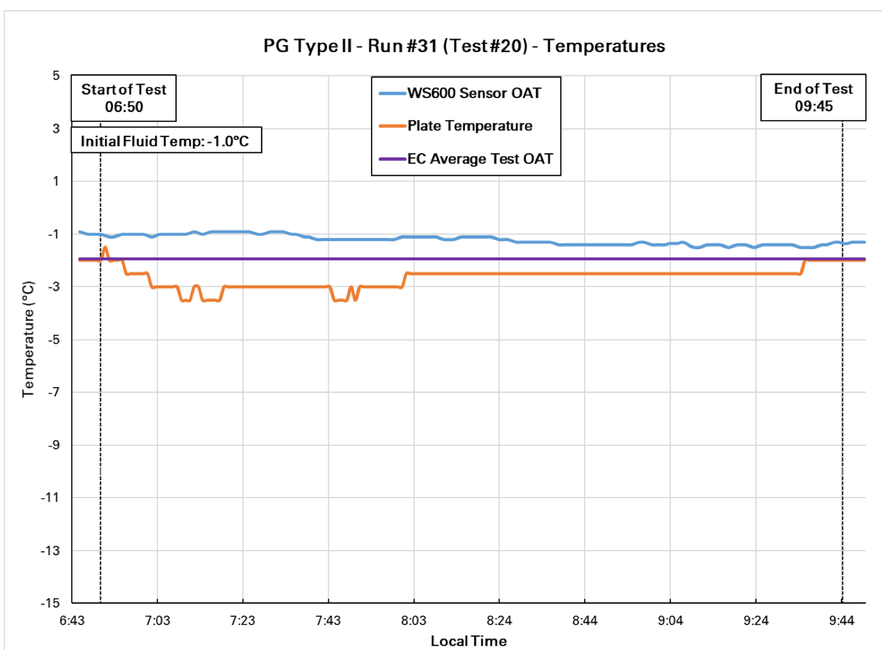
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

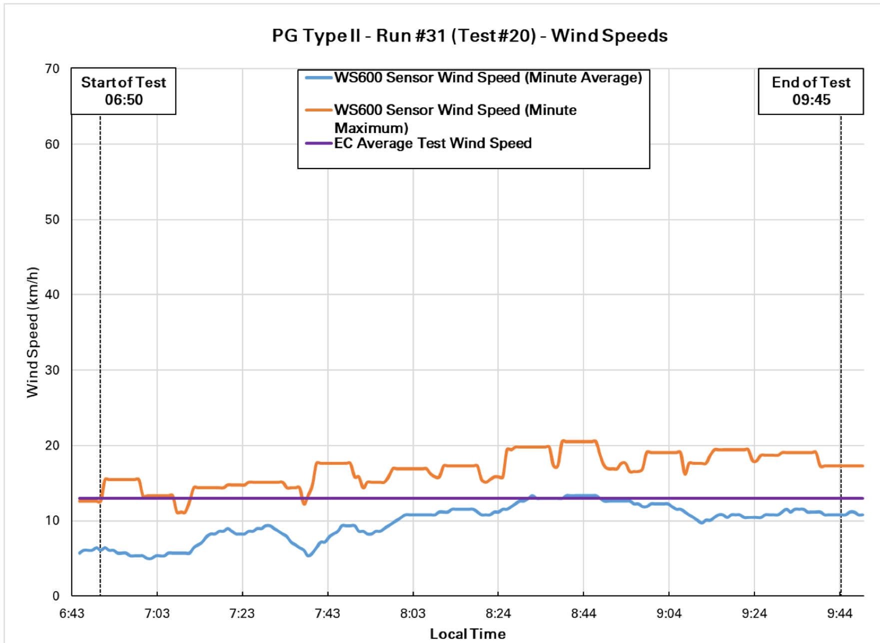
PG TYPE II
RUN #31 (TEST #20) – PG2-20

PG Type II – Run #31 (Test #20) – General Test Information

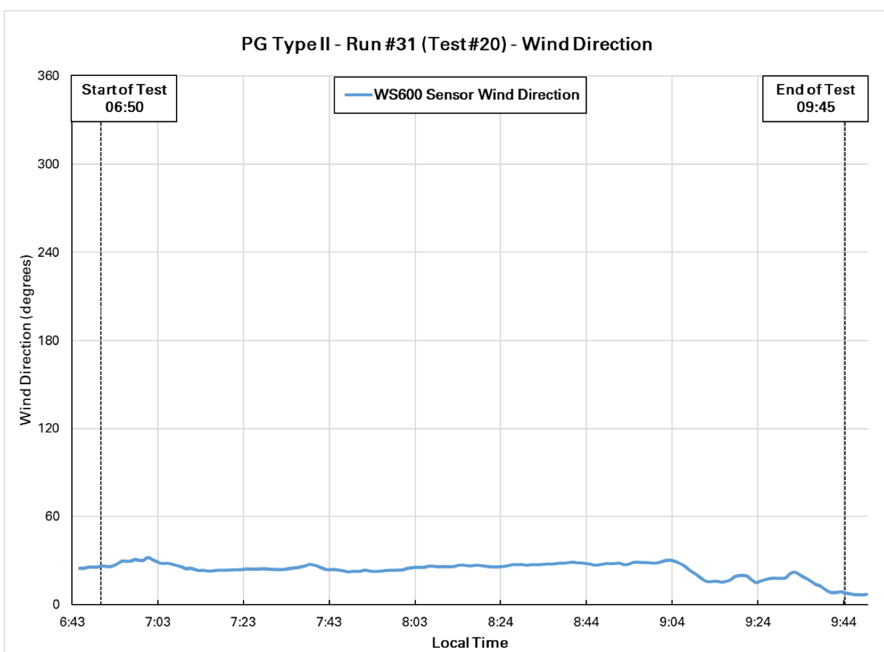
Test Number:	**PG2-20**
Date of Test:	**January 16, 2020**
Average OAT:	**-1.9**
Average Precipitation Rate:	**6.7 g/dm²/h**
Average Wind Speed:	**13.0 km/h**
Average Relative Humidity:	**92.9%**
Pour Time (Local):	**06:50:00**
Time of Fluid Failure (Local):	**09:45:00**
Fluid Brix at Failure:	**5°**
Endurance Time:	**175 minutes**
Expected Regression-Derived Endurance Time:	**183.4 minutes**
Difference (ET vs. Reg ET):	**- 7.9 minutes (- 4.3%)**


PG Type II - Run #31 (Test #20) - Precipitation Rate
Start of Test 06:50
End of Test 09:45
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
6:43
7:03
7:23
7:43
8:03
8:24
8:44
9:04
9:24
9:44
Local Time


PG Type II - Run #31 (Test #20) - Temperatures
Start of Test 06:50
Initial Fluid Temp: -1.0°C
End of Test 09:45
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
6:43
7:03
7:23
7:43
8:03
8:24
8:44
9:04
9:24
9:44
Local Time

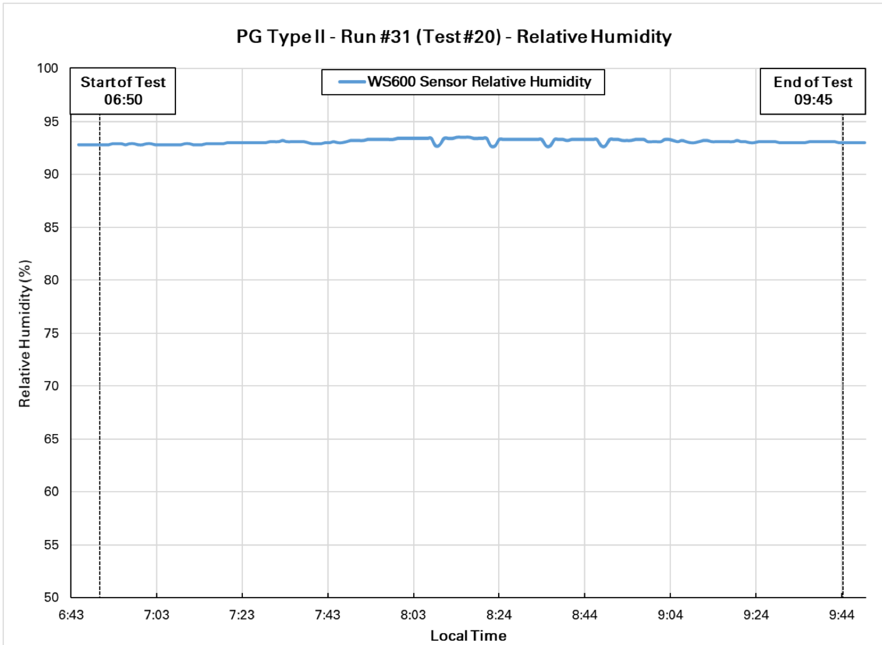


PG Type II - Run #31 (Test #20) - Wind Speeds
Start of Test 06:50
End of Test 09:45
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
6:43
7:03
7:23
7:43
8:03
8:24
8:44
9:04
9:24
9:44
Local Time



PG Type II - Run #31 (Test #20) - Wind Direction
Start of Test 06:50
End of Test 09:45
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
6:43
7:03
7:23
7:43
8:03
8:24
8:44
9:04
9:24
9:44
Local Time

DATA PACKAGE – PG TYPE II – RUN 31 (TEST 20)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 31 - Test 20/Data Package - PG Type II - Run 31 - Test 20.docx
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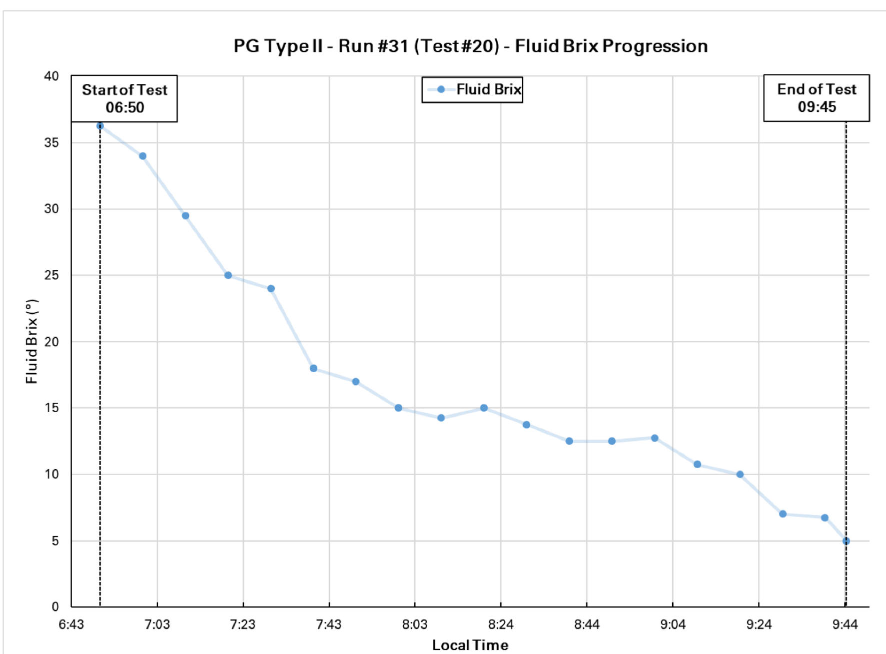
DATA PACKAGE – PG TYPE II – RUN 31 (TEST 20)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 31 - Test 20/Data Package - PG Type II - Run 31 - Test 20.docx
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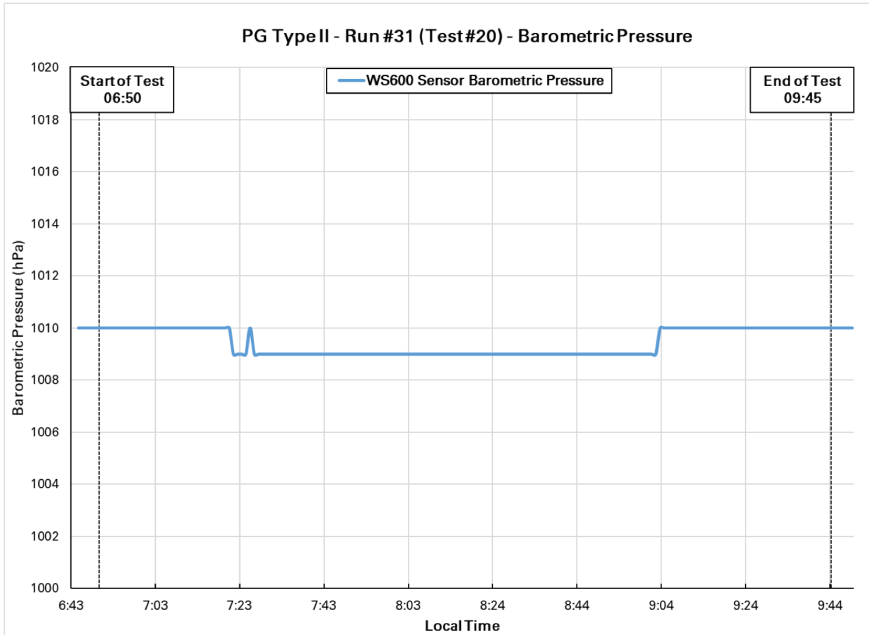
DATA PACKAGE – PG TYPE II – RUN 31 (TEST 20)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 31 - Test 20/Data Package - PG Type II - Run 31 - Test 20.docx
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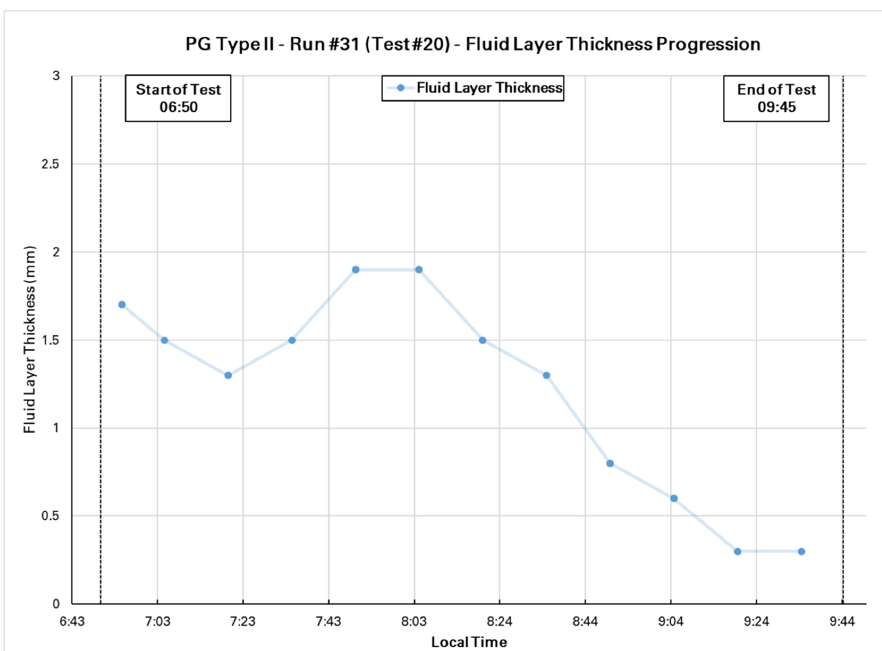
DATA PACKAGE – PG TYPE II – RUN 31 (TEST 20)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 31 - Test 20/Data Package - PG Type II - Run 31 - Test 20.docx
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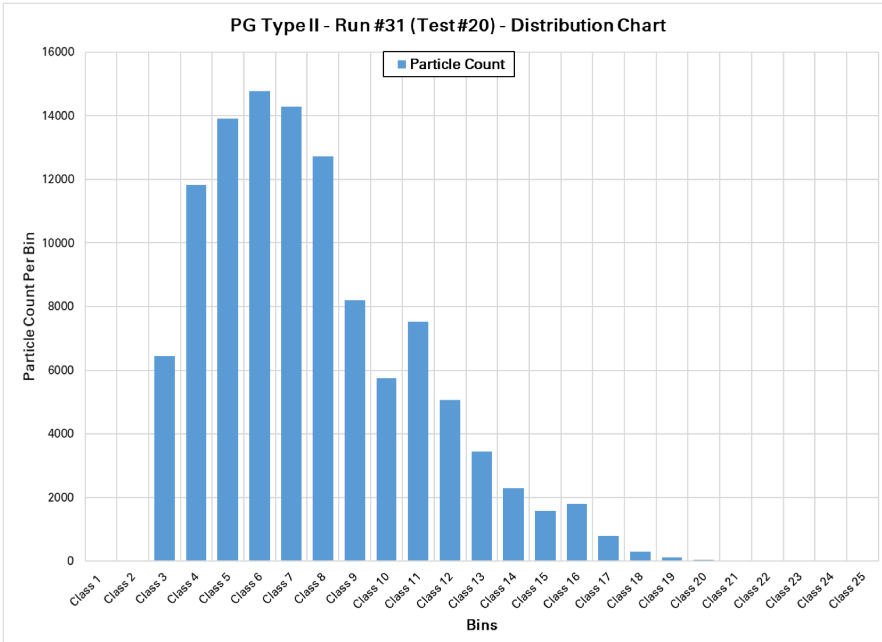
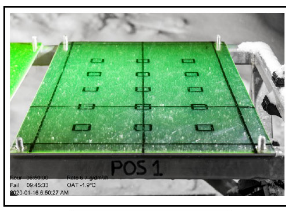
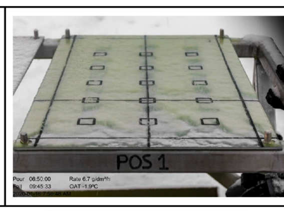


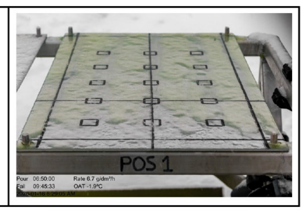
Safewing MP II Flight – Run 31 (Test 20) – Failure Progression Photos



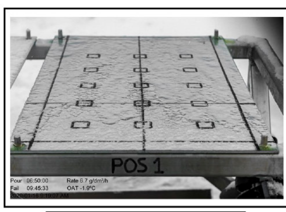
AT POUR (0/175 MIN)



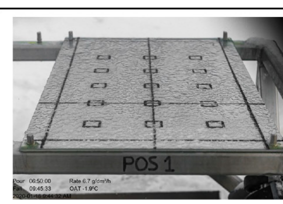
PRE-FAILURE (68/175 MIN)



PRE-FAILURE (99/175 MIN)



PRE-FAILURE (149/175 MIN)



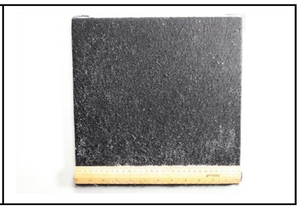
AT FAILURE (174/175 MIN)

POST-FAILURE (179/175 MIN)

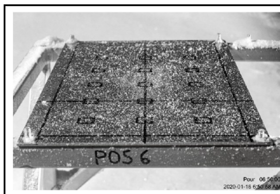
Safewing MP II Flight – Run 31 (Test 20) – Snow Characteristics Photos

FELT PAD (20/175 MIN)

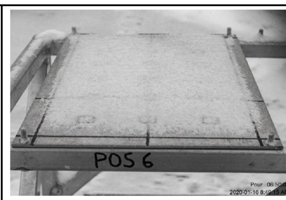
FELT PAD (70/175 MIN)



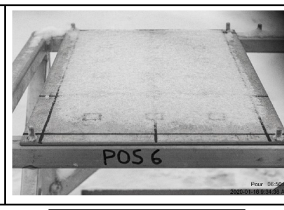
FELT PAD (161/175 MIN)



BARE PLATE (0/175 MIN)



BARE PLATE (119/175 MIN)



BARE PLATE (164/175 MIN)

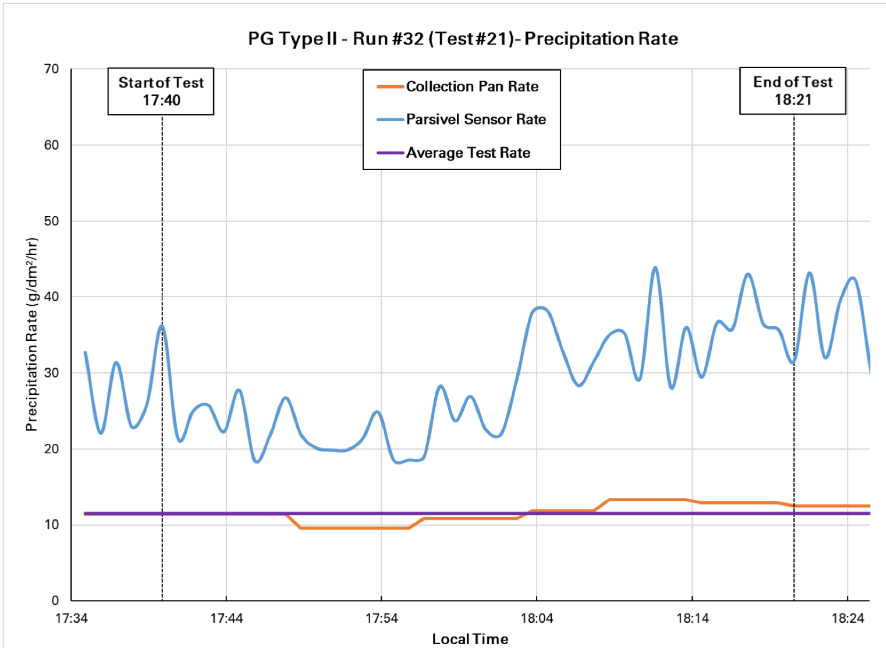
Final Bare Plate Contamination Thickness: **0.3mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

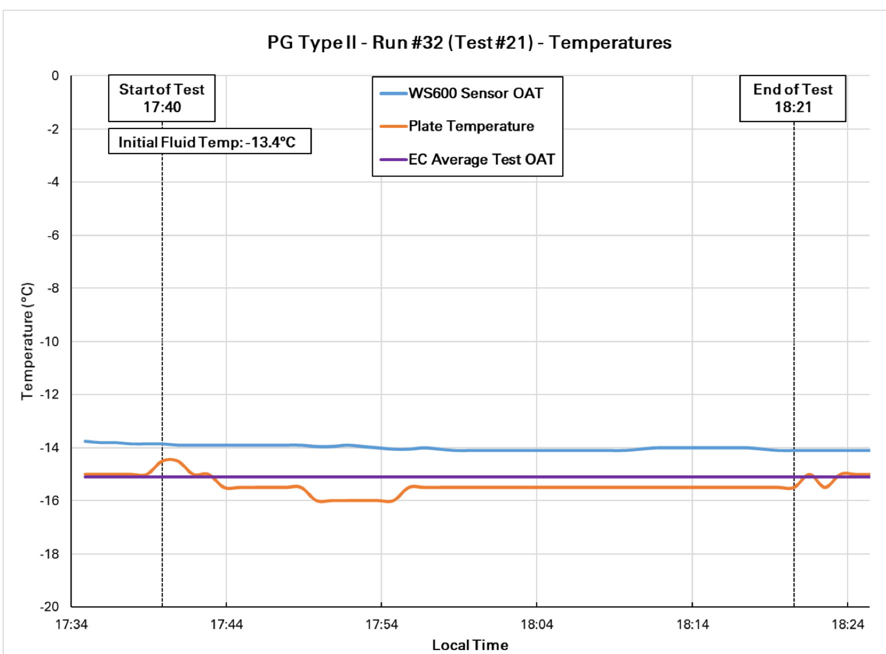
PG TYPE II
RUN #32 (TEST #21) – PG2-21

PG Type II – Run #32 (Test #21) – General Test Information

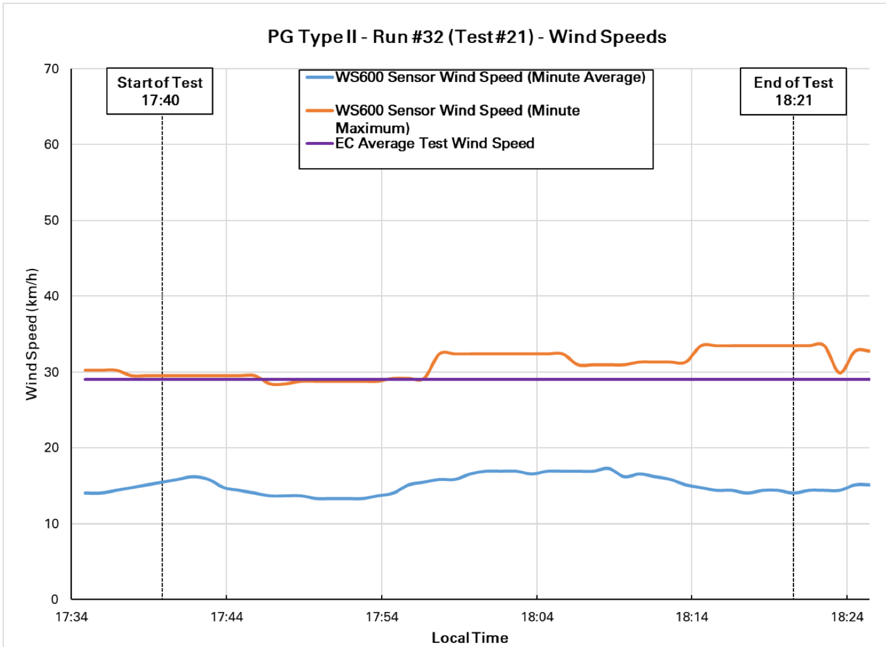
Test Number:	**PG2-21**
Date of Test:	**January 18, 2020**
Average OAT:	**-15.1**
Average Precipitation Rate:	**11.5 g/dm²/h**
Average Wind Speed:	**29.0 km/h**
Average Relative Humidity:	**75.36%**
Pour Time (Local):	**17:40:00**
Time of Fluid Failure (Local):	**18:21:00**
Fluid Brix at Failure:	**23.5°**
Endurance Time:	**41 minutes**
Expected Regression-Derived Endurance Time:	**48.2 minutes**
Difference (ET vs. Reg ET):	**- 54.2 minutes (- 13.0%)**

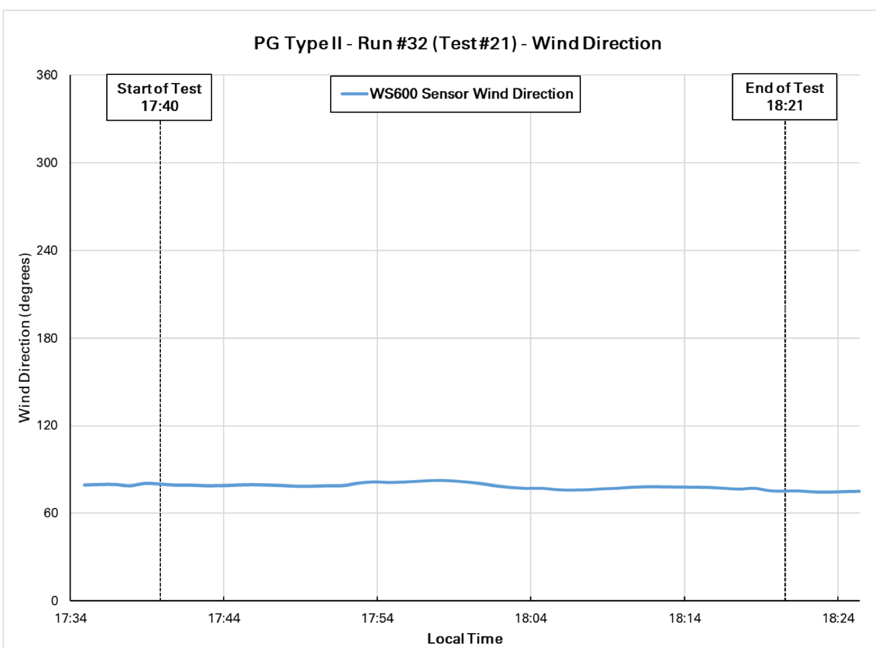


PG Type II - Run #32 (Test #21) - Precipitation Rate
Start of Test 17:40
End of Test 18:21
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
17:34
17:44
17:54
18:04
18:14
18:24
Local Time

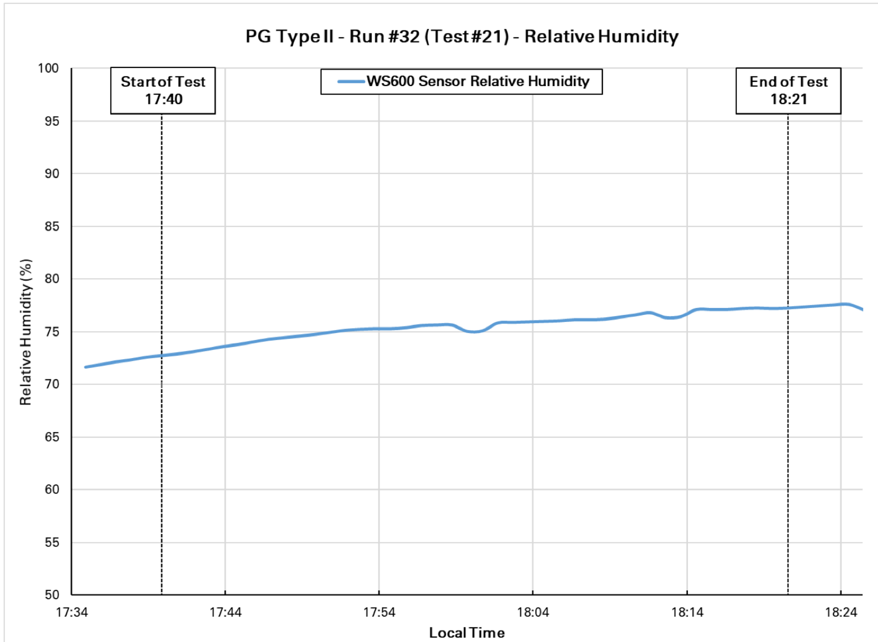


PG Type II - Run #32 (Test #21) - Temperatures
Start of Test 17:40
Initial Fluid Temp: -13.4°C
End of Test 18:21
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
17:34
17:44
17:54
18:04
18:14
18:24
Local Time


PG Type II - Run #32 (Test #21) - Wind Speeds
Start of Test 17:40
End of Test 18:21
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
17:34
17:44
17:54
18:04
18:14
18:24
Local Time


PG Type II - Run #32 (Test #21) - Wind Direction
Start of Test 17:40
End of Test 18:21
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
17:34
17:44
17:54
18:04
18:14
18:24
Local Time

DATA PACKAGE – PG TYPE II – RUN 32 (TEST 21)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 32 - Test 21/Data Package - PG Type II - Run 32 - Test 21.docx
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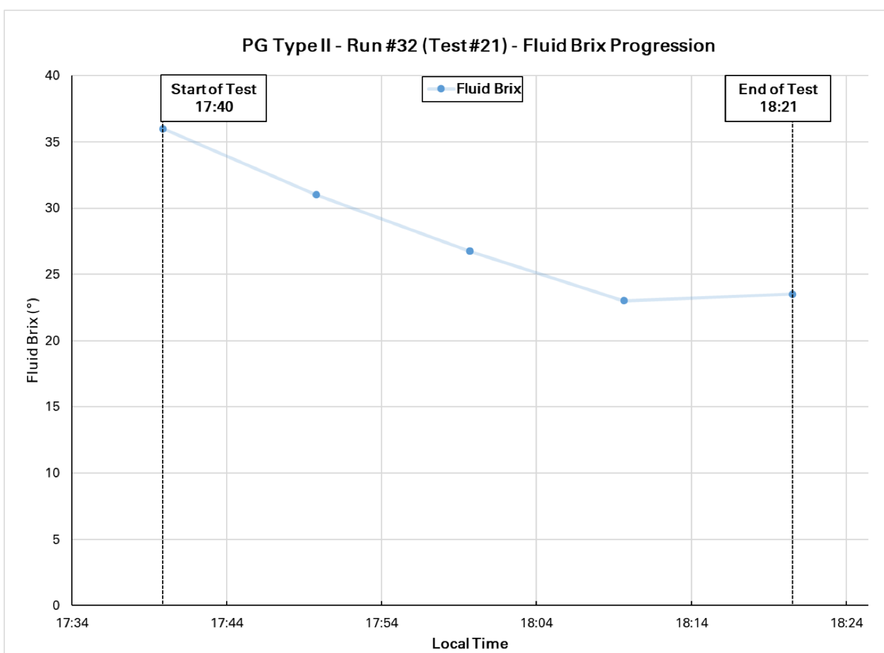
DATA PACKAGE – PG TYPE II – RUN 32 (TEST 21)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 32 - Test 21/Data Package - PG Type II - Run 32 - Test 21.docx
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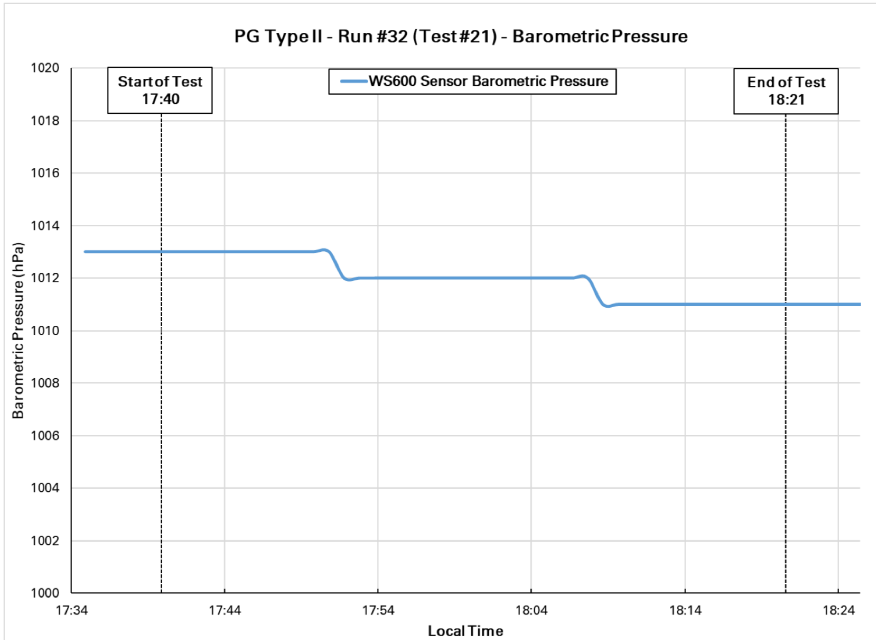
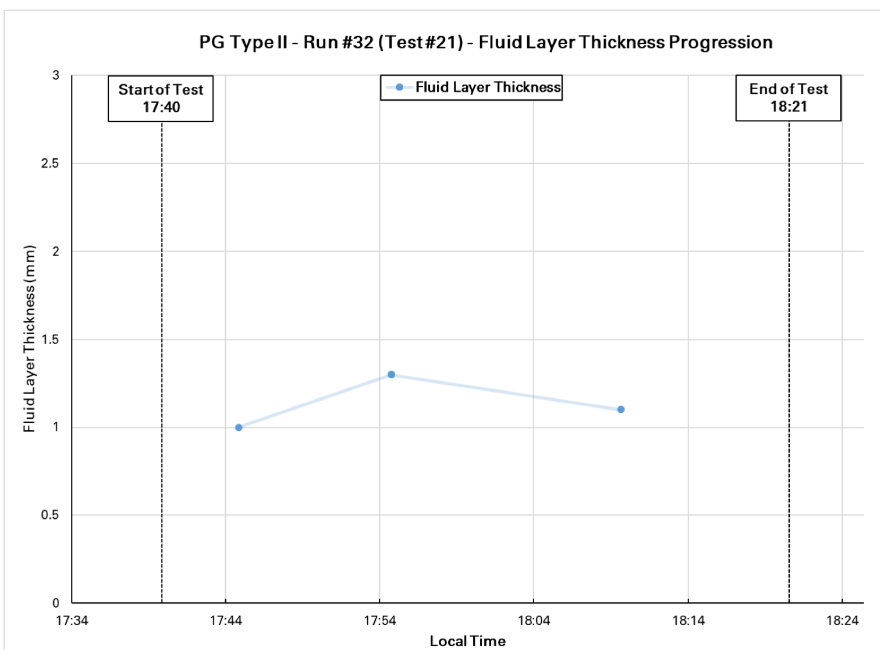
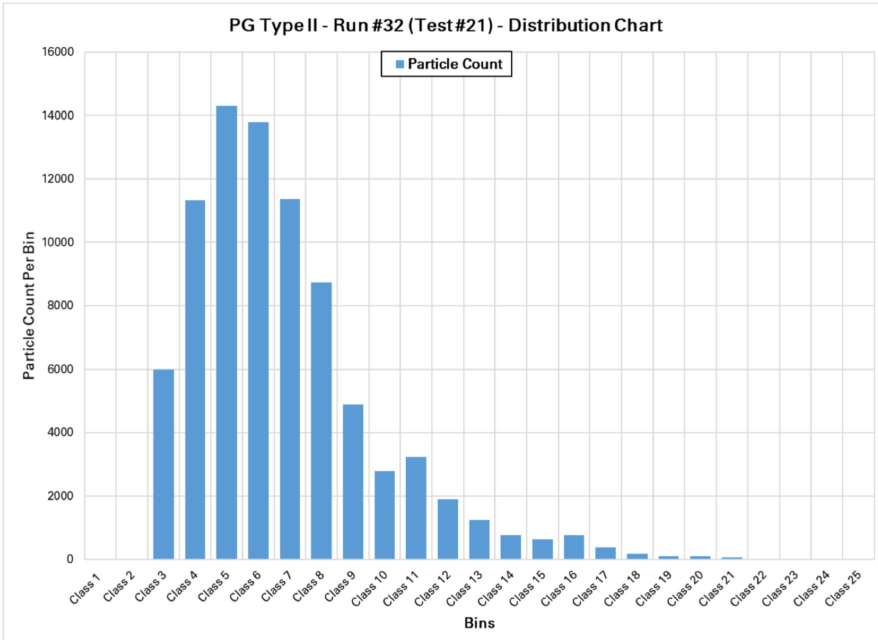


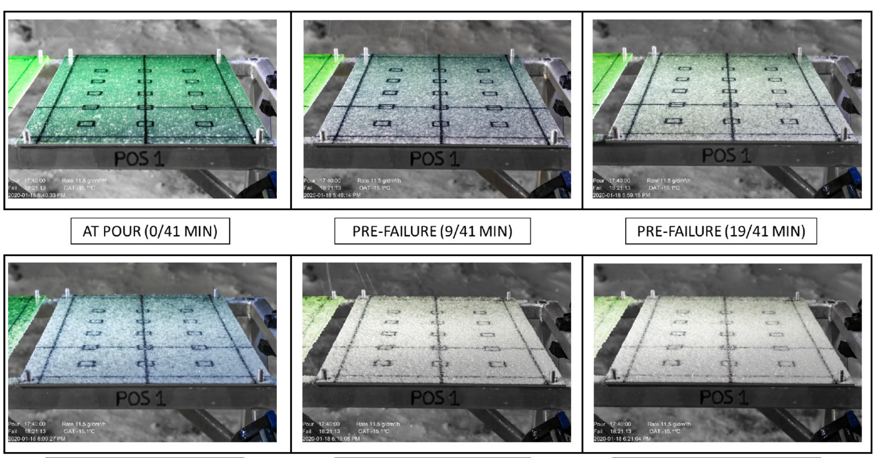
PG Type II - Run #32 (Test #21) - Barometric Pressure
Start of Test 17:40
WS600 Sensor Barometric Pressure
End of Test 18:21
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
17:34
17:44
17:54
18:04
18:14
18:24
Local Time



PG Type II - Run #32 (Test #21) - Fluid Layer Thickness Progression
Start of Test 17:40
Fluid Layer Thickness
End of Test 18:21
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
17:34
17:44
17:54
18:04
18:14
18:24
Local Time



Safewing MP II Flight – Run 32 (Test 21) – Failure Progression Photos



AT POUR (0/41 MIN) | PRE-FAILURE (9/41 MIN) | PRE-FAILURE (19/41 MIN)

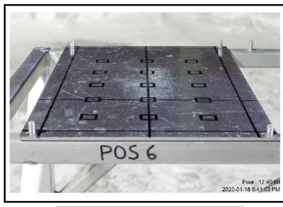
PRE-FAILURE (29/41 MIN) | PRE-FAILURE (39/41 MIN) | AT FAILURE (41/41 MIN)

Safewing MP II Flight – Run 32 (Test 21) – Snow Characteristics Photos

FELT PAD (2/41 MIN)

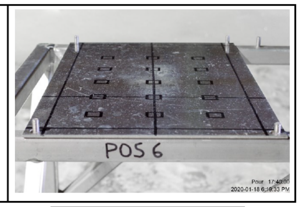
FELT PAD (21/41 MIN)

FELT PAD (41/41 MIN)



BARE PLATE (1/41 MIN)

BARE PLATE (19/41 MIN)



BARE PLATE (39/41 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

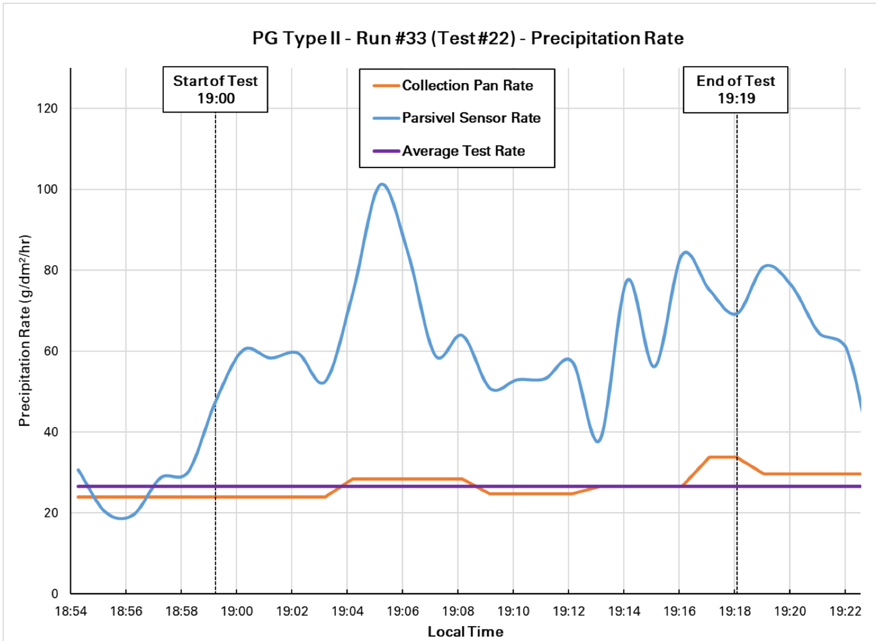
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #33 (TEST #22) – PG2-22

PG Type II – Run #33 (Test #22) – General Test Information

Test Number:	**PG2-22**
Date of Test:	**January 18, 2020**
Average OAT:	**-15.1**
Average Precipitation Rate:	**26.5 g/dm²/h**
Average Wind Speed:	**31.0 km/h**
Average Relative Humidity:	**78.3%**
Pour Time (Local):	**19:00:00**
Time of Fluid Failure (Local):	**19:19:00**
Fluid Brix at Failure:	**24.5°**
Endurance Time:	**19 minutes**
Expected Regression-Derived Endurance Time:	**27.4 minutes**
Difference (ET vs. Reg ET):	**- 7.9 minutes (- 28.9%)**

DATA PACKAGE – PG TYPE II – RUN 33 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 33 - Test 22/Data Package - PG Type II - Run 33 - Test 22.docx
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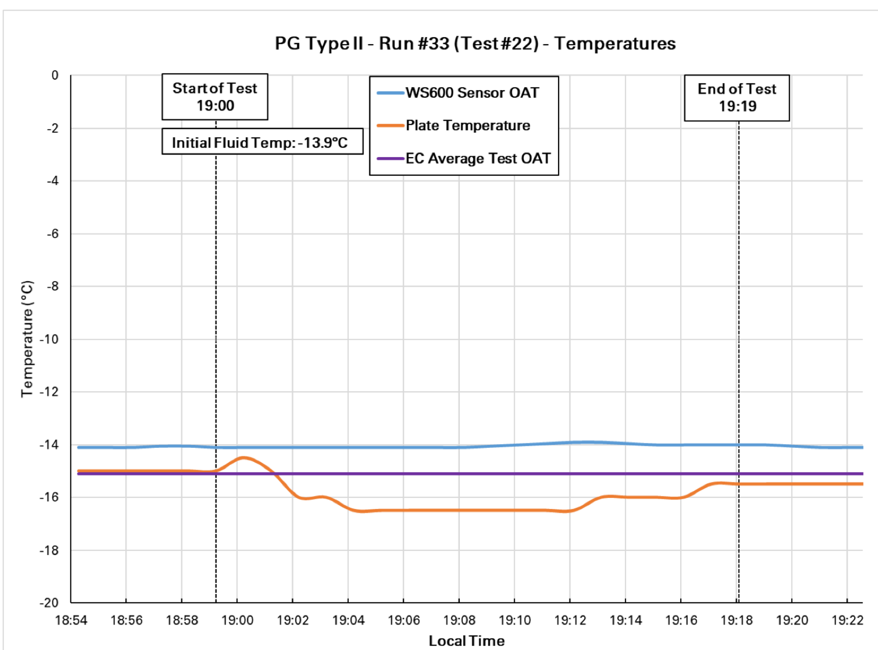
DATA PACKAGE – PG TYPE II – RUN 33 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 33 - Test 22/Data Package - PG Type II - Run 33 - Test 22.docx
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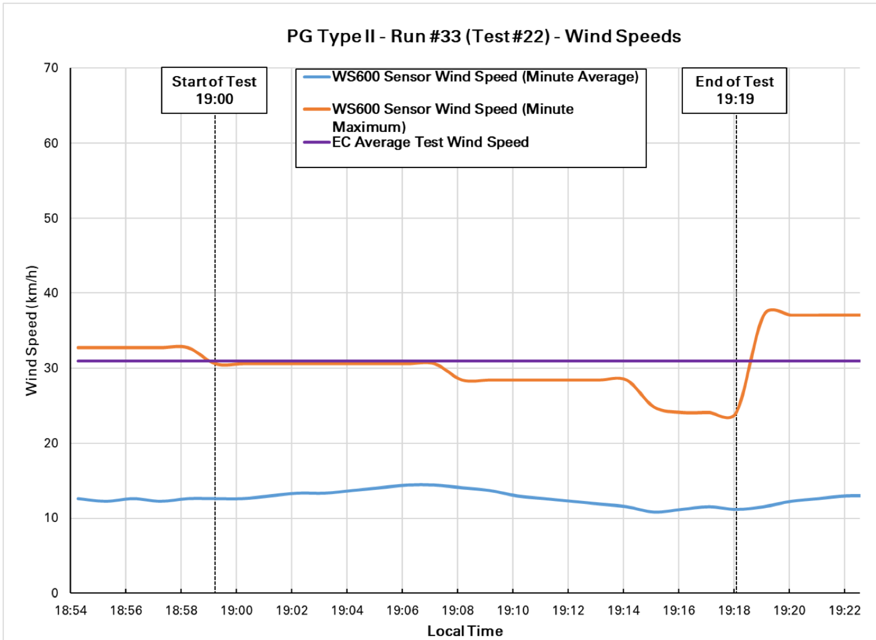
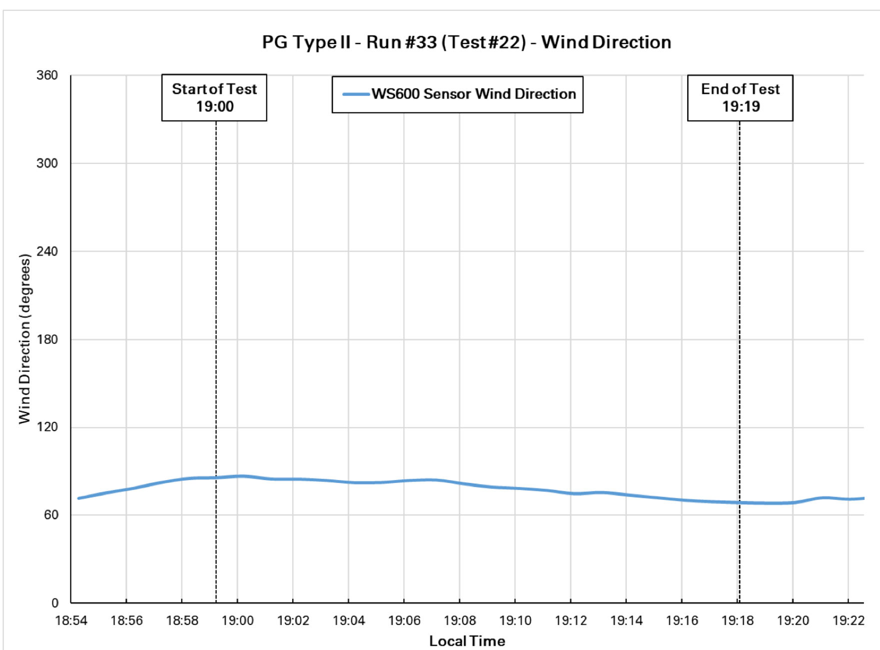
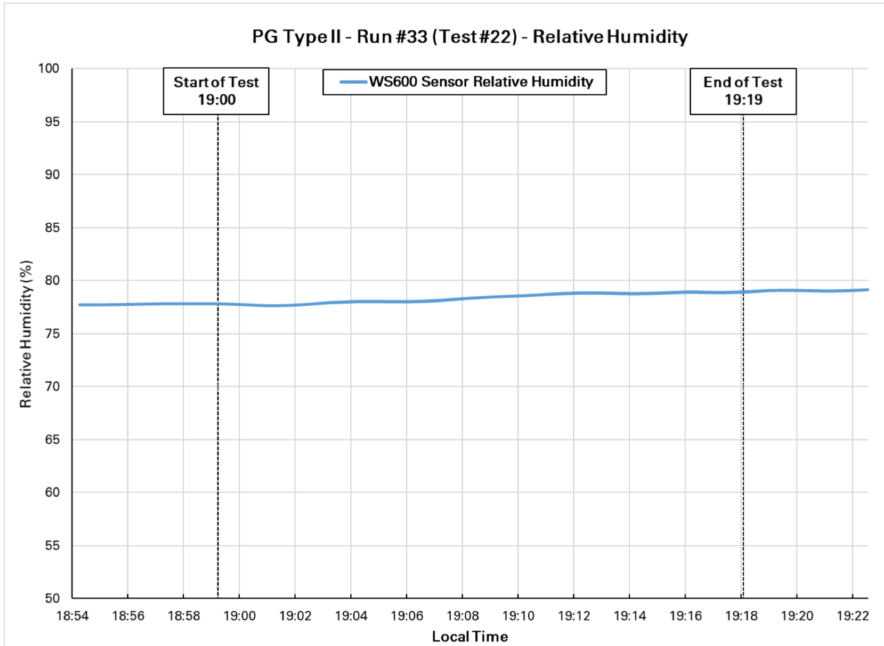


PG Type II - Run #33 (Test #22) - Wind Speeds
Start of Test 19:00
End of Test 19:19
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
18:54
18:56
18:58
19:00
19:02
19:04
19:06
19:08
19:10
19:12
19:14
19:16
19:18
19:20
19:22
Local Time



PG Type II - Run #33 (Test #22) - Wind Direction
Start of Test 19:00
End of Test 19:19
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
18:54
18:56
18:58
19:00
19:02
19:04
19:06
19:08
19:10
19:12
19:14
19:16
19:18
19:20
19:22
Local Time

DATA PACKAGE – PG TYPE II – RUN 33 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 33 - Test 22/Data Package - PG Type II - Run 33 - Test 22.docx
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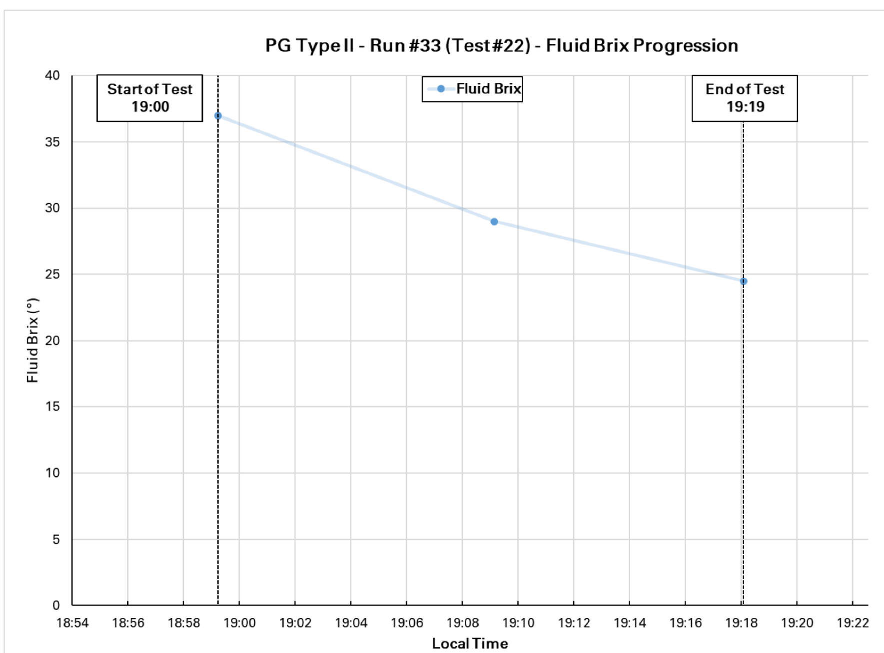
DATA PACKAGE – PG TYPE II – RUN 33 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 33 - Test 22/Data Package - PG Type II - Run 33 - Test 22.docx
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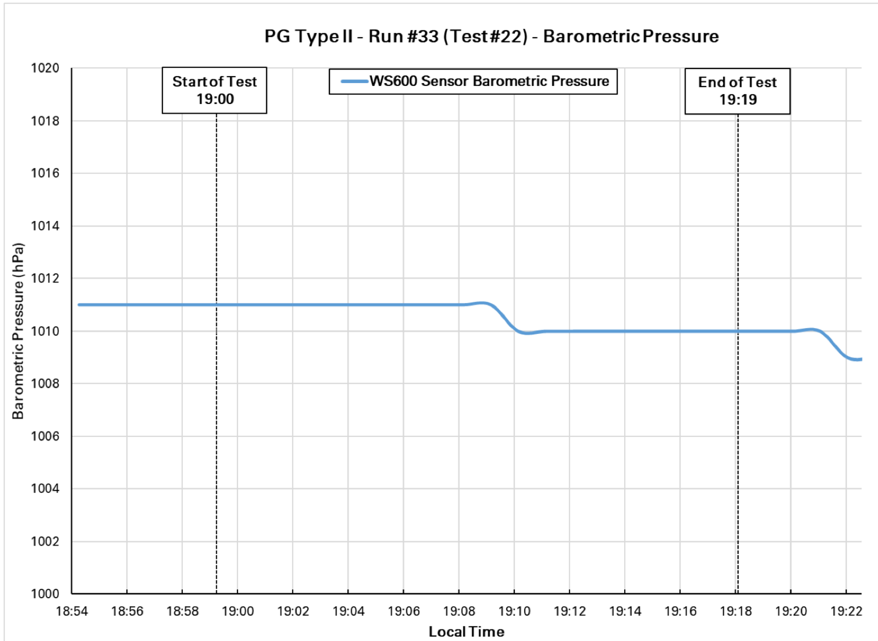
DATA PACKAGE – PG TYPE II – RUN 33 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 33 - Test 22/Data Package - PG Type II - Run 33 - Test 22.docx
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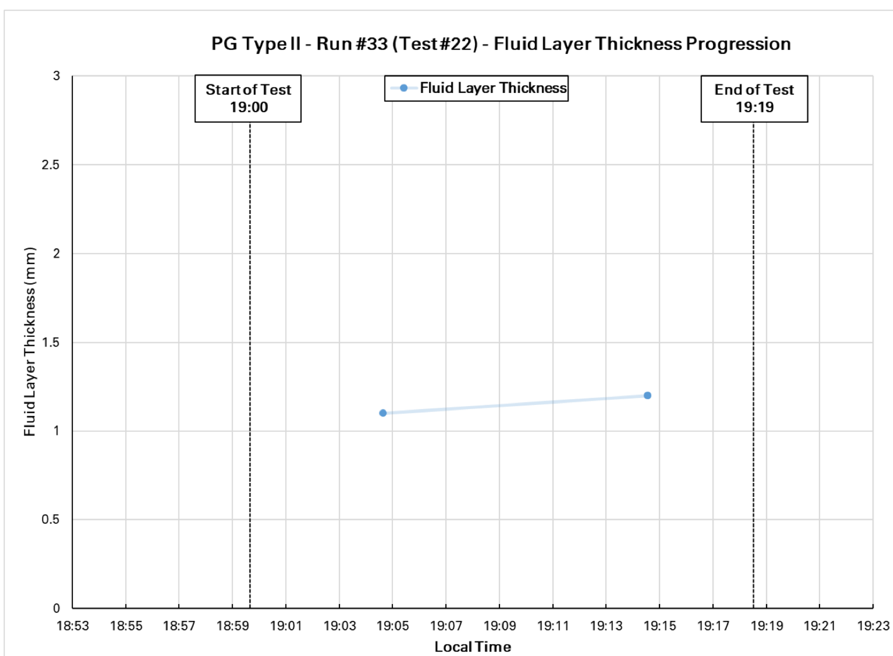
DATA PACKAGE – PG TYPE II – RUN 33 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 33 - Test 22/Data Package - PG Type II - Run 33 - Test 22.docx
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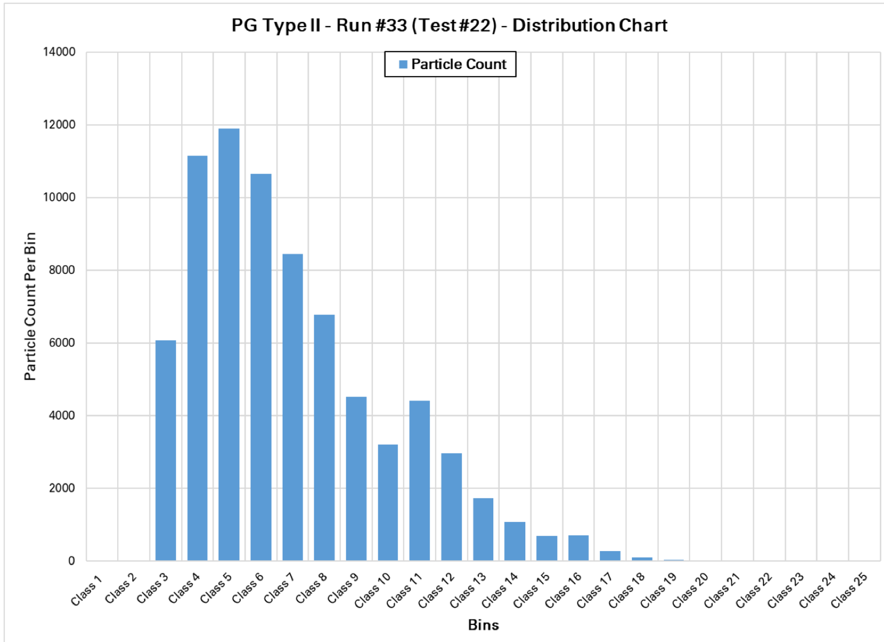
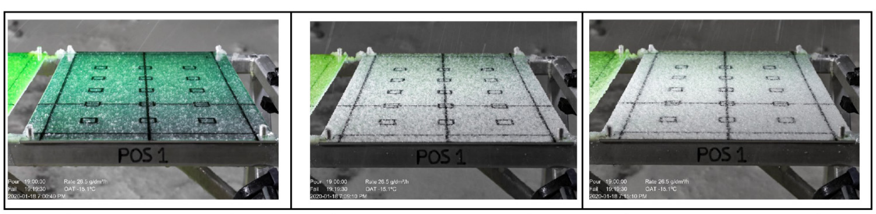
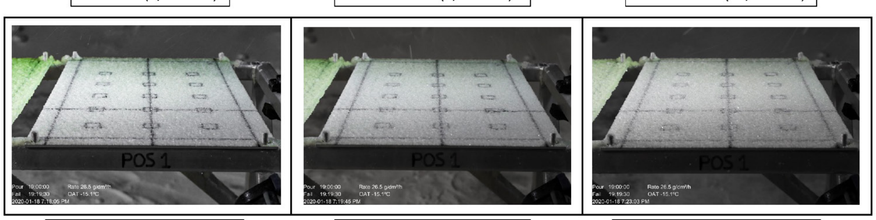


Safewing MP II Flight – Run 33 (Test 22) – Failure Progression Photos



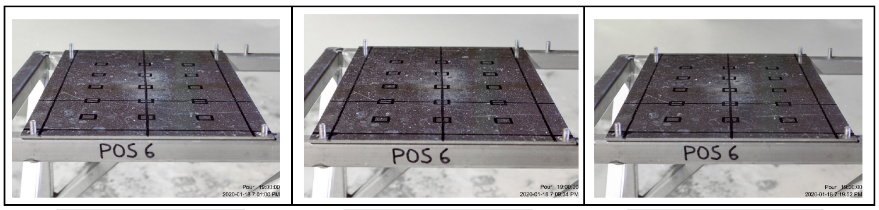
AT POUR (0/19 MIN) | PRE-FAILURE (9/19 MIN) | PRE-FAILURE (15/19 MIN)



PRE-FAILURE (18/19 MIN) | AT FAILURE (19/19 MIN) | POST-FAILURE (23/19 MIN)

Safewing MP II Flight – Run 33 (Test 22) – Snow Characteristics Photos

FELT PAD (1/19 MIN) | FELT PAD (10/19 MIN) | FELT PAD (18/19 MIN)



BARE PLATE (1/19 MIN) | BARE PLATE (9/19 MIN) | BARE PLATE (19/19 MIN)

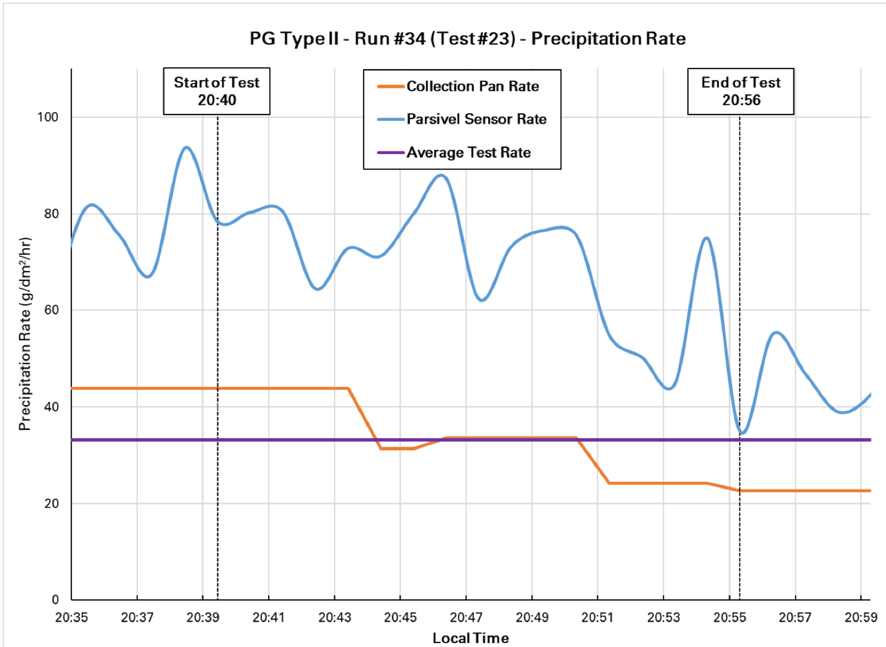
Final Bare Plate Contamination Thickness: **Nil (0mm)**

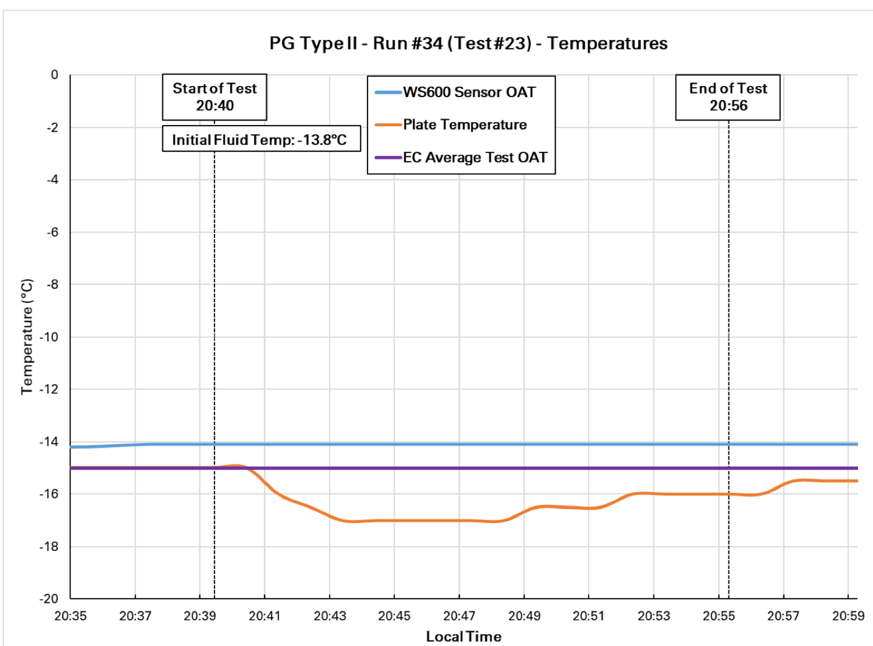
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

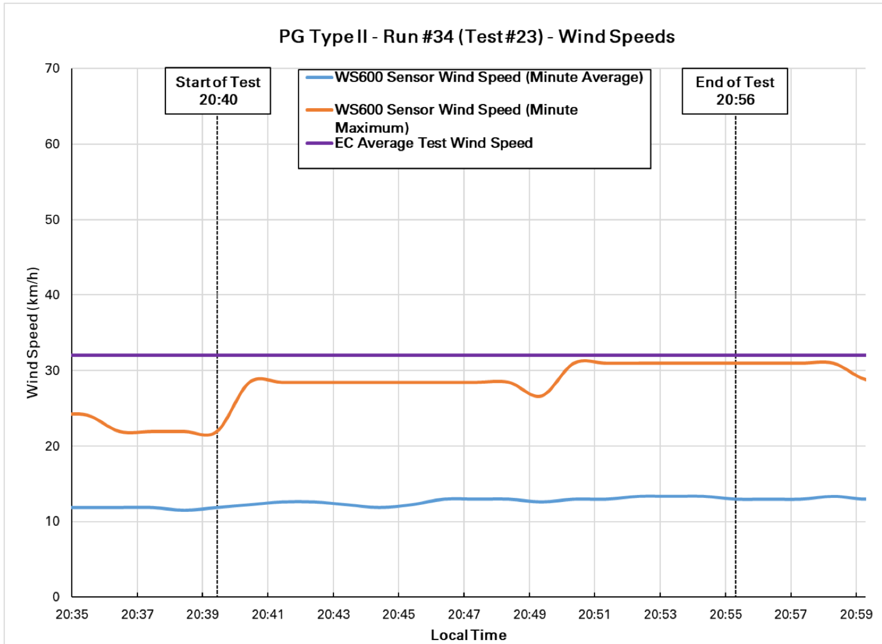
PG TYPE II
RUN #34 (TEST #23) – PG2-23

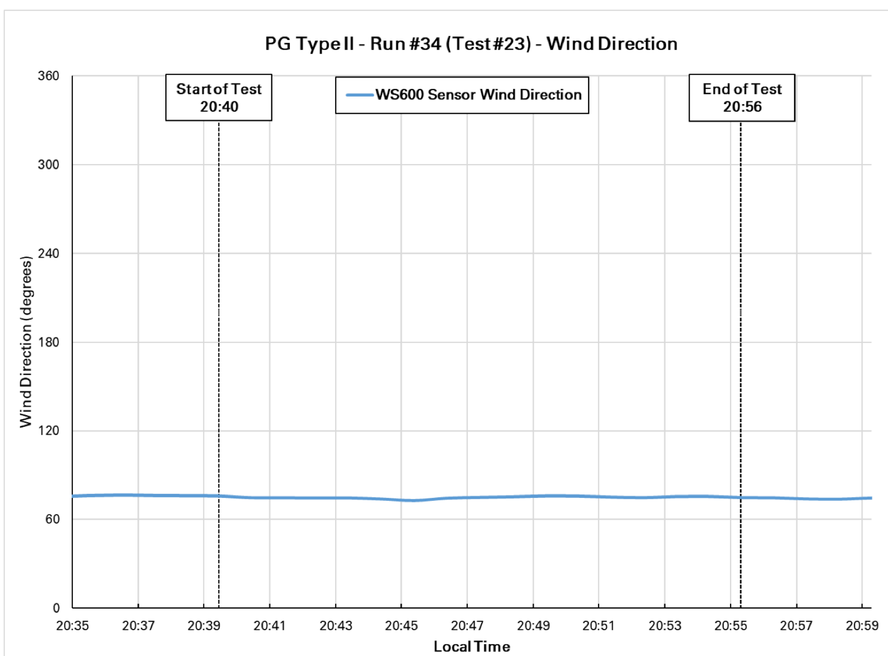
PG Type II – Run #34 (Test #23) – General Test Information

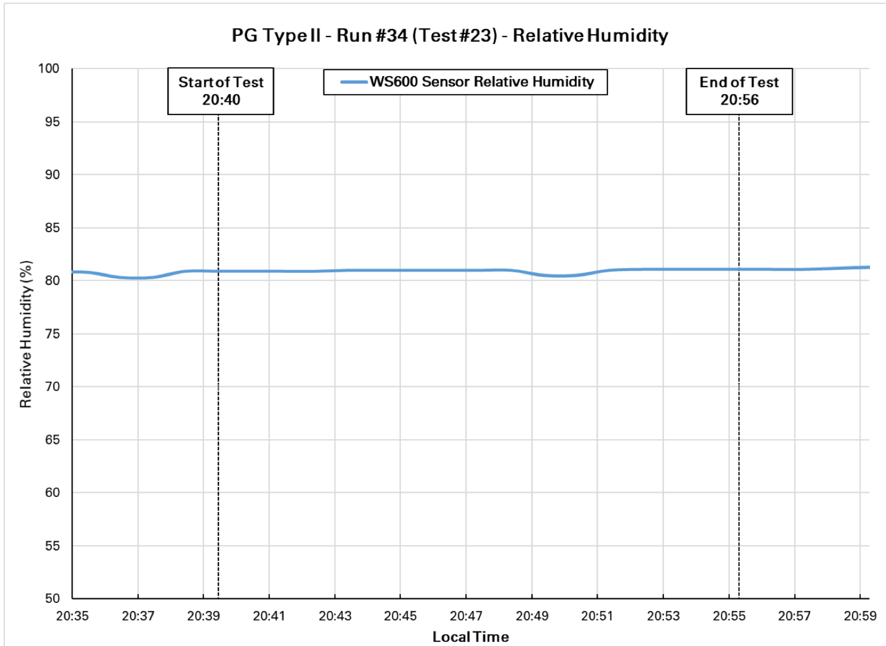
Test Number:	PG2-23
Date of Test:	January 18, 2020
Average OAT:	-15.0
Average Precipitation Rate:	33.1 g/dm²/h
Average Wind Speed:	32.0 km/h
Average Relative Humidity:	80.9%
Pour Time (Local):	20:40:00
Time of Fluid Failure (Local):	20:56:00
Fluid Brix at Failure:	25.75°
Endurance Time:	16 minutes
Expected Regression-Derived Endurance Time:	23 minutes
Difference (ET vs. Reg ET):	- 6.6 minutes (- 28.9%)


PG Type II - Run #34 (Test #23) - Precipitation Rate
Start of Test 20:40
End of Test 20:56
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time

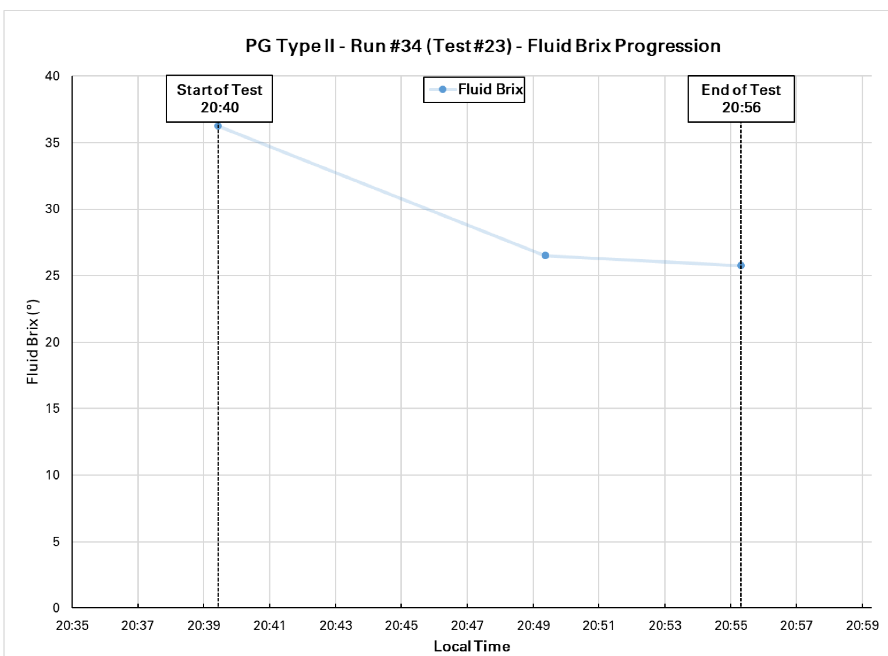

PG Type II - Run #34 (Test #23) - Temperatures
Start of Test 20:40
Initial Fluid Temp: -13.8°C
End of Test 20:56
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time


PG Type II - Run #34 (Test #23) - Wind Speeds
Start of Test
20:40
End of Test
20:56
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time

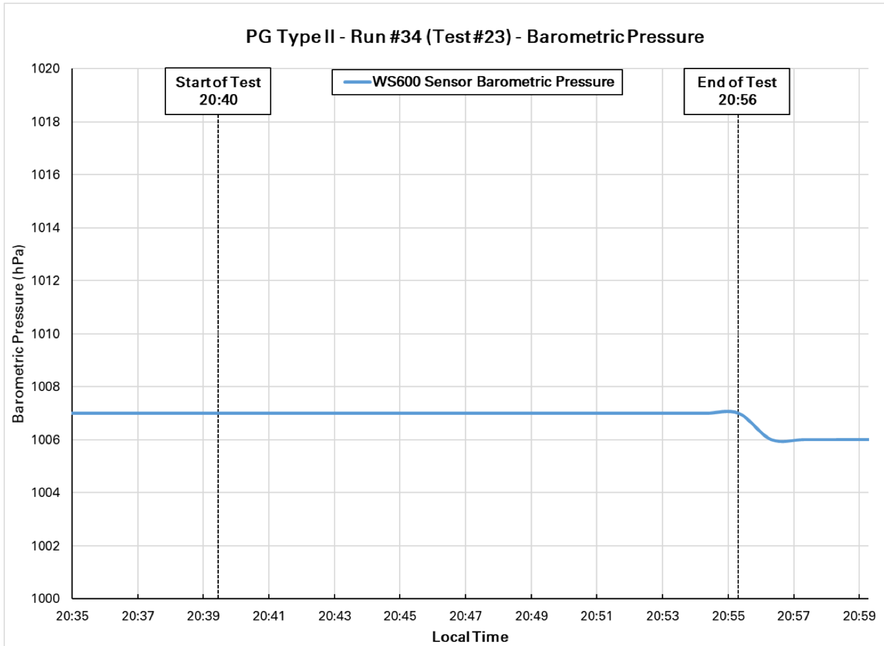

PG Type II - Run #34 (Test #23) - Wind Direction
Start of Test
20:40
WS600 Sensor Wind Direction
End of Test
20:56
Wind Direction (degrees)
0
60
120
180
240
300
360
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time

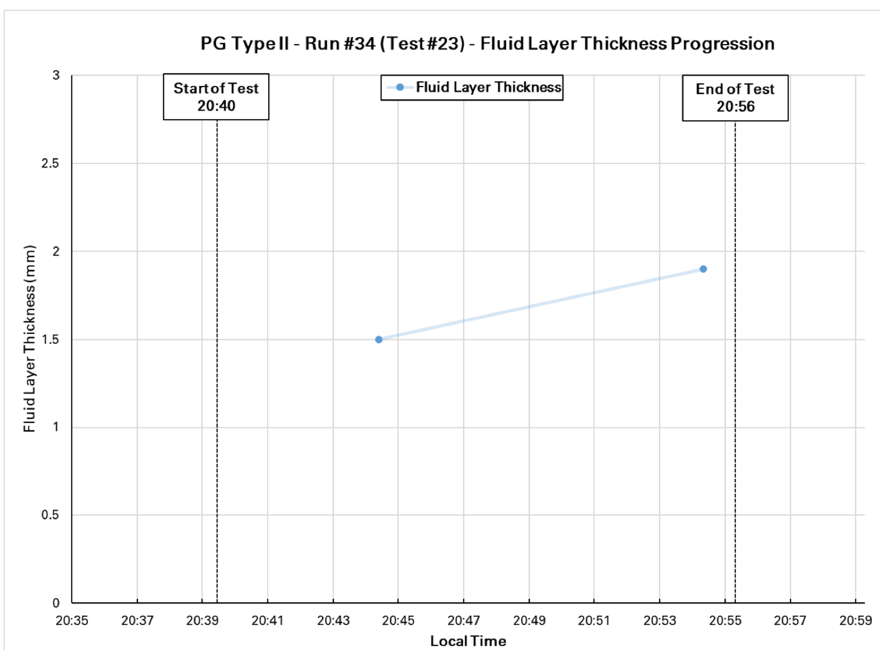


PG Type II - Run #34 (Test #23) - Relative Humidity
Start of Test 20:40
WS600 Sensor Relative Humidity
End of Test 20:56
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time

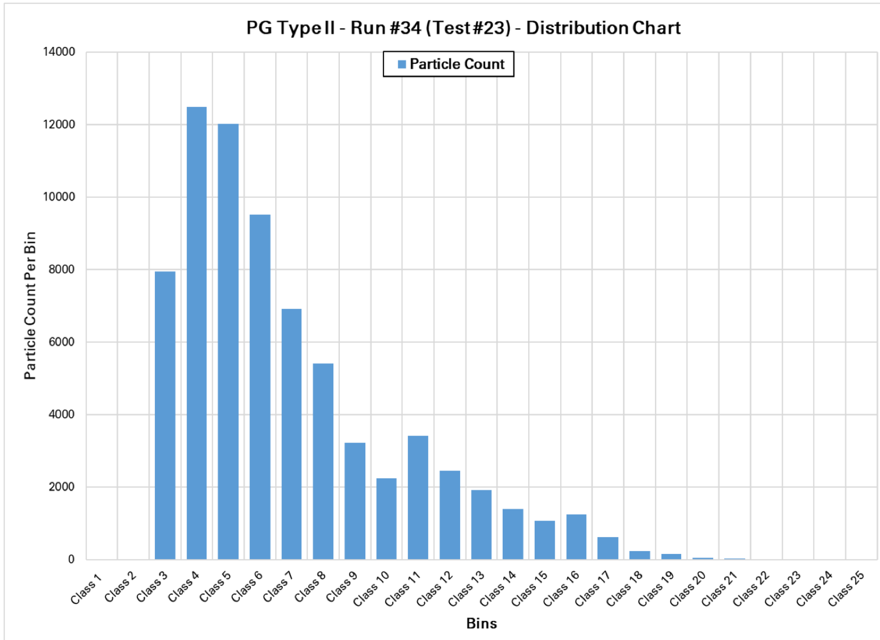


PG Type II - Run #34 (Test #23) - Fluid Brix Progression
Start of Test 20:40
Fluid Brix
End of Test 20:56
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time


PG Type II - Run #34 (Test #23) - Barometric Pressure
Start of Test 20:40
WS600 Sensor Barometric Pressure
End of Test 20:56
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time


PG Type II - Run #34 (Test #23) - Fluid Layer Thickness Progression
Start of Test 20:40
Fluid Layer Thickness
End of Test 20:56
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
20:57
20:59
Local Time

DATA PACKAGE – PG TYPE II – RUN 34 (TEST 23)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 34 - Test 23/Data Package - PG Type II - Run 34 - Test 23.docx
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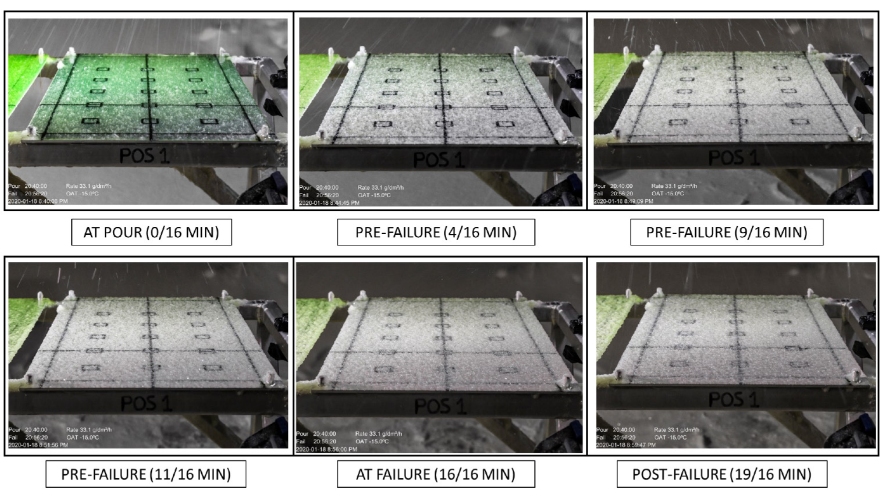
DATA PACKAGE – PG TYPE II – RUN 34 (TEST 23)

Safewing MP II Flight – Run 34 (Test 23) – Failure Progression Photos



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 34 - Test 23/Data Package - PG Type II - Run 34 - Test 23.docx
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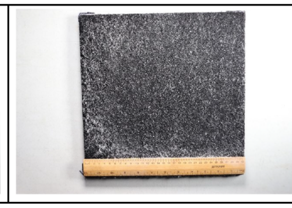
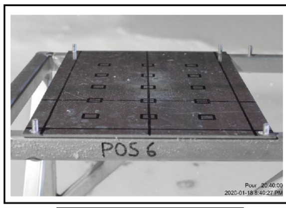
Safewing MP II Flight – Run 34 (Test 23) – Snow Characteristics Photos

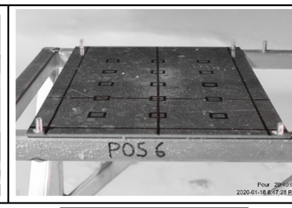

FELT PAD (1/16 MIN)


FELT PAD (10/16 MIN)

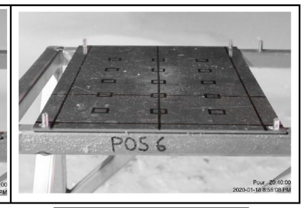

FELT PAD (20/16 MIN)



BARE PLATE (0/16 MIN)



BARE PLATE (7/16 MIN)



BARE PLATE (16/16 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

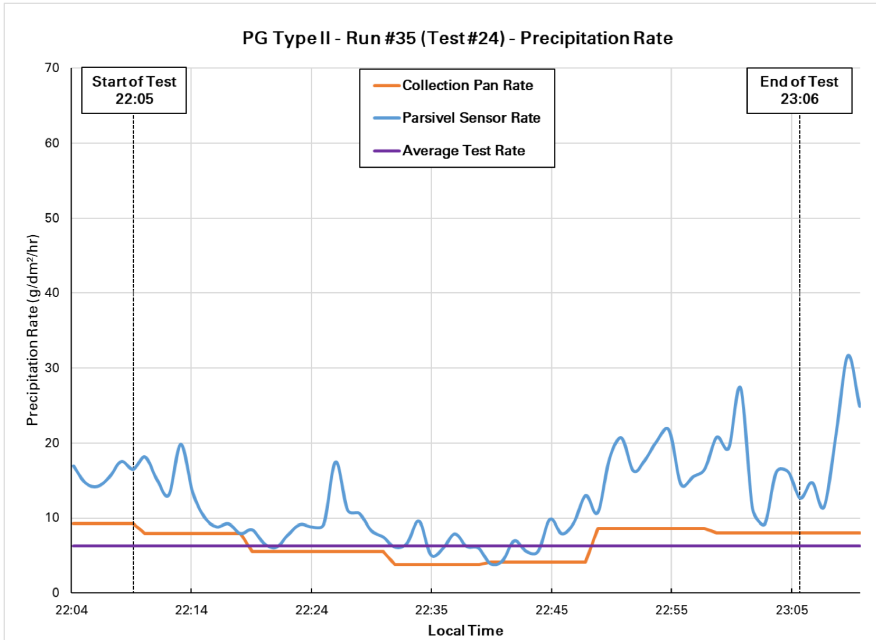
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #35 (TEST #24) – PG2-24

PG Type II – Run #35 (Test #24) – General Test Information

Test Number:	**PG2-24**
Date of Test:	**January 18, 2020**
Average OAT:	**-14.8**
Average Precipitation Rate:	**6.3 g/dm²/h**
Average Wind Speed:	**31.6 km/h**
Average Relative Humidity:	**81.1%**
Pour Time (Local):	**22:10:00**
Time of Fluid Failure (Local):	**23:07:00**
Fluid Brix at Failure:	**22.75°**
Endurance Time:	**57 minutes**
Expected Regression-Derived Endurance Time:	**89.5 minutes**
Difference (ET vs. Reg ET):	**- 32.6 minutes (- 36.4%)**

DATA PACKAGE – PG TYPE II – RUN 35 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 35 - Test 24/Data Package - PG Type II - Run 35 - Test 24.docx
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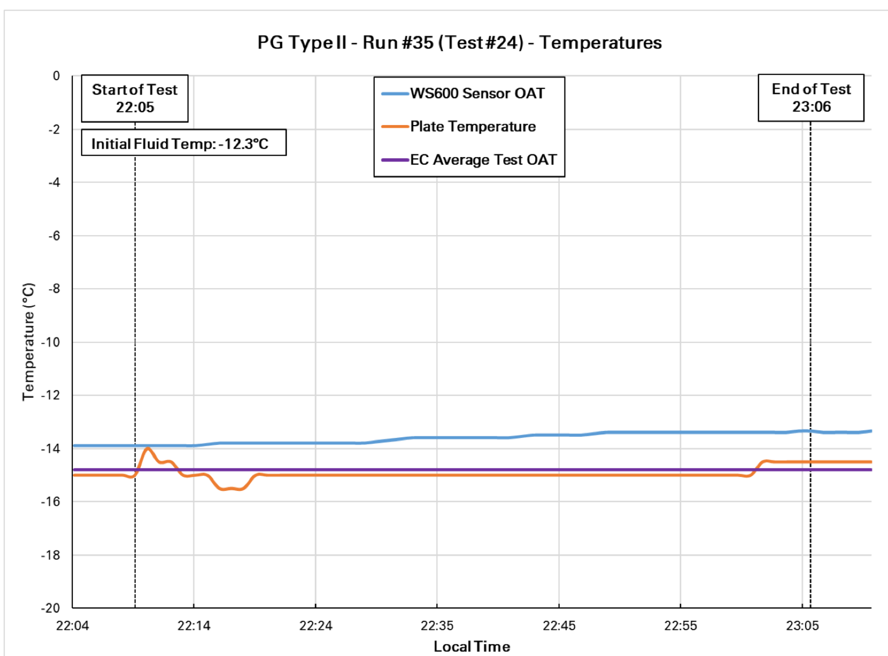
DATA PACKAGE – PG TYPE II – RUN 35 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 35 - Test 24/Data Package - PG Type II - Run 35 - Test 24.docx
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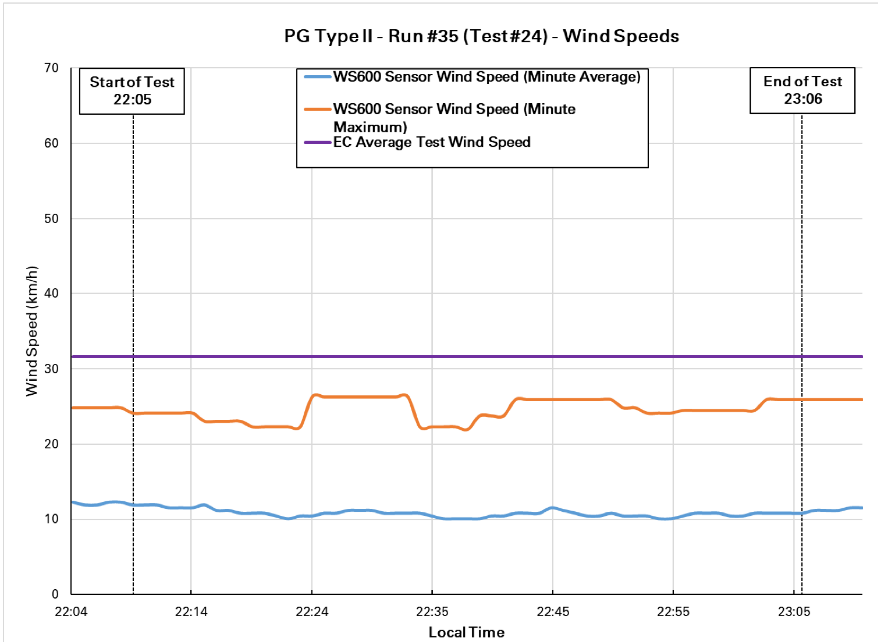
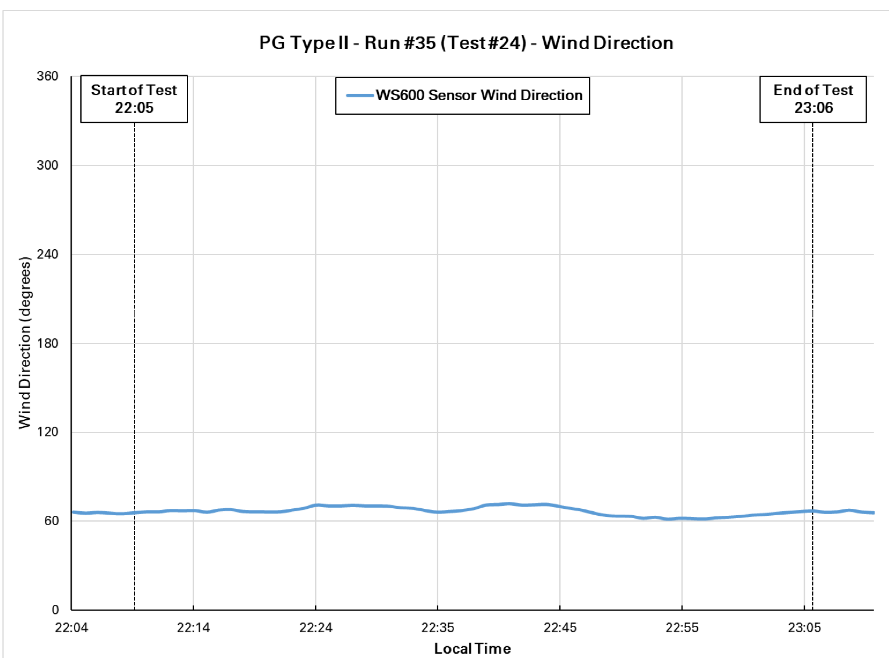
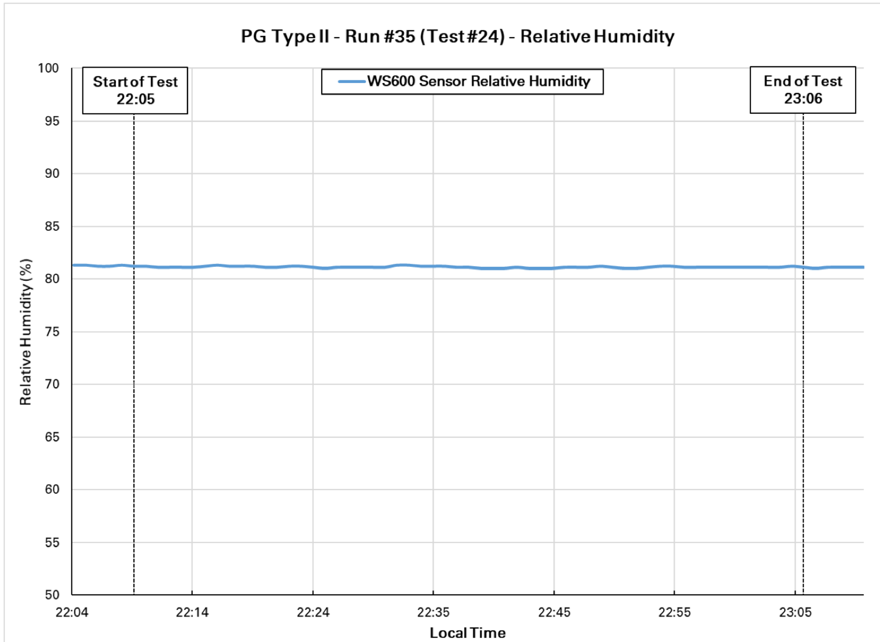
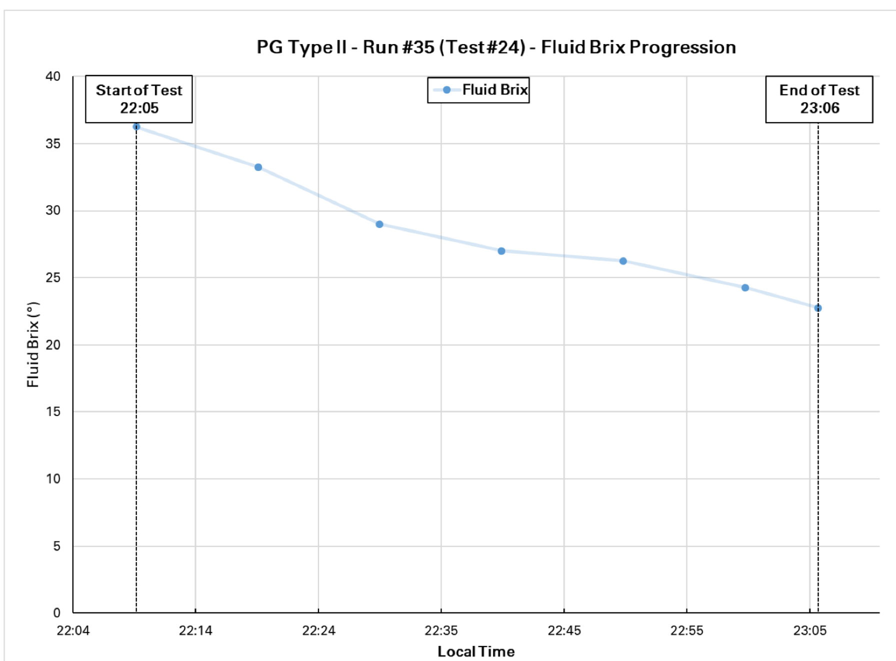


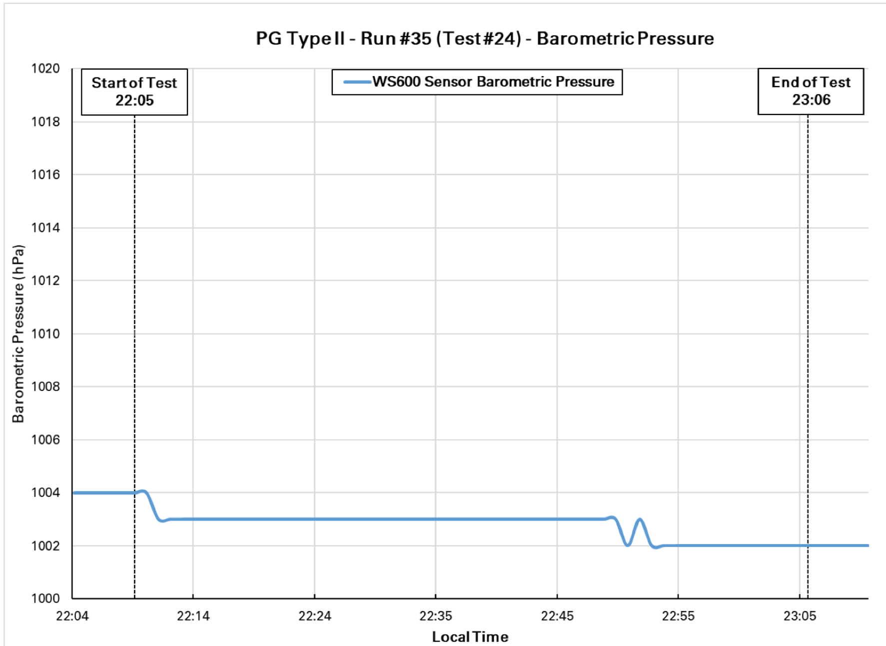
PG Type II - Run #35 (Test #24) - Wind Speeds
Start of Test 22:05
End of Test 23:06
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

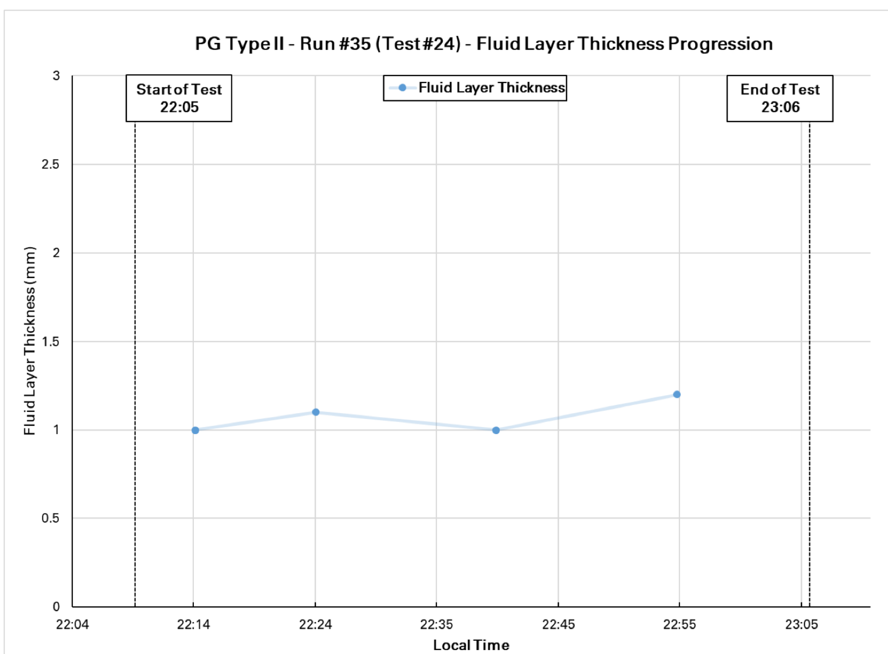


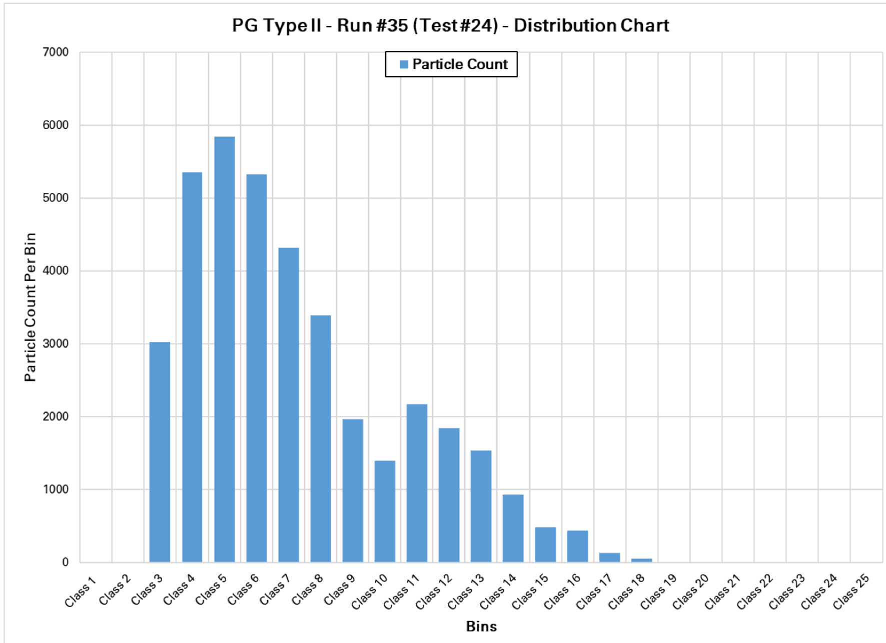
PG Type II - Run #35 (Test #24) - Wind Direction
Start of Test 22:05
WS600 Sensor Wind Direction
End of Test 23:06
Wind Direction (degrees)
360
300
240
180
120
60
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type II - Run #35 (Test #24) - Relative Humidity
Start of Test 22:05
WS600 Sensor Relative Humidity
End of Test 23:06
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

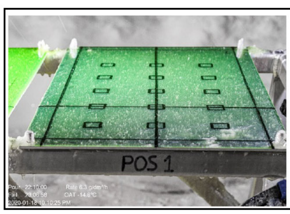

PG Type II - Run #35 (Test #24) - Fluid Brix Progression
Start of Test 22:05
Fluid Brix
End of Test 23:06
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type II - Run #35 (Test #24) - Barometric Pressure
Start of Test 22:05
WS600 Sensor Barometric Pressure
End of Test 23:06
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

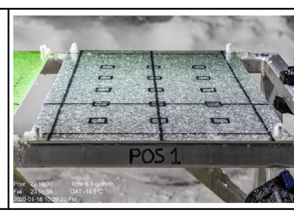

PG Type II - Run #35 (Test #24) - Fluid Layer Thickness Progression
Start of Test 22:05
Fluid Layer Thickness
End of Test 23:06
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time



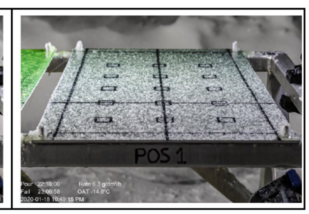
Safewing MP II Flight – Run 35 (Test 24) – Failure Progression Photos



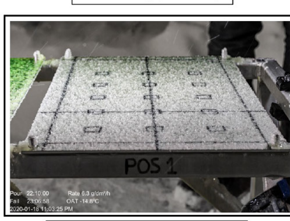
AT POUR (0/57 MIN)



PRE-FAILURE (19/57 MIN)



PRE-FAILURE (39/57 MIN)



PRE-FAILURE (53/57 MIN)

AT FAILURE (56/57 MIN)

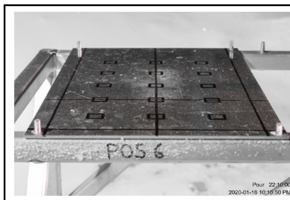
POST-FAILURE (59/57 MIN)

Safewing MP II Flight – Run 35 (Test 24) – Snow Characteristics Photos

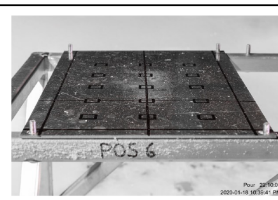
FELT PAD (10/57 MIN)

FELT PAD (30/57 MIN)

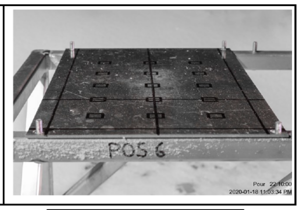
FELT PAD (50/57 MIN)



BARE PLATE (0/57 MIN)



BARE PLATE (29/57 MIN)



BARE PLATE (53/57 MIN)

Final Bare Plate Contamination Thickness: **Nil (0 mm)**

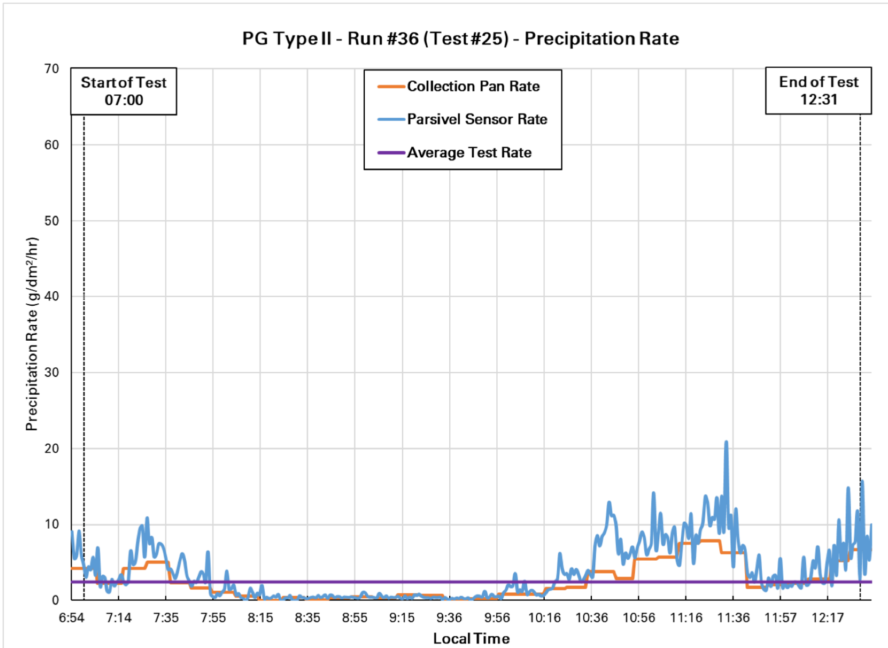
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #36 (TEST #25) – PG2-25

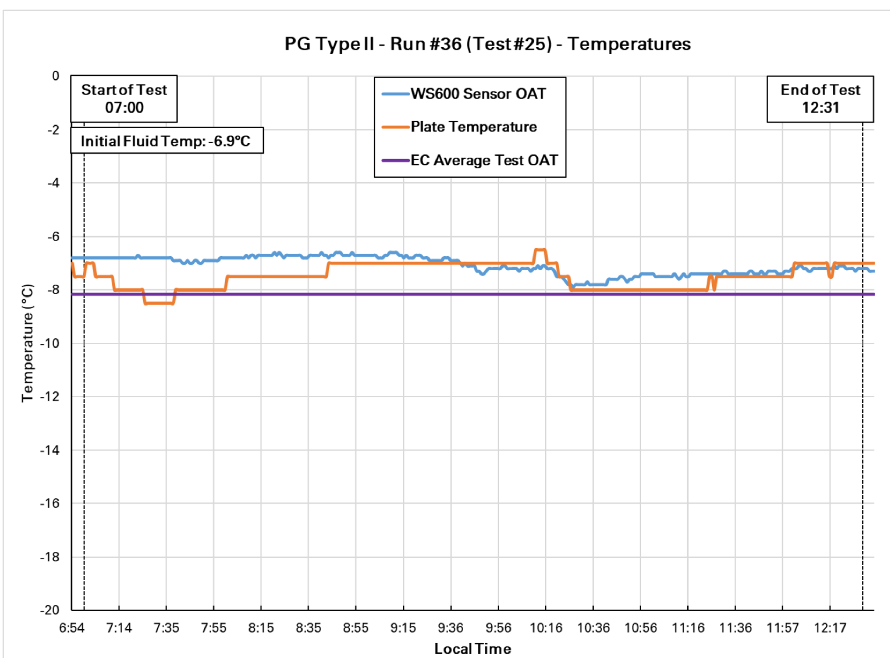
DATA PACKAGE – PG TYPE II – RUN 36 (TEST 25)

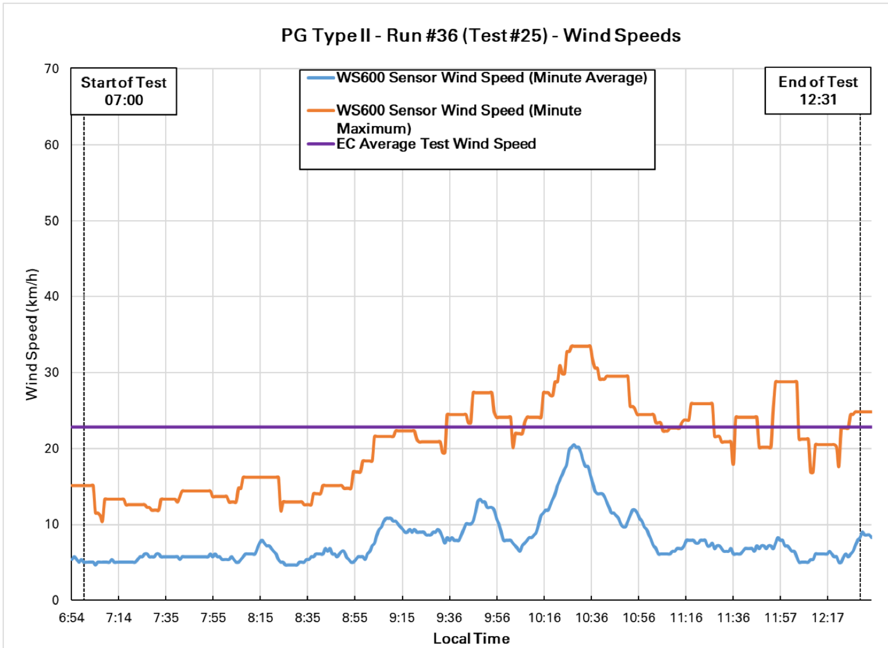
PG Type II – Run #36 (Test #25) – General Test Information

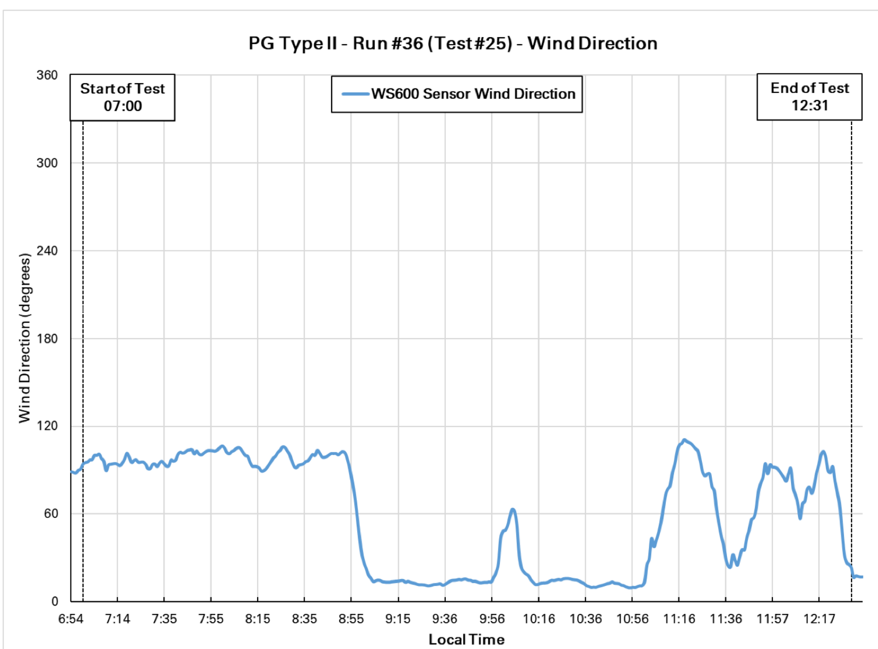
Test Number:	**PG2-25**
Date of Test:	**February 6, 2020**
Average OAT:	**-8.2**
Average Precipitation Rate:	**2.4 g/dm²/h**
Average Wind Speed:	**22.8 km/h**
Average Relative Humidity:	**79.85%**
Pour Time (Local):	**07:00:00**
Time of Fluid Failure (Local):	**12:31:00**
Fluid Brix at Failure:	**14.75°**
Endurance Time:	**331 minutes**
Expected Regression-Derived Endurance Time:	**253.2 minutes**
Difference (ET vs. Reg ET):	**+78.3 minutes (+30.9%)**

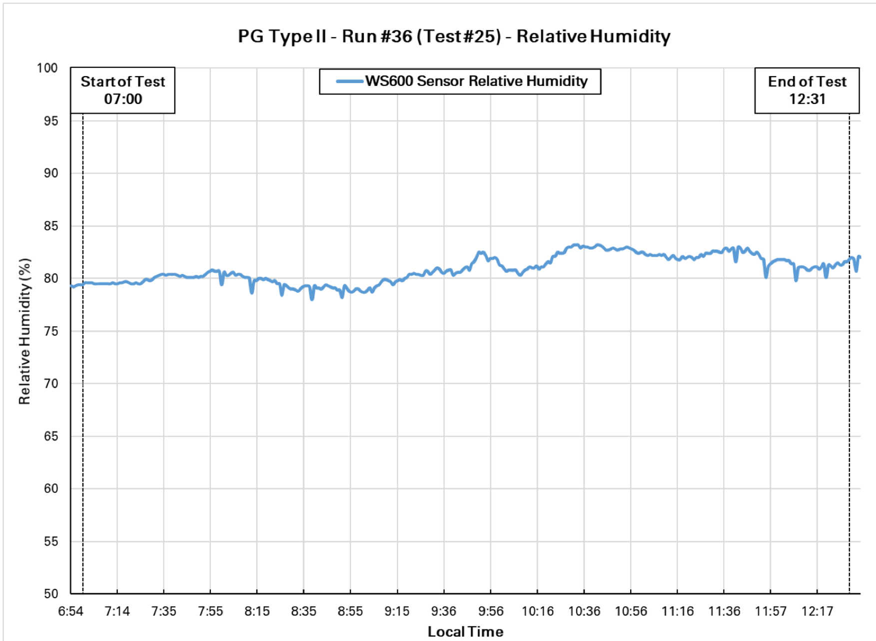


DATA PACKAGE – PG TYPE II – RUN 36 (TEST 25)

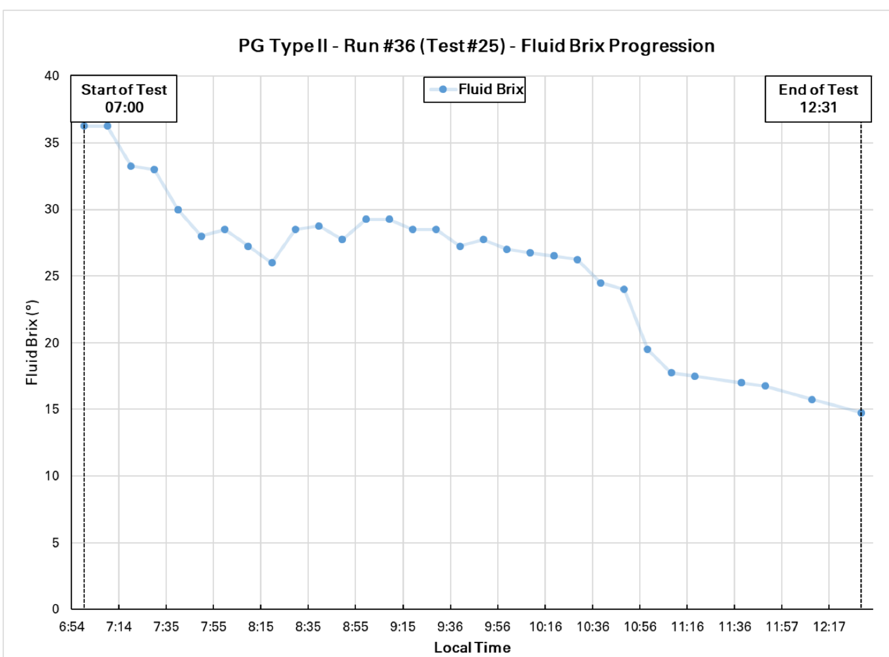



PG Type II - Run #36 (Test #25) - Wind Speeds
Start of Test 07:00
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 12:31
Wind Speed (km/h)
0
10
20
30
40
50
60
70
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
12:17
Local Time

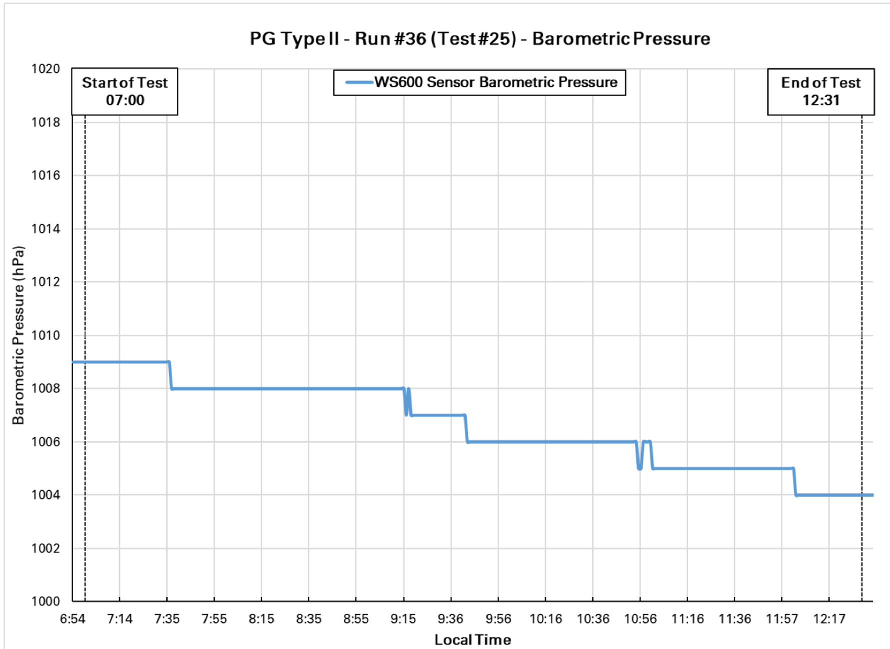

PG Type II - Run #36 (Test #25) - Wind Direction
Start of Test 07:00
WS600 Sensor Wind Direction
End of Test 12:31
Wind Direction (degrees)
0
60
120
180
240
300
360
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
12:17
Local Time

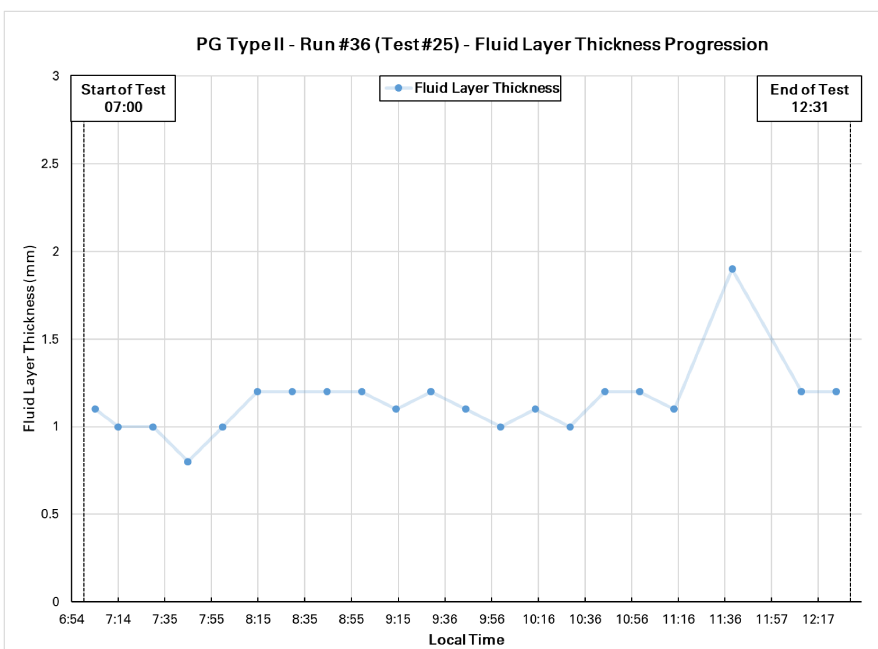


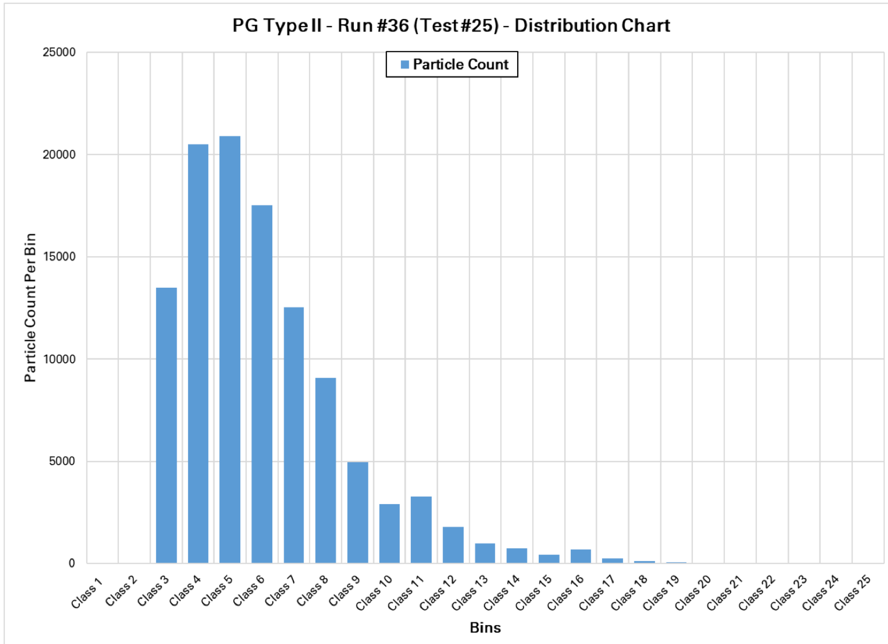
PG Type II - Run #36 (Test #25) - Relative Humidity
Start of Test 07:00
WS600 Sensor Relative Humidity
End of Test 12:31
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
12:17
Local Time



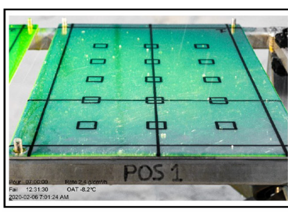
PG Type II - Run #36 (Test #25) - Fluid Brix Progression
Start of Test 07:00
Fluid Brix
End of Test 12:31
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
12:17
Local Time


PG Type II - Run #36 (Test #25) - Barometric Pressure
Start of Test 07:00
WS600 Sensor Barometric Pressure
End of Test 12:31
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
12:17
Local Time

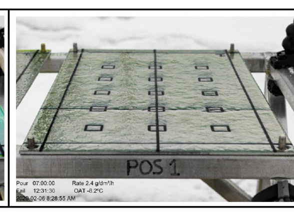

PG Type II - Run #36 (Test #25) - Fluid Layer Thickness Progression
Start of Test 07:00
Fluid Layer Thickness
End of Test 12:31
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
12:17
Local Time



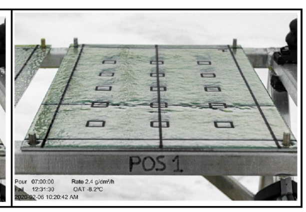
Safewing MP II Flight – Run 36 (Test 25) – Failure Progression Photos



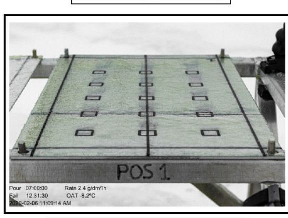
AT POUR (0/331 MIN)



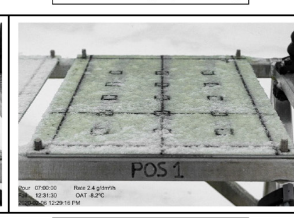
PRE-FAILURE (88/331 MIN)



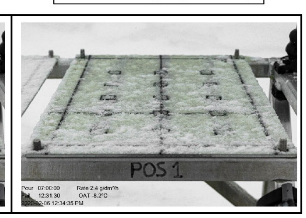
PRE-FAILURE (200/331 MIN)



PRE-FAILURE (249/331 MIN)



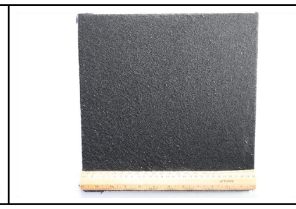
AT FAILURE (329/331 MIN)



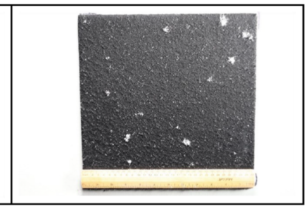
POST-FAILURE (334/331 MIN)

Safewing MP II Flight – Run 36 (Test 25) – Snow Characteristics Photos

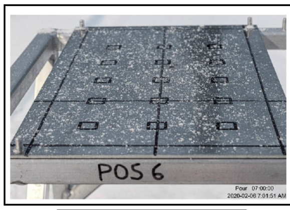
FELT PAD (10/331 MIN)



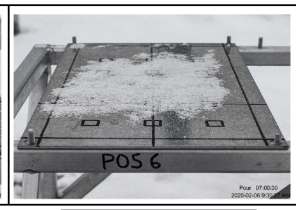
FELT PAD (160/331 MIN)



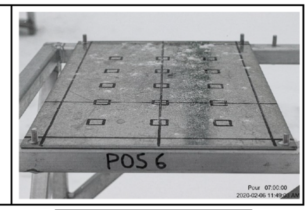
FELT PAD (319/331 MIN)



BARE PLATE (1/331 MIN)



BARE PLATE (159/331 MIN)



BARE PLATE (289/331 MIN)

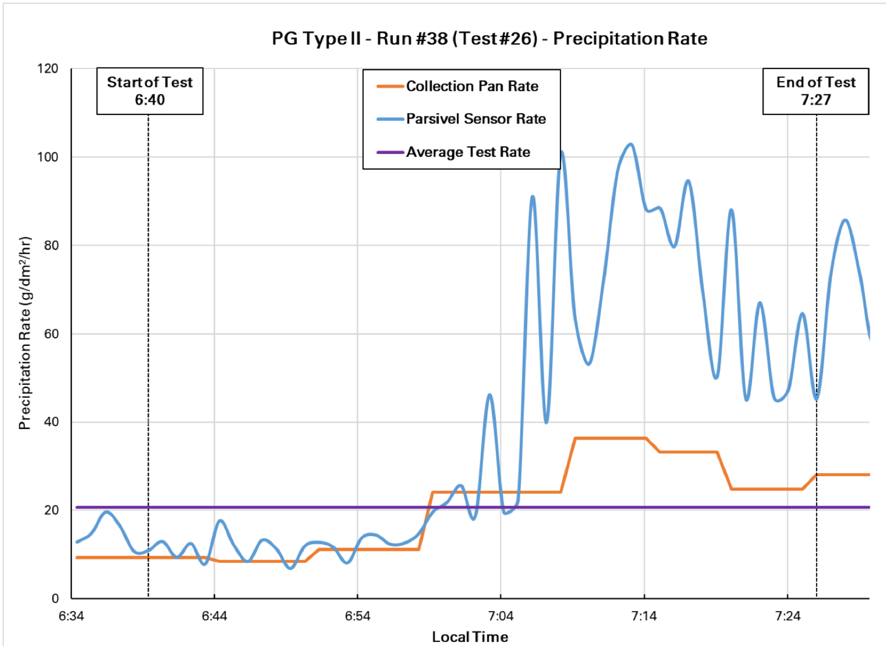
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

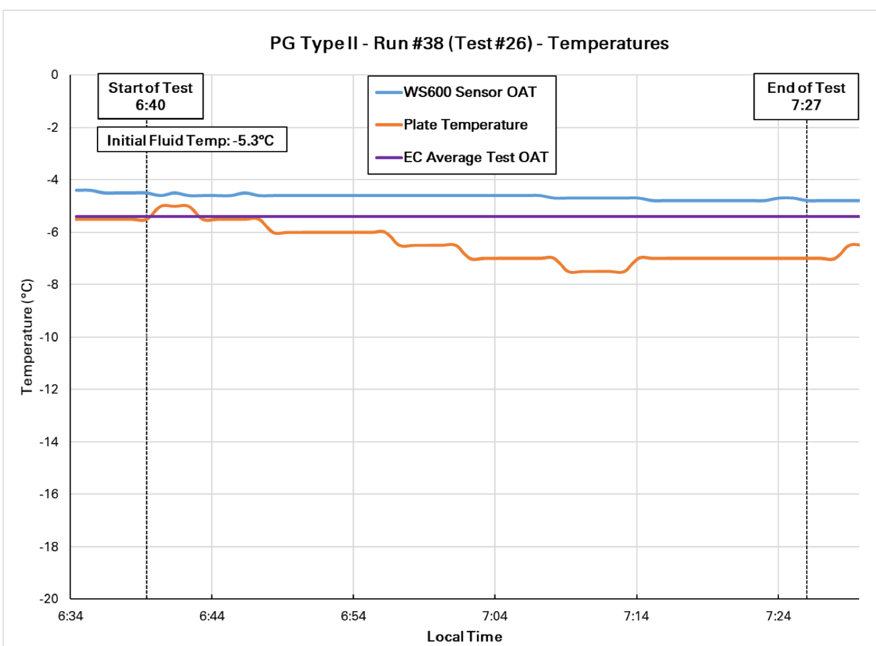
PG TYPE II
RUN #38 (TEST #26) – PG2-26

PG Type II – Run #38 (Test #26) – General Test Information

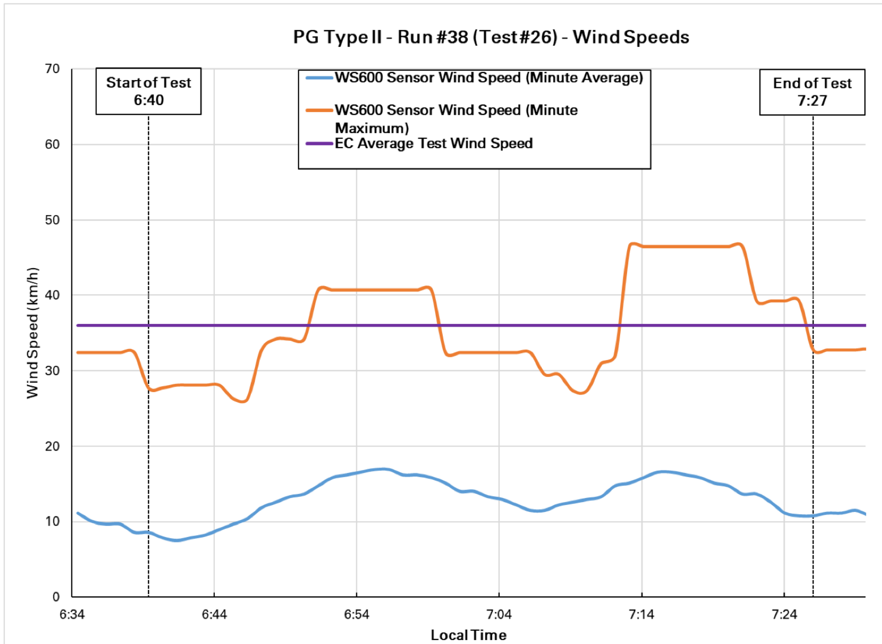
Test Number:	PG2-26
Date of Test:	February 7, 2020
Average OAT:	-5.4
Average Precipitation Rate:	20.7 g/dm²/h
Average Wind Speed:	36.0 km/h
Average Relative Humidity:	89.1%
Pour Time (Local):	06:40:00
Time of Fluid Failure (Local):	07:27:00
Fluid Brix at Failure:	13.5°
Endurance Time:	47 minutes
Expected Regression-Derived Endurance Time:	52.2 minutes
Difference (ET vs. Reg ET):	- 4.4 minutes (- 8.5%)

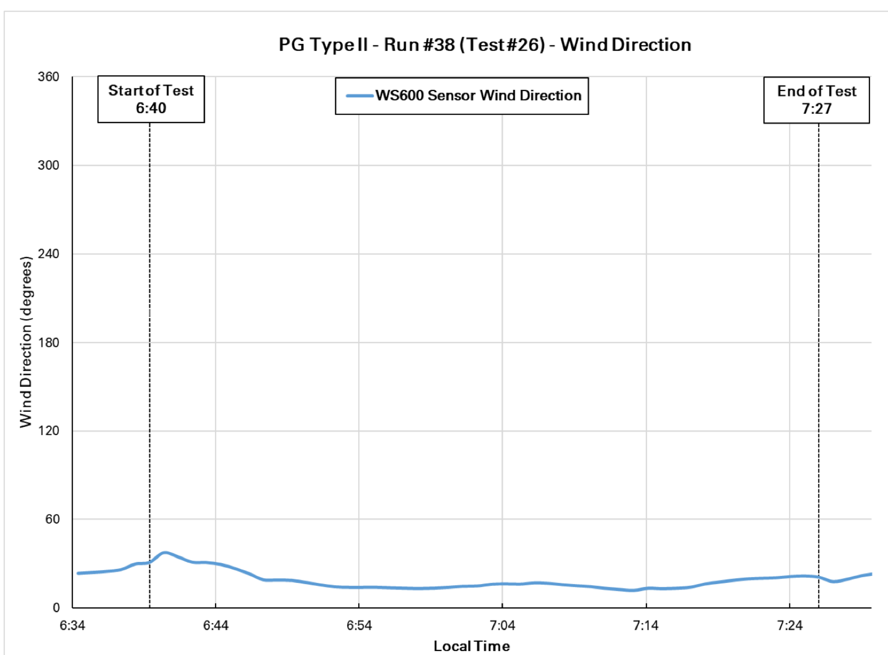


PG Type II - Run #38 (Test #26) - Precipitation Rate
Start of Test 6:40
End of Test 7:27
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
120
6:34
6:44
6:54
7:04
7:14
7:24
Local Time

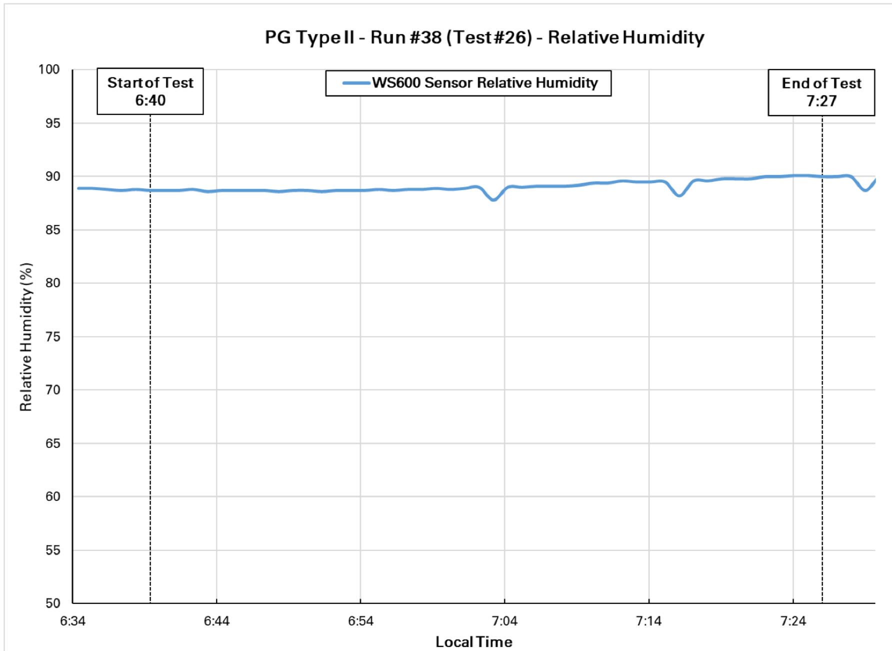


PG Type II - Run #38 (Test #26) - Temperatures
Start of Test 6:40
Initial Fluid Temp: -5.3°C
End of Test 7:27
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
6:34
6:44
6:54
7:04
7:14
7:24
Local Time


PG Type II - Run #38 (Test #26) - Wind Speeds
Start of Test 6:40
End of Test 7:27
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
6:34
6:44
6:54
7:04
7:14
7:24
Local Time


PG Type II - Run #38 (Test #26) - Wind Direction
Start of Test 6:40
End of Test 7:27
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
6:34
6:44
6:54
7:04
7:14
7:24
Local Time

DATA PACKAGE – PG TYPE II – RUN 38 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 38 - Test 26/Data Package - PG Type II - Run 38 - Test 26.docx
Final Version 1.0, February 2021

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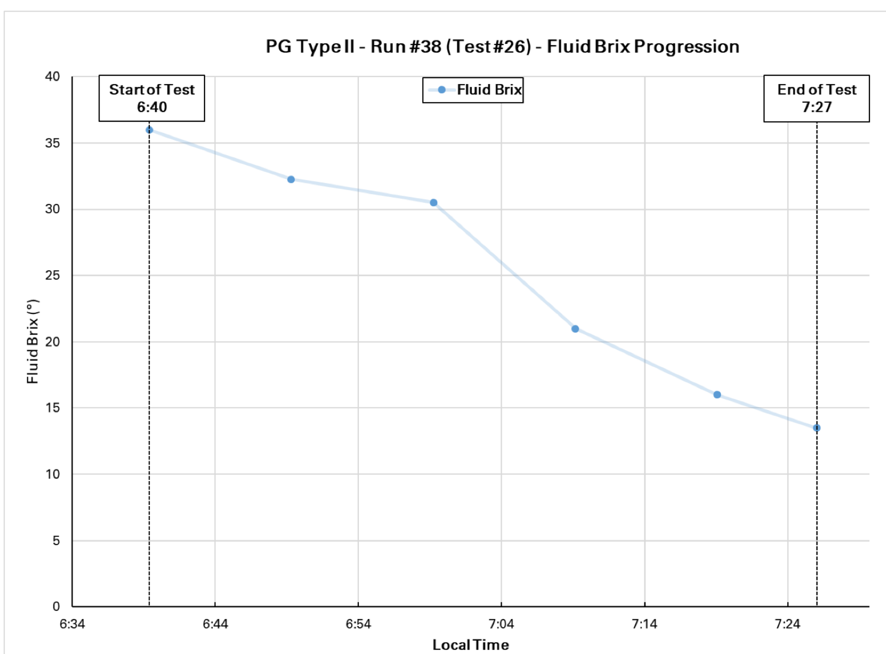
DATA PACKAGE – PG TYPE II – RUN 38 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 38 - Test 26/Data Package - PG Type II - Run 38 - Test 26.docx
Final Version 1.0, February 2021

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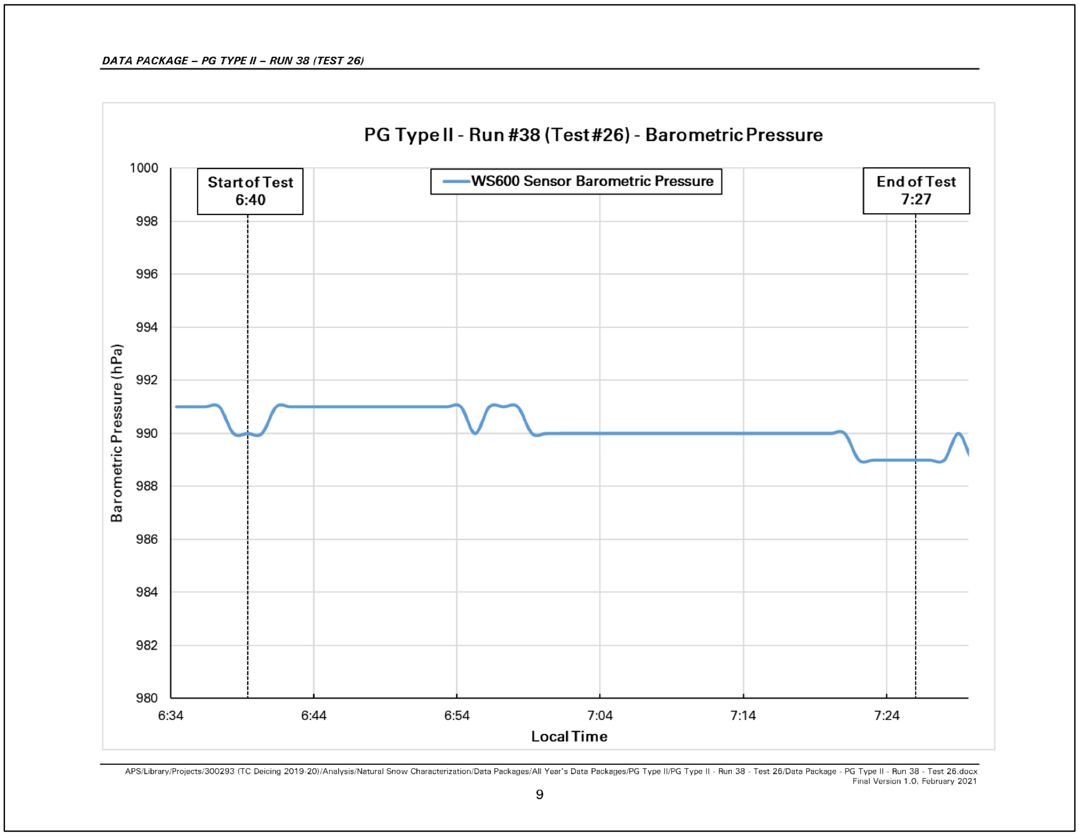
DATA PACKAGE – PG TYPE II – RUN 38 (TEST 26)
PG Type II - Run #38 (Test #26) - Barometric Pressure
Start of Test 6:40
WS600 Sensor Barometric Pressure
End of Test 7:27
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
6:34
6:44
6:54
7:04
7:14
7:24
Local Time
APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 38 - Test 26/Data Package - PG Type II - Run 38 - Test 26.docx
Final Version 1.0, February 2021
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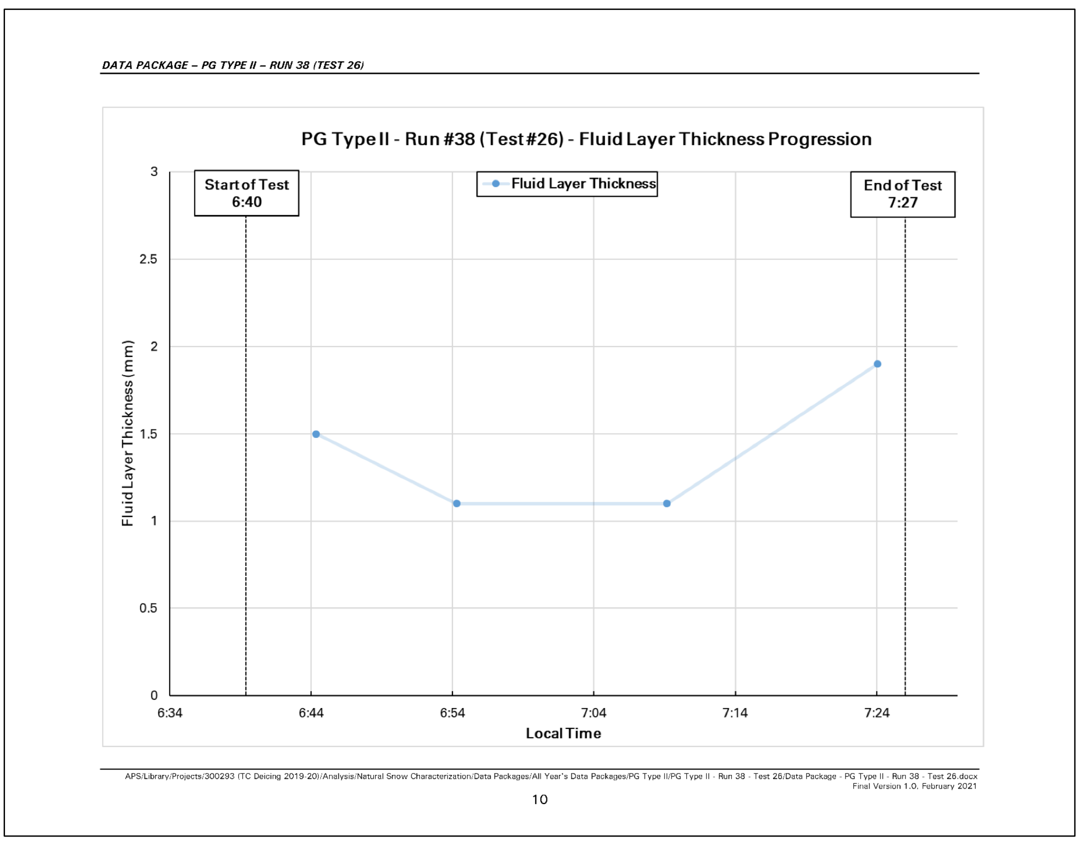
DATA PACKAGE – PG TYPE II – RUN 38 (TEST 26)
PG Type II - Run #38 (Test #26) - Fluid Layer Thickness Progression
Start of Test 6:40
Fluid Layer Thickness
End of Test 7:27
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:34
6:44
6:54
7:04
7:14
7:24
Local Time
APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 38 - Test 26/Data Package - PG Type II - Run 38 - Test 26.docx
Final Version 1.0, February 2021
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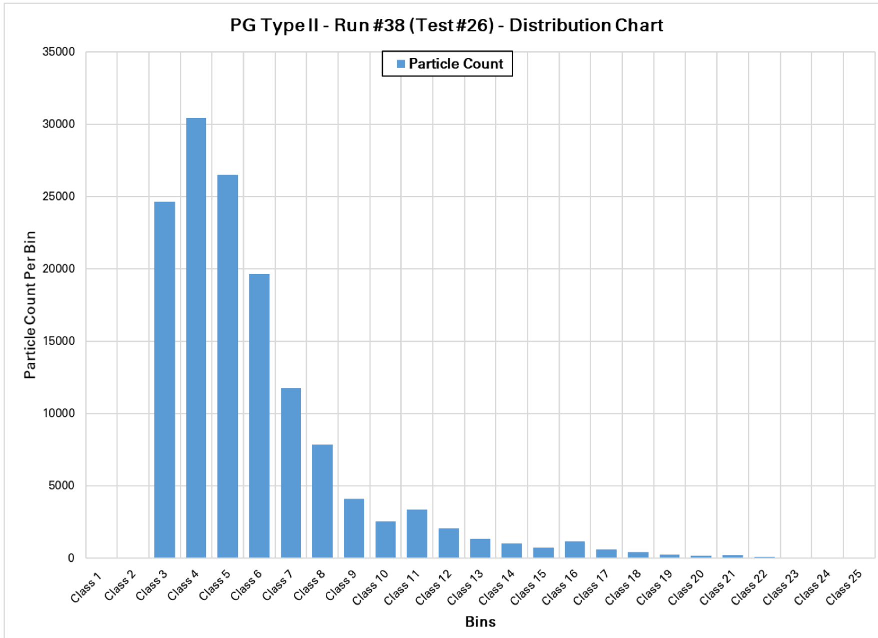
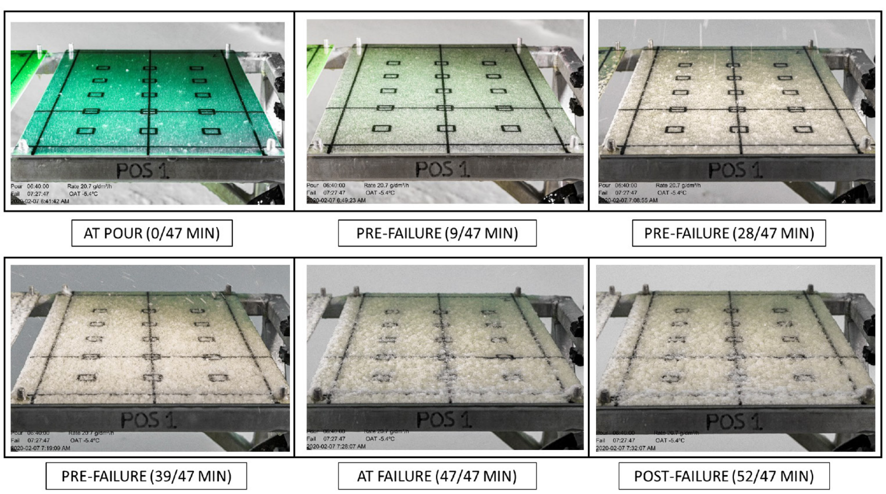
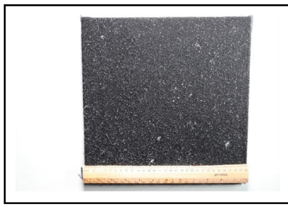


Safewing MP II Flight – Run 38 (Test 26) – Failure Progression Photos



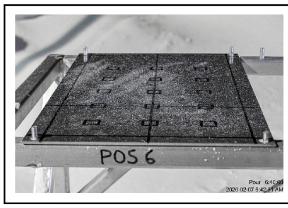
Safewing MP II Flight – Run 38 (Test 26) – Snow Characteristics Photos



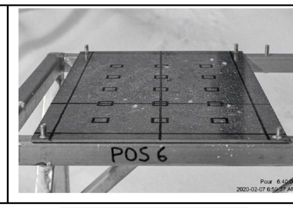
FELT PAD (10/47 MIN)

FELT PAD (35/47 MIN)

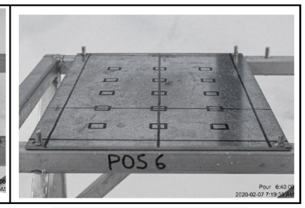
FELT PAD (50/47 MIN)



BARE PLATE (2/47 MIN)



BARE PLATE (19/47 MIN)



BARE PLATE (39/47 MIN)

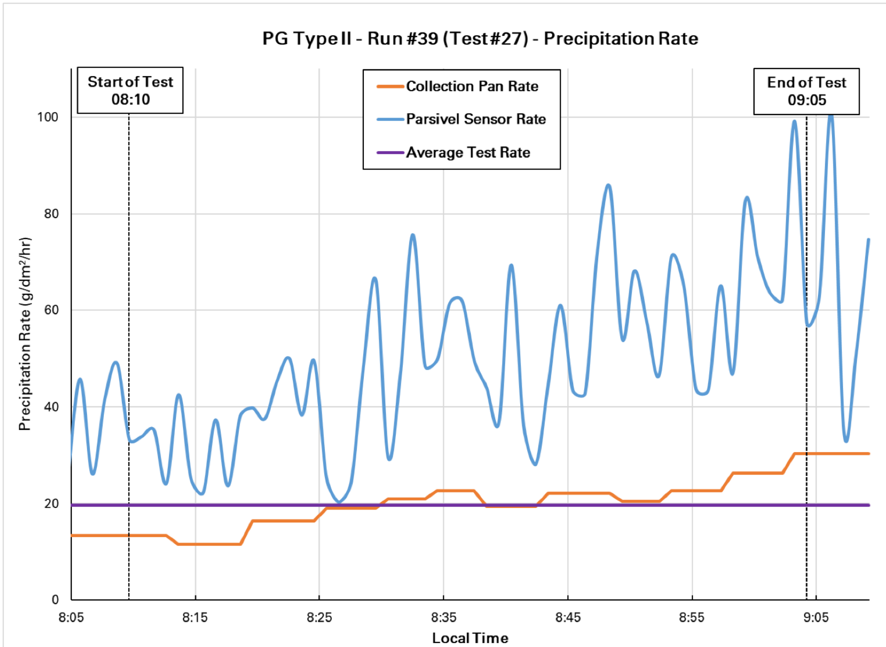
Final Bare Plate Contamination Thickness: **Nil (0 mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

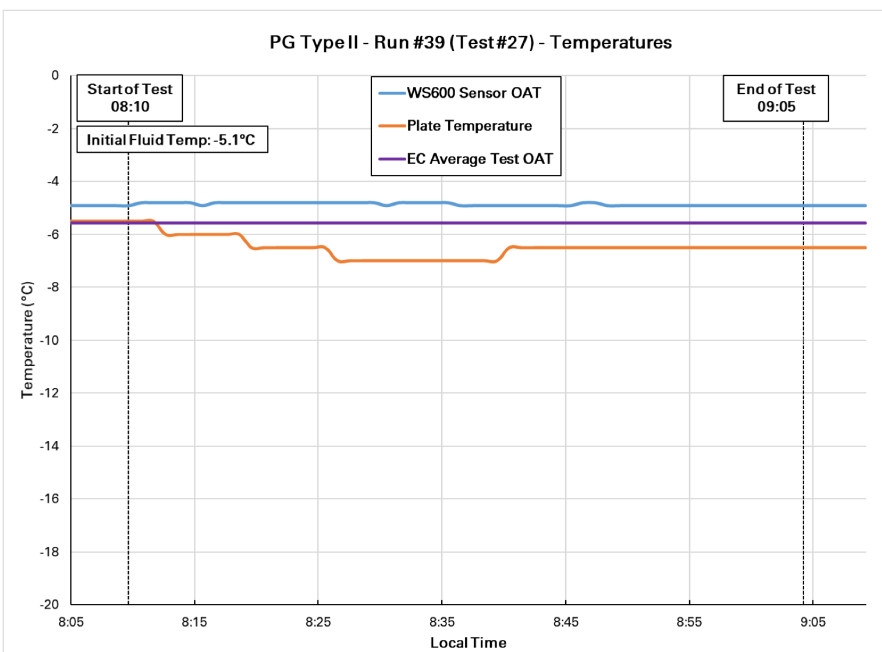
PG TYPE II
RUN #39 (TEST #27) – PG2-27

PG Type II – Run #39 (Test #27) – General Test Information

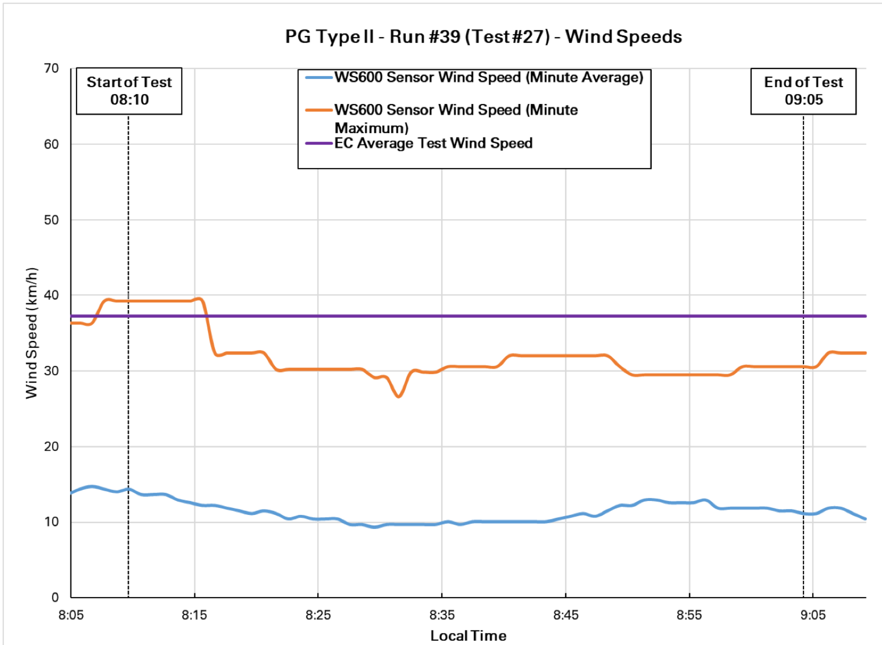
Test Number:	PG2-27
Date of Test:	February 7, 2020
Average OAT:	-5.6
Average Precipitation Rate:	19.7 g/dm²/h
Average Wind Speed:	37.3 km/h
Average Relative Humidity:	89.5%
Pour Time (Local):	08:10:00
Time of Fluid Failure (Local):	09:05:00
Fluid Brix at Failure:	12.75°
Endurance Time:	55 minutes
Expected Regression-Derived Endurance Time:	53.8 minutes
Difference (ET vs. Reg ET):	+1.4 minutes (+2.6%)

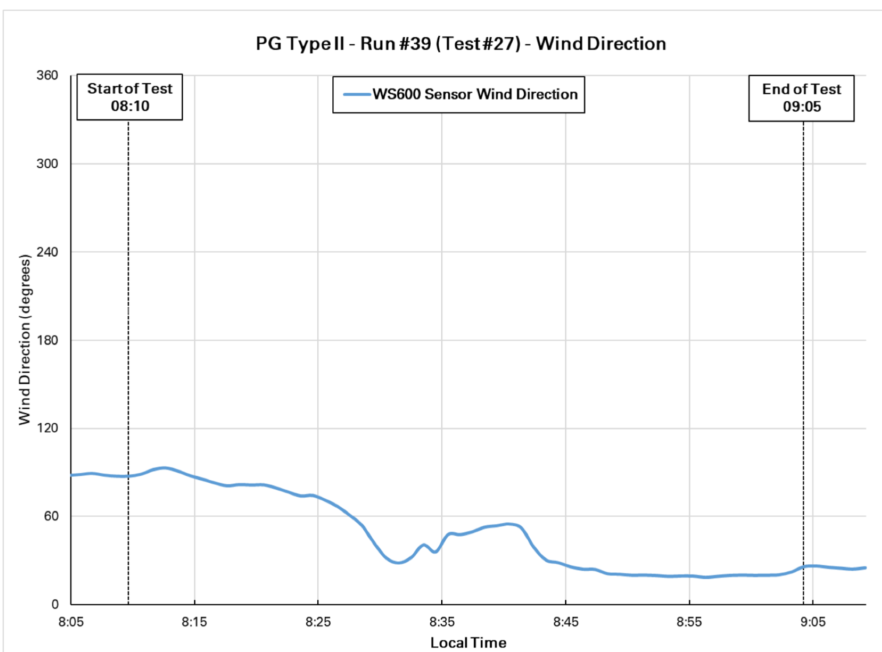


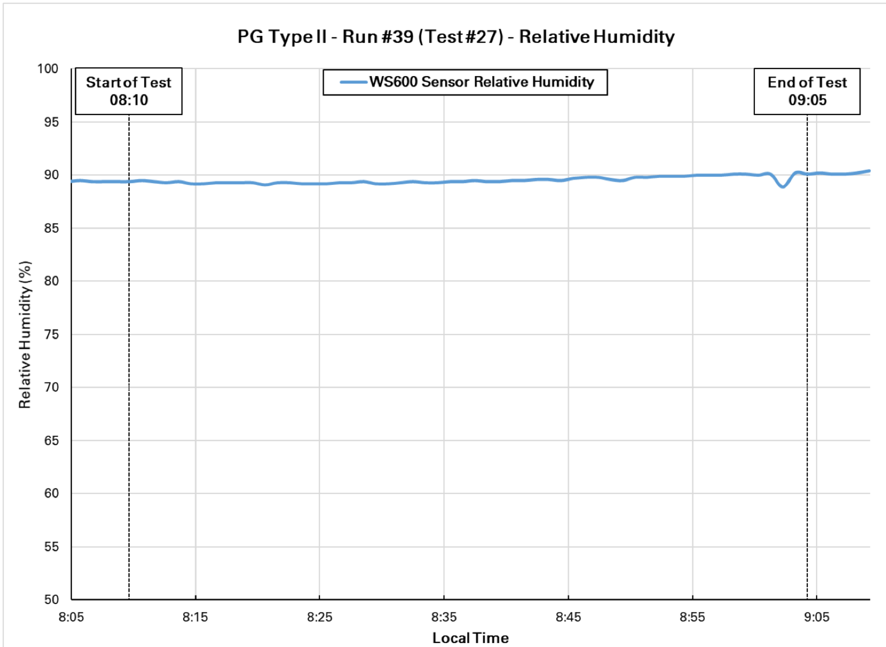
PG Type II - Run #39 (Test #27) - Precipitation Rate
Start of Test 08:10
End of Test 09:05
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time



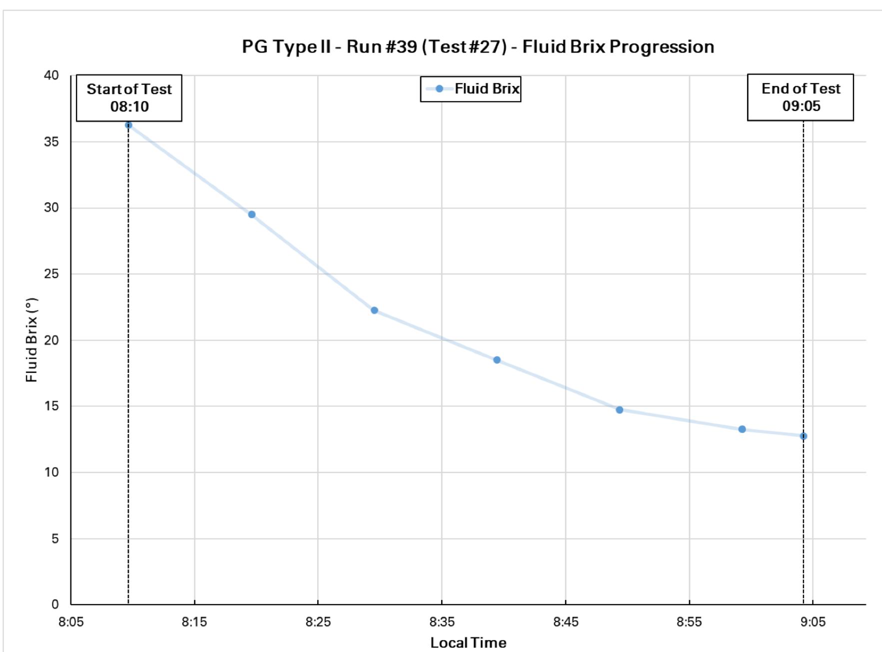
PG Type II - Run #39 (Test #27) - Temperatures
Start of Test 08:10
Initial Fluid Temp: -5.1°C
End of Test 09:05
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time

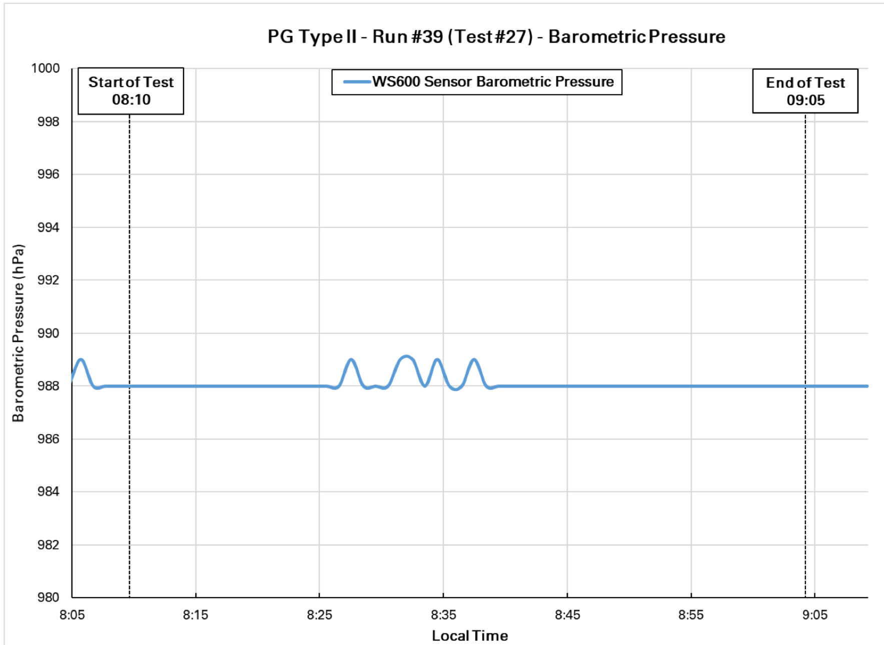

PG Type II - Run #39 (Test #27) - Wind Speeds
Start of Test 08:10
End of Test 09:05
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time

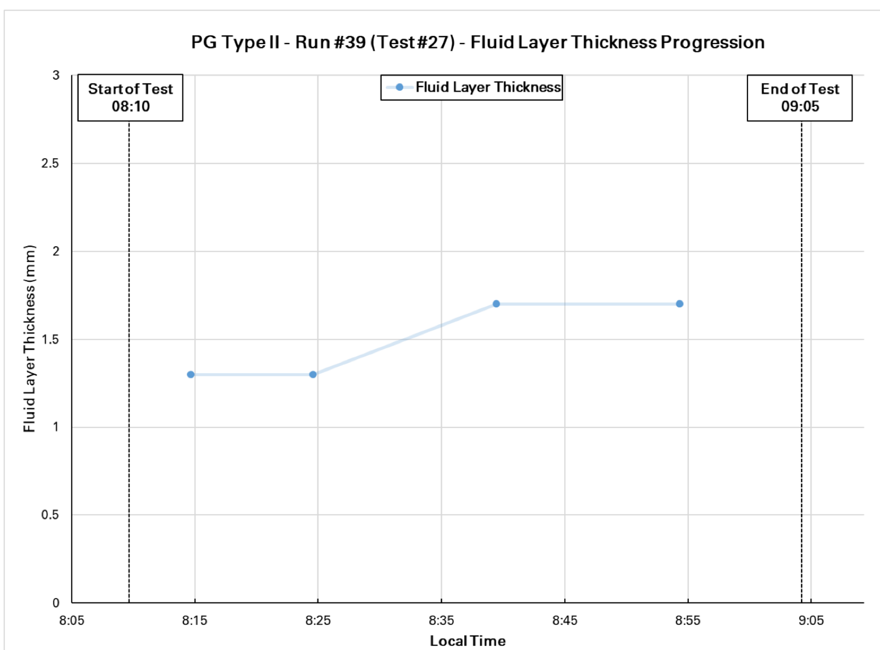

PG Type II - Run #39 (Test #27) - Wind Direction
Start of Test 08:10
WS600 Sensor Wind Direction
End of Test 09:05
Wind Direction (degrees)
0
60
120
180
240
300
360
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time

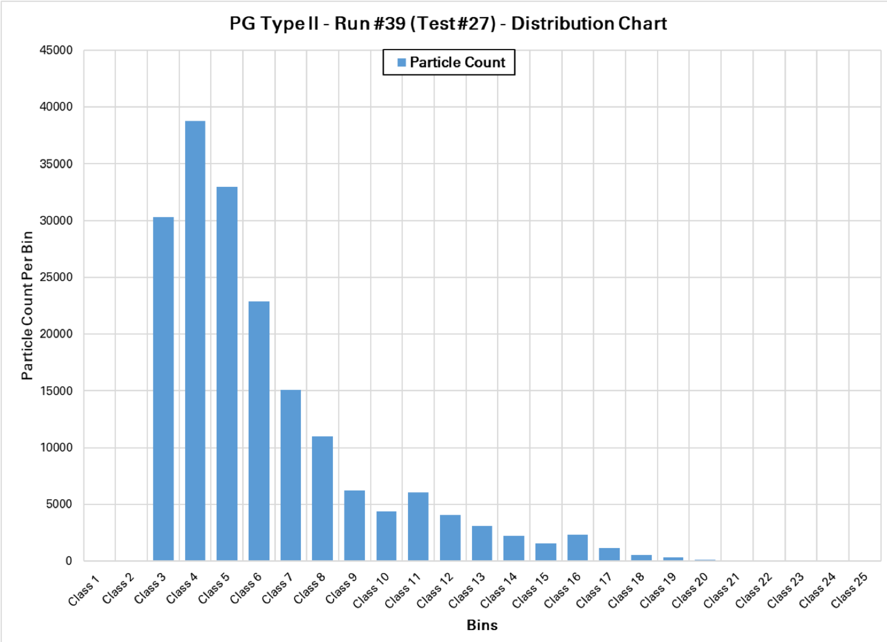


DATA PACKAGE – PG TYPE II – RUN 39 (TEST 27)

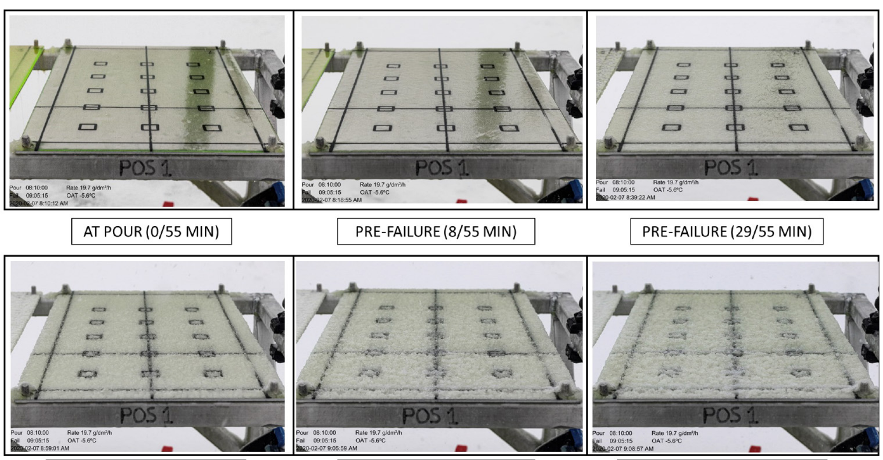



PG Type II - Run #39 (Test #27) - Barometric Pressure
Start of Test 08:10
WS600 Sensor Barometric Pressure
End of Test 09:05
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time


PG Type II - Run #39 (Test #27) - Fluid Layer Thickness Progression
Start of Test 08:10
Fluid Layer Thickness
End of Test 09:05
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time



Safewing MP II Flight – Run 39 (Test 27) – Failure Progression Photos



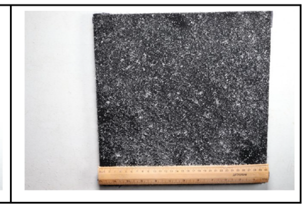
AT POUR (0/55 MIN) | PRE-FAILURE (8/55 MIN) | PRE-FAILURE (29/55 MIN)

PRE-FAILURE (49/55 MIN) | AT FAILURE (55/55 MIN) | POST-FAILURE (58/55 MIN)

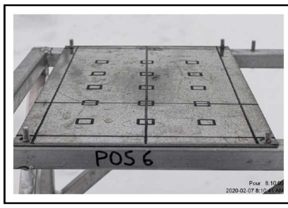
Safewing MP II Flight – Run 39 (Test 27) – Snow Characteristics Photos

FELT PAD (3/55 MIN)

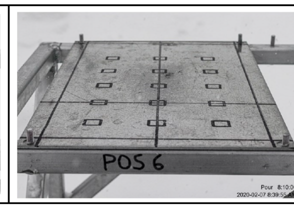
FELT PAD (19/55 MIN)



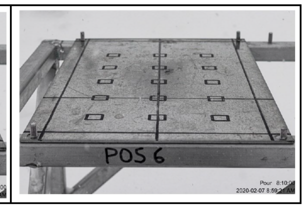
FELT PAD (40/55 MIN)



BARE PLATE (0/55 MIN)



BARE PLATE (29/55 MIN)



BARE PLATE (49/55 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

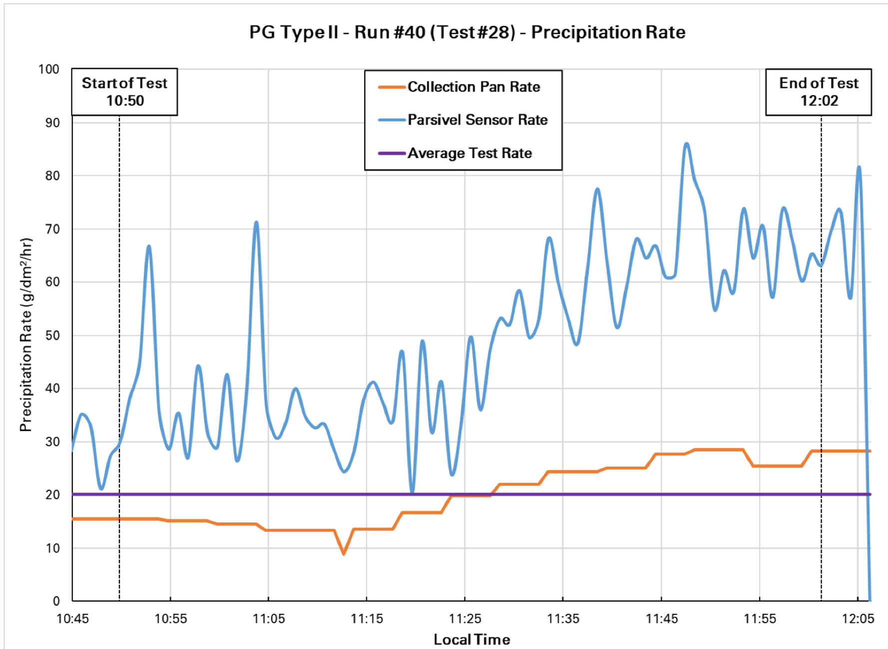
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #40 (TEST #28) – PG2-28

PG Type II – Run #40 (Test #28)– General Test Information

Test Number:	**PG2-28**
Date of Test:	**February 7, 2020**
Average OAT:	**-5.8**
Average Precipitation Rate:	**20.1 g/dm²/h**
Average Wind Speed:	**38.1 km/h**
Average Relative Humidity:	**89.8%**
Pour Time (Local):	**10:50:00**
Time of Fluid Failure (Local):	**12:02:00**
Fluid Brix at Failure:	**13°**
Endurance Time:	**72 minutes**
Expected Regression-Derived Endurance Time:	**52.1 minutes**
Difference (ET vs. Reg ET):	**+20.5 minutes (+39.3%)**

DATA PACKAGE – PG TYPE II – RUN 40 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 40 - Test 28/Data Package - PG Type II - Run 40 - Test 28.docx
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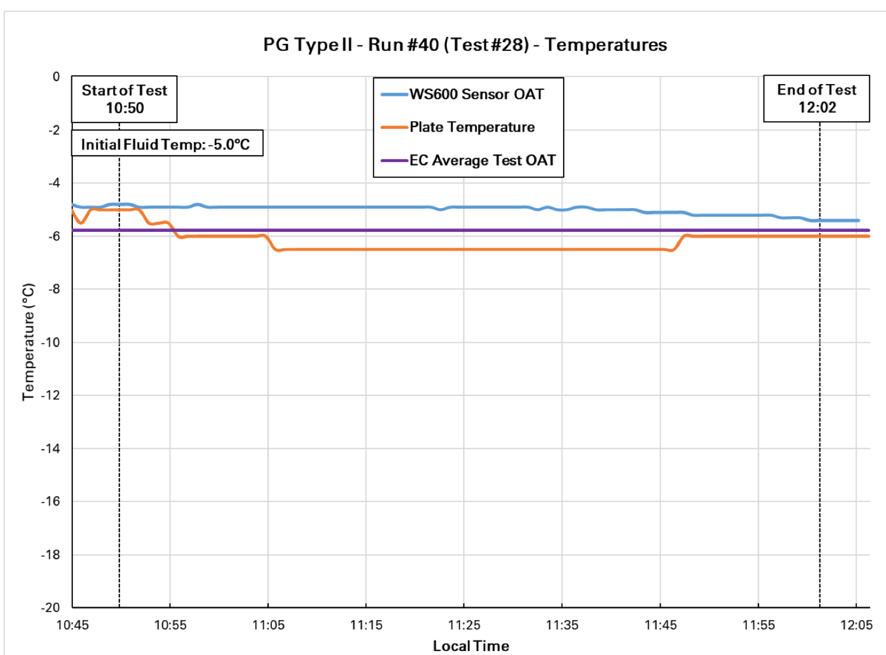
DATA PACKAGE – PG TYPE II – RUN 40 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 40 - Test 28/Data Package - PG Type II - Run 40 - Test 28.docx
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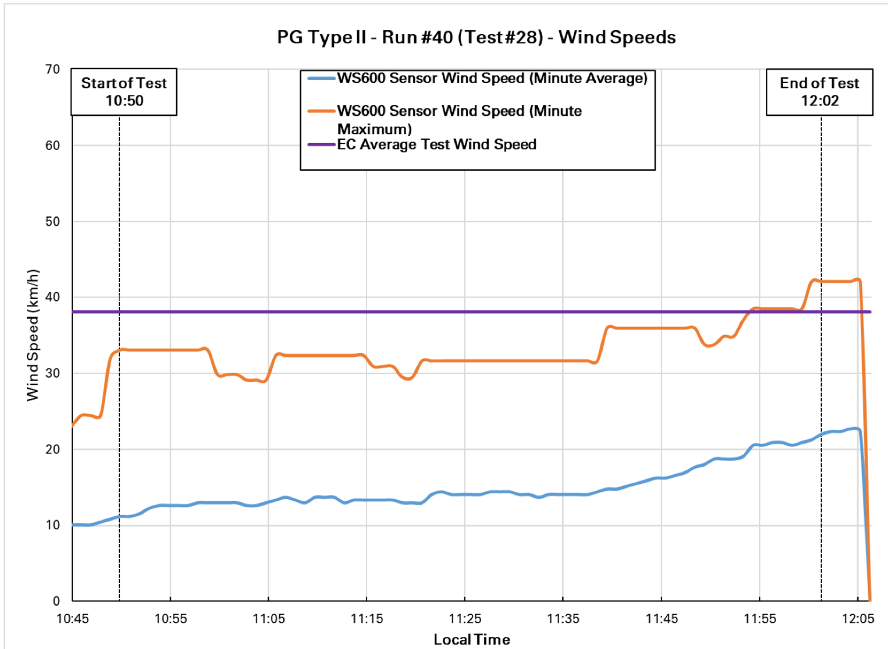
DATA PACKAGE – PG TYPE II – RUN 40 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 40 - Test 28/Data Package - PG Type II - Run 40 - Test 28.docx
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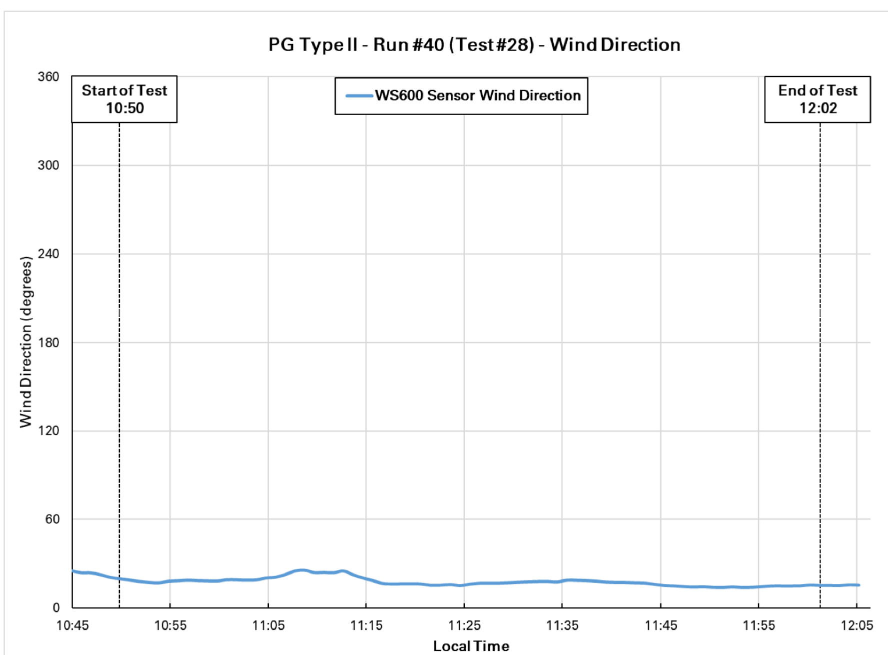
DATA PACKAGE – PG TYPE II – RUN 40 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 40 - Test 28/Data Package - PG Type II - Run 40 - Test 28.docx
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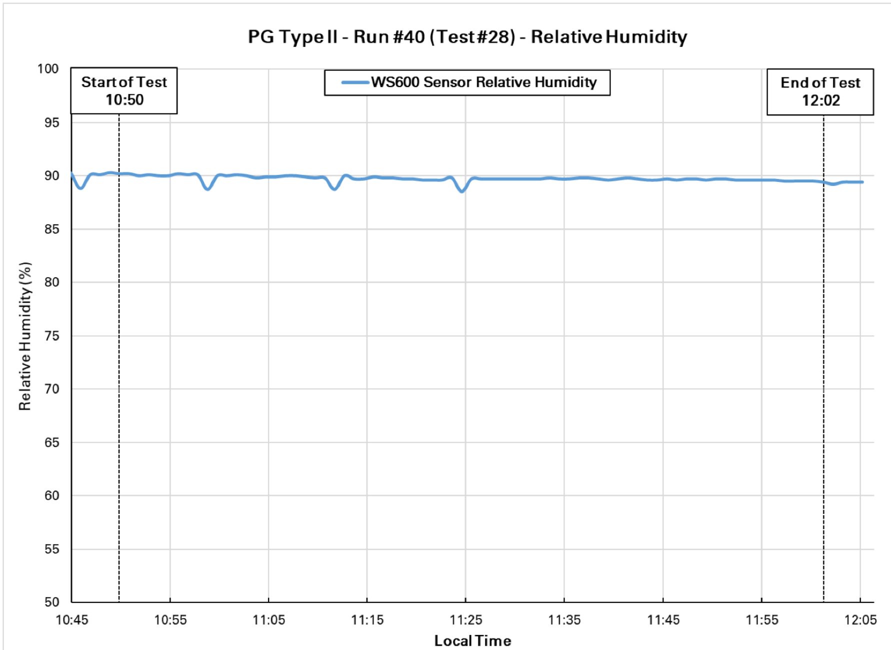
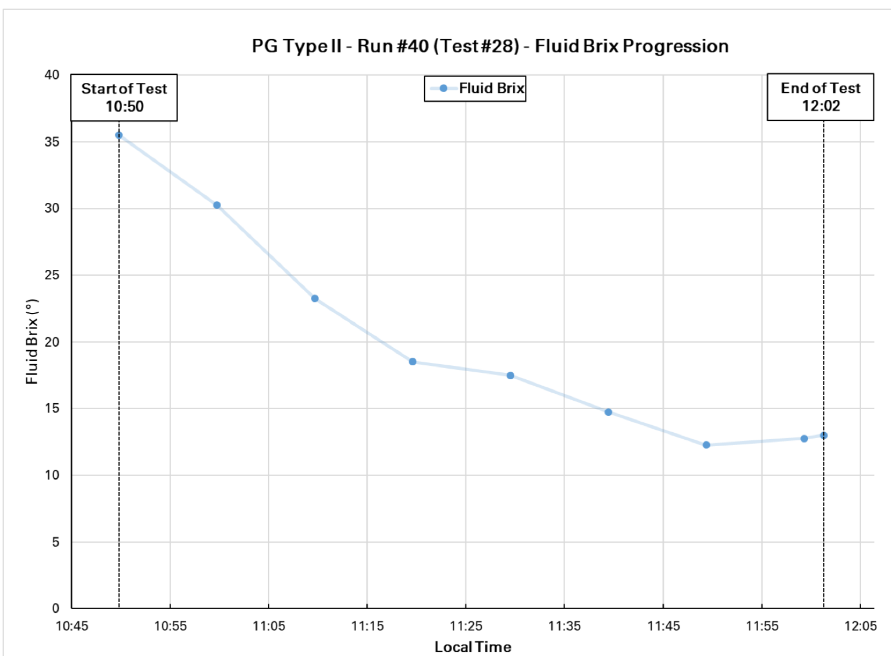
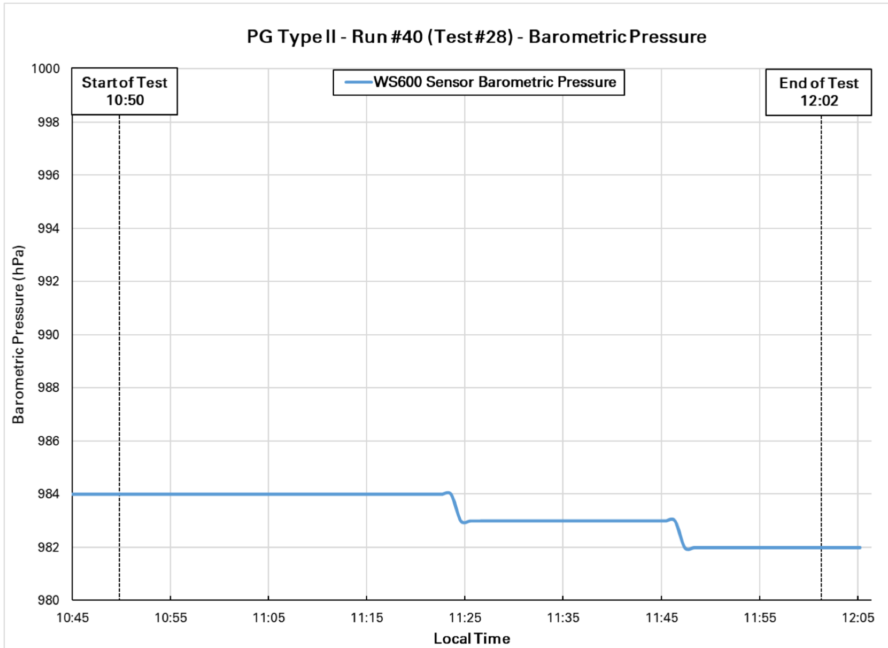
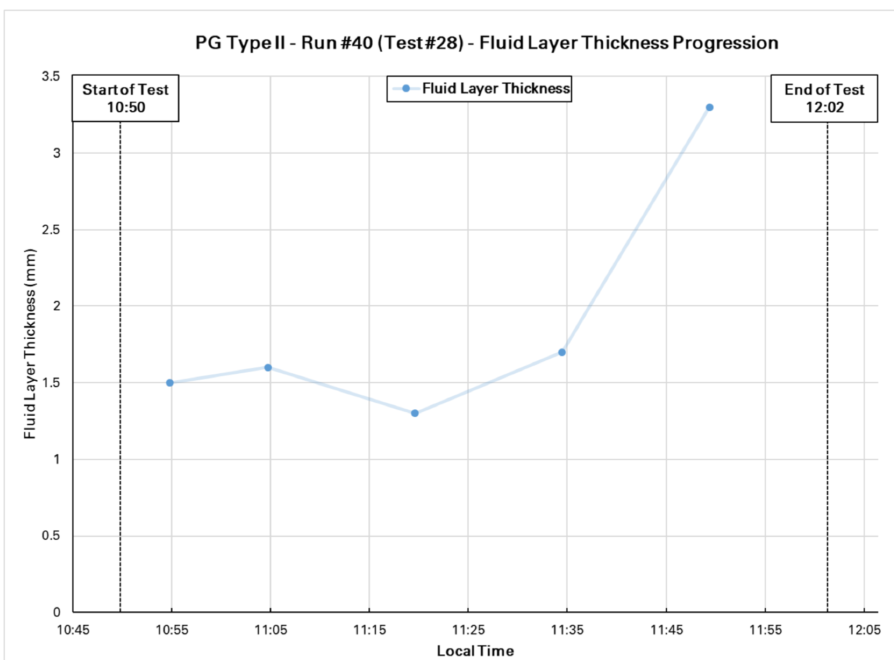

PG Type II - Run #40 (Test #28) - Relative Humidity
Start of Test 10:50
WS600 Sensor Relative Humidity
End of Test 12:02
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
Local Time

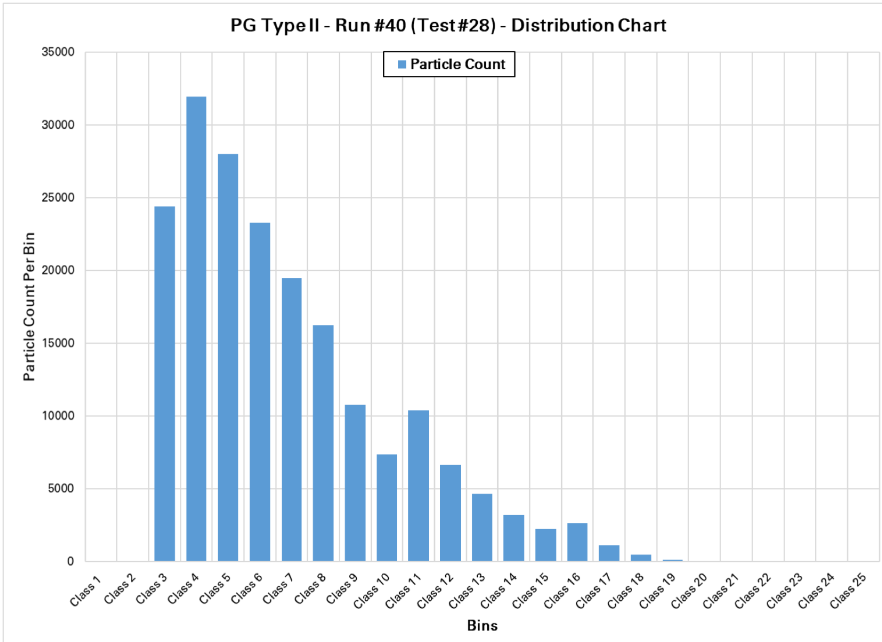

PG Type II - Run #40 (Test #28) - Fluid Brix Progression
Start of Test 10:50
Fluid Brix
End of Test 12:02
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
Local Time



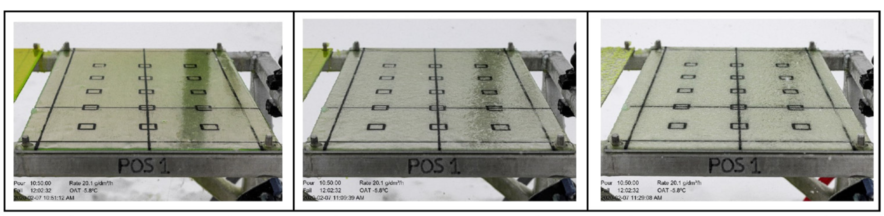
PG Type II - Run #40 (Test #28) - Barometric Pressure
Start of Test 10:50
WS600 Sensor Barometric Pressure
End of Test 12:02
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
Local Time



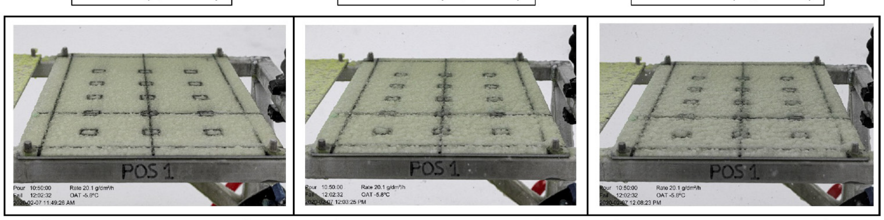
PG Type II - Run #40 (Test #28) - Fluid Layer Thickness Progression
Start of Test 10:50
Fluid Layer Thickness
End of Test 12:02
Fluid Layer Thickness (mm)
3.5
3
2.5
2
1.5
1
0.5
0
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
Local Time



Safewing MP II Flight – Run 40 (Test 28) – Failure Progression Photos



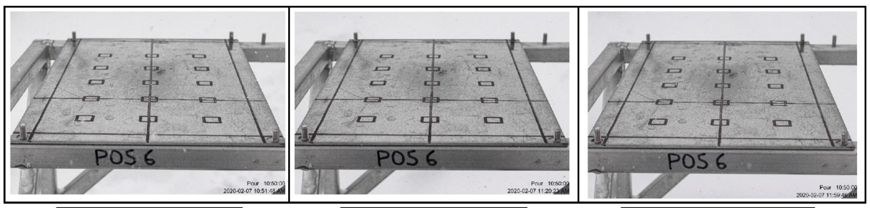
AT POUR (0/72 MIN) | PRE-FAILURE (19/72 MIN) | PRE-FAILURE (39/72 MIN)



PRE-FAILURE (59/72 MIN) | AT FAILURE (73/72 MIN) | POST-FAILURE (78/72 MIN)

Safewing MP II Flight – Run 40 (Test 28) – Snow Characteristics Photos

FELT PAD (9/72 MIN) | FELT PAD (39/72 MIN) | FELT PAD (70/72 MIN)



BARE PLATE (1/72 MIN) | BARE PLATE (30/72 MIN) | BARE PLATE (69/72 MIN)

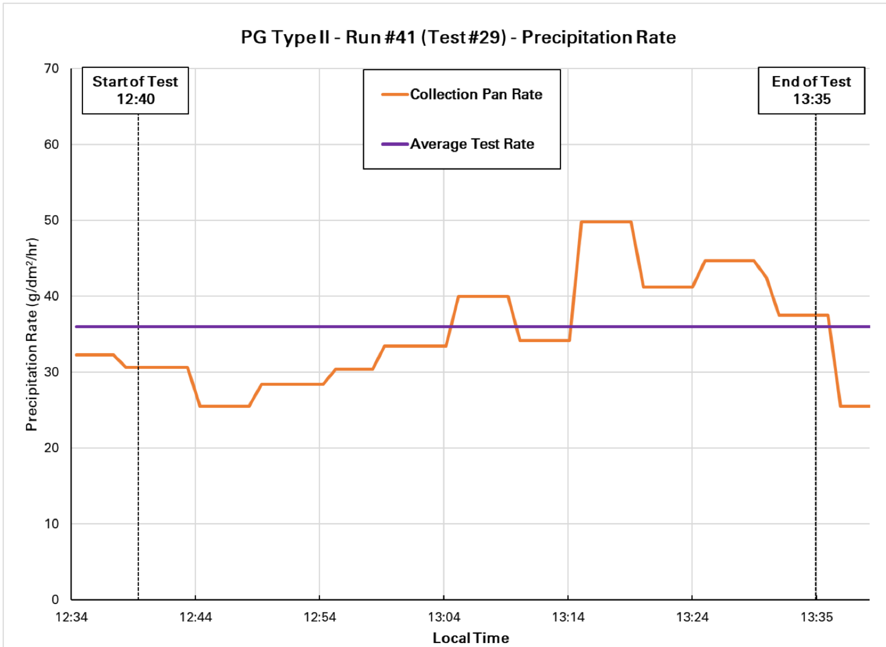
Final Bare Plate Contamination Thickness: **Nil (0 mm)**

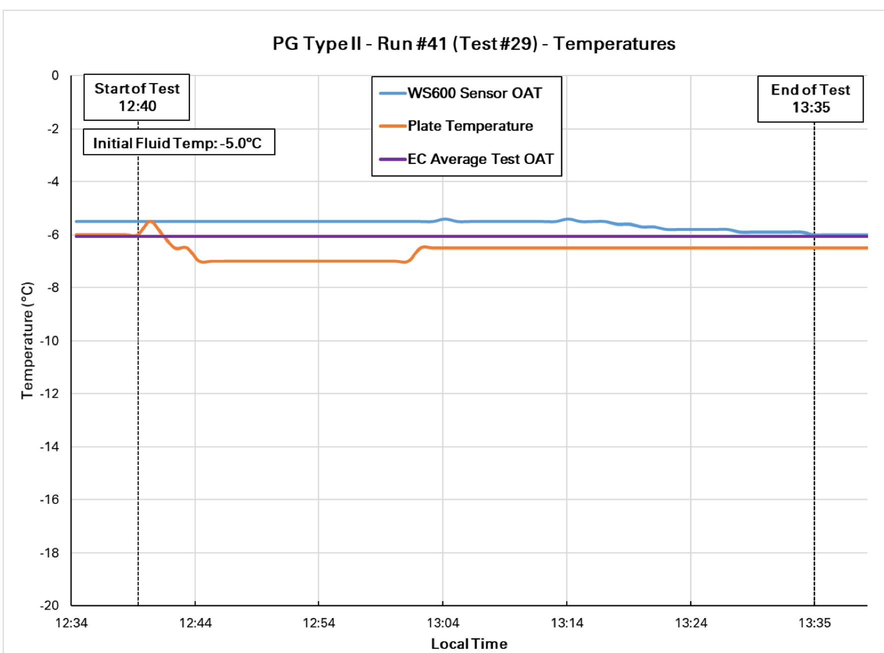
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

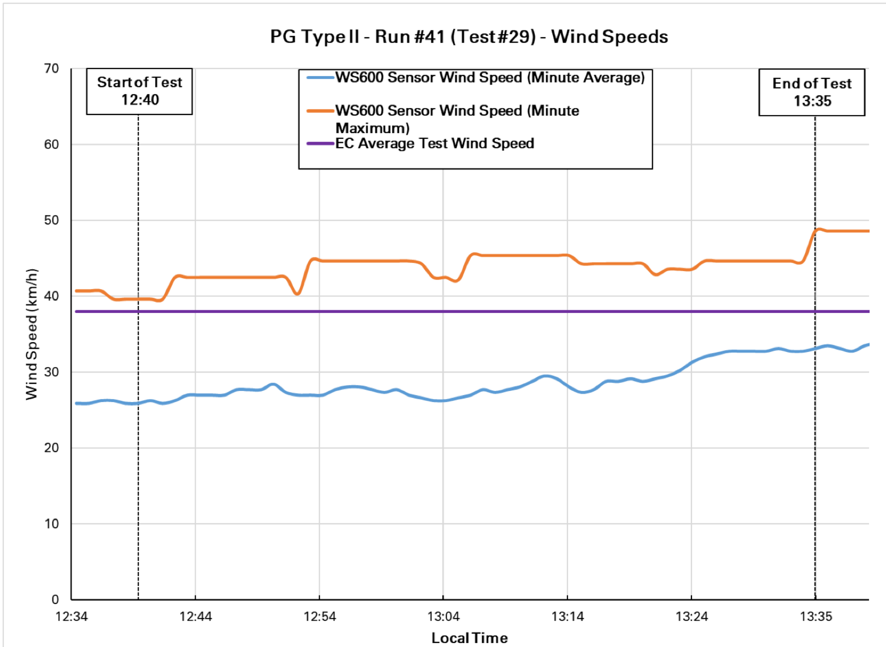
PG TYPE II
RUN #41 (TEST #29) – PG2-29

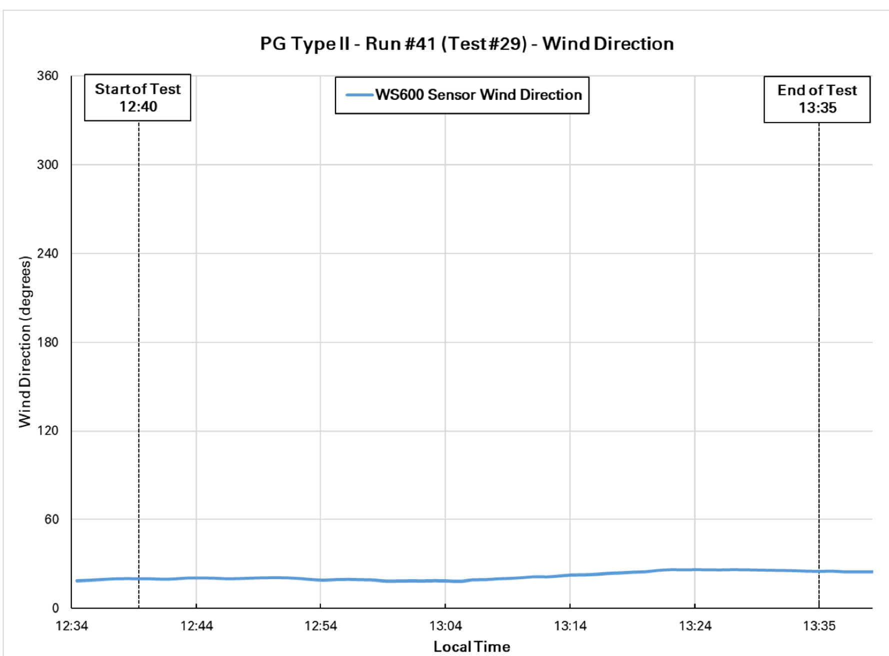
PG Type II – Run #41 (Test #29) – General Test Information

Test Number:	PG2-29
Date of Test:	February 7, 2020
Average OAT:	-6.1
Average Precipitation Rate:	36.0 g/dm²/h
Average Wind Speed:	38.0 km/h
Average Relative Humidity:	89.3%
Pour Time (Local):	12:40:00
Time of Fluid Failure (Local):	13:35:00
Fluid Brix at Failure:	12.25°
Endurance Time:	55 minutes
Expected Regression-Derived Endurance Time:	31.8 minutes
Difference (ET vs. Reg ET):	+23.5 minutes (+74.0%)

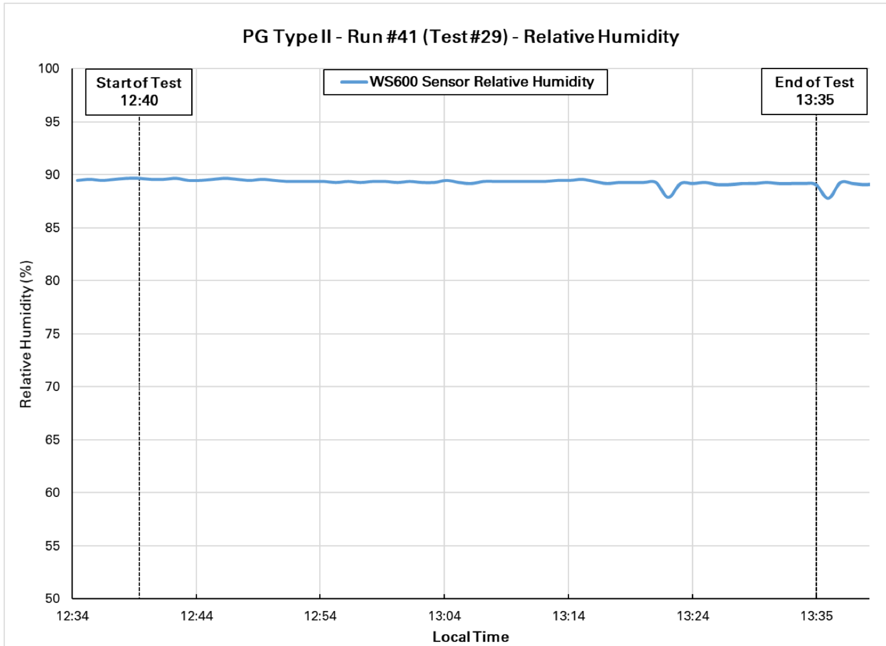

PG Type II - Run #41 (Test #29) - Precipitation Rate
Start of Test 12:40
Collection Pan Rate
Average Test Rate
End of Test 13:35
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
12:34
12:44
12:54
13:04
13:14
13:24
13:35
Local Time


PG Type II - Run #41 (Test #29) - Temperatures
Start of Test 12:40
Initial Fluid Temp: -5.0°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 13:35
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
12:34
12:44
12:54
13:04
13:14
13:24
13:35
Local Time


PG Type II - Run #41 (Test #29) - Wind Speeds
Start of Test 12:40
End of Test 13:35
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
12:34
12:44
12:54
13:04
13:14
13:24
13:35
Local Time


PG Type II - Run #41 (Test #29) - Wind Direction
Start of Test 12:40
End of Test 13:35
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
12:34
12:44
12:54
13:04
13:14
13:24
13:35
Local Time

DATA PACKAGE – PG TYPE II – RUN 41 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 41 - Test 29/Data Package - PG Type II - Run 41 - Test 29.docx
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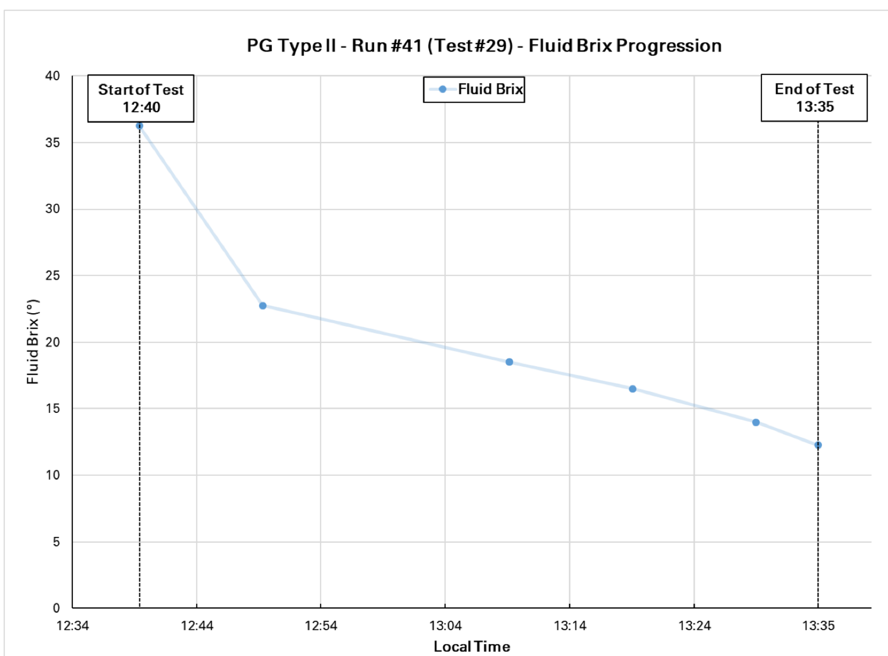
DATA PACKAGE – PG TYPE II – RUN 41 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 41 - Test 29/Data Package - PG Type II - Run 41 - Test 29.docx
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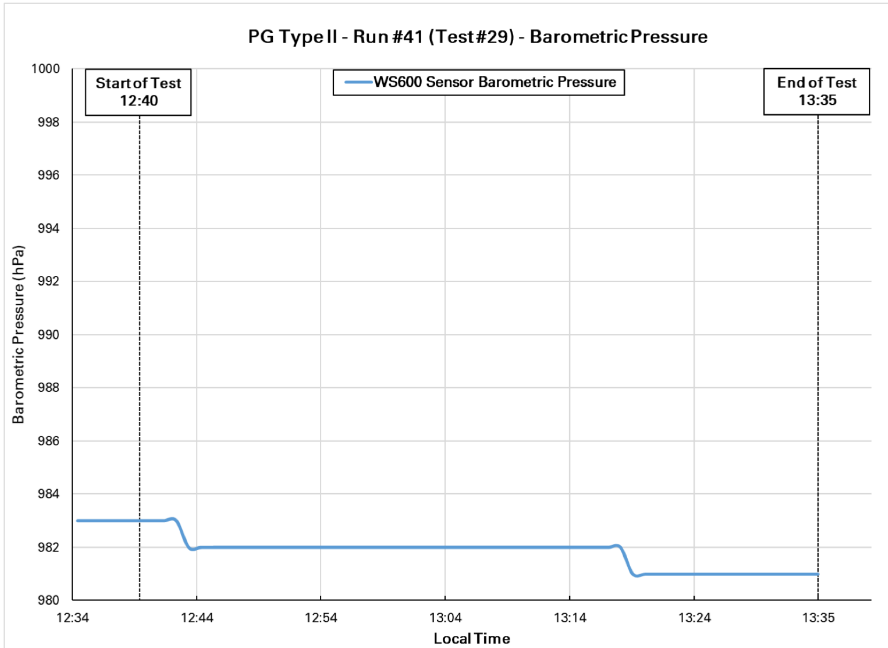
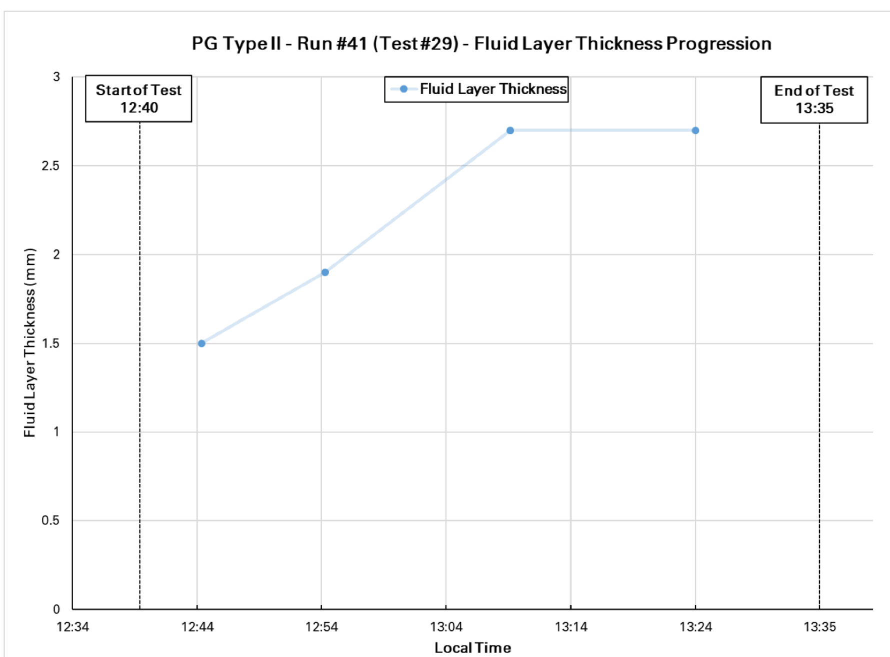
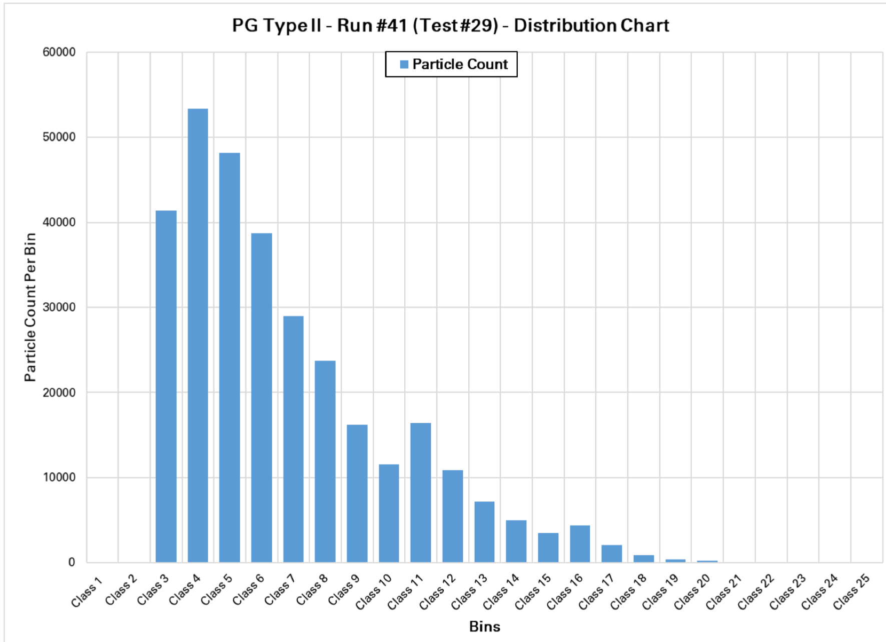
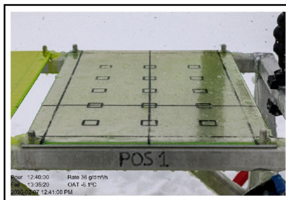

PG Type II - Run #41 (Test #29) - Barometric Pressure
Start of Test 12:40
WS600 Sensor Barometric Pressure
End of Test 13:35
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
12:34
12:44
12:54
13:04
13:14
13:24
13:35
Local Time

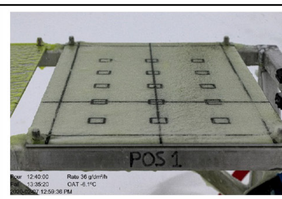

PG Type II - Run #41 (Test #29) - Fluid Layer Thickness Progression
Start of Test 12:40
Fluid Layer Thickness
End of Test 13:35
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
12:34
12:44
12:54
13:04
13:14
13:24
13:35
Local Time



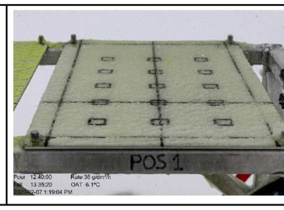
Safewing MP II Flight – Run 41 (Test 29) – Failure Progression Photos



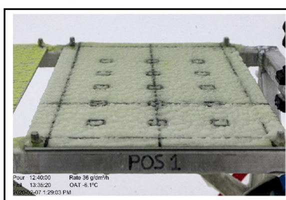
AT POUR (0/55 MIN)



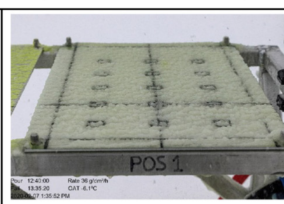
PRE-FAILURE (19/55 MIN)



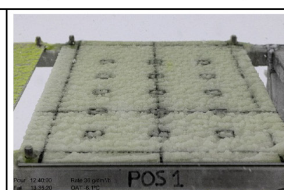
PRE-FAILURE (39/55 MIN)



PRE-FAILURE (49/55 MIN)



AT FAILURE (55/55 MIN)



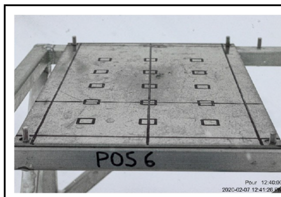
POST-FAILURE (63/55 MIN)

Safewing MP II Flight – Run 41 (Test 29) – Snow Characteristics Photos

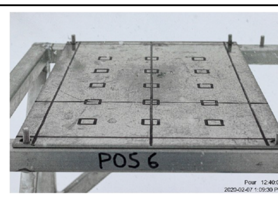
FELT PAD (10/55 MIN)

FELT PAD (30/55 MIN)

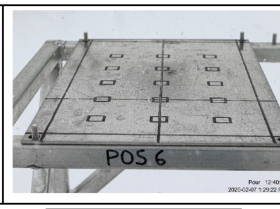
FELT PAD (45/55 MIN)



BARE PLATE (1/55 MIN)



BARE PLATE (29/55 MIN)



BARE PLATE (49/55 MIN)

Final Bare Plate Contamination Thickness: **Nil (0 mm)**

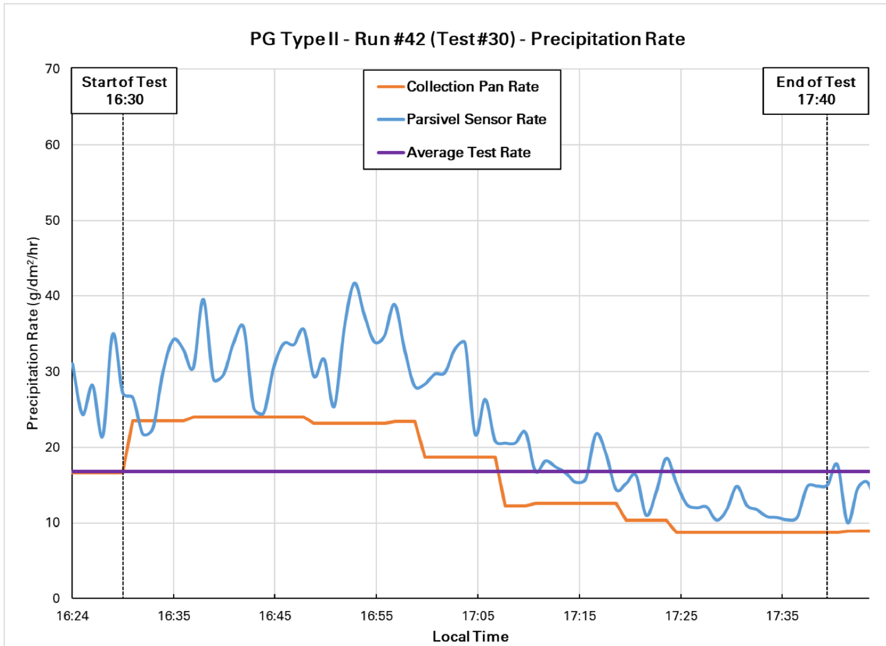
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #42 (TEST #30) – PG2-30

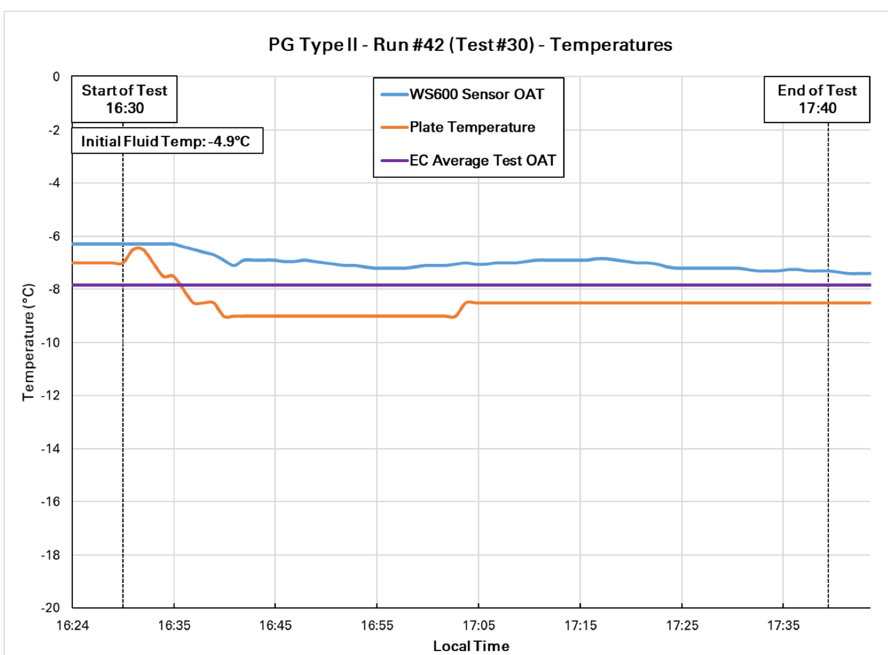
DATA PACKAGE – PG TYPE II – RUN 42 (TEST 30)

PG Type II – Run #42 (Test #30) – General Test Information

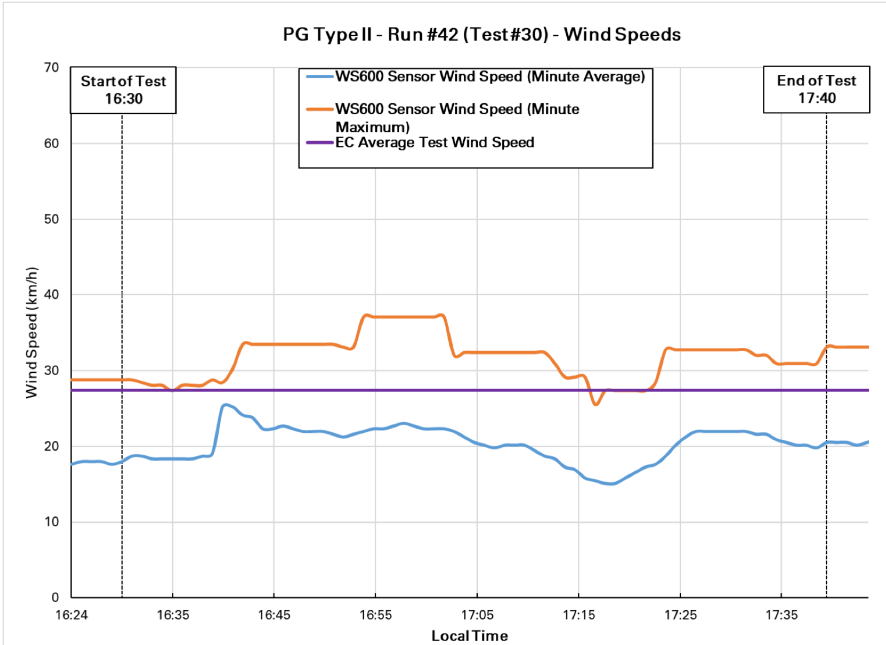
Test Number:	**PG2-30**
Date of Test:	**February 7, 2020**
Average OAT:	**-7.8**
Average Precipitation Rate:	**16.8 g/dm²/h**
Average Wind Speed:	**27.4 km/h**
Average Relative Humidity:	**87.6%**
Pour Time (Local):	**16:30:00**
Time of Fluid Failure (Local):	**17:40:00**
Fluid Brix at Failure:	**15.75°**
Endurance Time:	**70 minutes**
Expected Regression-Derived Endurance Time:	**53.3 minutes**
Difference (ET vs. Reg ET):	**+16.7 minutes (+31.4%)**

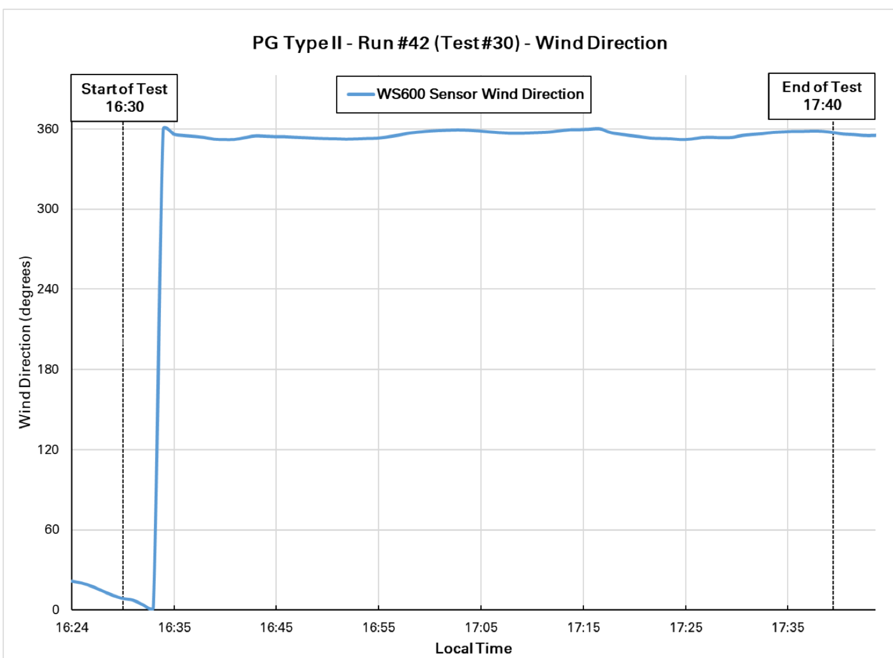


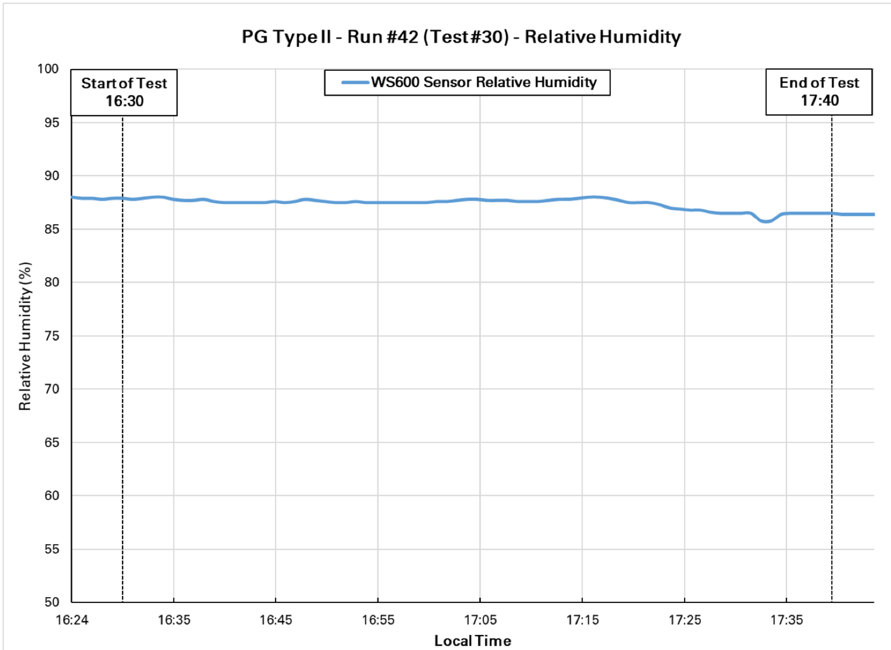
PG Type II - Run #42 (Test #30) - Precipitation Rate
Start of Test
16:30
End of Test
17:40
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time



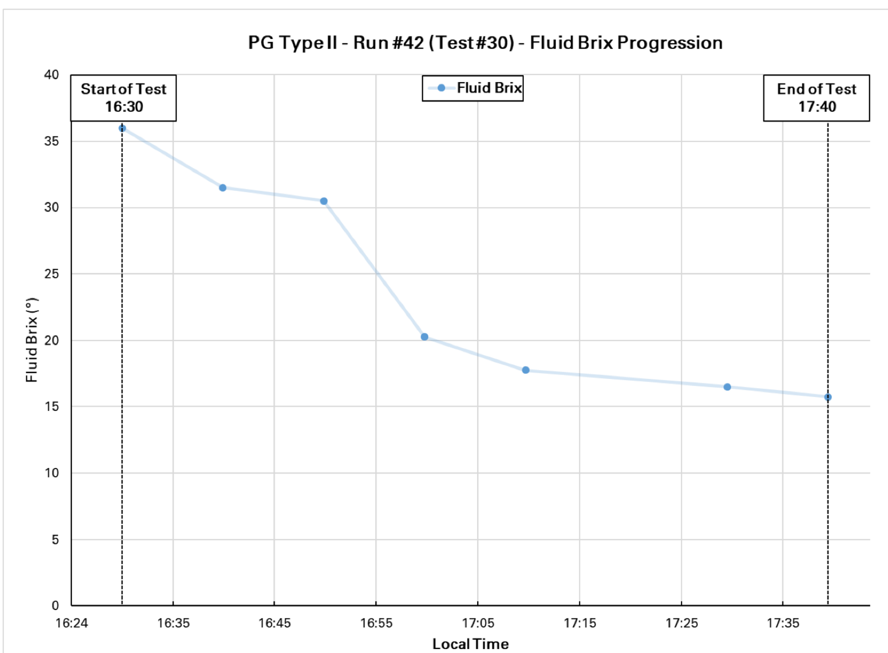
PG Type II - Run #42 (Test #30) - Temperatures
Start of Test
16:30
Initial Fluid Temp: -4.9°C
End of Test
17:40
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time


PG Type II - Run #42 (Test #30) - Wind Speeds
Start of Test 16:30
End of Test 17:40
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time

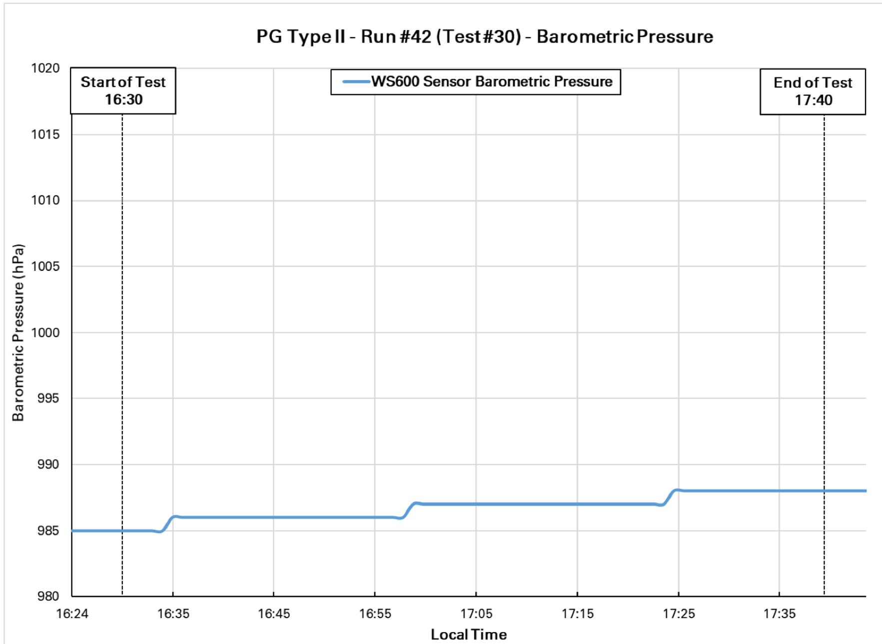

PG Type II - Run #42 (Test #30) - Wind Direction
Start of Test 16:30
End of Test 17:40
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time



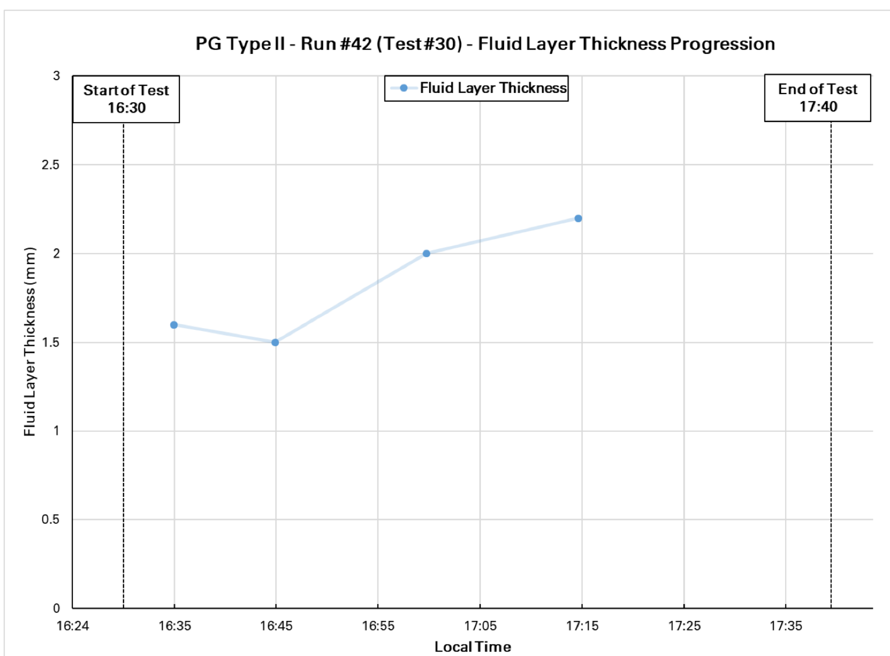
PG Type II - Run #42 (Test #30) - Relative Humidity
Start of Test 16:30
WS600 Sensor Relative Humidity
End of Test 17:40
Relative Humidity (%)
Local Time
100
95
90
85
80
75
70
65
60
55
50
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35

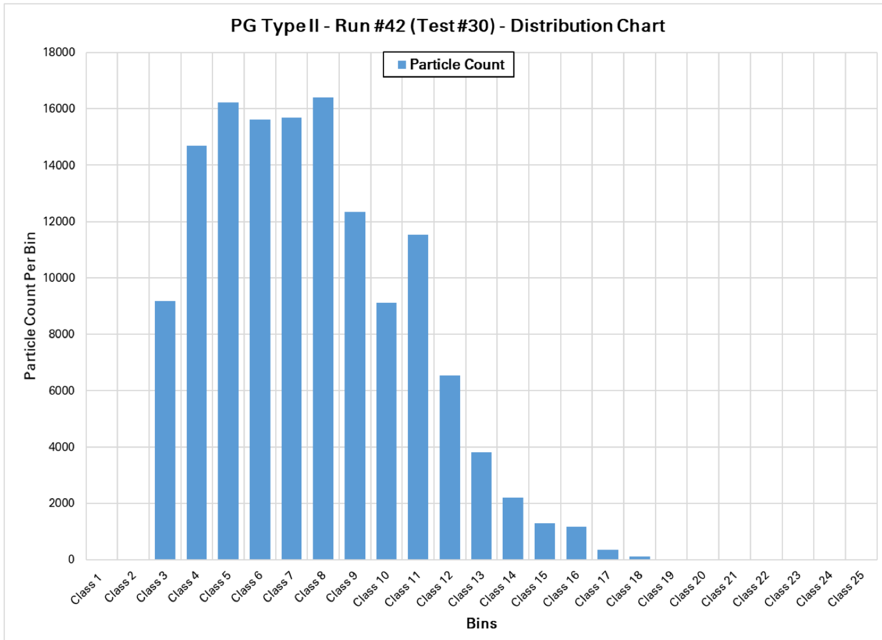


PG Type II - Run #42 (Test #30) - Fluid Brix Progression
Start of Test 16:30
Fluid Brix
End of Test 17:40
Fluid Brix (°)
Local Time
40
35
30
25
20
15
10
5
0
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35

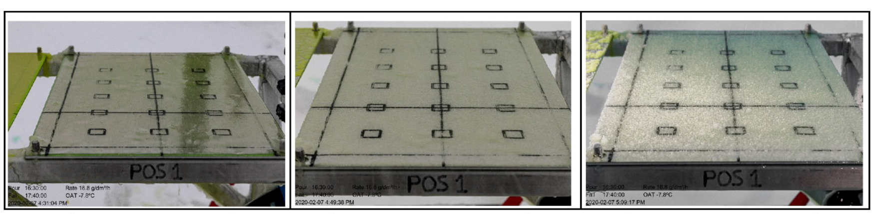


DATA PACKAGE – PG TYPE II – RUN 42 (TEST 30)





Safewing MP II Flight – Run 42 (Test 30) – Failure Progression Photos

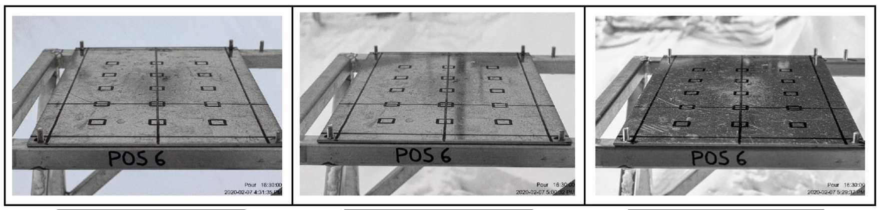


AT POUR (1/70 MIN) | PRE-FAILURE (19/70 MIN) | PRE-FAILURE (39/70 MIN)

PRE-FAILURE (59/70 MIN) | AT FAILURE (70/70 MIN) | POST-FAILURE (75/70 MIN)

Safewing MP II Flight – Run 42 (Test 30) – Snow Characteristics Photos

FELT PAD (11/70 MIN) | FELT PAD (31/70 MIN) | FELT PAD (50/70 MIN)



BARE PLATE (1/70 MIN) | BARE PLATE (30/70 MIN) | BARE PLATE (59/70 MIN)

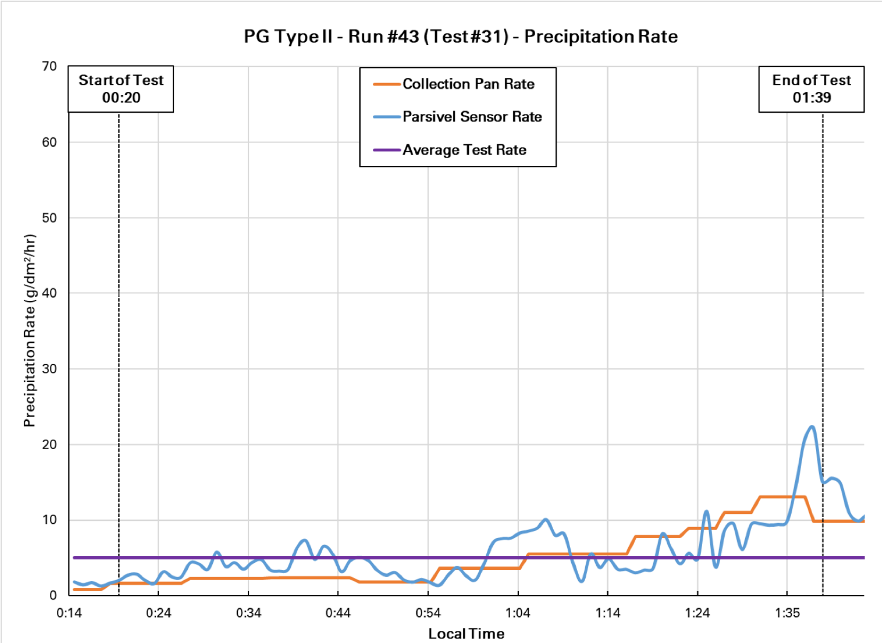
Final Bare Plate Contamination Thickness: **Nil (0mm)**

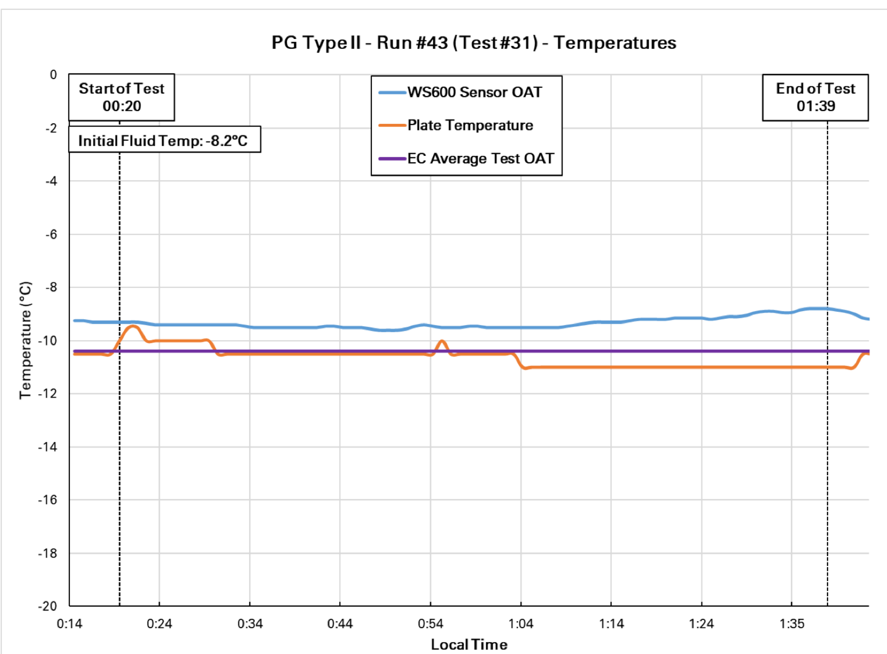
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

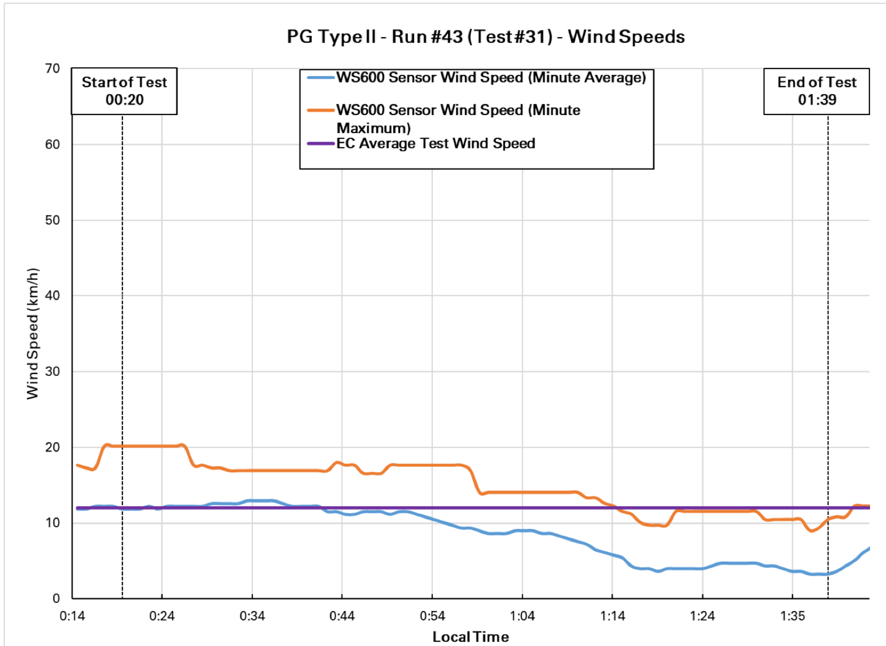
PG TYPE II
RUN #43 (TEST #31) – PG2-31

PG Type II – Run #14 (Test #14) – General Test Information

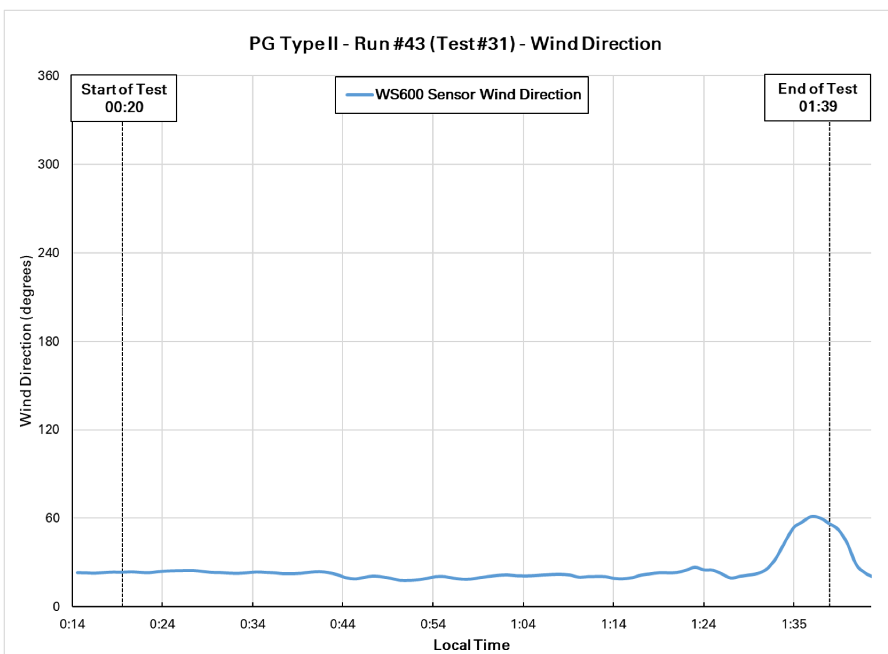
Test Number:	**PG2-31**
Date of Test:	**February 10, 2020**
Average OAT:	**-10.4**
Average Precipitation Rate:	**5.0 g/dm²/h**
Average Wind Speed:	**12.0 km/h**
Average Relative Humidity:	**80.8%**
Pour Time (Local):	**00:20:00**
Time of Fluid Failure (Local):	**01:39:00**
Fluid Brix at Failure:	**18.5°**
Endurance Time:	**79 minutes**
Expected Regression-Derived Endurance Time:	**126.6 minutes**
Difference (ET vs. Reg ET):	**- 46.8 minutes (- 37.0%)**


PG Type II - Run #43 (Test #31) - Precipitation Rate
Start of Test 00:20
End of Test 01:39
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

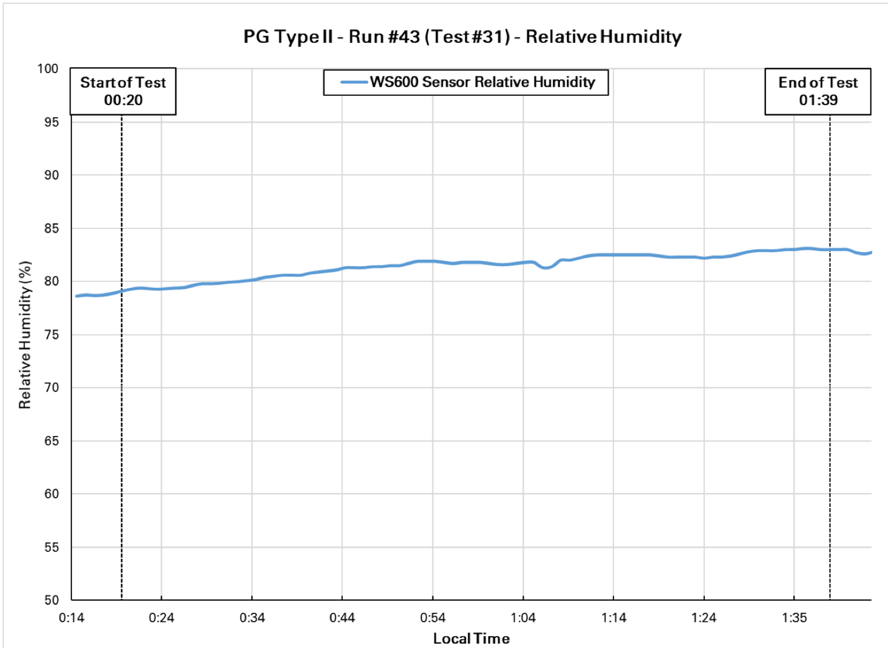

PG Type II - Run #43 (Test #31) - Temperatures
Start of Test 00:20
Initial Fluid Temp: -8.2°C
End of Test 01:39
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time



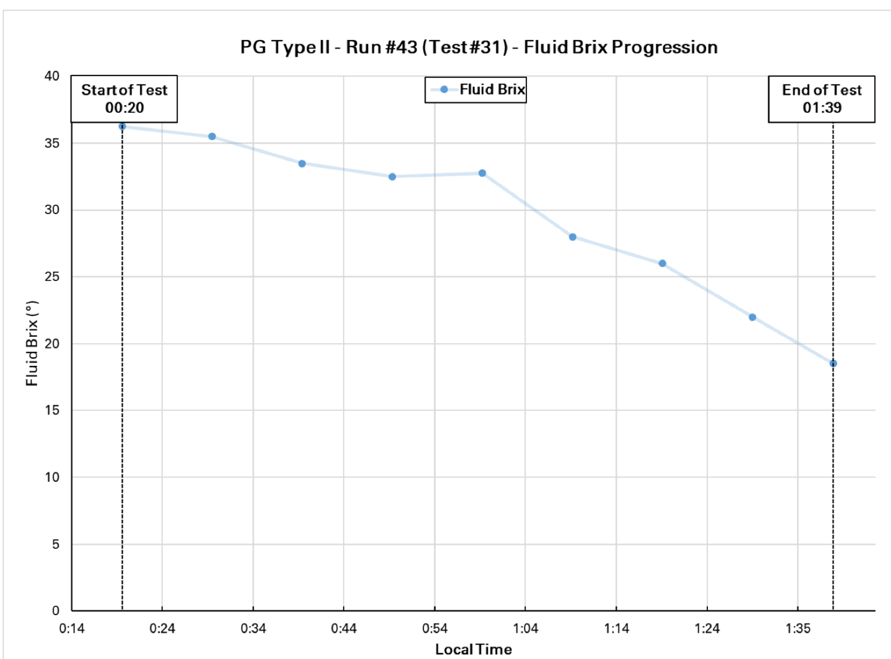
PG Type II - Run #43 (Test #31) - Wind Speeds
Start of Test 00:20
End of Test 01:39
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

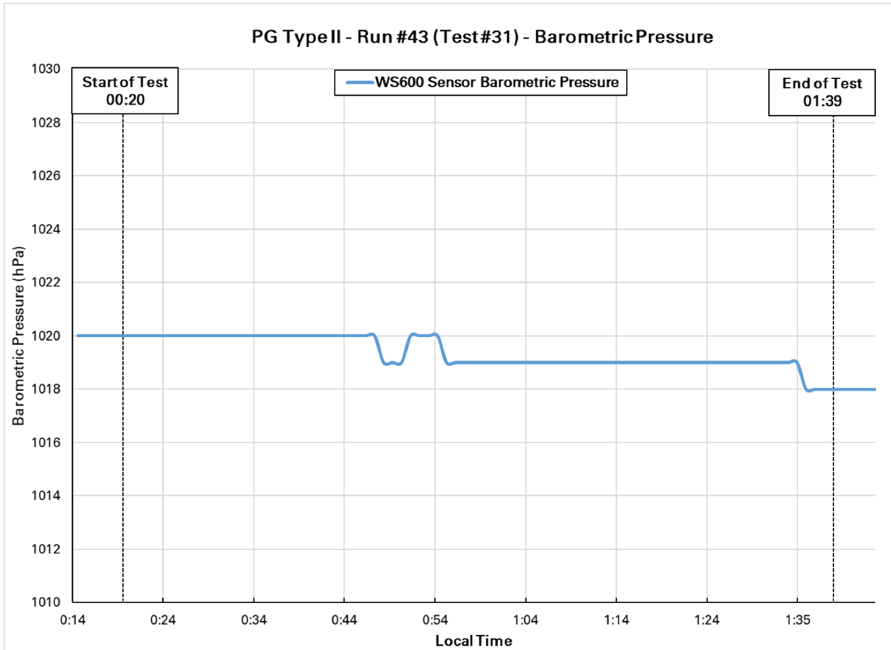


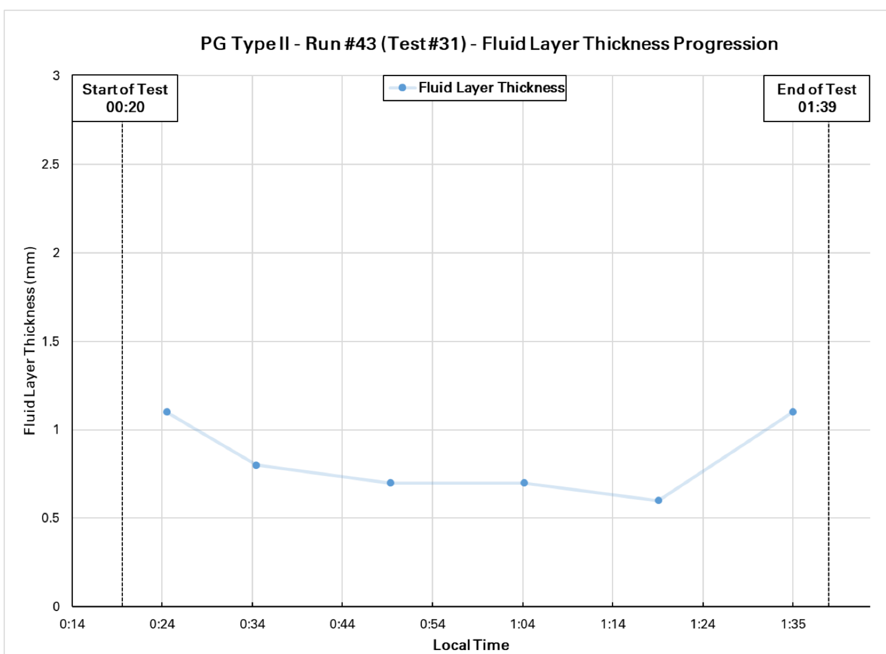
PG Type II - Run #43 (Test #31) - Wind Direction
Start of Test 00:20
End of Test 01:39
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

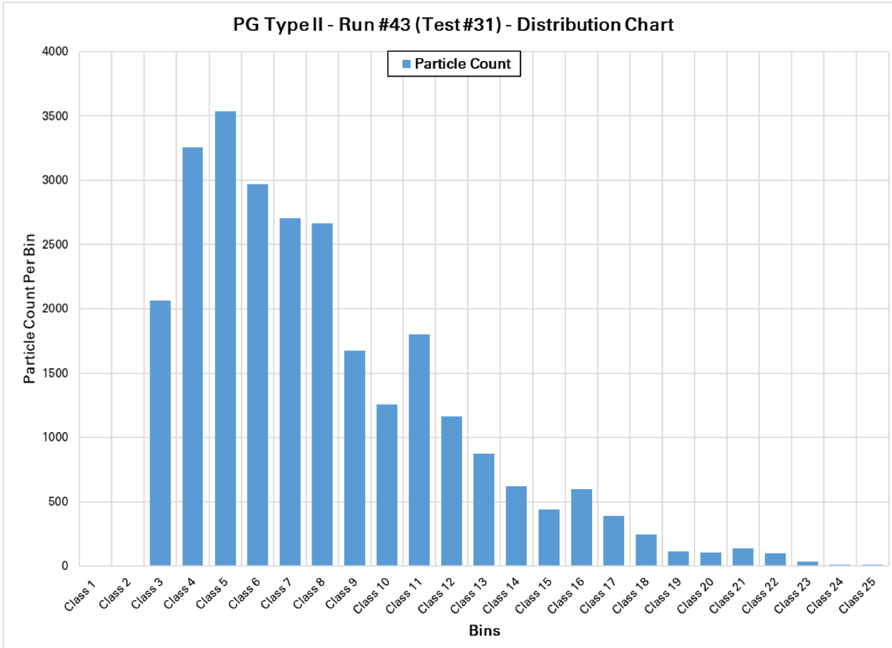


DATA PACKAGE – PG TYPE II – RUN 43 (TEST 31)

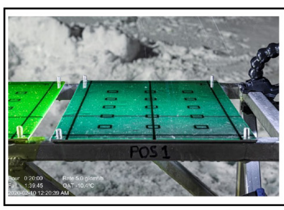



PG Type II - Run #43 (Test #31) - Barometric Pressure
Start of Test 00:20
WS600 Sensor Barometric Pressure
End of Test 01:39
Barometric Pressure (hPa)
1030
1028
1026
1024
1022
1020
1018
1016
1014
1012
1010
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

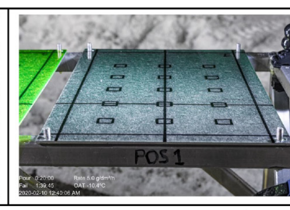

PG Type II - Run #43 (Test #31) - Fluid Layer Thickness Progression
Start of Test 00:20
Fluid Layer Thickness
End of Test 01:39
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time



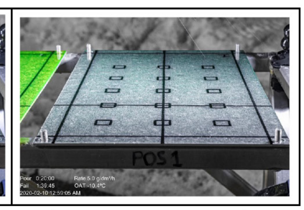
Safewing MP II Flight – Run 43 (Test 31) – Failure Progression Photos



AT POUR (0/79 MIN)

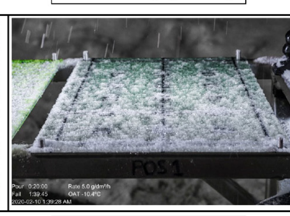


PRE-FAILURE (20/79 MIN)

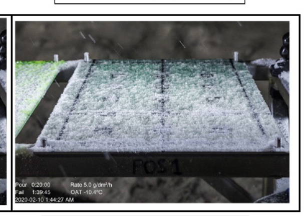


PRE-FAILURE (39/79 MIN)

PRE-FAILURE (69/79 MIN)

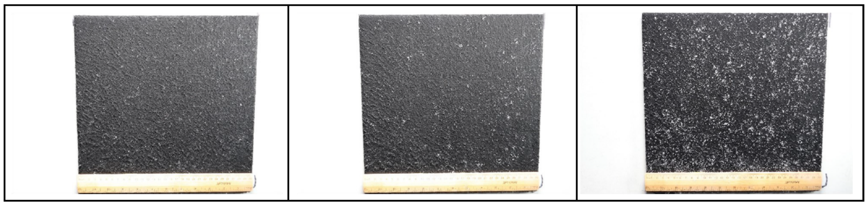


AT FAILURE (80/79 MIN)

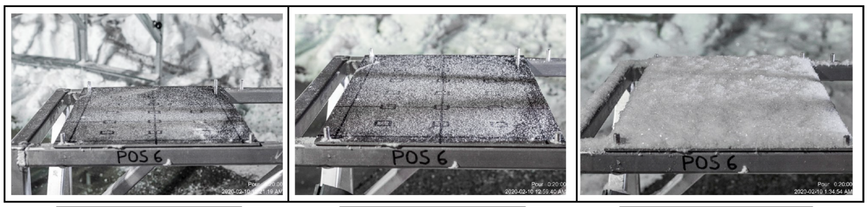


POST-FAILURE (84/79 MIN)

Safewing MP II Flight – Run 43 (Test 31) – Snow Characteristics Photos



FELT PAD (2/79 MIN) | FELT PAD (40/79 MIN) | FELT PAD (80/79 MIN)



BARE PLATE (1/79 MIN) | BARE PLATE (39/79 MIN) | BARE PLATE (74/79 MIN)

Final Bare Plate Contamination Thickness: **10mm**

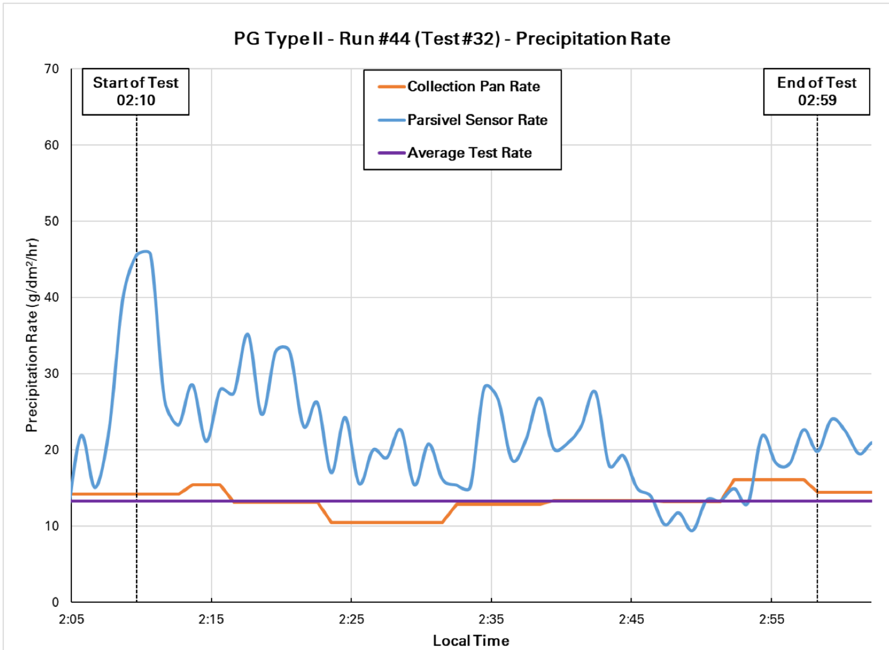
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #44 (TEST #32) – PG2-32

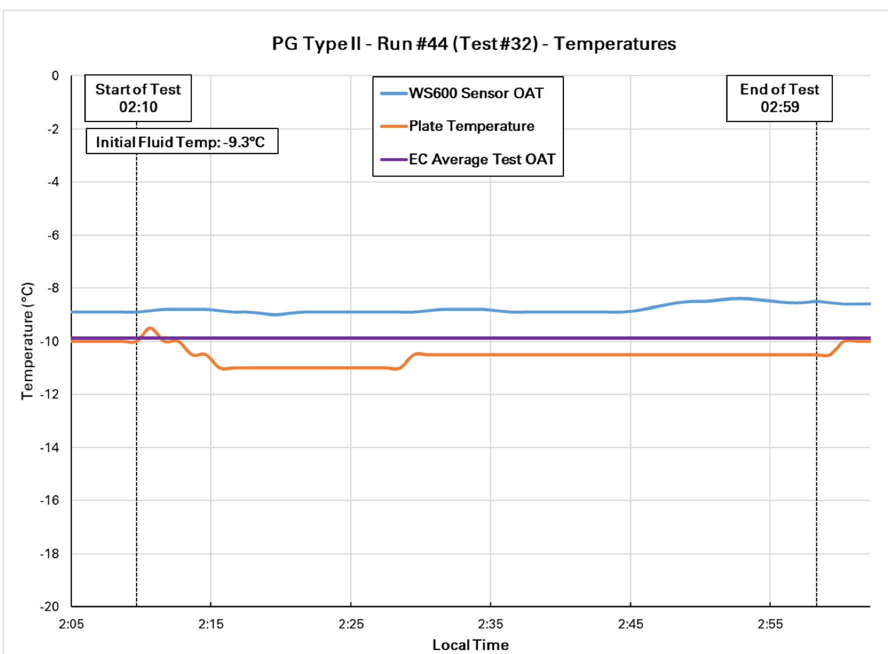
DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)

PG Type II – Run #44 (Test #32) – General Test Information

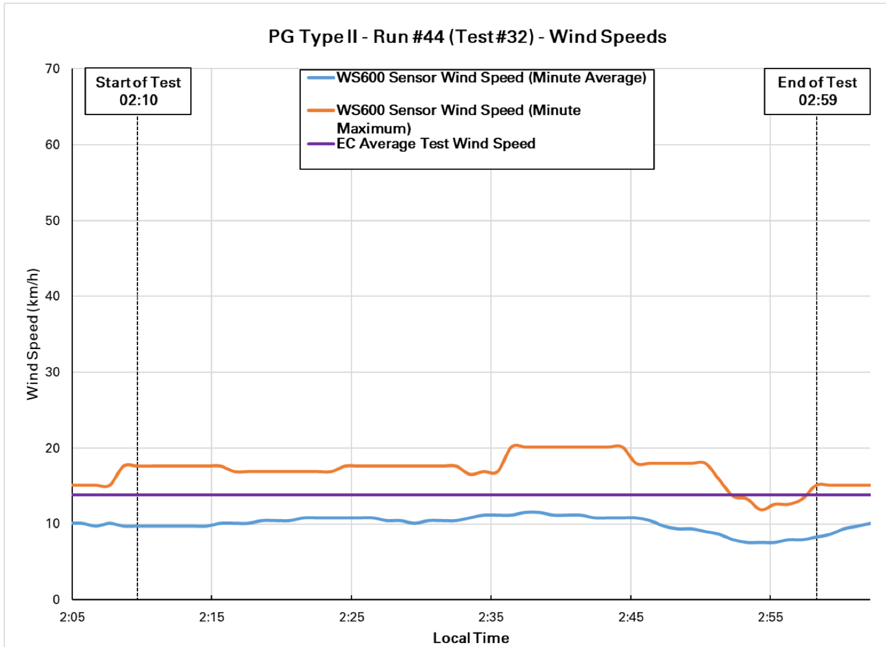
Test Number:	**PG2-32**
Date of Test:	**February 10, 2020**
Average OAT:	**-9.9**
Average Precipitation Rate:	**13.2 g/dm²/h**
Average Wind Speed:	**13.8 km/h**
Average Relative Humidity:	**84.9%**
Pour Time (Local):	**02:10:00**
Time of Fluid Failure (Local):	**02:59:00**
Fluid Brix at Failure:	**19.25°**
Endurance Time:	**49 minutes**
Expected Regression-Derived Endurance Time:	**58.6 minutes**
Difference (ET vs. Reg ET):	**- 9.6 minutes (- 16.4%)**



DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)



DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 44 - Test 32/Data Package - PG Type II - Run 44 - Test 32.docx
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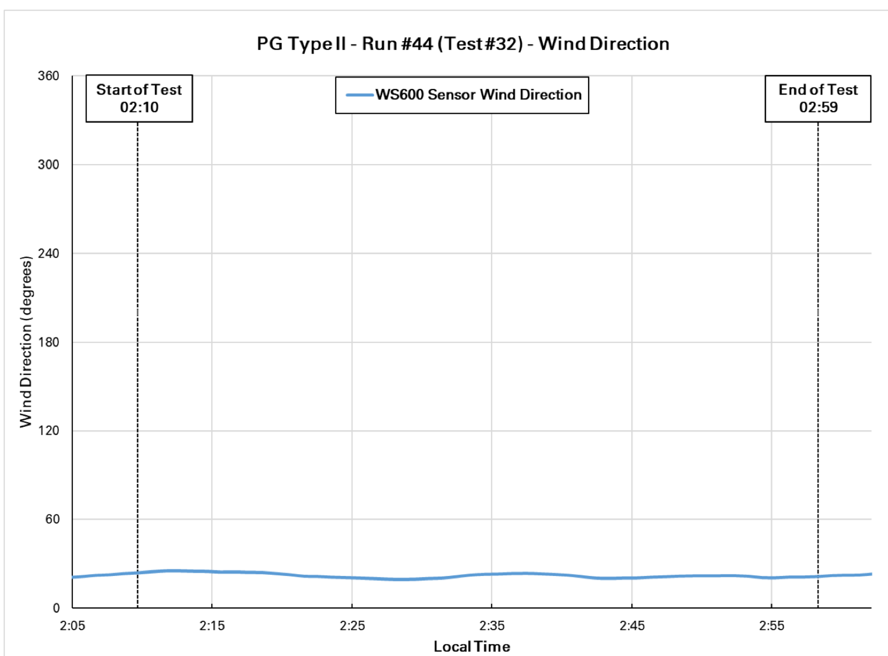
DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 44 - Test 32/Data Package - PG Type II - Run 44 - Test 32.docx
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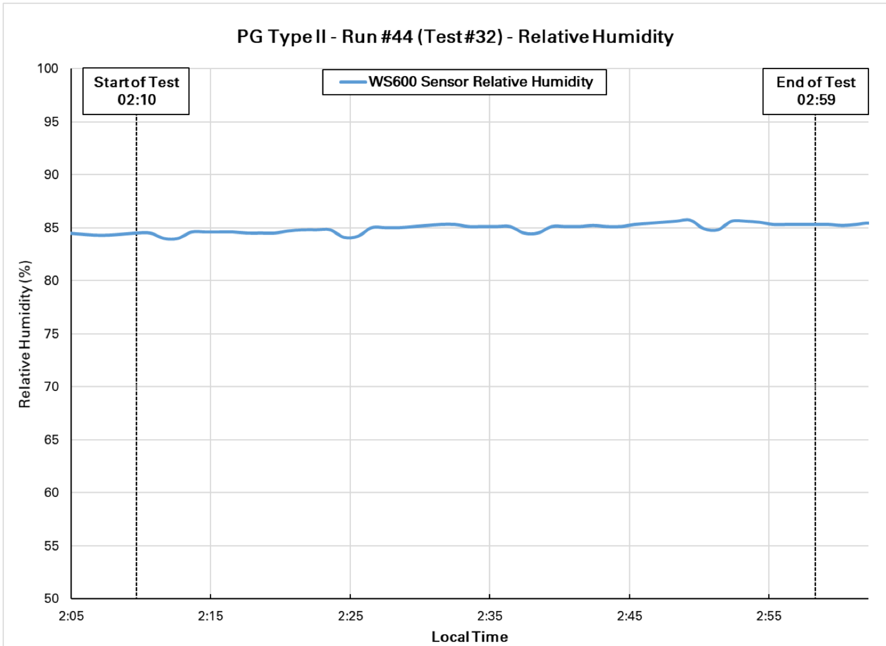
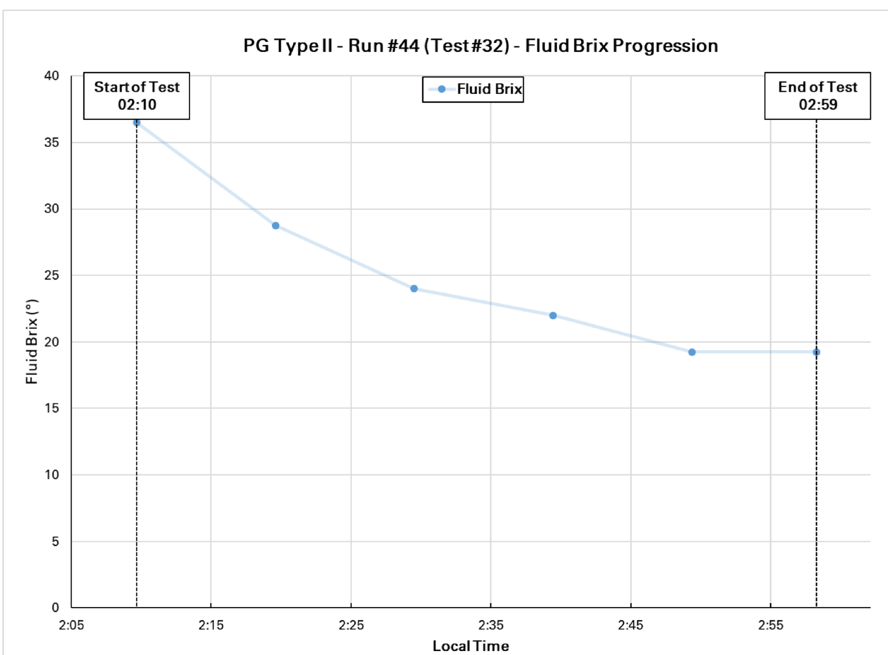
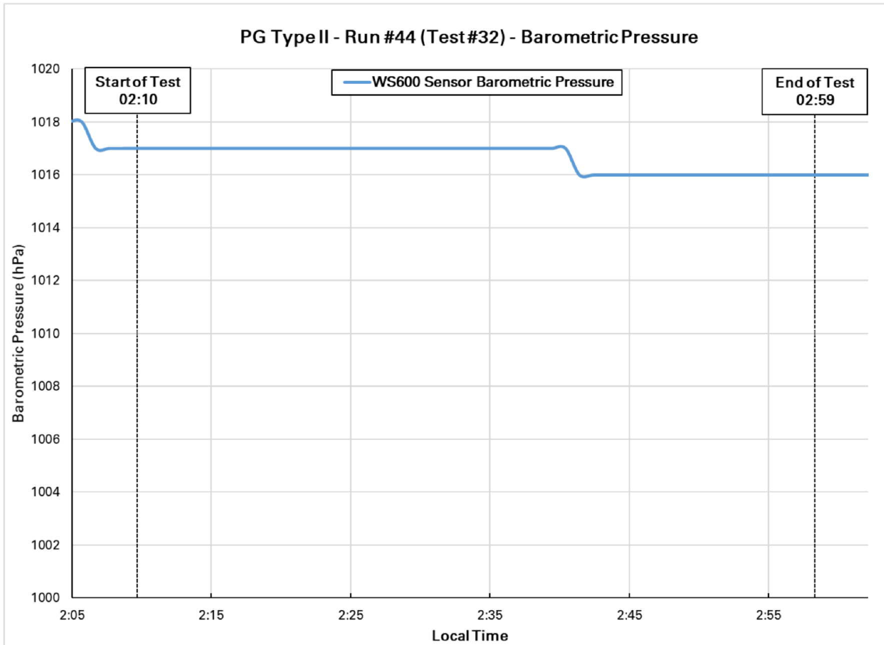

PG Type II - Run #44 (Test #32) - Relative Humidity
Start of Test 02:10
WS600 Sensor Relative Humidity
End of Test 02:59
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:05
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type II - Run #44 (Test #32) - Fluid Brix Progression
Start of Test 02:10
Fluid Brix
End of Test 02:59
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
2:05
2:15
2:25
2:35
2:45
2:55
Local Time

DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 44 - Test 32/Data Package - PG Type II - Run 44 - Test 32.docx
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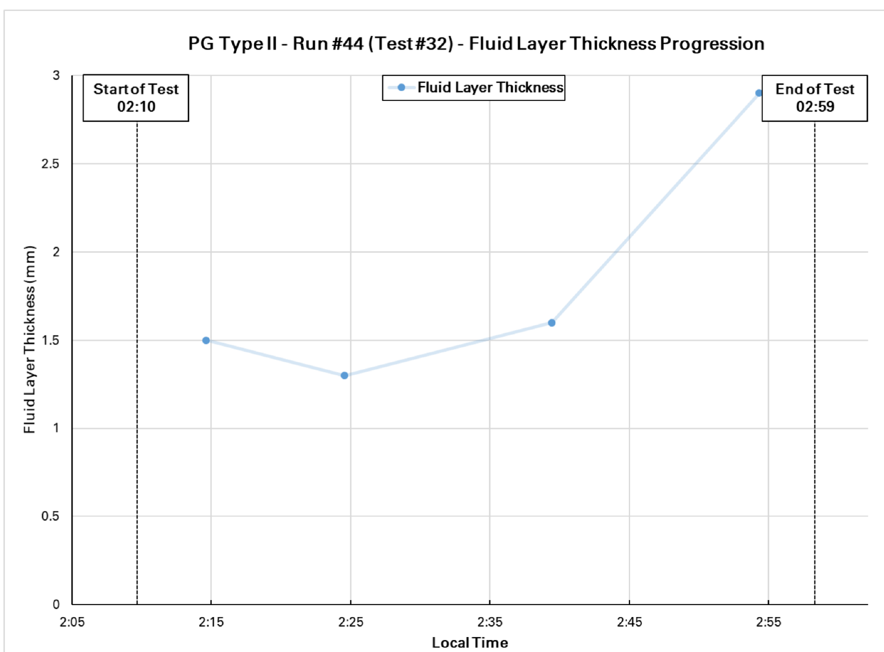
DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 44 - Test 32/Data Package - PG Type II - Run 44 - Test 32.docx
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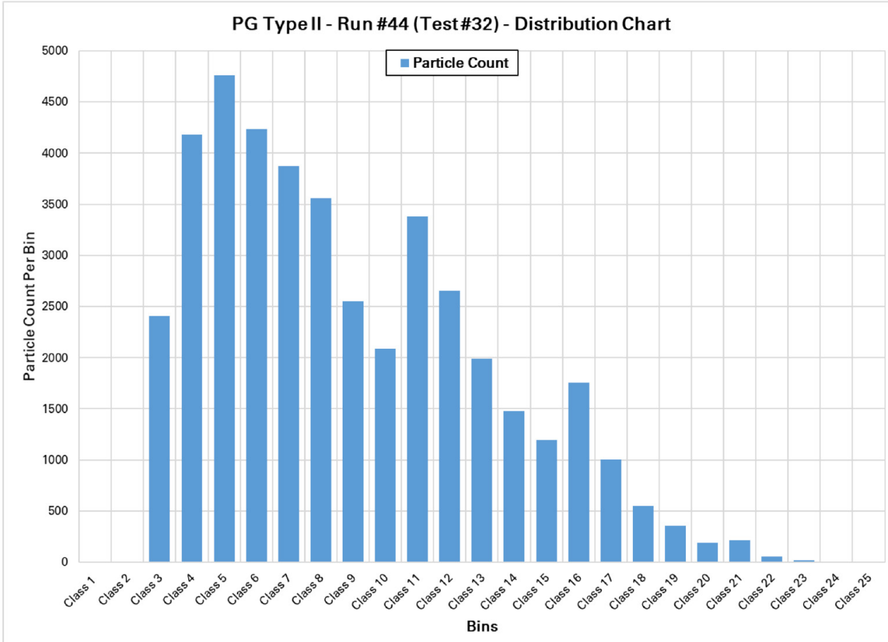
DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 44 - Test 32/Data Package - PG Type II - Run 44 - Test 32.docx
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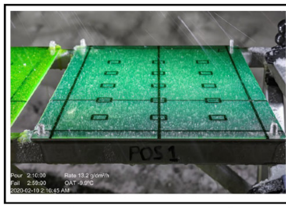
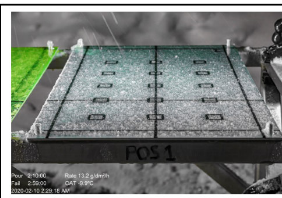
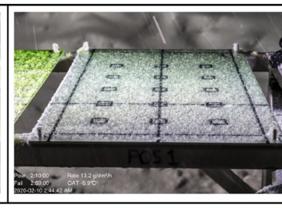
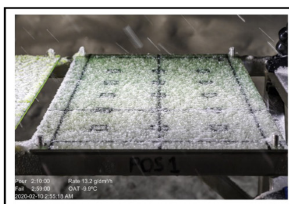
DATA PACKAGE – PG TYPE II – RUN 44 (TEST 32)

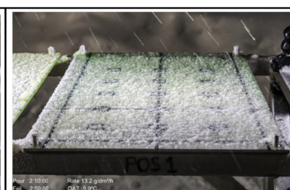
Safewing MP II Flight – Run 44 (Test 32) – Failure Progression Photos


AT POUR (0/49 MIN)


PRE-FAILURE (19/49 MIN)


PRE-FAILURE (34/49 MIN)


PRE-FAILURE (45/49 MIN)


AT FAILURE (49/49 MIN)


POST-FAILURE (54/49 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 44 - Test 32/Data Package - PG Type II - Run 44 - Test 32.docx
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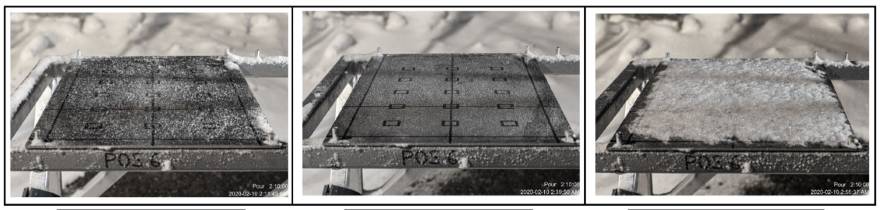
Safewing MP II Flight – Run 42 (Test 32) – Snow Characteristics Photos

FELT PAD (3/49 MIN) | FELT PAD (20/49 MIN) | FELT PAD (40/49 MIN)



BARE PLATE (1/49 MIN) | BARE PLATE (29/49 MIN) | BARE PLATE (45/49 MIN)

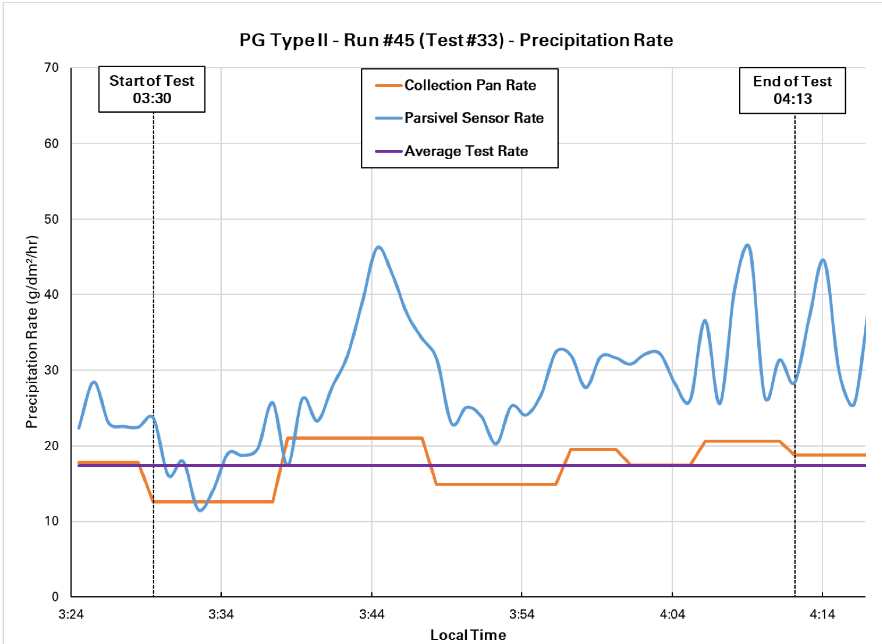
Final Bare Plate Contamination Thickness: **Nil (0mm)**

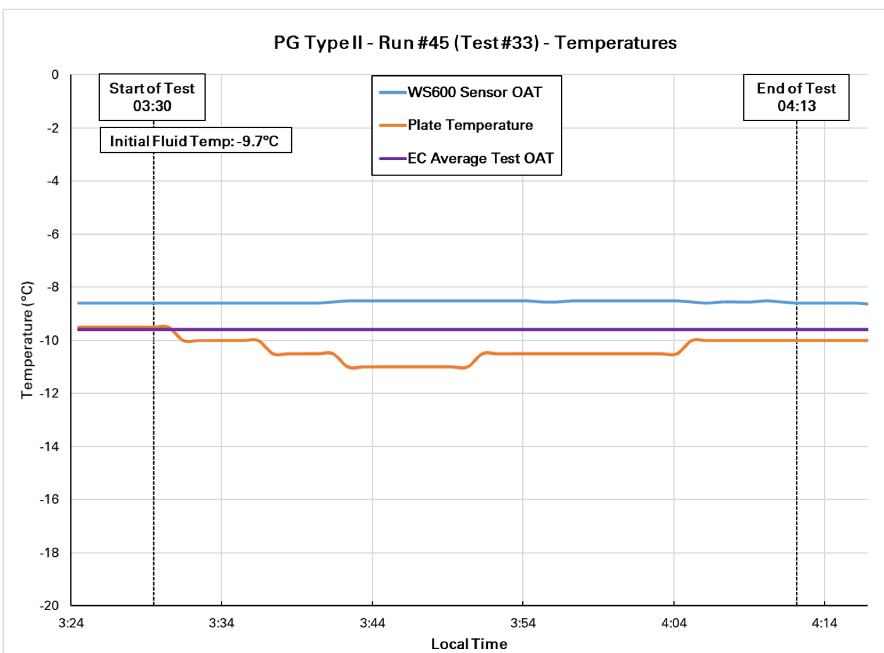
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

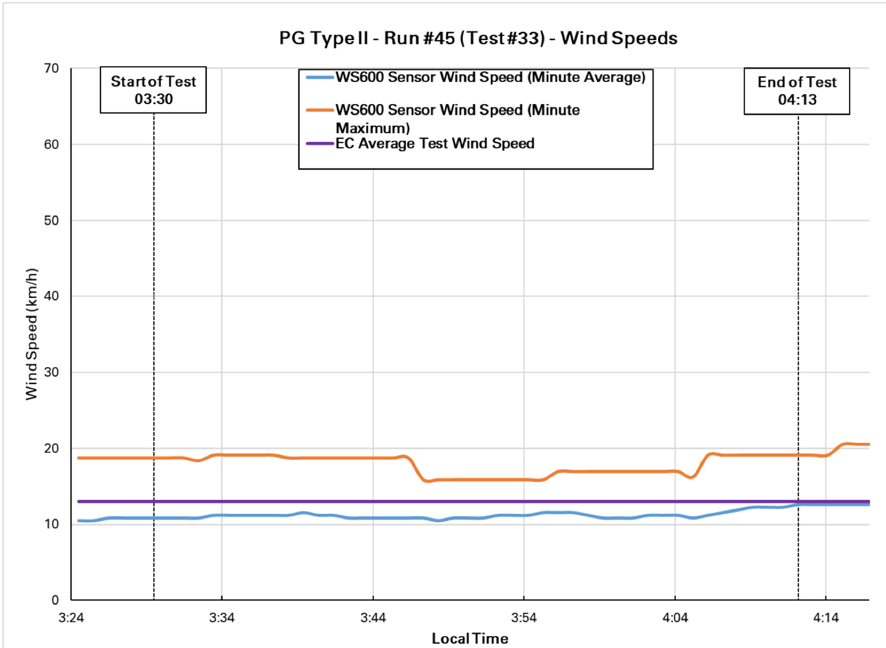
PG TYPE II
RUN #45 (TEST #33) – PG2-33

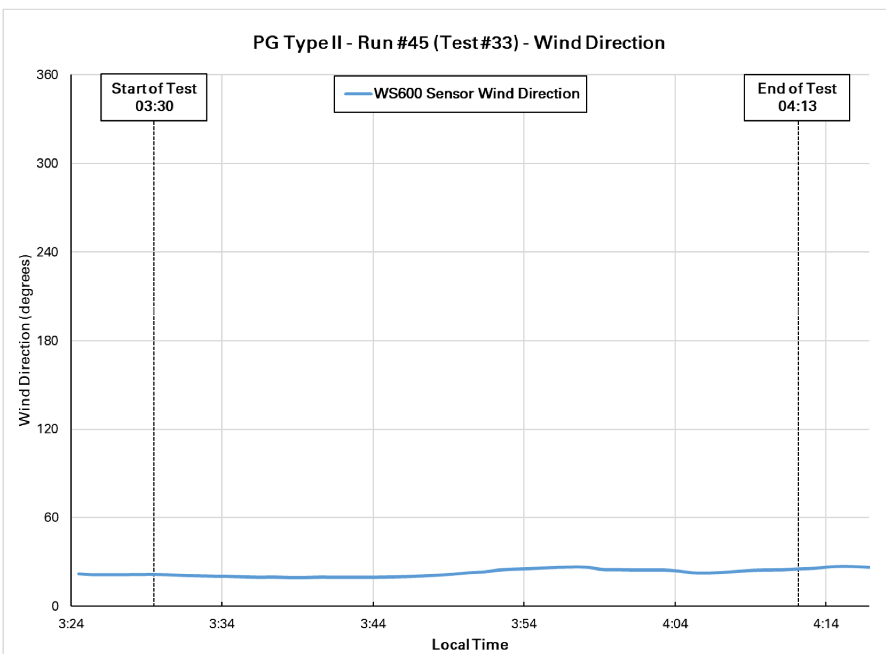
PG Type II – Run #45 (Test #33) – General Test Information

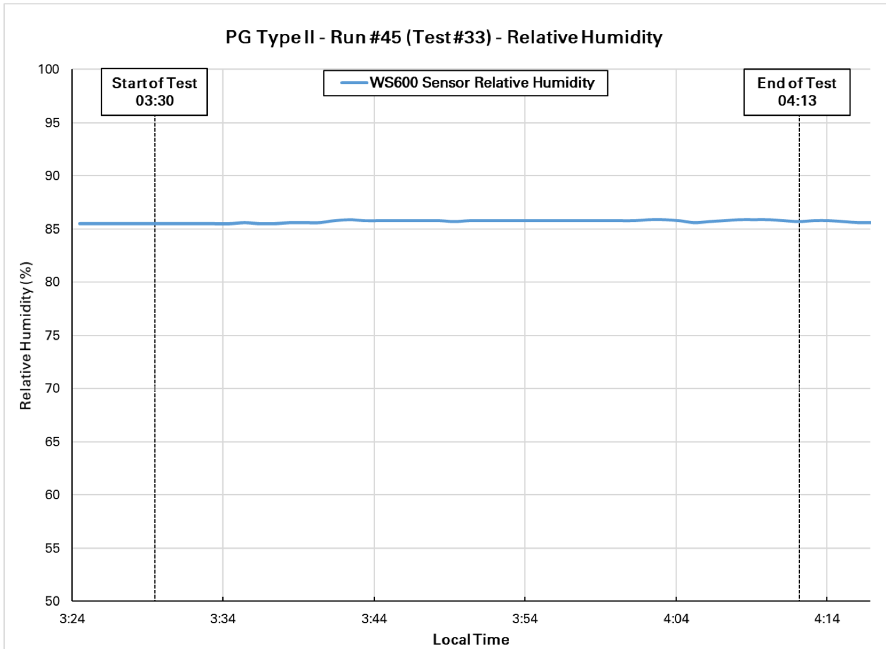
Test Number:	PG2-33
Date of Test:	February 10, 2020
Average OAT:	-9.6
Average Precipitation Rate:	17.4 g/dm²/h
Average Wind Speed:	13.0 km/h
Average Relative Humidity:	85.7%
Pour Time (Local):	03:30:00
Time of Fluid Failure (Local):	04:13:00
Fluid Brix at Failure:	18.25°
Endurance Time:	43 minutes
Expected Regression-Derived Endurance Time:	47.5 minutes
Difference (ET vs. Reg ET):	- 4.5 minutes (- 9.4%)

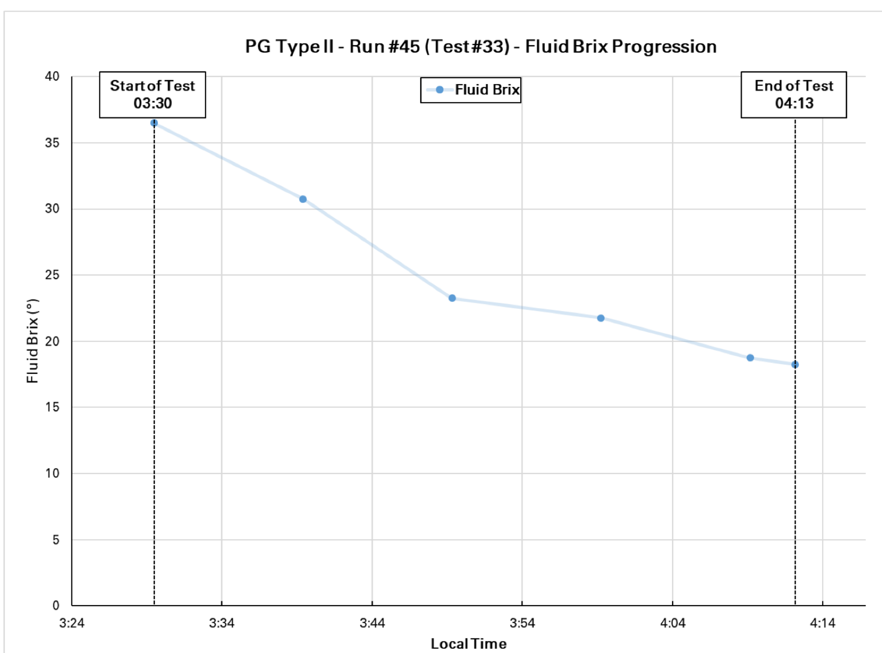

PG Type II - Run #45 (Test #33) - Precipitation Rate
Start of Test 03:30
End of Test 04:13
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
3:24
3:34
3:44
3:54
4:04
4:14
Local Time

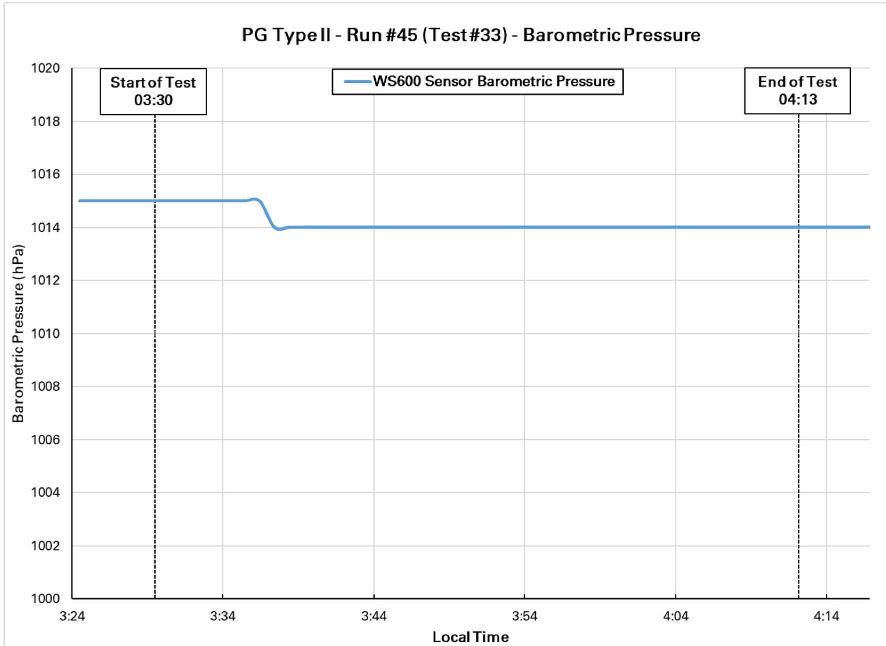

PG Type II - Run #45 (Test #33) - Temperatures
Start of Test 03:30
Initial Fluid Temp: -9.7°C
End of Test 04:13
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:24
3:34
3:44
3:54
4:04
4:14
Local Time

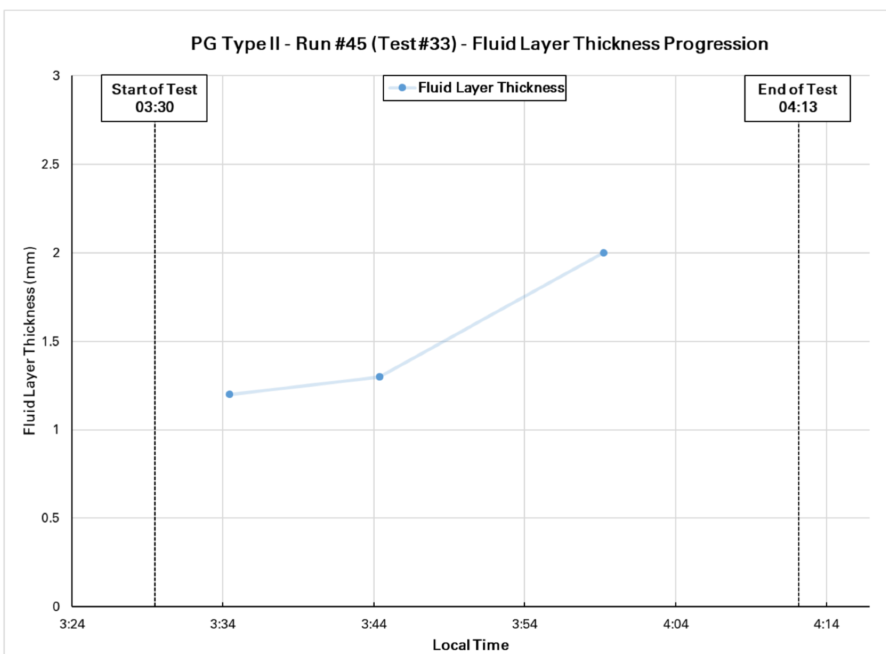

PG Type II - Run #45 (Test #33) - Wind Speeds
Start of Test 03:30
End of Test 04:13
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
3:24
3:34
3:44
3:54
4:04
4:14


PG Type II - Run #45 (Test #33) - Wind Direction
Start of Test 03:30
End of Test 04:13
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
3:24
3:34
3:44
3:54
4:04
4:14

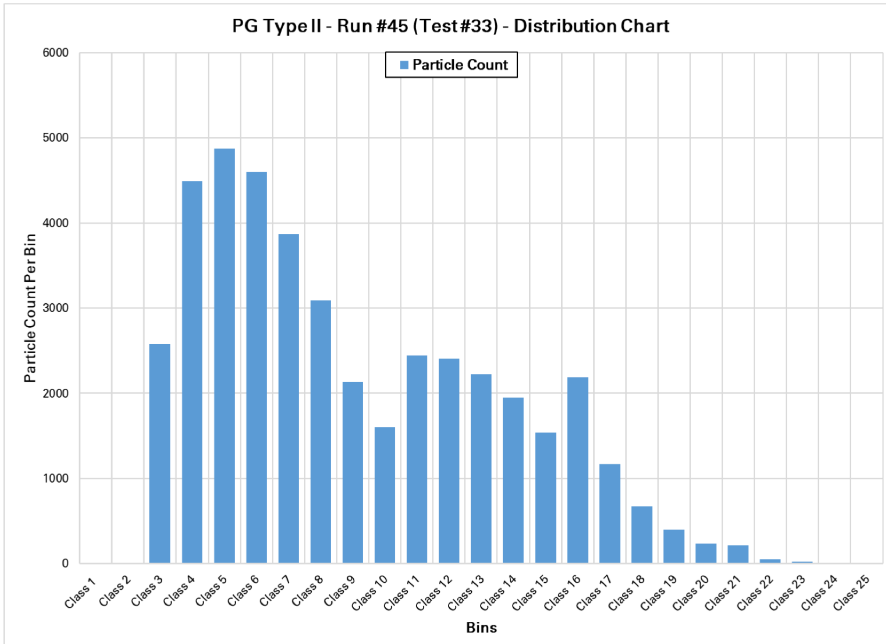

PG Type II - Run #45 (Test #33) - Relative Humidity
Start of Test 03:30
WS600 Sensor Relative Humidity
End of Test 04:13
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:24
3:34
3:44
3:54
4:04
4:14
Local Time


PG Type II - Run #45 (Test #33) - Fluid Brix Progression
Start of Test 03:30
Fluid Brix
End of Test 04:13
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
3:24
3:34
3:44
3:54
4:04
4:14
Local Time


PG Type II - Run #45 (Test #33) - Barometric Pressure
Start of Test
03:30
WS600 Sensor Barometric Pressure
End of Test
04:13
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:24
3:34
3:44
3:54
4:04
4:14
Local Time


PG Type II - Run #45 (Test #33) - Fluid Layer Thickness Progression
Start of Test
03:30
Fluid Layer Thickness
End of Test
04:13
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:24
3:34
3:44
3:54
4:04
4:14
Local Time

DATA PACKAGE – PG TYPE II – RUN 45 (TEST 33)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 45 - Test 33/Data Package - PG Type II - Run 45 - Test 33.docx
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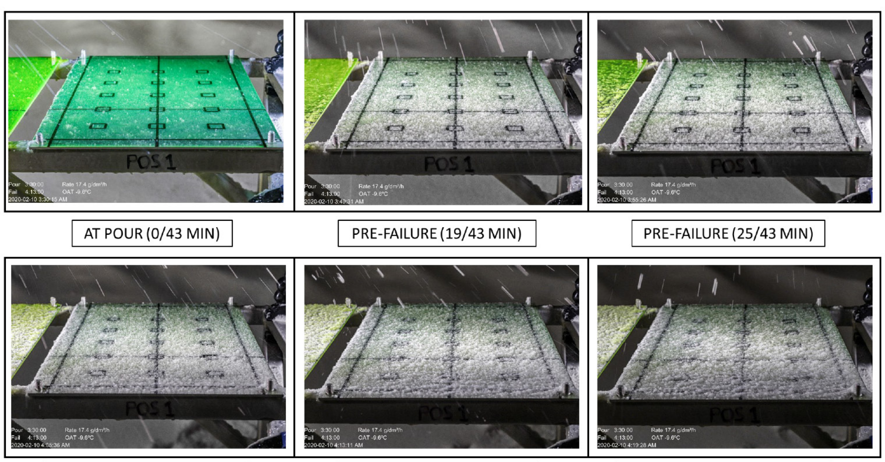
DATA PACKAGE – PG TYPE II – RUN 45 (TEST 33)

Safewing MP II Flight – Run 45 (Test 33) – Failure Progression Photos



AT POUR (0/43 MIN) | PRE-FAILURE (19/43 MIN) | PRE-FAILURE (25/43 MIN)

PRE-FAILURE (35/43 MIN) | AT FAILURE (43/43 MIN) | POST-FAILURE (49/43 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 45 - Test 33/Data Package - PG Type II - Run 45 - Test 33.docx
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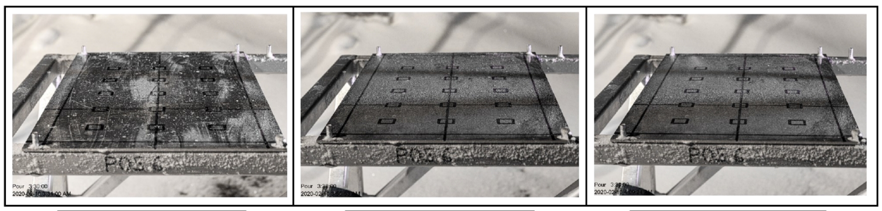
Safewing MP II Flight – Run 45 (Test 33) – Snow Characteristics Photos

FELT PAD (1/43 MIN) | FELT PAD (20/43 MIN) | FELT PAD (39/43 MIN)



BARE PLATE (1/43 MIN) | BARE PLATE (25/43 MIN) | BARE PLATE (39/43 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

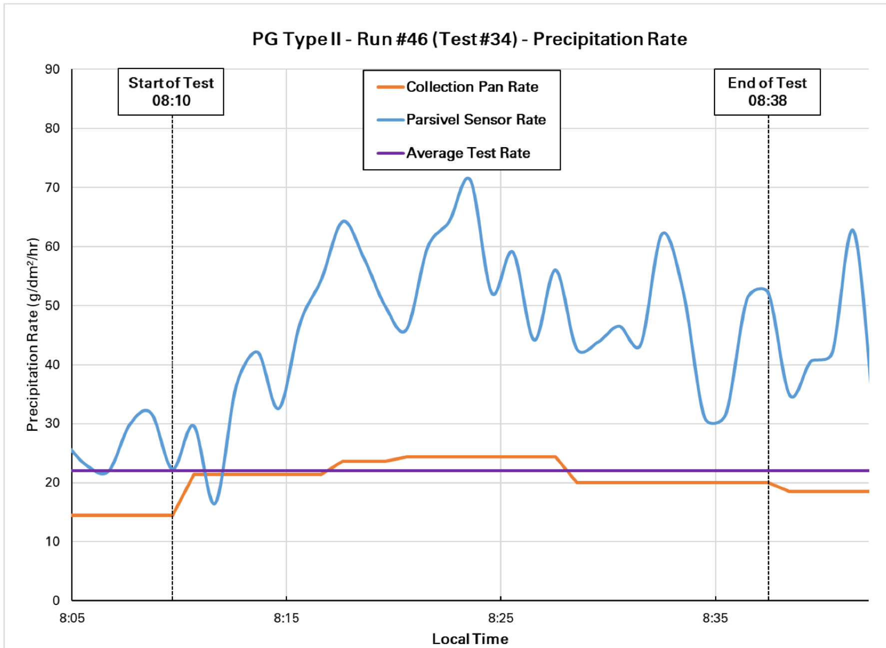
0NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

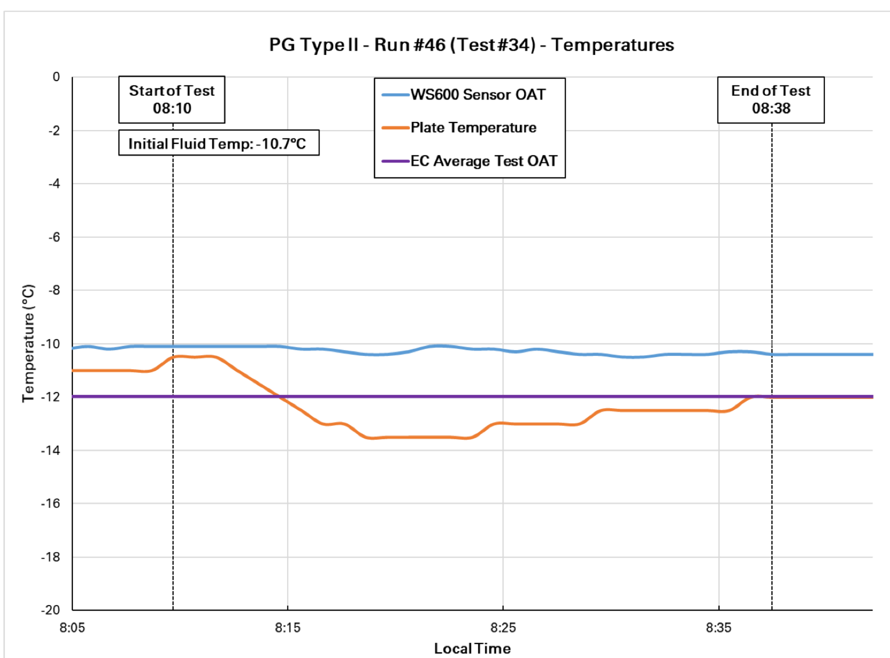
PG TYPE II
RUN #46 (TEST #34) – PG2-34

DATA PACKAGE – PG TYPE II – RUN 46 (TEST 34)

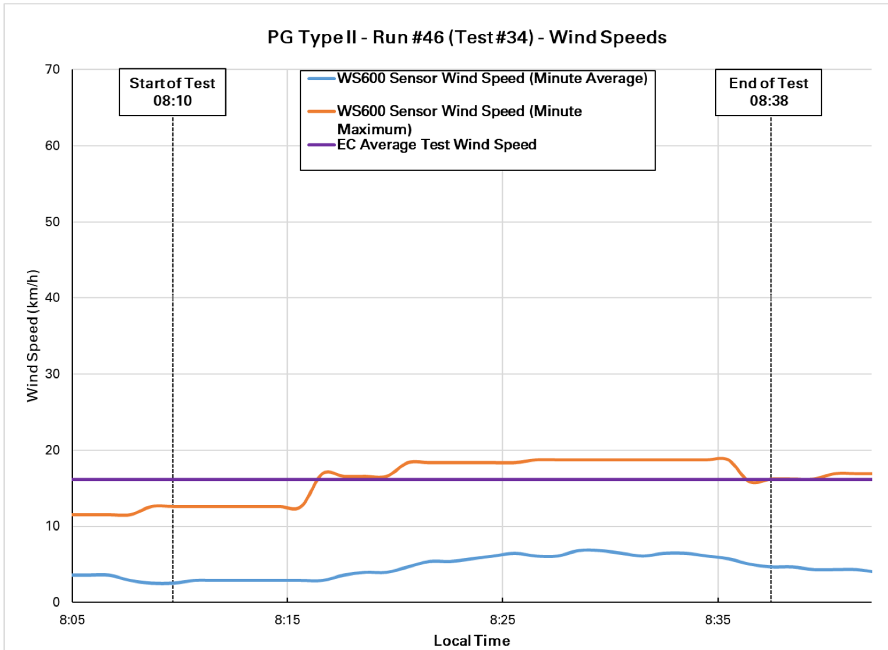
PG Type II – Run #46 (Test #34) – General Test Information

Test Number:	**PG2-34**
Date of Test:	**February 18, 2020**
Average OAT:	**-12.0**
Average Precipitation Rate:	**22.0 g/dm²/h**
Average Wind Speed:	**16.1 km/h**
Average Relative Humidity:	**75.9%**
Pour Time (Local):	**08:10:00**
Time of Fluid Failure (Local):	**08:38:00**
Fluid Brix at Failure:	**19.5°**
Endurance Time:	**28 minutes**
Expected Regression-Derived Endurance Time:	**35.6 minutes**
Difference (ET vs. Reg ET):	**- 7.6 minutes (- 21.3%)**


PG Type II - Run #46 (Test #34) - Precipitation Rate
Start of Test 08:10
End of Test 08:38
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
80
90
8:05
8:15
8:25
8:35
Local Time


PG Type II - Run #46 (Test #34) - Temperatures
Start of Test 08:10
Initial Fluid Temp: -10.7°C
End of Test 08:38
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
8:05
8:15
8:25
8:35
Local Time

DATA PACKAGE – PG TYPE II – RUN 46 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 46 - Test 34/Data Package - PG Type II - Run 46 - Test 34.docx
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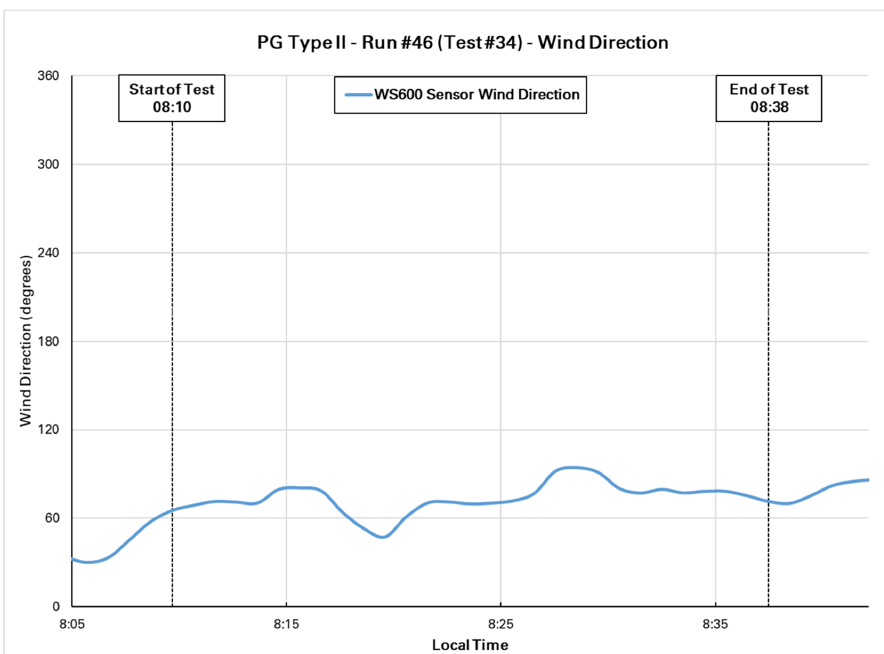
DATA PACKAGE – PG TYPE II – RUN 46 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 46 - Test 34/Data Package - PG Type II - Run 46 - Test 34.docx
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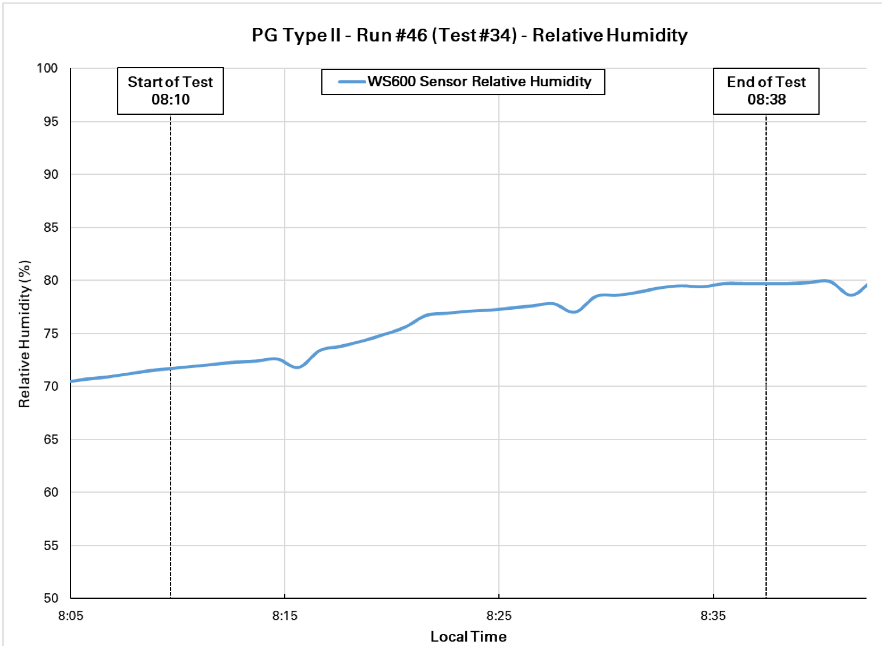
DATA PACKAGE – PG TYPE II – RUN 46 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 46 - Test 34/Data Package - PG Type II - Run 46 - Test 34.docx
Final Version 1.0, February 2021

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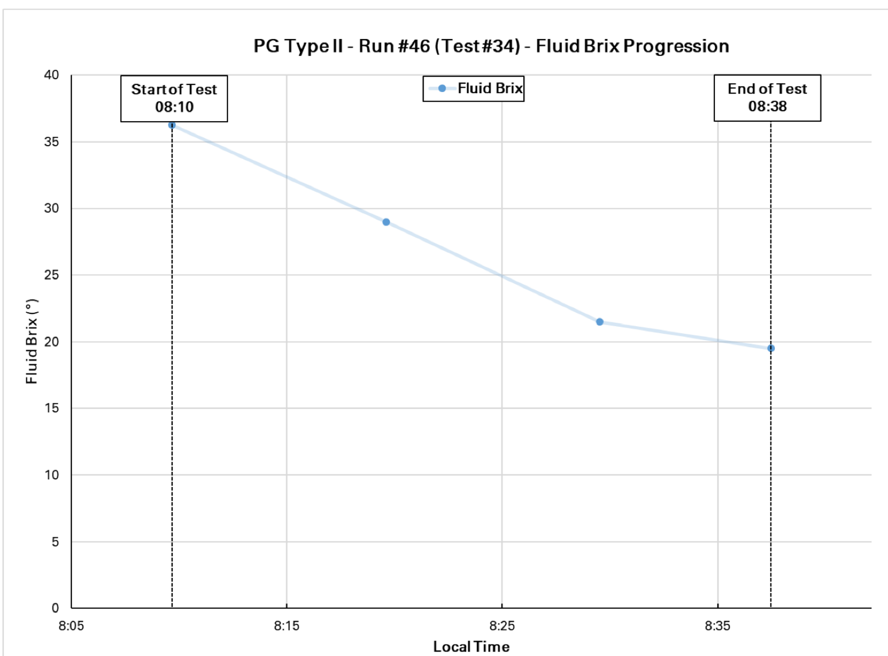
DATA PACKAGE – PG TYPE II – RUN 46 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 46 - Test 34/Data Package - PG Type II - Run 46 - Test 34.docx
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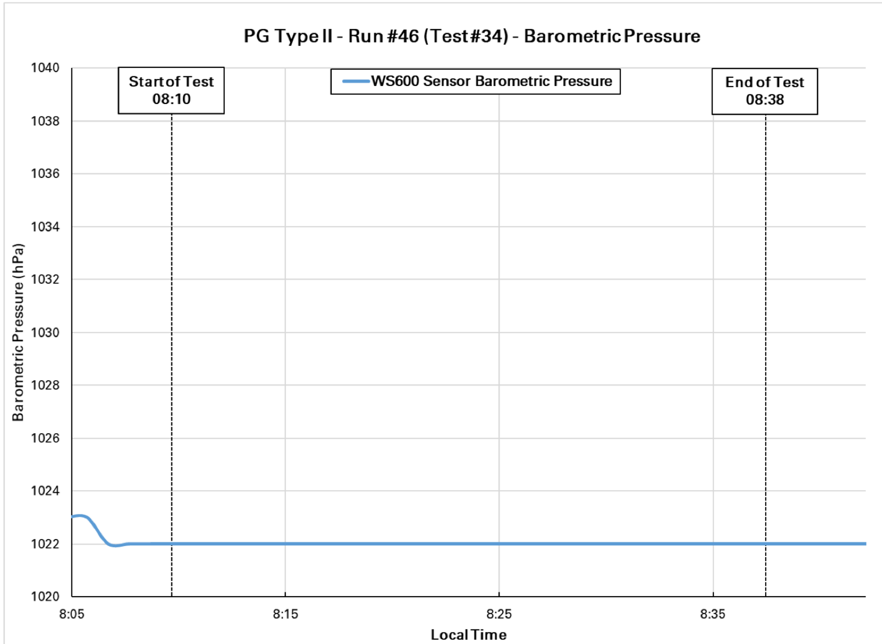
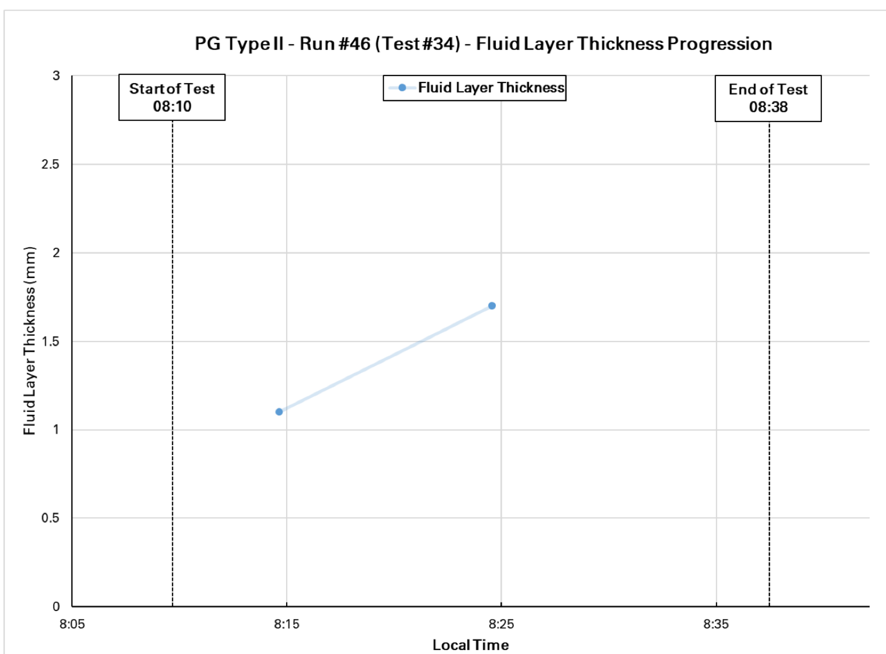
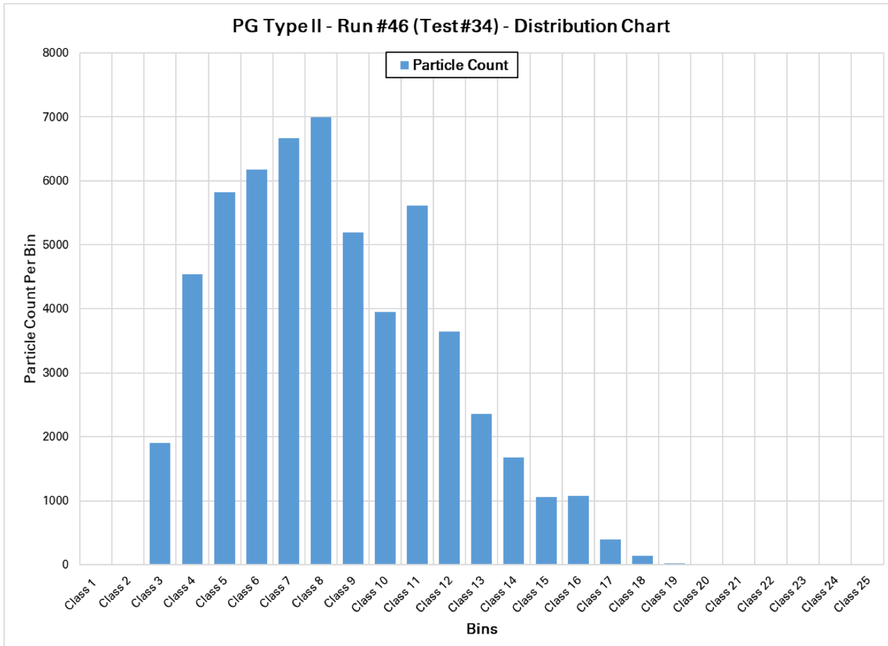


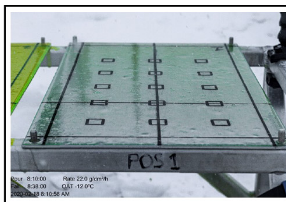
PG Type II - Run #46 (Test #34) - Barometric Pressure
Start of Test 08:10
WS600 Sensor Barometric Pressure
End of Test 08:38
Barometric Pressure (hPa)
1040
1038
1036
1034
1032
1030
1028
1026
1024
1022
1020
8:05
8:15
8:25
8:35
Local Time



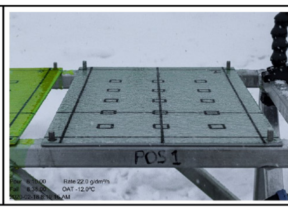
PG Type II - Run #46 (Test #34) - Fluid Layer Thickness Progression
Start of Test 08:10
Fluid Layer Thickness
End of Test 08:38
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
8:05
8:15
8:25
8:35
Local Time



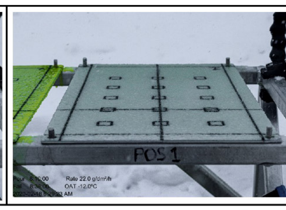
Safewing MP II Flight – Run 46 (Test 34) – Failure Progression Photos



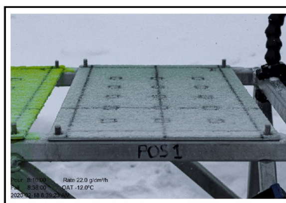
AT POUR (0/28 MIN)



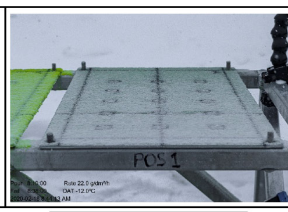
PRE-FAILURE (9/28 MIN)



PRE-FAILURE (19/28 MIN)



AT FAILURE (29/28 MIN)

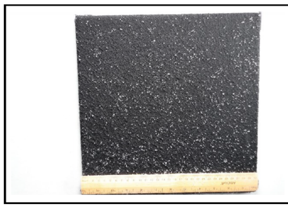


POST-FAILURE (34/28 MIN)

No Photo Available

POST-FAILURE (-/- MIN)

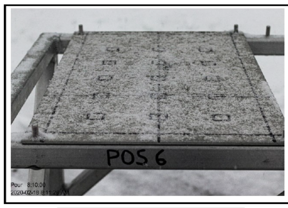
Safewing MP II Flight – Run 46 (Test 34) – Snow Characteristics Photos



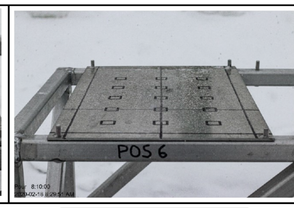
FELT PAD (1/28 MIN)

FELT PAD (10/28 MIN)

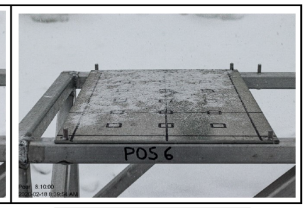
FELT PAD (20/28 MIN)



BARE PLATE (1/28 MIN)



BARE PLATE (19/28 MIN)



BARE PLATE (29/28 MIN)

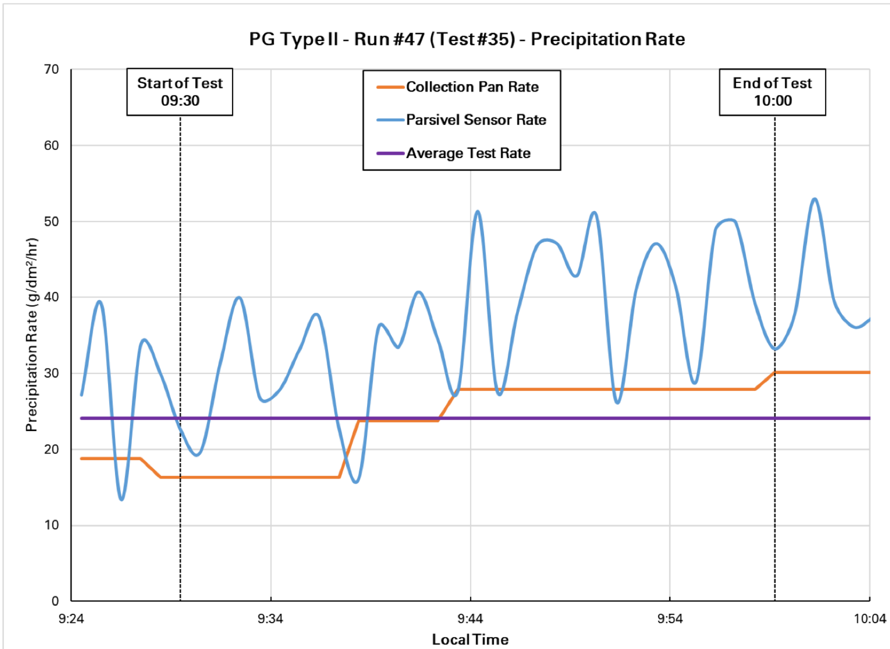
Final Bare Plate Contamination Thickness: **Nil (0mm)**

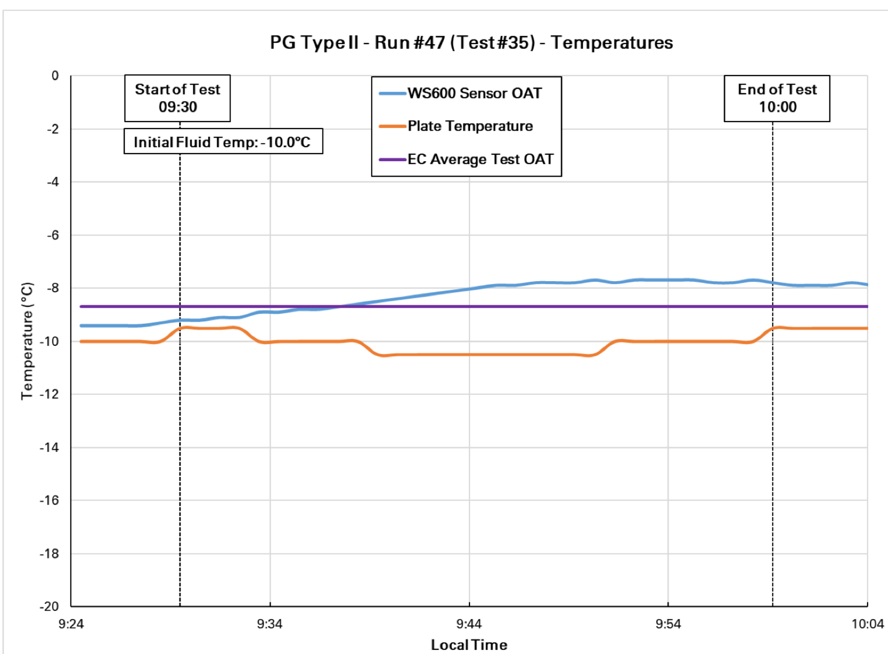
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #47 (TEST #35) PG2-35

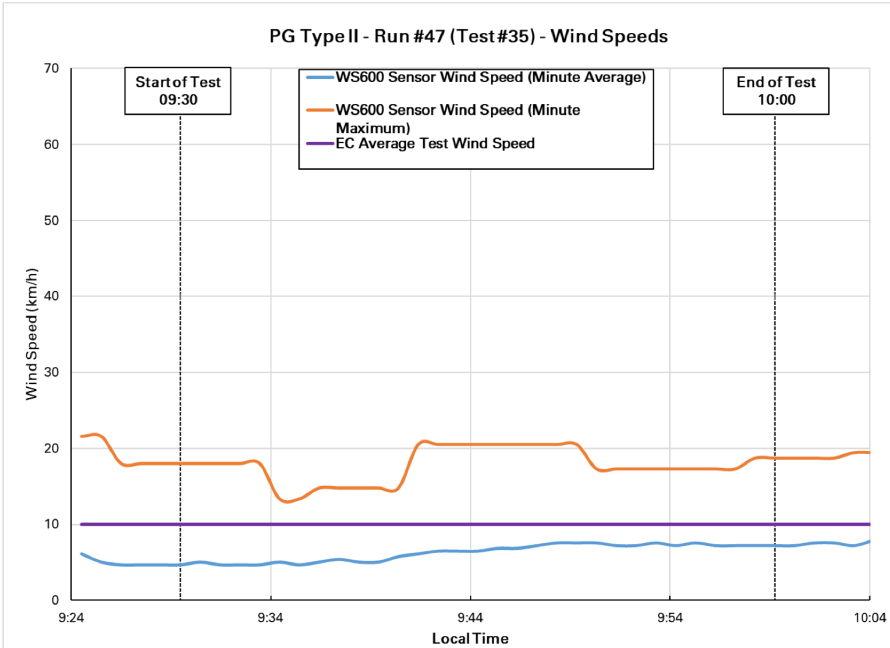
PG Type II – Run #47 (Test #35) – General Test Information

Test Number:	PG2-35
Date of Test:	February 18, 2020
Average OAT:	-8.7
Average Precipitation Rate:	24.1 g/dm²/h
Average Wind Speed:	10.0 km/h
Average Relative Humidity:	83.0%
Pour Time (Local):	09:30:00
Time of Fluid Failure (Local):	10:00:00
Fluid Brix at Failure:	17.25°
Endurance Time:	30 minutes
Expected Regression-Derived Endurance Time:	38 minutes
Difference (ET vs. Reg ET):	- 7.5 minutes (- 19.8%)


PG Type II - Run #47 (Test #35) - Precipitation Rate
Start of Test
09:30
End of Test
10:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
9:24
9:34
9:44
9:54
10:04
Local Time


PG Type II - Run #47 (Test #35) - Temperatures
Start of Test
09:30
Initial Fluid Temp: -10.0°C
End of Test
10:00
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
9:24
9:34
9:44
9:54
10:04
Local Time

DATA PACKAGE – PG TYPE II – RUN 47 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 47 - Test 35/Data Package - PG Type II - Run 47 - Test 35.docx
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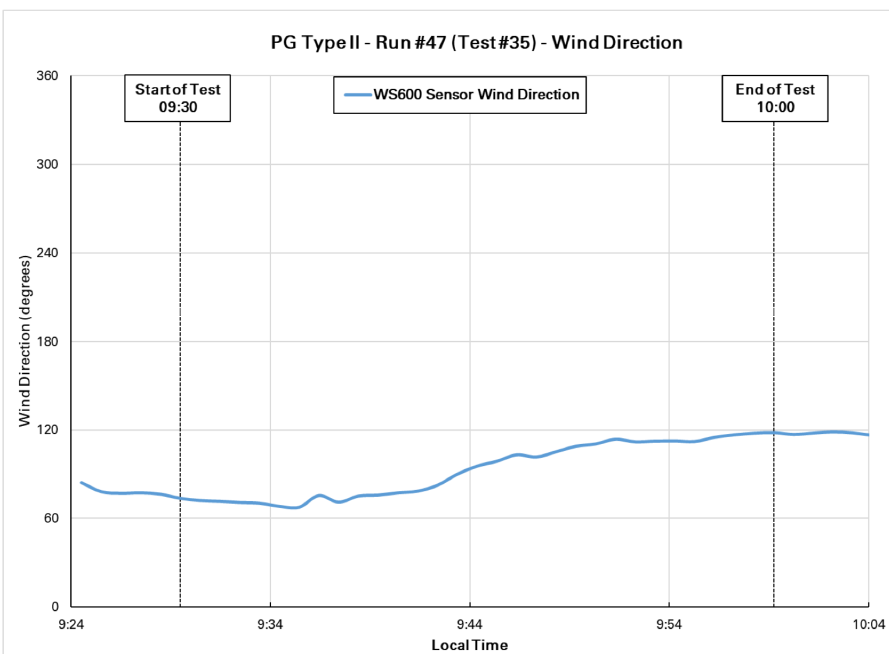
DATA PACKAGE – PG TYPE II – RUN 47 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 47 - Test 35/Data Package - PG Type II - Run 47 - Test 35.docx
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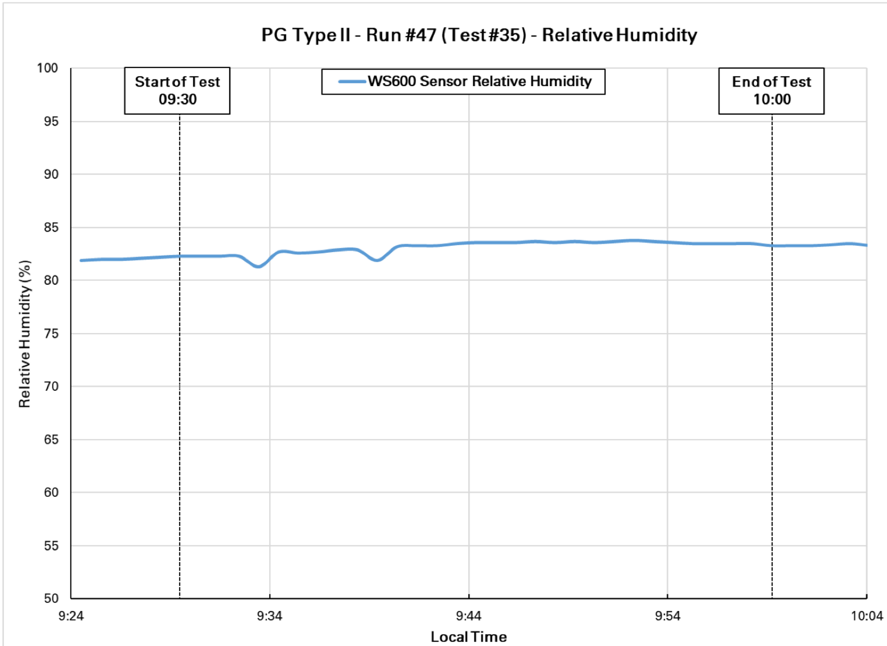
DATA PACKAGE – PG TYPE II – RUN 47 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 47 - Test 35/Data Package - PG Type II - Run 47 - Test 35.docx
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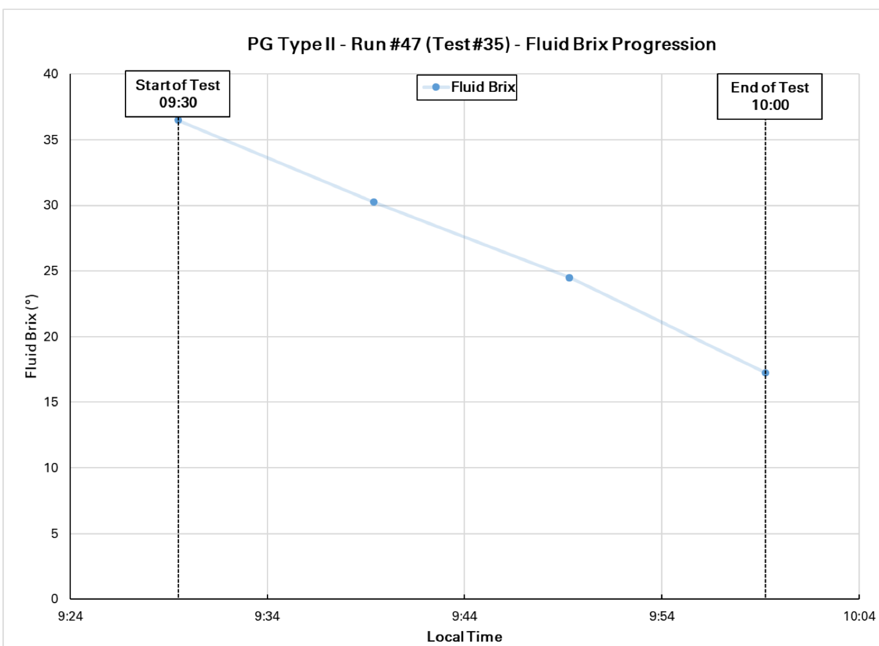
DATA PACKAGE – PG TYPE II – RUN 47 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 47 - Test 35/Data Package - PG Type II - Run 47 - Test 35.docx
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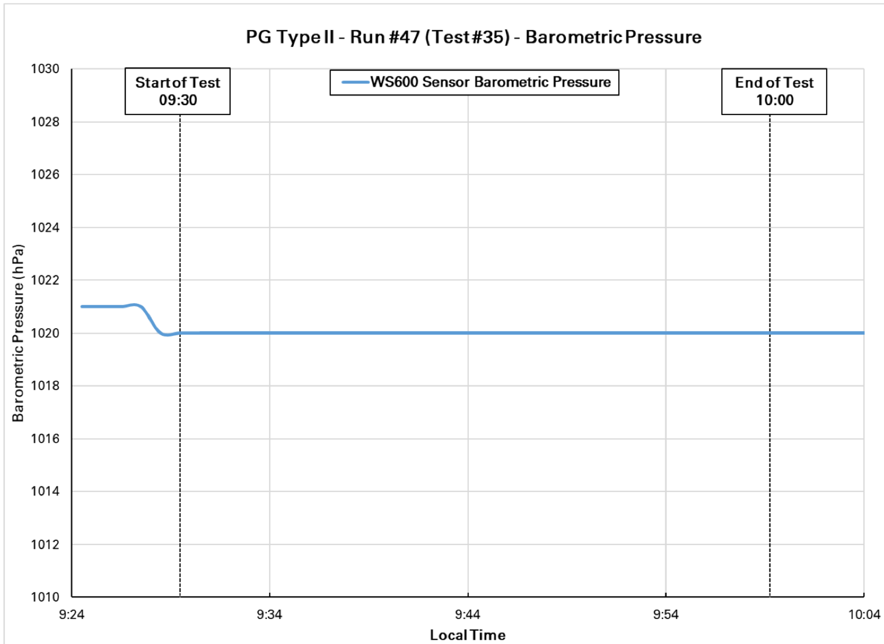
DATA PACKAGE – PG TYPE II – RUN 47 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 47 - Test 35/Data Package - PG Type II - Run 47 - Test 35.docx
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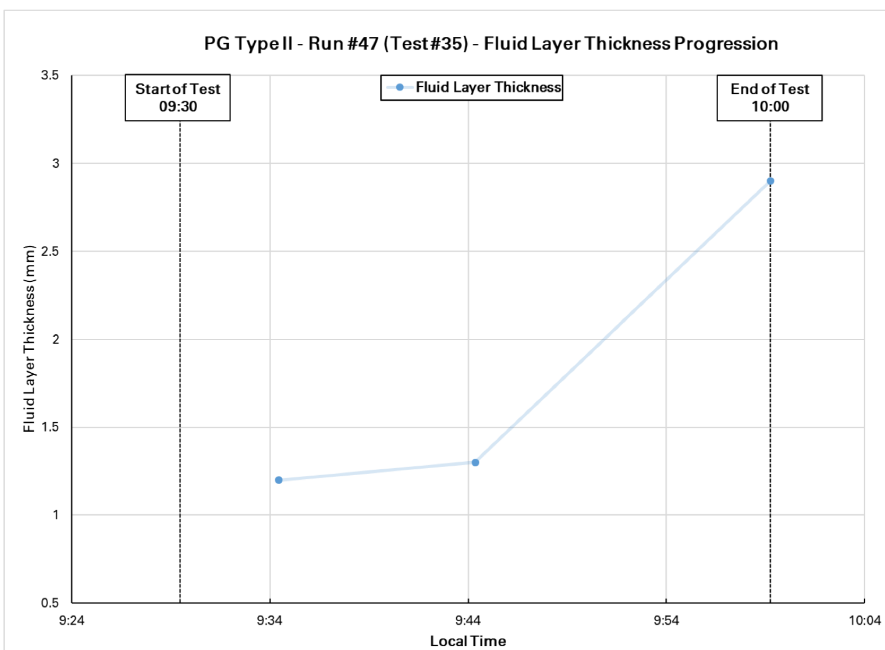
DATA PACKAGE – PG TYPE II – RUN 47 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 47 - Test 35/Data Package - PG Type II - Run 47 - Test 35.docx
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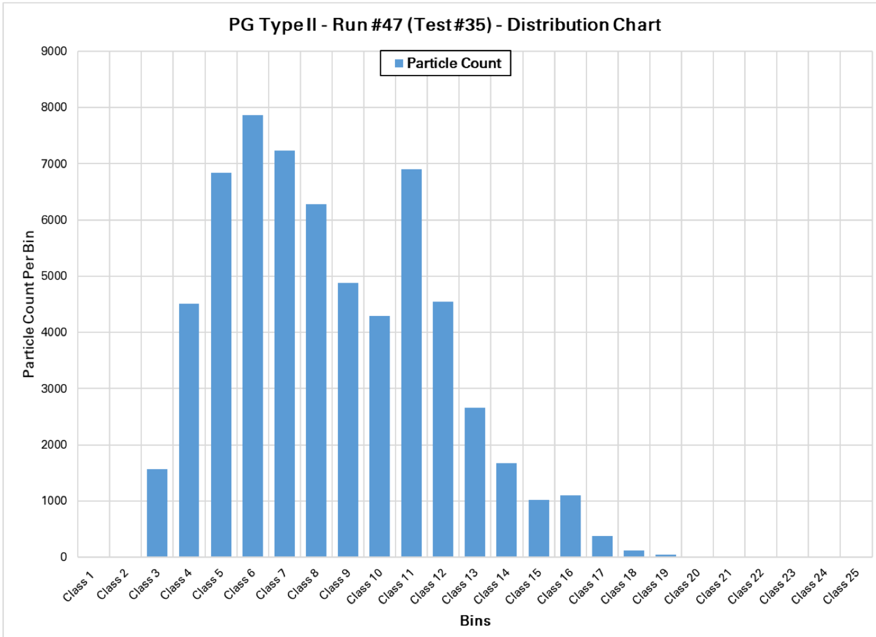
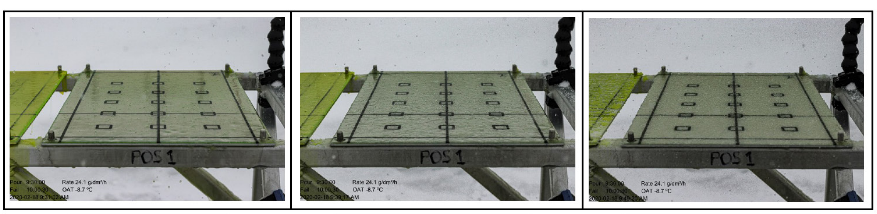
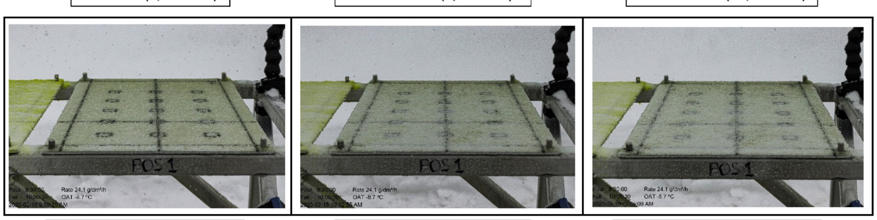


Safewing MP II Flight – Run 47 (Test 35) – Failure Progression Photos

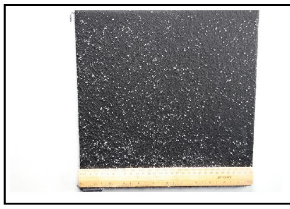


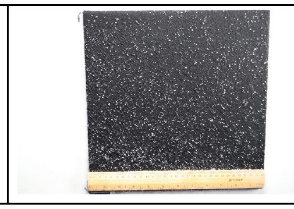
AT POUR (0/30 MIN) | PRE-FAILURE (9/30 MIN) | PRE-FAILURE (19/30 MIN)

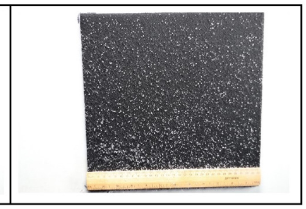


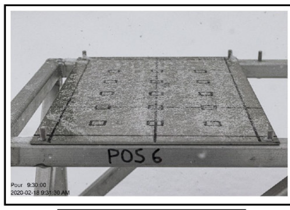
AT FAILURE (30/30 MIN) | POST-FAILURE (32/30 MIN) | POST-FAILURE (35/30 MIN)

Safewing MP II Flight – Run 47 (Test 35) – Snow Characteristics Photos

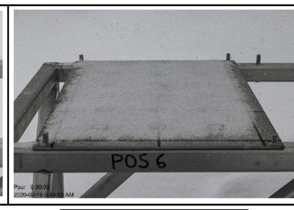

FELT PAD (10/30 MIN)


FELT PAD (20/30 MIN)


FELT PAD (30/30 MIN)



BARE PLATE (1/30 MIN)



BARE PLATE (19/30 MIN)

BARE PLATE (29/30 MIN)

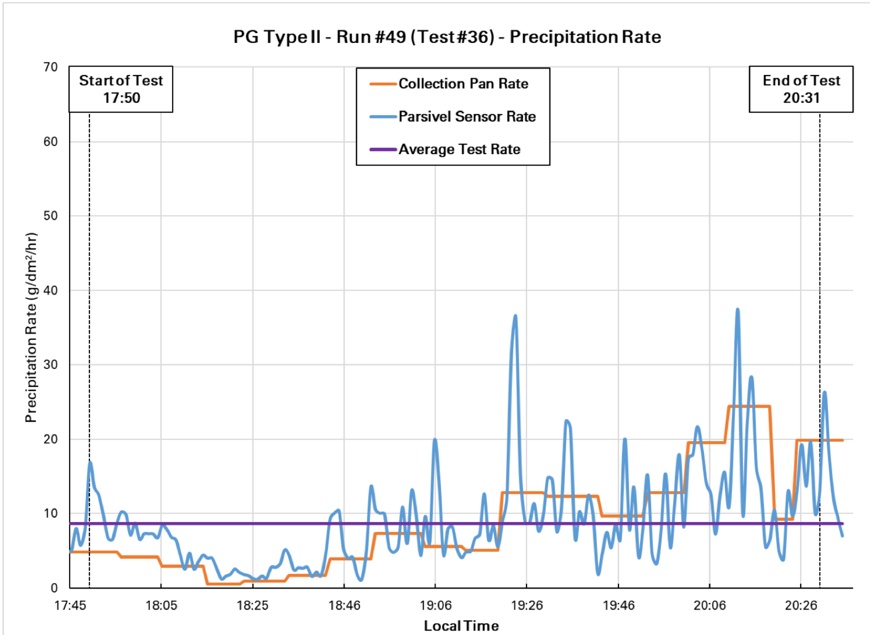
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

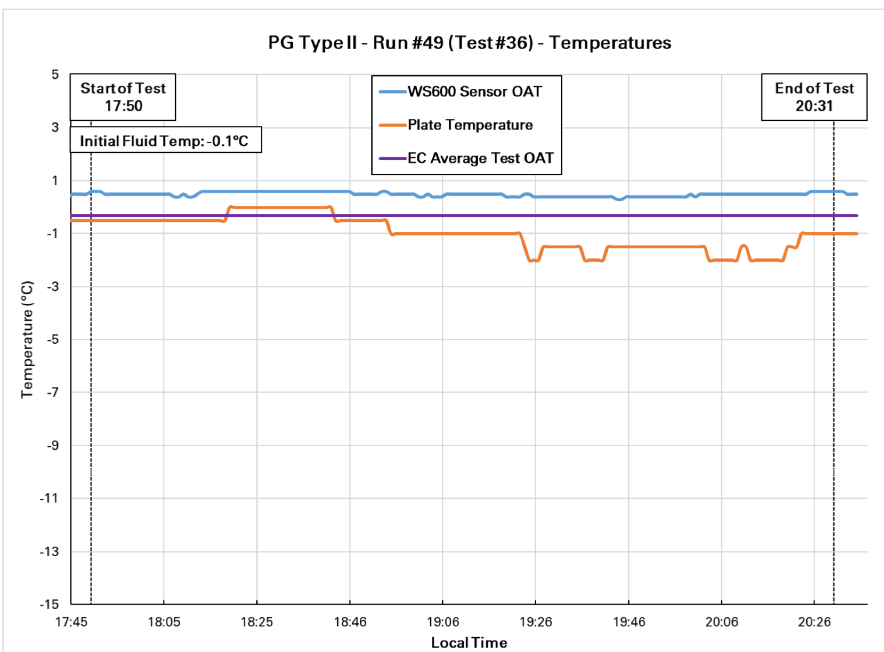
PG TYPE II
RUN #49 (TEST #36) - PG2-36

PG Type II – Run #49 (Test #36) – General Test Information

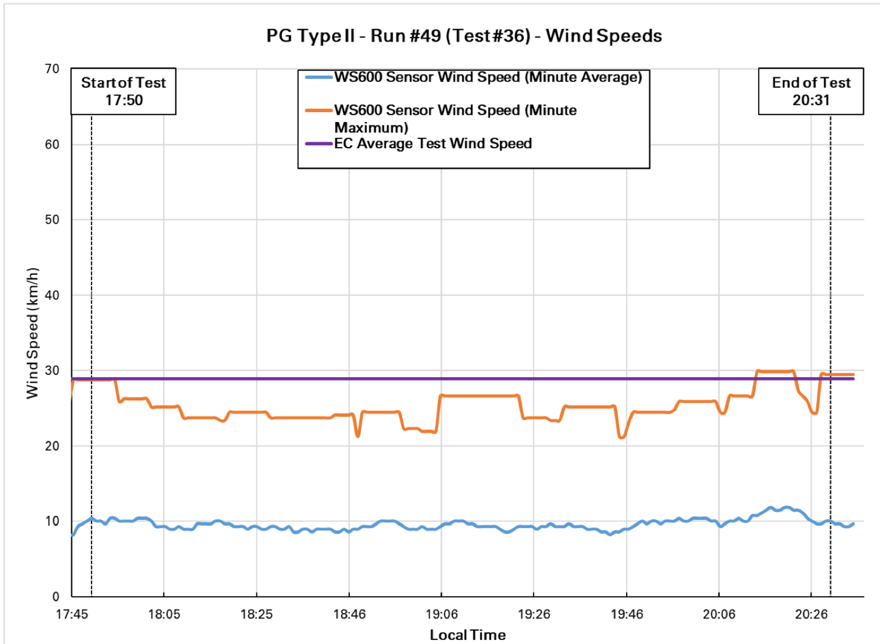
Test Number:	PG2-36
Date of Test:	February 26, 2020
Average OAT:	-0.3
Average Precipitation Rate:	8.7 g/dm²/h
Average Wind Speed:	28.9 km/h
Average Relative Humidity:	82.9%
Pour Time (Local):	17:50:00
Time of Fluid Failure (Local):	20:31:00
Fluid Brix at Failure:	3.5°
Endurance Time:	161 minutes
Expected Regression-Derived Endurance Time:	195.1 minutes
Difference (ET vs. Reg ET):	- 34.1 minutes (- 17.5%)

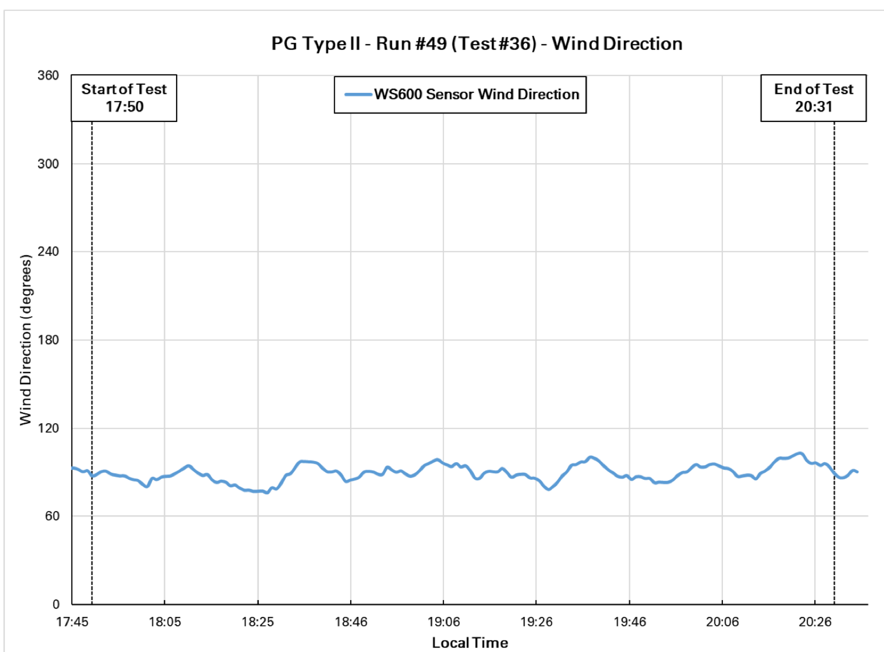


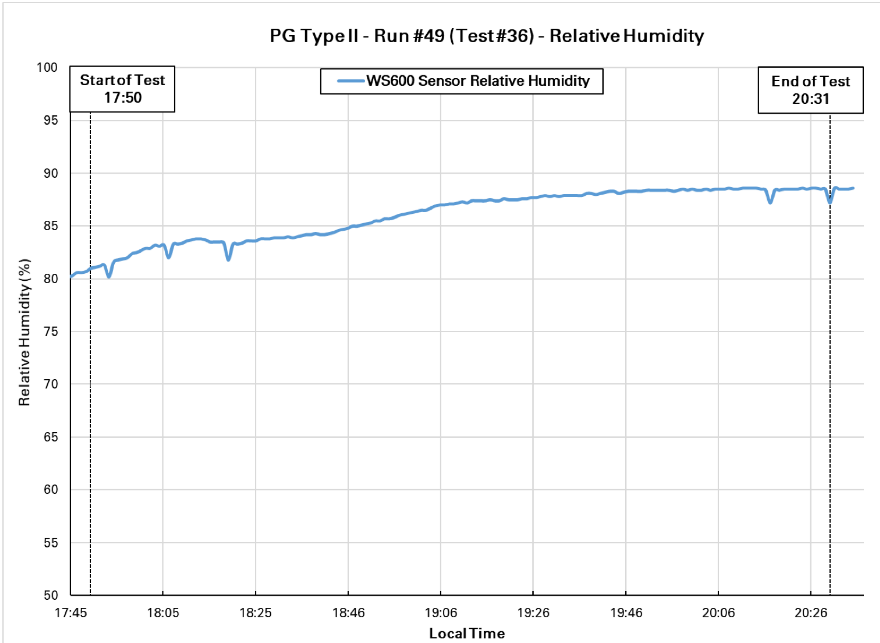
PG Type II - Run #49 (Test #36) - Precipitation Rate
Start of Test 17:50
End of Test 20:31
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

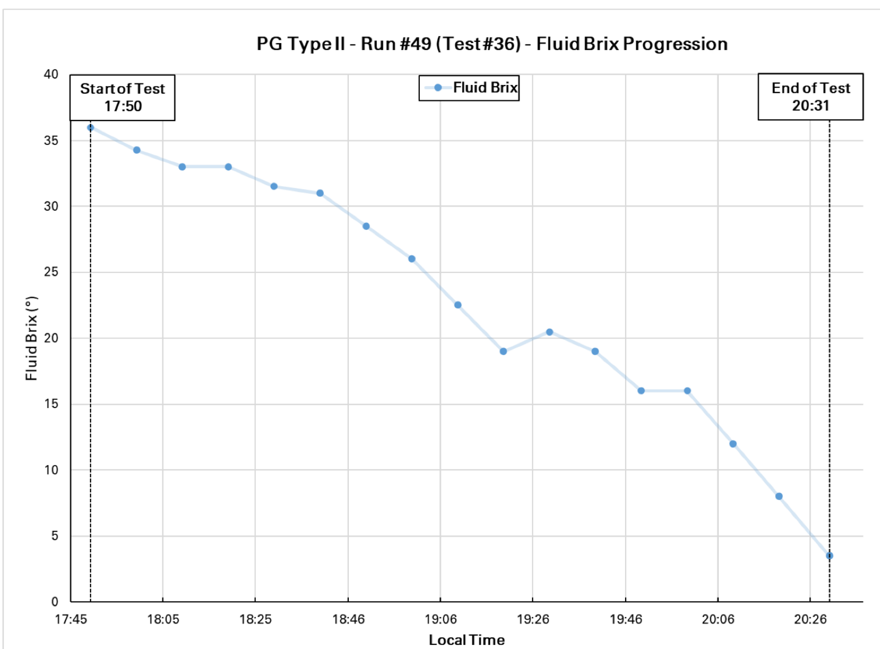


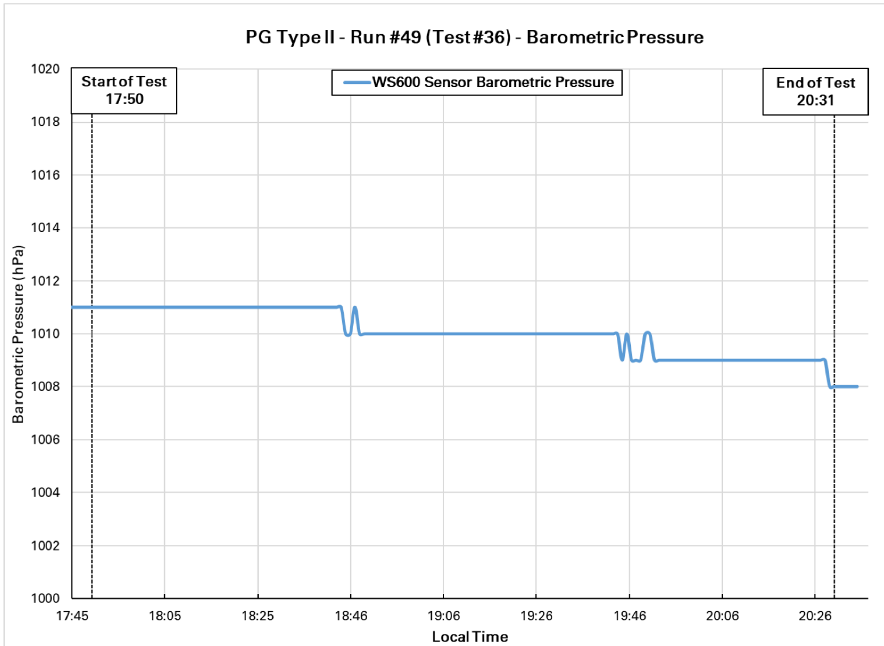
PG Type II - Run #49 (Test #36) - Temperatures
Start of Test 17:50
Initial Fluid Temp: -0.1°C
End of Test 20:31
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

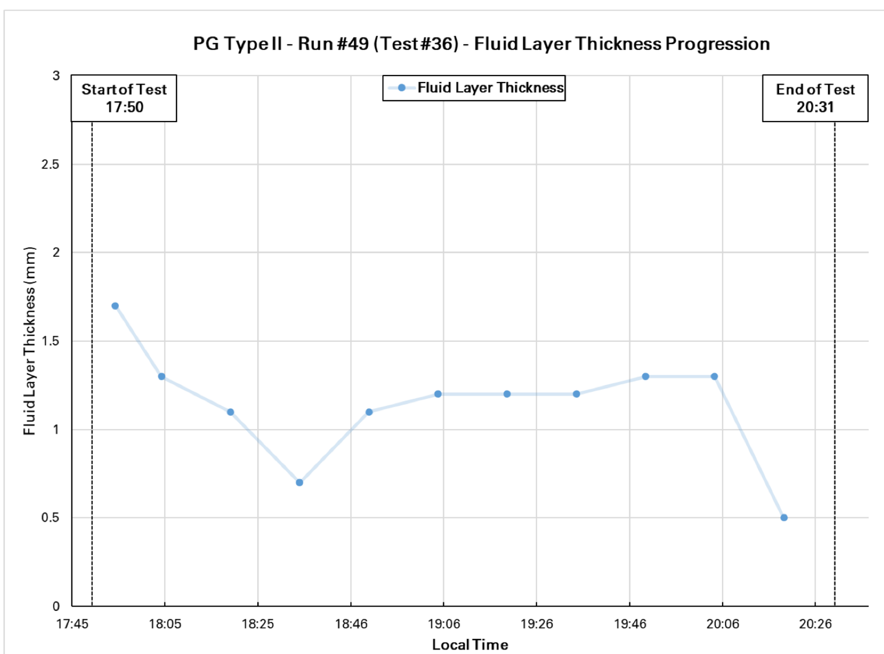

PG Type II - Run #49 (Test #36) - Wind Speeds
Start of Test 17:50
End of Test 20:31
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

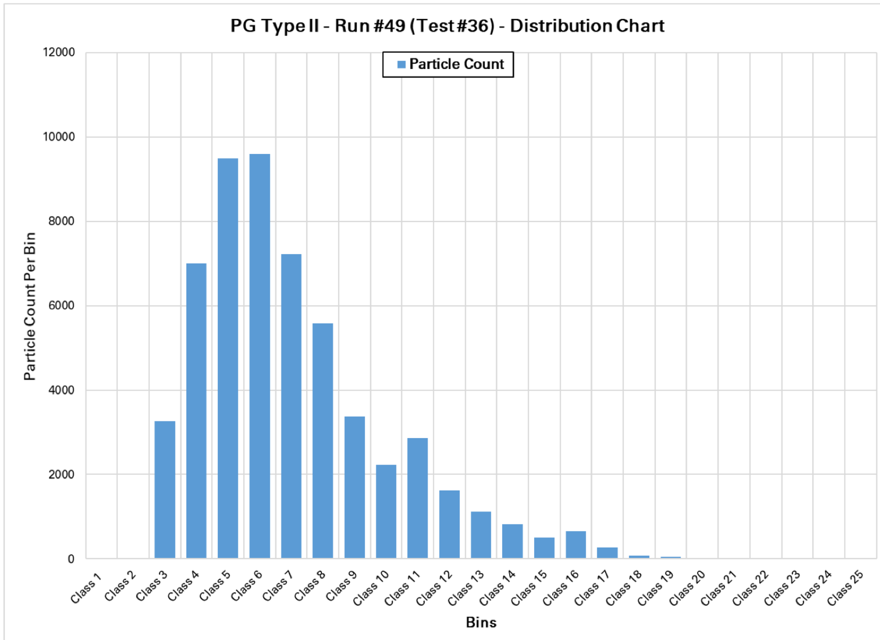

PG Type II - Run #49 (Test #36) - Wind Direction
Start of Test 17:50
End of Test 20:31
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time


PG Type II - Run #49 (Test #36) - Relative Humidity
Start of Test 17:50
WS600 Sensor Relative Humidity
End of Test 20:31
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

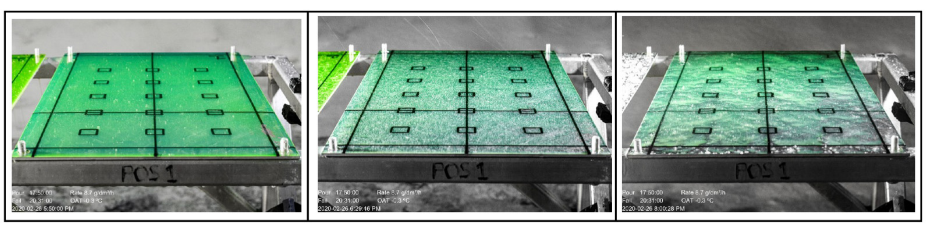

PG Type II - Run #49 (Test #36) - Fluid Brix Progression
Start of Test 17:50
Fluid Brix
End of Test 20:31
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time


PG Type II - Run #49 (Test #36) - Barometric Pressure
Start of Test 17:50
WS600 Sensor Barometric Pressure
End of Test 20:31
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time


PG Type II - Run #49 (Test #36) - Fluid Layer Thickness Progression
Start of Test 17:50
Fluid Layer Thickness
End of Test 20:31
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time



Safewing MP II Flight – Run 49 (Test 36) – Failure Progression Photos

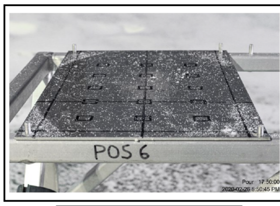


AT POUR (0/161 MIN) | PRE-FAILURE (39/161 MIN) | PRE-FAILURE (130/161 MIN)

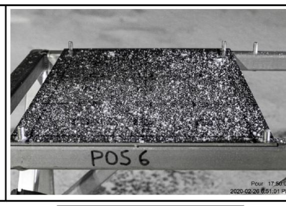
PRE-FAILURE (150/161 MIN) | AT FAILURE (161/161 MIN) | POST-FAILURE (164/161 MIN)

Safewing MP II Flight – Run 49 (Test 36) – Snow Characteristics Photos

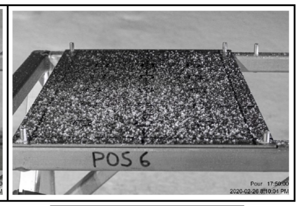
No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (0/161 MIN)



BARE PLATE (61/161 MIN)



BARE PLATE (140/161 MIN)

Final Bare Plate Contamination Thickness: **1.7mm**

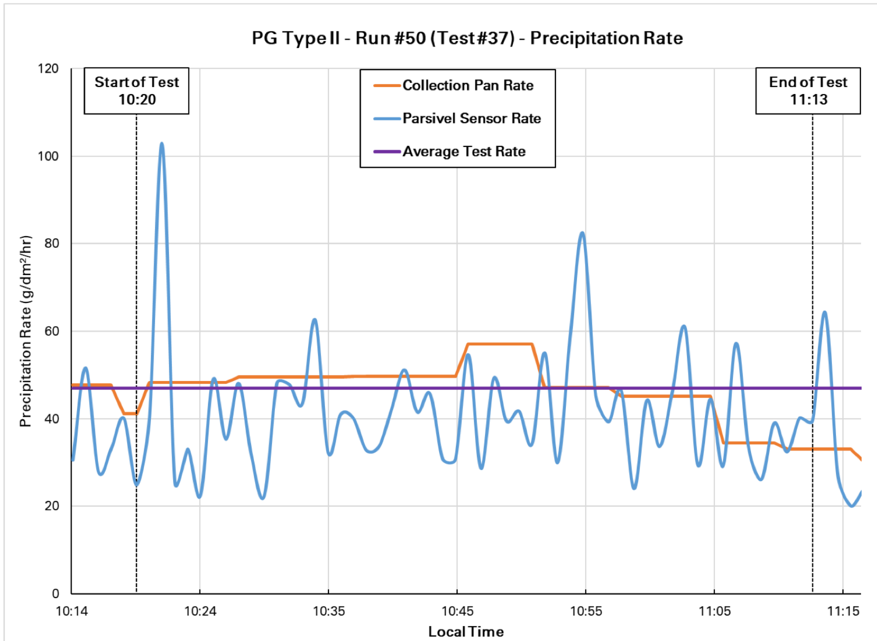
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #50 (TEST #37) PG2-37

PG Type II – Run #50 (Test #37) – General Test Information

Test Number:	PG2-37
Date of Test:	February 27, 2020
Average OAT:	0.4
Average Precipitation Rate:	46.9 g/dm²/h
Average Wind Speed:	20.6 km/h
Average Relative Humidity:	91.8%
Pour Time (Local):	10:20:00
Time of Fluid Failure (Local):	11:13:00
Fluid Brix at Failure:	4°
Endurance Time:	53 minutes
Expected Regression-Derived Endurance Time:	60.8 minutes
Difference (ET vs. Reg ET):	- 7.5 minutes (- 12.3%)

DATA PACKAGE – PG TYPE II – RUN 50 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 50 - Test 37/Data Package - PG Type II - Run 50 - Test 37.docx
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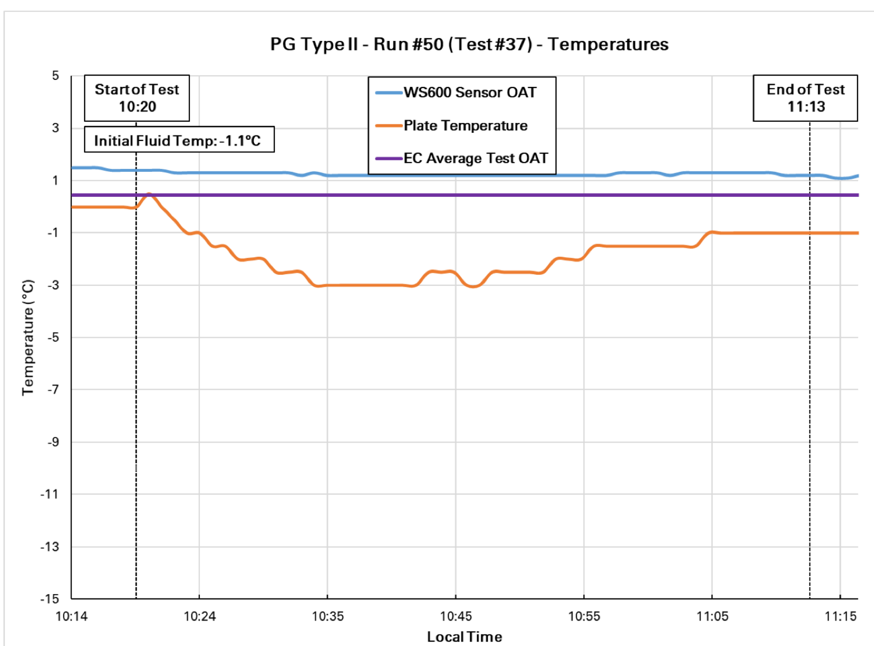
DATA PACKAGE – PG TYPE II – RUN 50 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 50 - Test 37/Data Package - PG Type II - Run 50 - Test 37.docx
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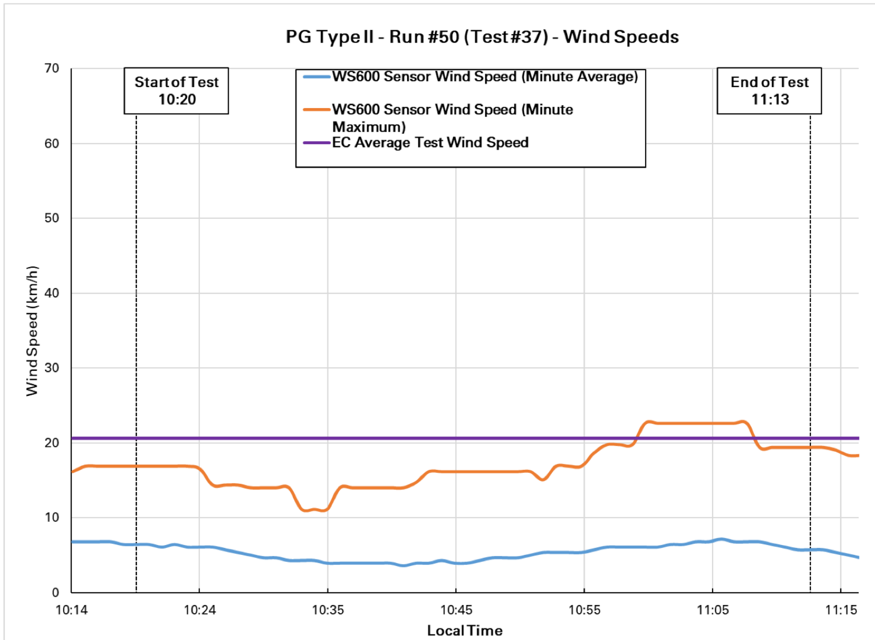
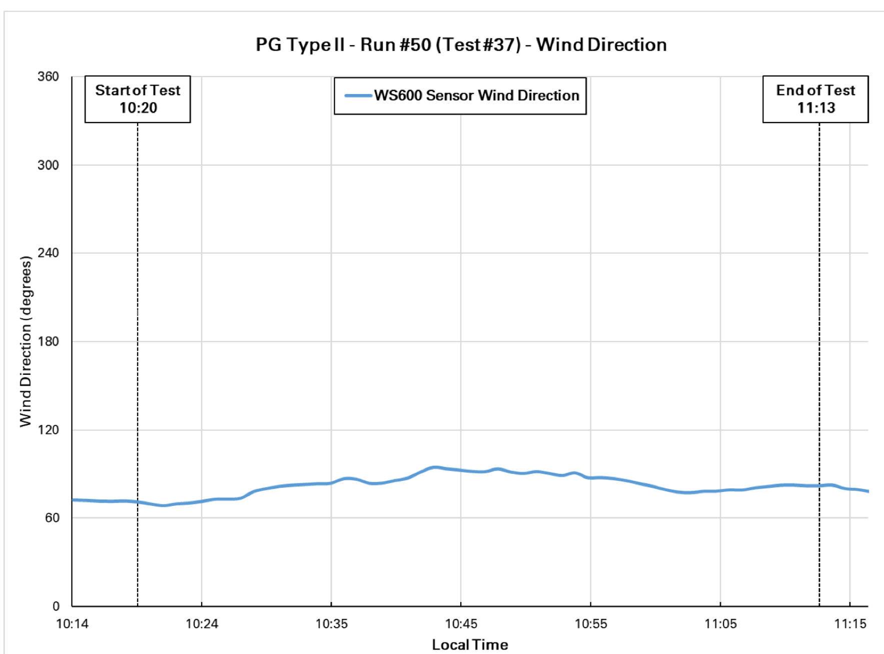
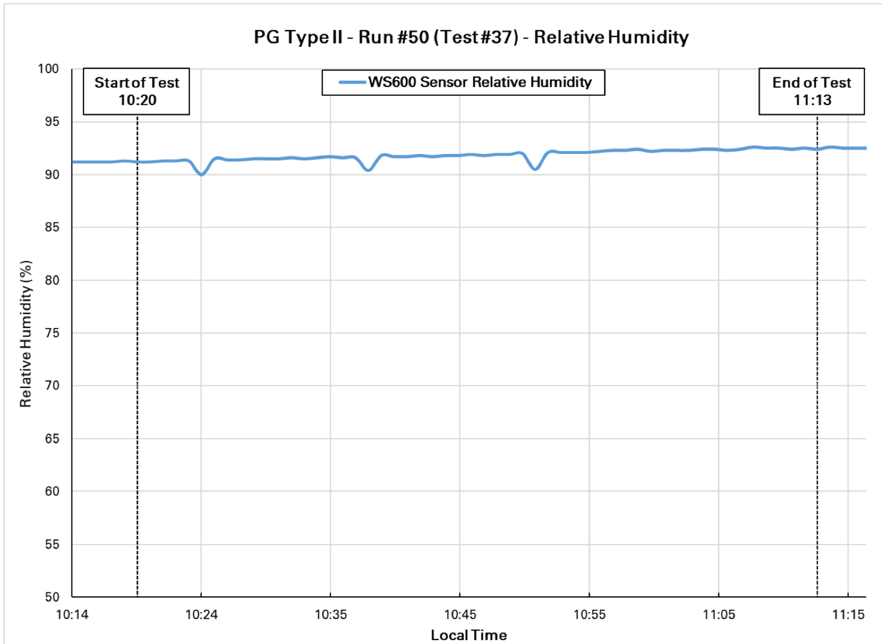
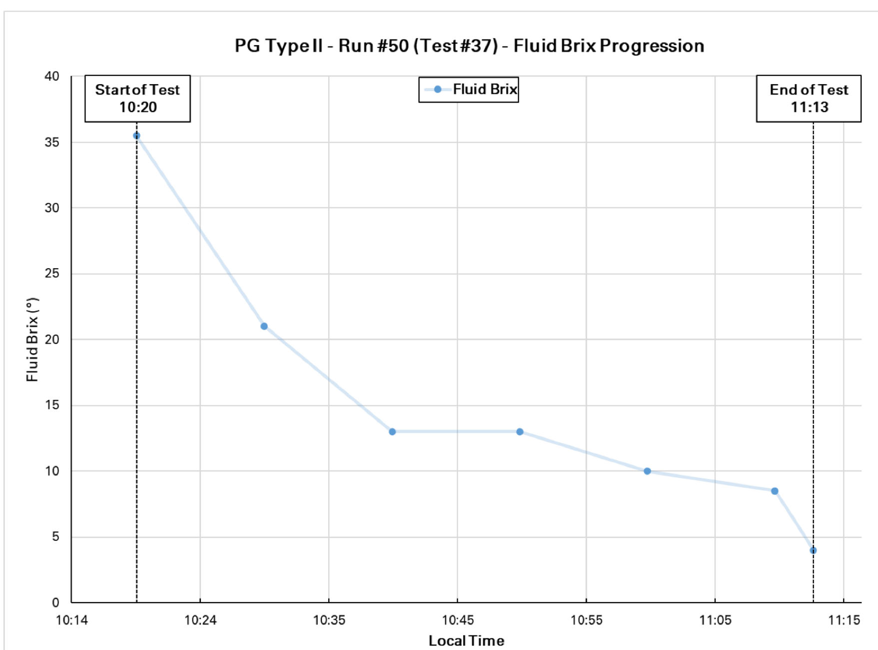
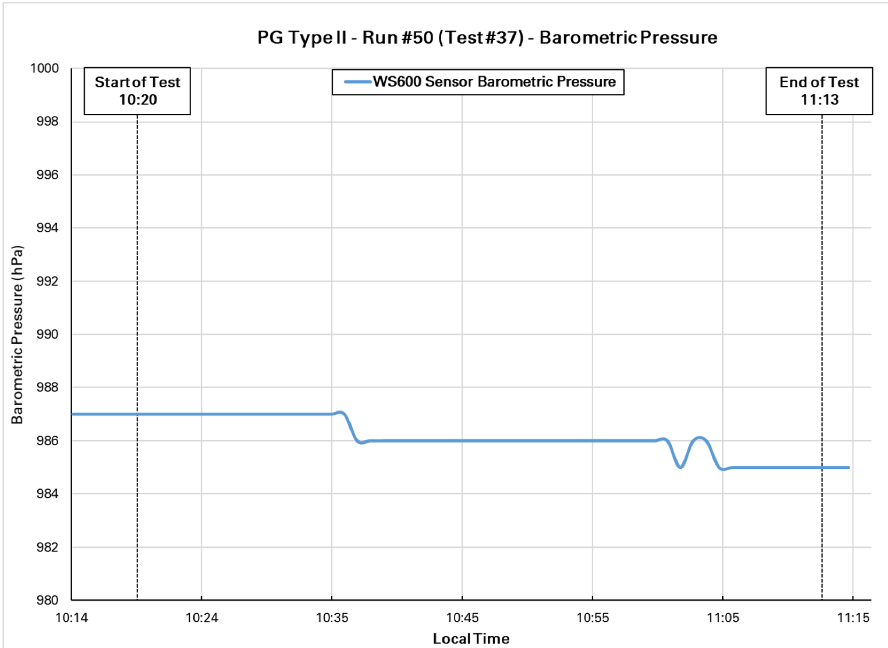
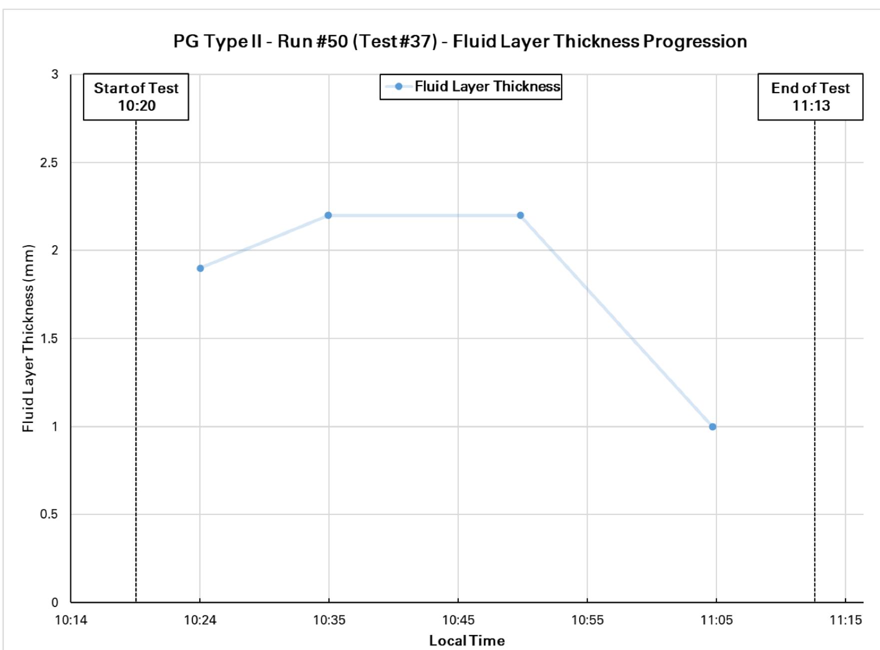

PG Type II - Run #50 (Test #37) - Wind Speeds
Start of Test 10:20
End of Test 11:13
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
10:14
10:24
10:35
10:45
10:55
11:05
11:15
Local Time


PG Type II - Run #50 (Test #37) - Wind Direction
Start of Test 10:20
WS600 Sensor Wind Direction
End of Test 11:13
Wind Direction (degrees)
0
60
120
180
240
300
360
10:14
10:24
10:35
10:45
10:55
11:05
11:15
Local Time

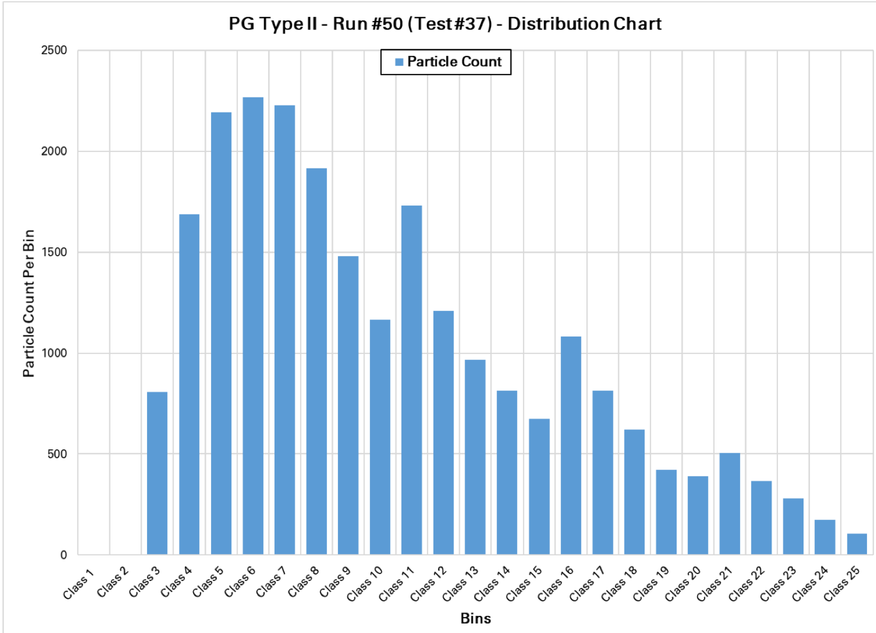

PG Type II - Run #50 (Test #37) - Relative Humidity
Start of Test 10:20
WS600 Sensor Relative Humidity
End of Test 11:13
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:14
10:24
10:35
10:45
10:55
11:05
11:15
Local Time


PG Type II - Run #50 (Test #37) - Fluid Brix Progression
Start of Test 10:20
Fluid Brix
End of Test 11:13
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:14
10:24
10:35
10:45
10:55
11:05
11:15
Local Time


PG Type II - Run #50 (Test #37) - Barometric Pressure
Start of Test 10:20
WS600 Sensor Barometric Pressure
End of Test 11:13
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
10:14
10:24
10:35
10:45
10:55
11:05
11:15
Local Time


PG Type II - Run #50 (Test #37) - Fluid Layer Thickness Progression
Start of Test 10:20
Fluid Layer Thickness
End of Test 11:13
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:14
10:24
10:35
10:45
10:55
11:05
11:15
Local Time

DATA PACKAGE – PG TYPE II – RUN 50 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 50 - Test 37/Data Package - PG Type II - Run 50 - Test 37.docx
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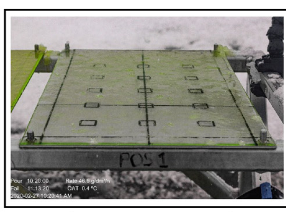
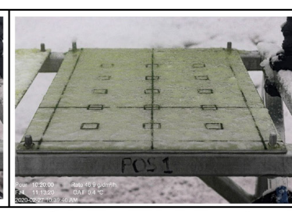
DATA PACKAGE – PG TYPE II – RUN 50 (TEST 37)

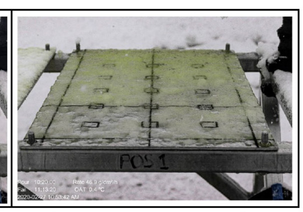
Safewing MP II Flight – Run 50 (Test 37) – Failure Progression Photos



AT POUR (0/53 MIN)



PRE-FAILURE (19/53 MIN)



PRE-FAILURE (33/53 MIN)

PRE-FAILURE (45/53 MIN)

AT FAILURE (53/53 MIN)

POST-FAILURE (57/53 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 50 - Test 37/Data Package - PG Type II - Run 50 - Test 37.docx
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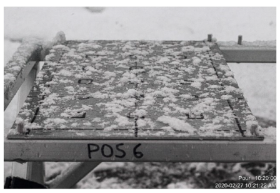
Safewing MP II Flight – Run 50 (Test 37) – Snow Characteristics Photos

No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (1/53 MIN)

BARE PLATE (20/53 MIN)

BARE PLATE (40/53 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

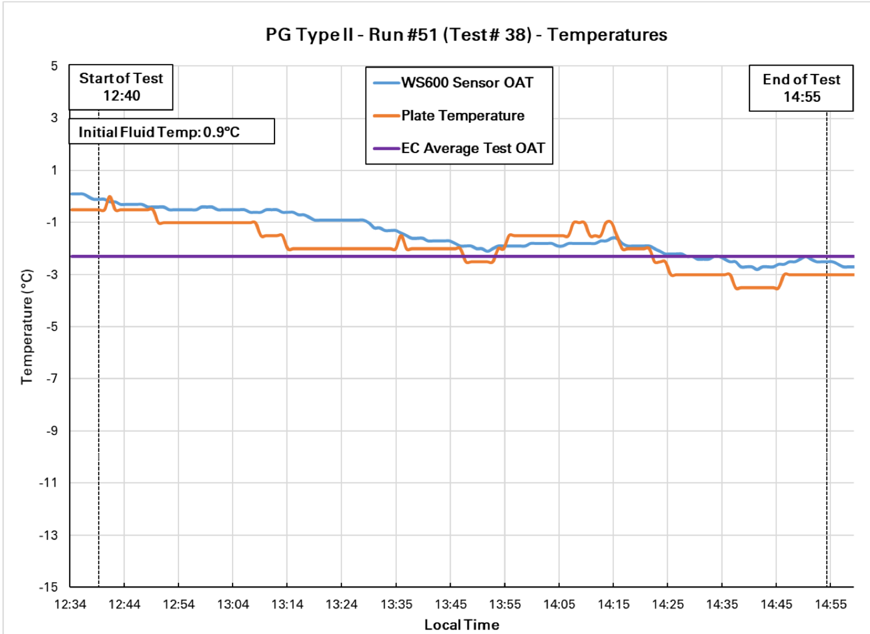
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #51 (TEST #38) - PG2-38

PG Type II – Run #51 (Test #38) – General Test Information

Test Number:	**PG2-38**
Date of Test:	**February 27, 2020**
Average OAT:	**-2.3**
Average Precipitation Rate:	**11.2 g/dm²/h**
Average Wind Speed:	**41.8 km/h**
Average Relative Humidity:	**93.3%**
Pour Time (Local):	**12:40:00**
Time of Fluid Failure (Local):	**14:55:00**
Fluid Brix at Failure:	**8°**
Endurance Time:	**135 minutes**
Expected Regression-Derived Endurance Time:	**114.4 minutes**
Difference (ET vs. Reg ET):	**+21.1 minutes (+18.4%)**

DATA PACKAGE – PG TYPE II – RUN 51 (TEST 38)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 51 - Test 38/Data Package - PG Type II - Run 51 - Test 38.docx
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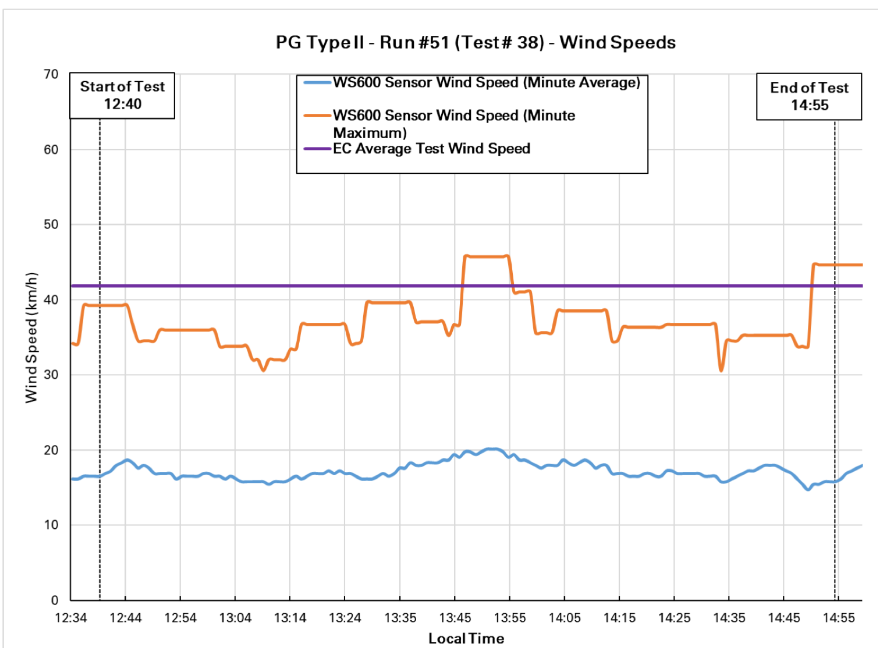
DATA PACKAGE – PG TYPE II – RUN 51 (TEST 38)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 51 - Test 38/Data Package - PG Type II - Run 51 - Test 38.docx
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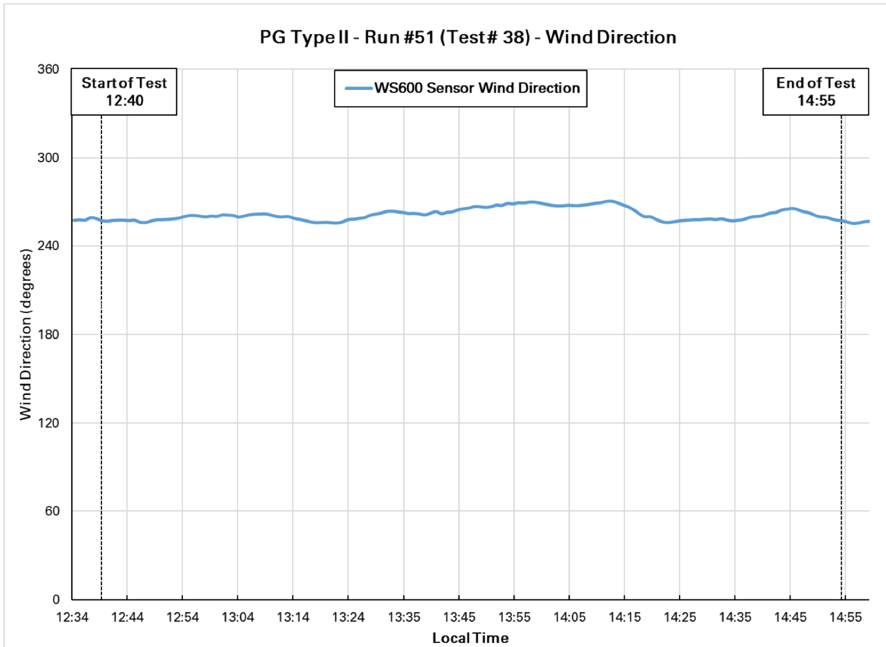
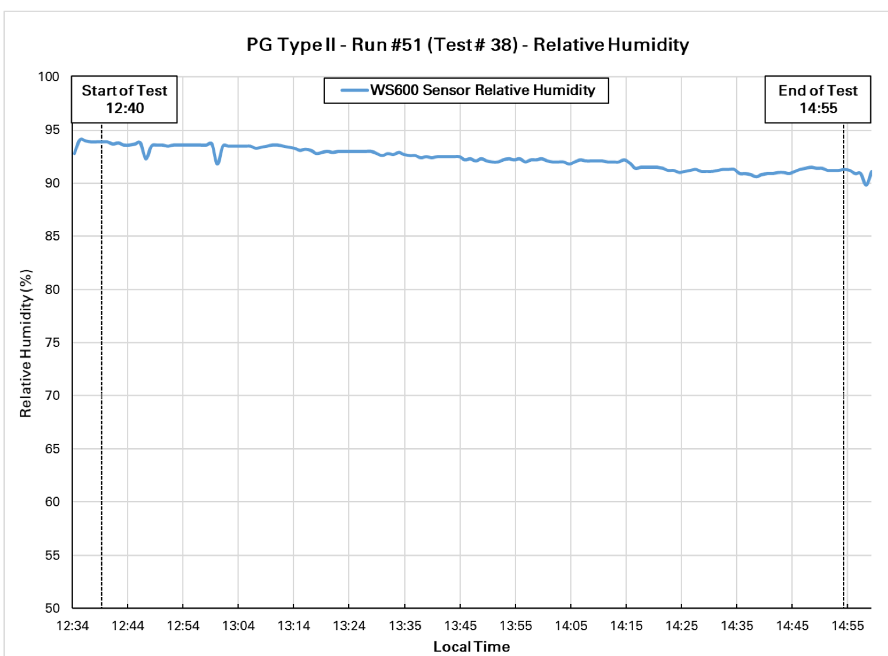
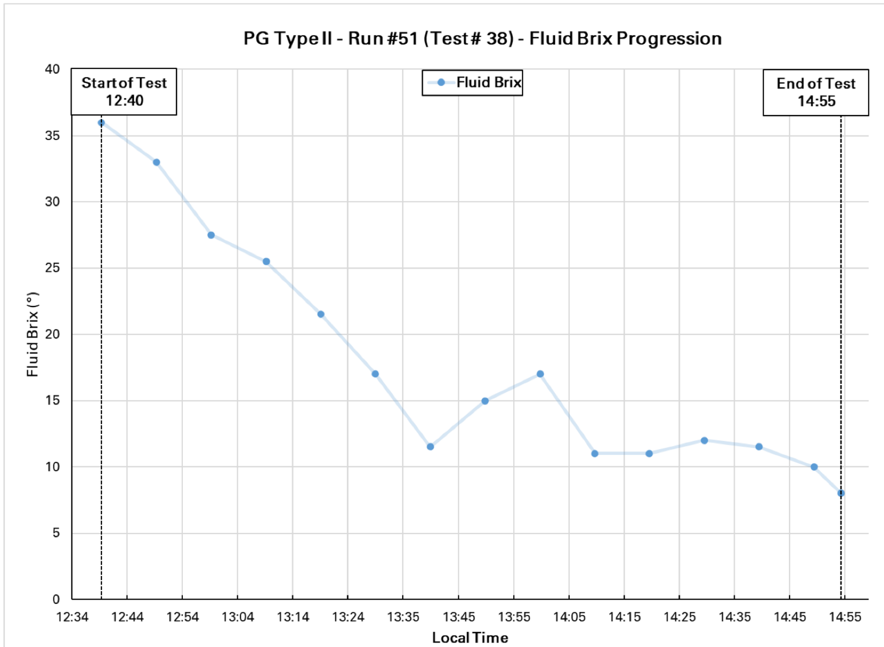
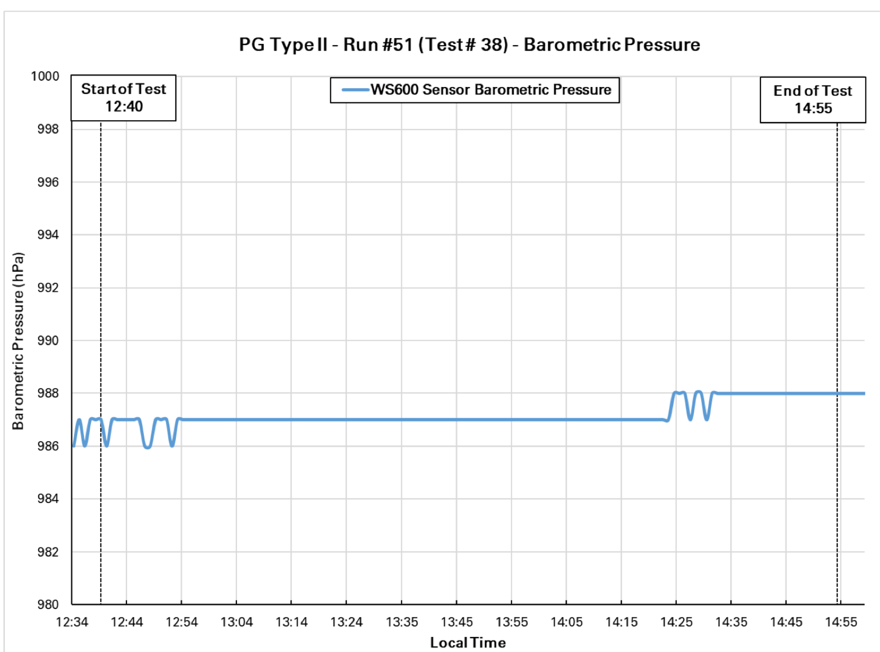


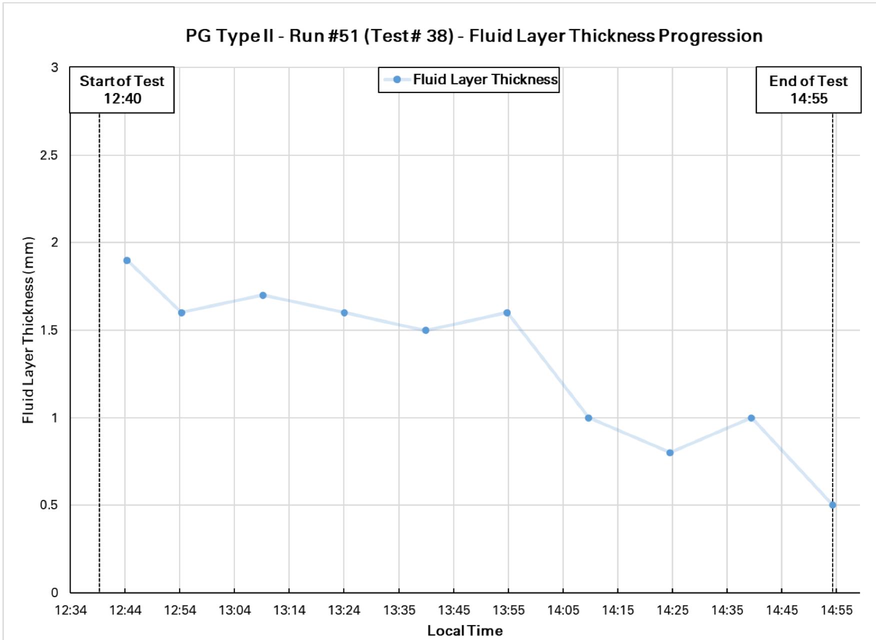
PG Type II - Run #51 (Test # 38) - Wind Direction
Start of Test
12:40
WS600 Sensor Wind Direction
End of Test
14:55
Wind Direction (degrees)
360
300
240
180
120
60
0
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
Local Time

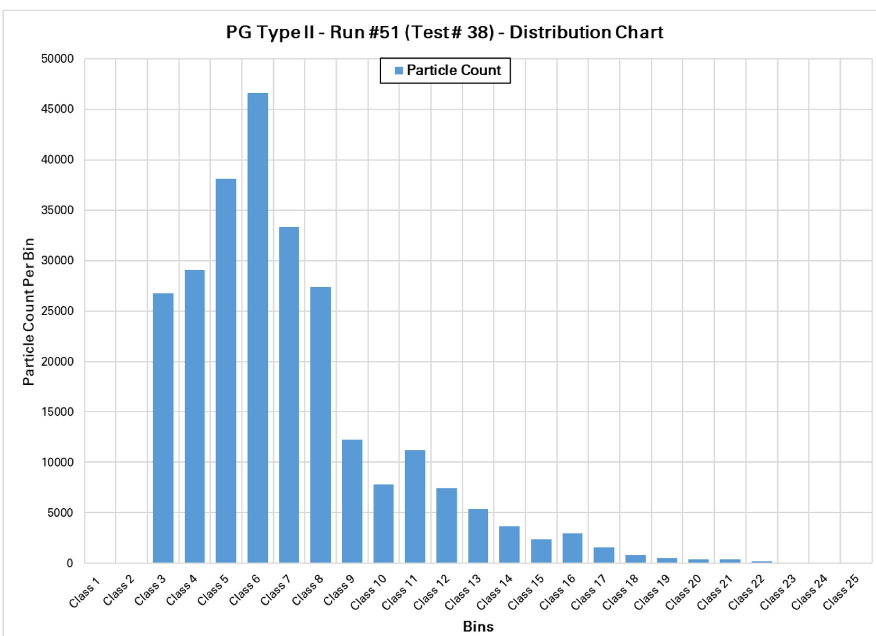


PG Type II - Run #51 (Test # 38) - Relative Humidity
Start of Test
12:40
WS600 Sensor Relative Humidity
End of Test
14:55
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
Local Time

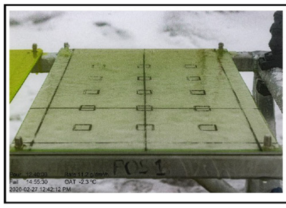

PG Type II - Run #51 (Test # 38) - Fluid Brix Progression
Start of Test 12:40
Fluid Brix
End of Test 14:55
Fluid Brix (°)
0
5
10
15
20
25
30
35
40
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
Local Time

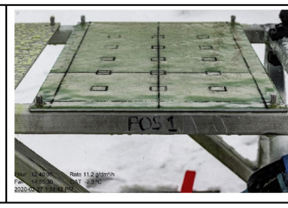

PG Type II - Run #51 (Test # 38) - Barometric Pressure
Start of Test 12:40
WS600 Sensor Barometric Pressure
End of Test 14:55
Barometric Pressure (hPa)
980
982
984
986
988
990
992
994
996
998
1000
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
Local Time

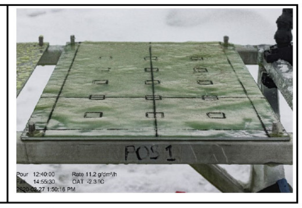

PG Type II - Run #51 (Test# 38) - Fluid Layer Thickness Progression
Start of Test
12:40
Fluid Layer Thickness
End of Test
14:55
Fluid Layer Thickness (mm)
0
0.5
1
1.5
2
2.5
3
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
14:45
14:55
Local Time

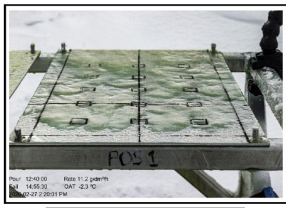

PG Type II - Run #51 (Test# 38) - Distribution Chart
Particle Count
Particle Count Per Bin
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
Class 9
Class 10
Class 11
Class 12
Class 13
Class 14
Class 15
Class 16
Class 17
Class 18
Class 19
Class 20
Class 21
Class 22
Class 23
Class 24
Class 25
Bins

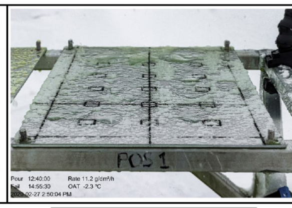
Safewing MP II Flight – Run 51 (Test 38) – Failure Progression Photos

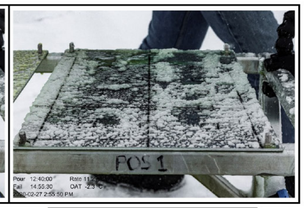

AT POUR (0/135 MIN)


PRE-FAILURE (58/135 MIN)


PRE-FAILURE (70/135 MIN)

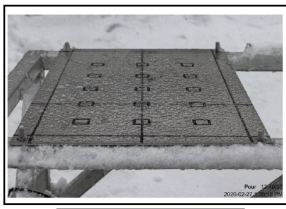

PRE-FAILURE (100/135 MIN)

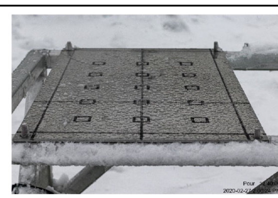

PRE-FAILURE (130/135 MIN)

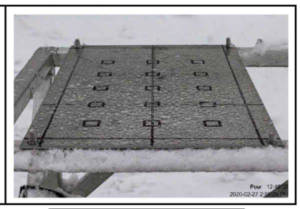

AT FAILURE (135/135 MIN)

Safewing MP II Flight – Run 51 (Test 38) – Snow Characteristics Photos

No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)


BARE PLATE (59/135 MIN)


BARE PLATE (80/135 MIN)


BARE PLATE (139/135 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

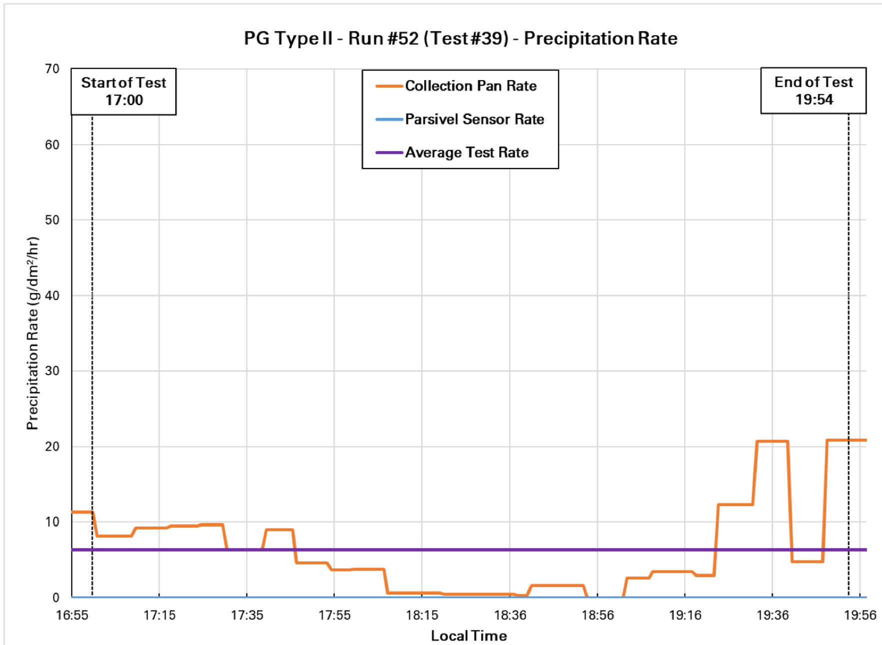
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE II
RUN #52 (TEST 39) - PG2-39

PG Type II – Run #52 (Test #39) – General Test Information

Test Number:	PG2-39
Date of Test:	February 27, 2020
Average OAT:	-4.5
Average Precipitation Rate:	6.4 g/dm²/h
Average Wind Speed:	35.2 km/h
Average Relative Humidity:	90.1%
Pour Time (Local):	17:00:00
Time of Fluid Failure (Local):	19:54:00
Fluid Brix at Failure:	12°
Endurance Time:	174 minutes
Expected Regression-Derived Endurance Time:	146 minutes
Difference (ET vs. Reg ET):	+28.2 minutes (+19.3%)

DATA PACKAGE – PG TYPE II – RUN 52 (TEST 39)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 52 - Test 39/Data Package - PG Type II - Run 52 - Test 39.docx
Final Version 1.0, February 2021

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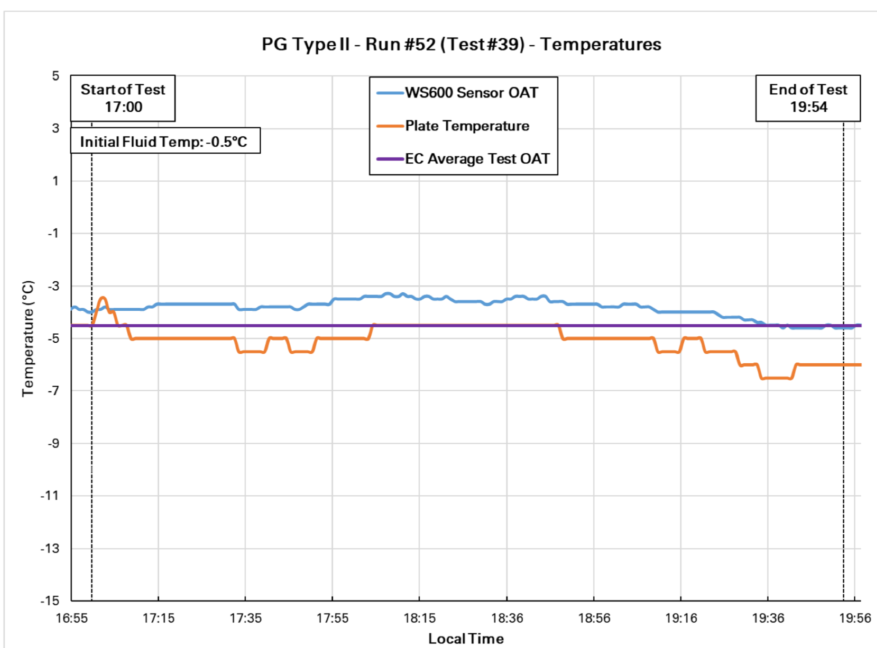
DATA PACKAGE – PG TYPE II – RUN 52 (TEST 39)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type II/PG Type II - Run 52 - Test 39/Data Package - PG Type II - Run 52 - Test 39.docx
Final Version 1.0, February 2021

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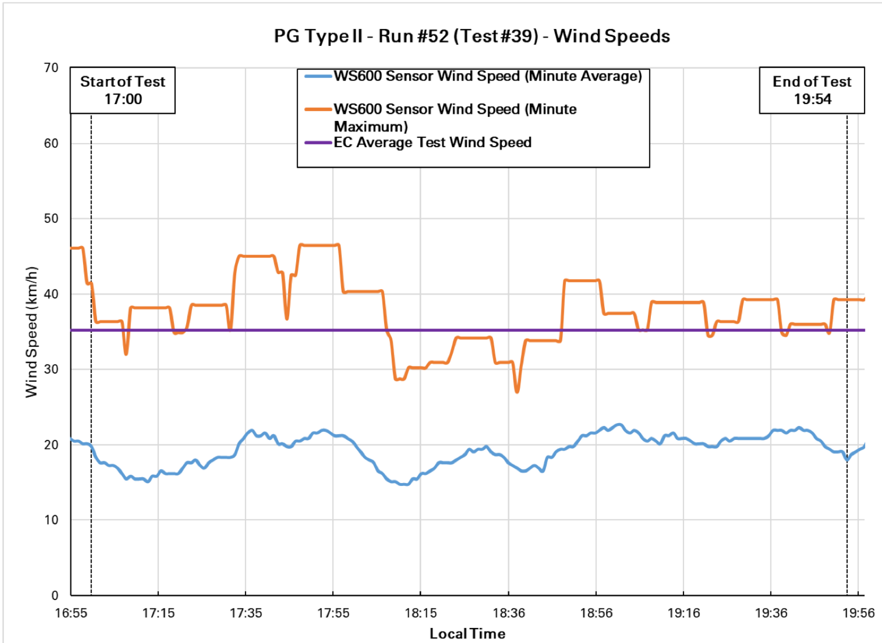
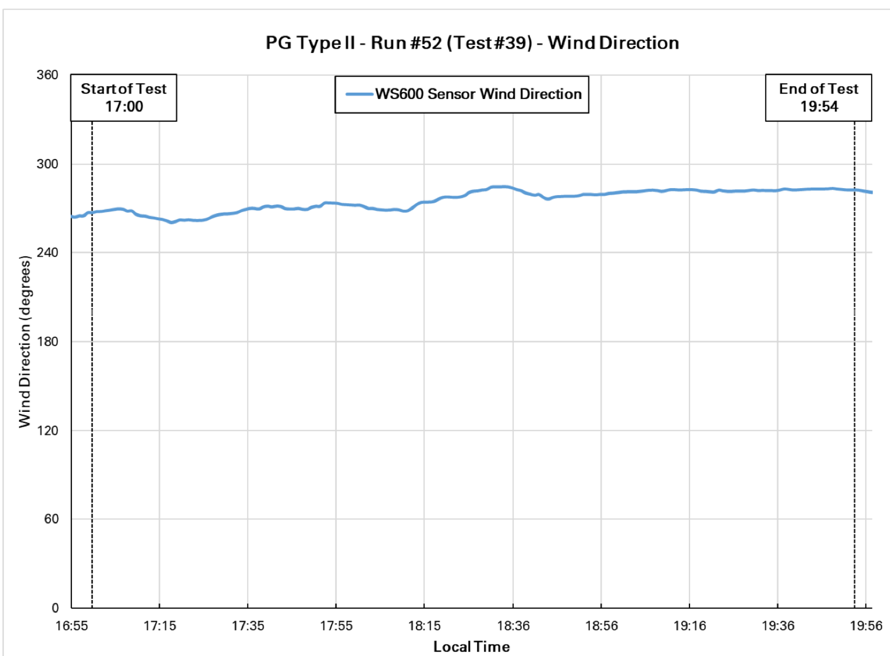
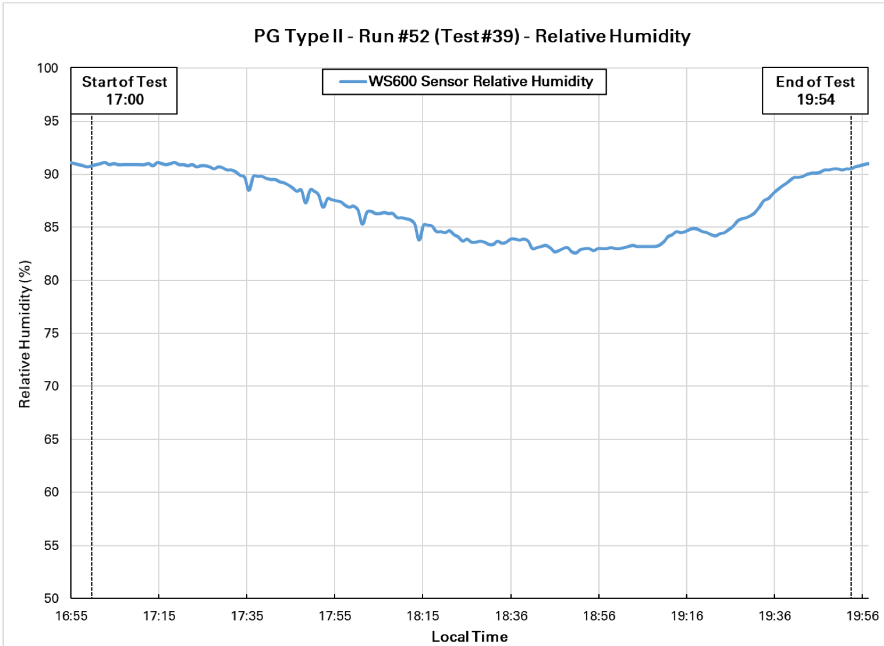
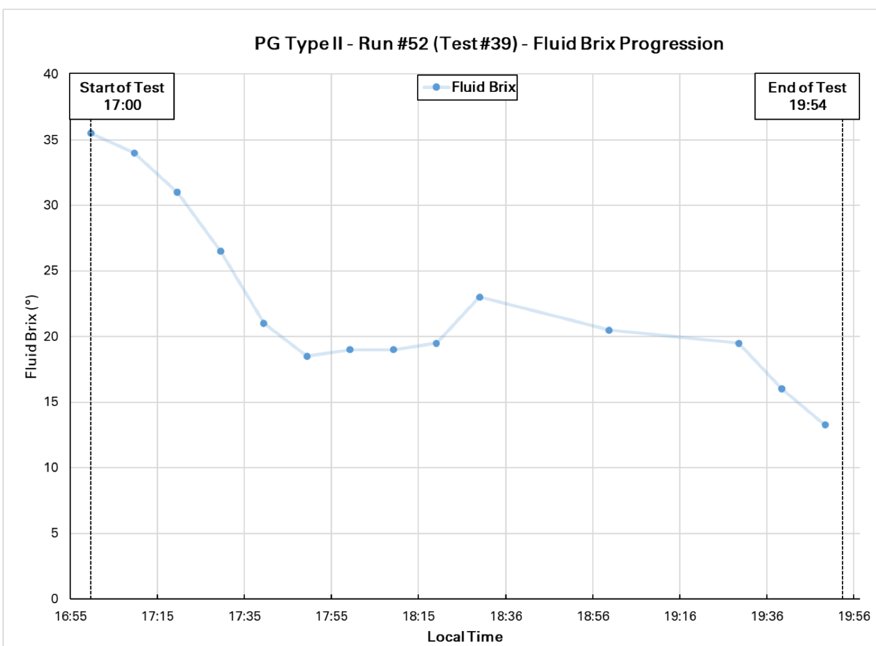
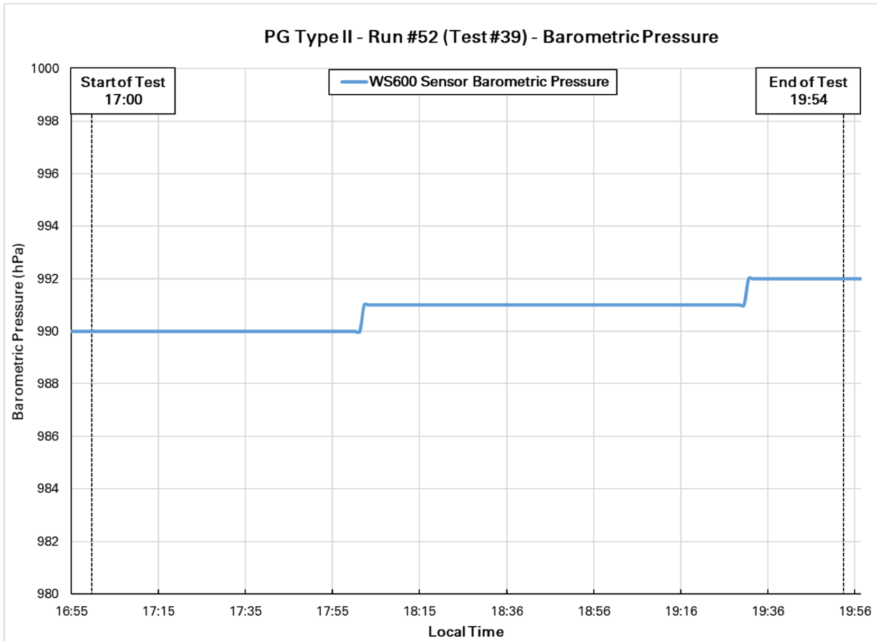

PG Type II - Run #52 (Test #39) - Wind Speeds
Start of Test 17:00
End of Test 19:54
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
19:56

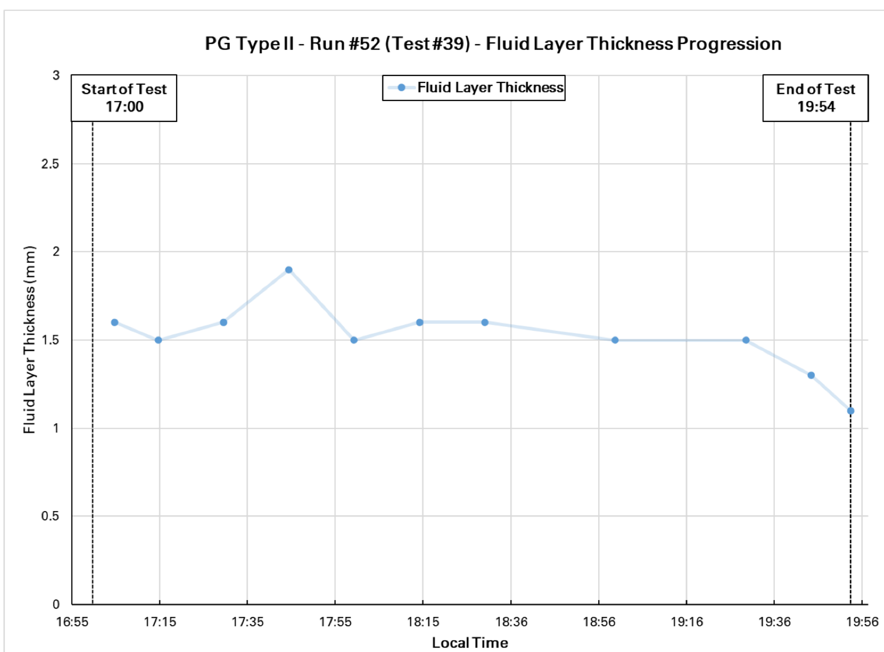

PG Type II - Run #52 (Test #39) - Wind Direction
Start of Test 17:00
End of Test 19:54
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
19:56



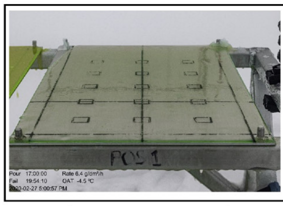
DATA PACKAGE – PG TYPE II – RUN 52 (TEST 39)



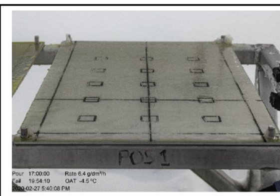

PG Type II - Run #52 (Test #39) - Barometric Pressure
Start of Test 17:00
WS600 Sensor Barometric Pressure
End of Test 19:54
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
19:56
Local Time


PG Type II - Run #52 (Test #39) - Fluid Layer Thickness Progression
Start of Test 17:00
Fluid Layer Thickness
End of Test 19:54
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
19:56
Local Time

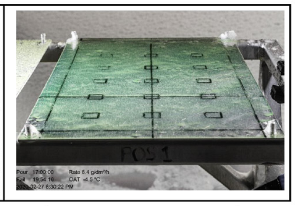
Safewing MP II Flight – Run 52 (Test 39) – Failure Progression Photos



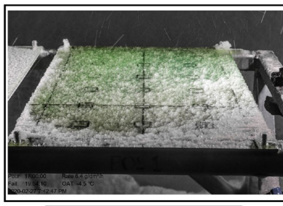
AT POUR (0/174 MIN)



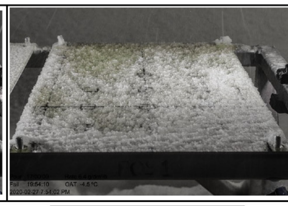
PRE-FAILURE (40/174 MIN)



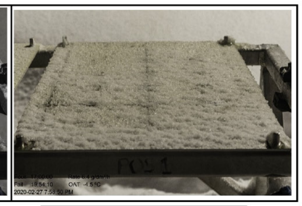
PRE-FAILURE (90/174 MIN)



PRE-FAILURE (162/174 MIN)



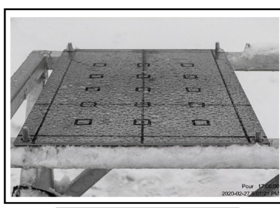
AT FAILURE (174/174 MIN)



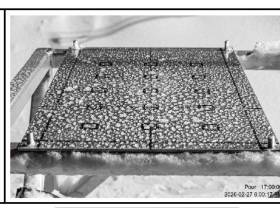
POST-FAILURE (178/174 MIN)

Safewing MP II Flight – Run 52 (Test 39) – Snow Characteristics Photos

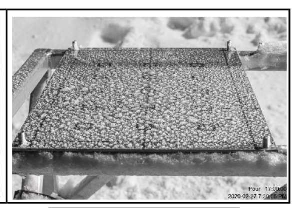
No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (1/174 MIN)



BARE PLATE 60/174 MIN)



BARE PLATE (150/174 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

Particle Size Classes Explained

After determining the volume equivalent diameter (D) and the particle speed (V), the OTT Parsivel² subdivides the particles into appropriate classes. The scale of this classification is smaller for small, slow particles than for large and fast particles.

C.1 Class limits

The measured particles are subdivided into D and V classes in a two-dimensional field, wherein there are 32 different D and V classes so that there are a total of 32 x 32 = 1024 classes.

Classification according to volume-equivalent diameter

Class number	Mid-value of class [mm]	Class spread [mm]
1	0.062	0.125
2	0.187	0.125
3	0.312	0.125
4	0.437	0.125
5	0.562	0.125
6	0.687	0.125
7	0.812	0.125
8	0.937	0.125
9	1.062	0.125
10	1.187	0.125
11	1.375	0.250
12	1.625	0.250
13	1.875	0.250
14	2.125	0.250
15	2.375	0.250
16	2.750	0.500
17	3.250	0.500
18	3.750	0.500
19	4.250	0.500
20	4.750	0.500
21	5.500	1.000
22	6.500	1.000
23	7.500	1.000
24	8.500	1.000
25	9.500	1.000
26	11.000	2.000
27	13.000	2.000
28	15.000	2.000
29	17.000	2.000
30	19.000	2.000
31	21.500	3.000
32	24.500	3.000

Note:
Class 1 and class 2 are limits and are not evaluated at the current time in measurements using the OTT Parsivel² since they are outside the measurement range of the device.

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APPENDIX E

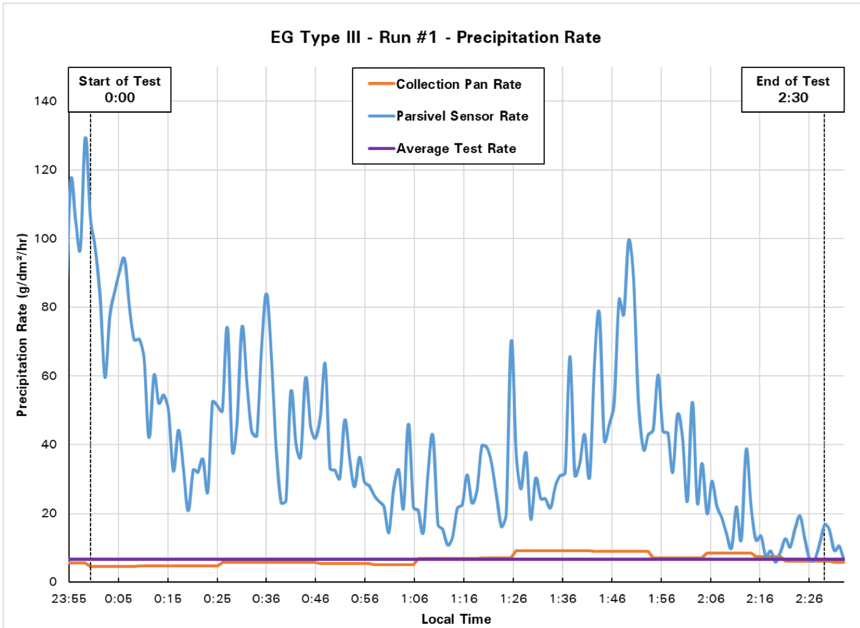
DATA PACKAGES – NATURAL SNOW CHARACTERIZATION
EG TYPE III RUNS

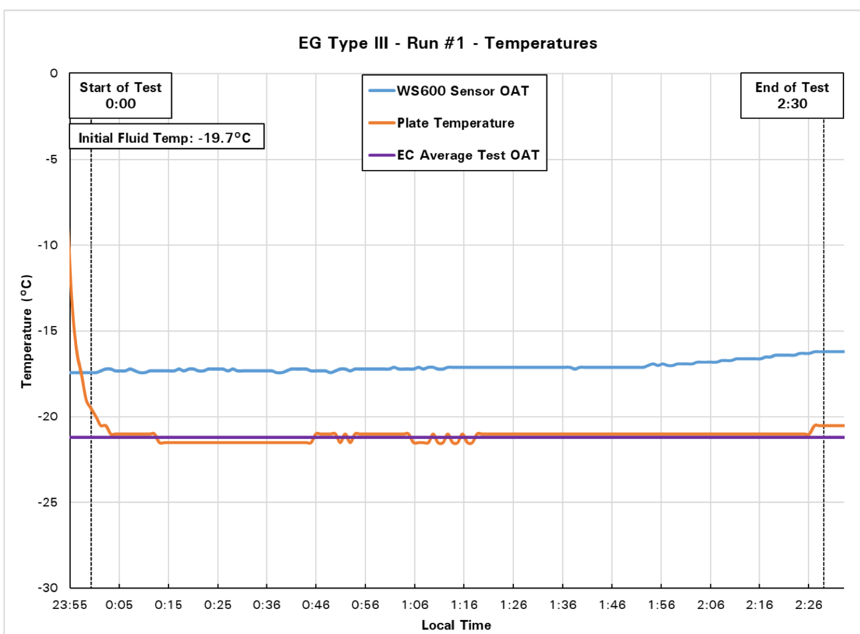
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

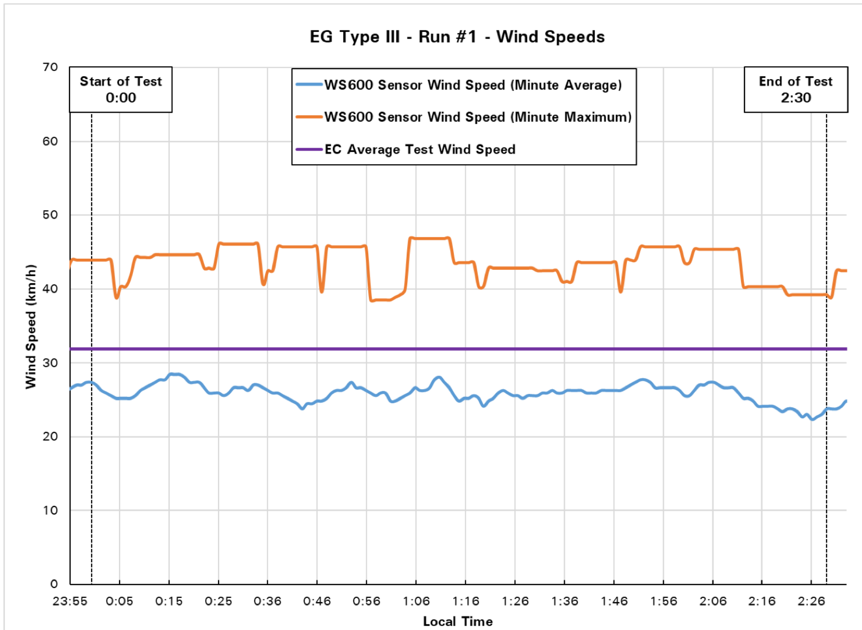
EG TYPE III
RUN #1 – (TEST #1) EG3-1

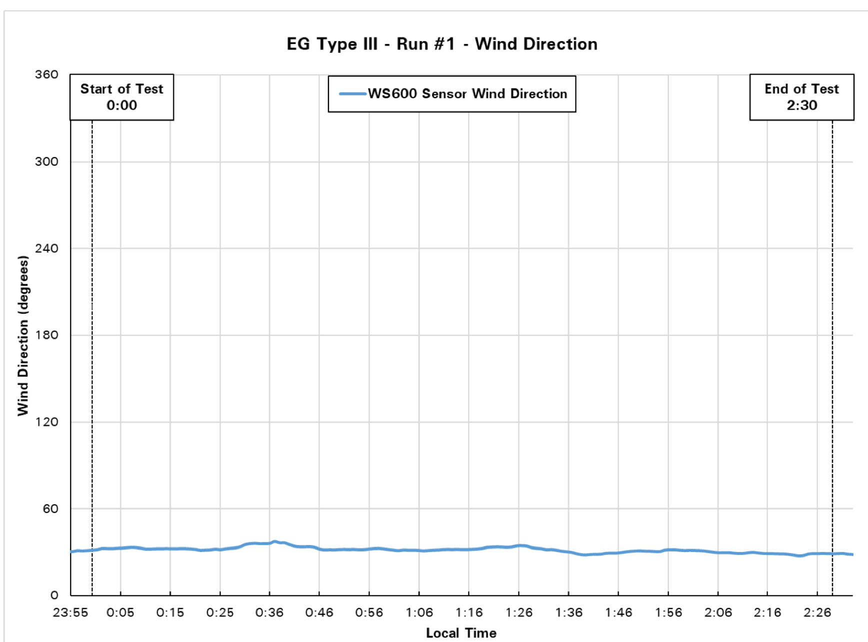
EG Type III – Run #1 – General Test Information

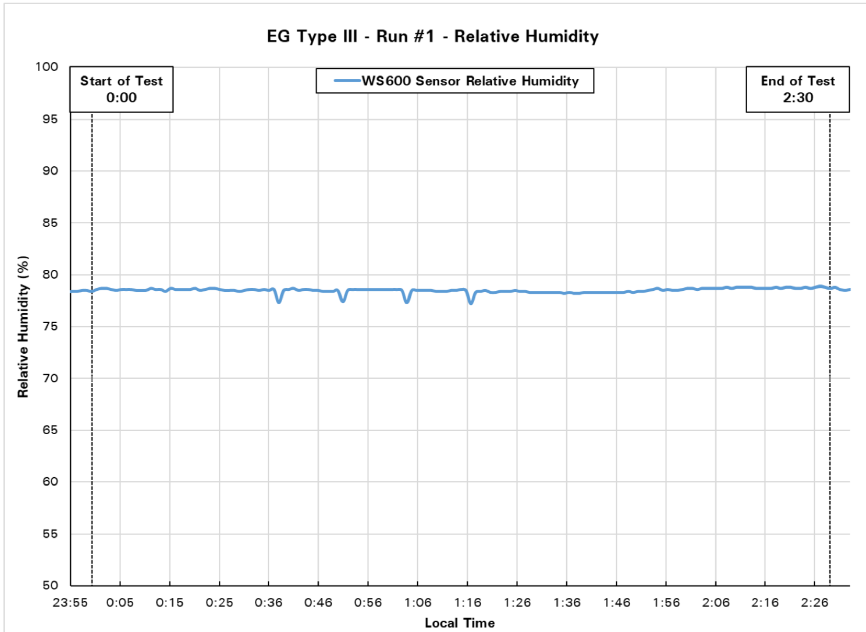
Test Number:	EG3-1
Date of Test:	January 20, 2019
Average OAT:	-21.2
Average Precipitation Rate:	6.7 g/dm²/h
Average Wind Speed:	31.9 km/h
Average Relative Humidity:	79%
Pour Time (Local):	00:00:00
Time of Fluid Failure (Local):	02:30:00
Fluid Brix at Failure:	24.5°
Endurance Time:	150 minutes
Expected Regression-Derived Endurance Time:	71.6 minutes
Difference (ET vs. Reg ET):	+78.4 minutes (+109.4%)

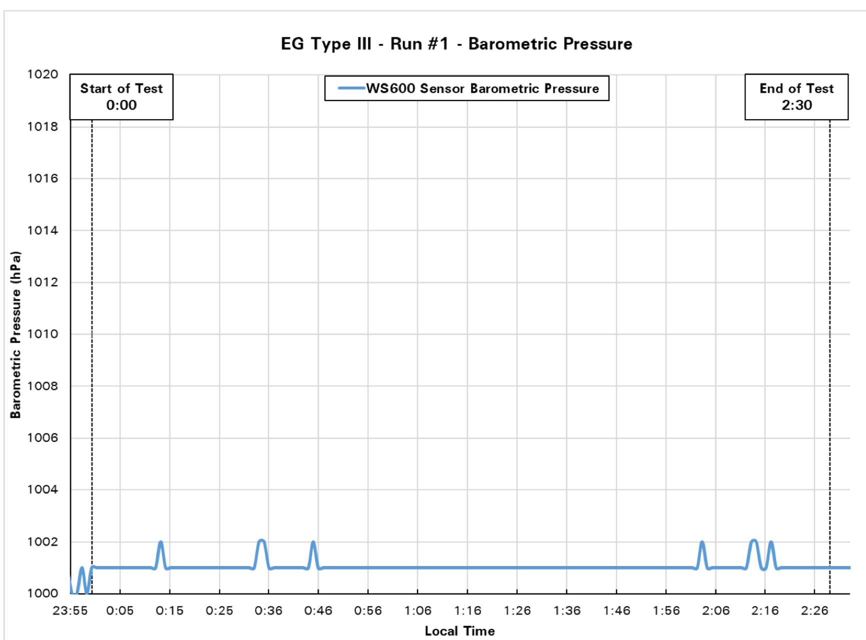

EG Type III - Run #1 - Precipitation Rate
Start of Test
0:00
End of Test
2:30
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
140
120
100
80
60
40
20
0
23:55
0:05
0:15
0:25
0:36
0:46
0:56
1:06
1:16
1:26
1:36
1:46
1:56
2:06
2:16
2:26
Local Time

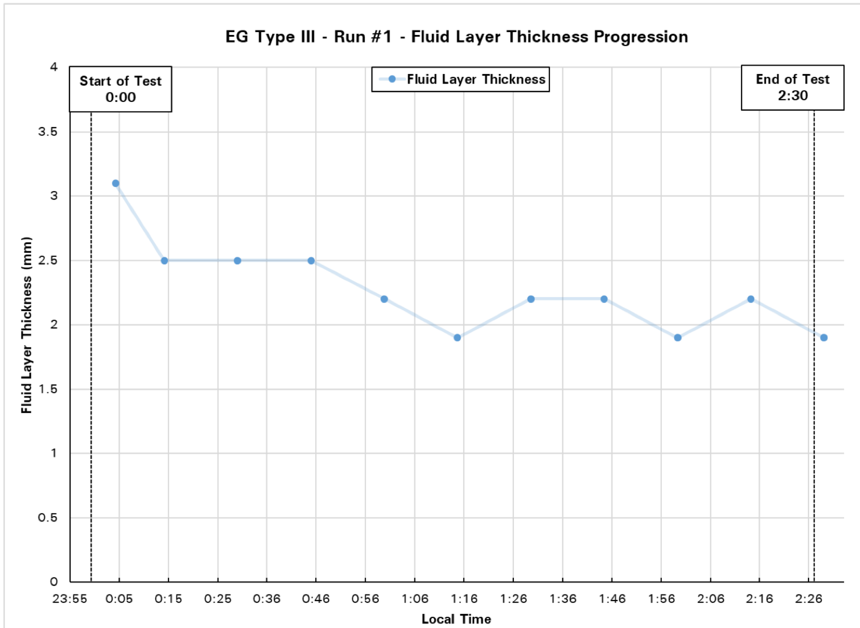

EG Type III - Run #1 - Temperatures
Start of Test
0:00
Initial Fluid Temp: -19.7°C
End of Test
2:30
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-5
-10
-15
-20
-25
-30
23:55
0:05
0:15
0:25
0:36
0:46
0:56
1:06
1:16
1:26
1:36
1:46
1:56
2:06
2:16
2:26
Local Time


EG Type III - Run #1 - Wind Speeds
Start of Test 0:00
End of Test 2:30
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
23:55
0:05
0:15
0:25
0:36
0:46
0:56
1:06
1:16
1:26
1:36
1:46
1:56
2:06
2:16
2:26
Local Time

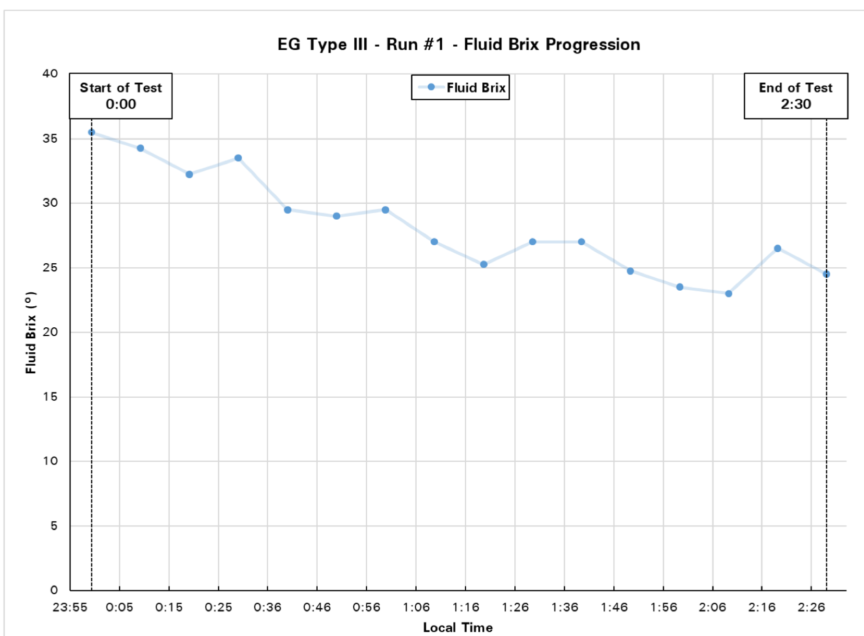

EG Type III - Run #1 - Wind Direction
Start of Test 0:00
End of Test 2:30
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
23:55
0:05
0:15
0:25
0:36
0:46
0:56
1:06
1:16
1:26
1:36
1:46
1:56
2:06
2:16
2:26
Local Time

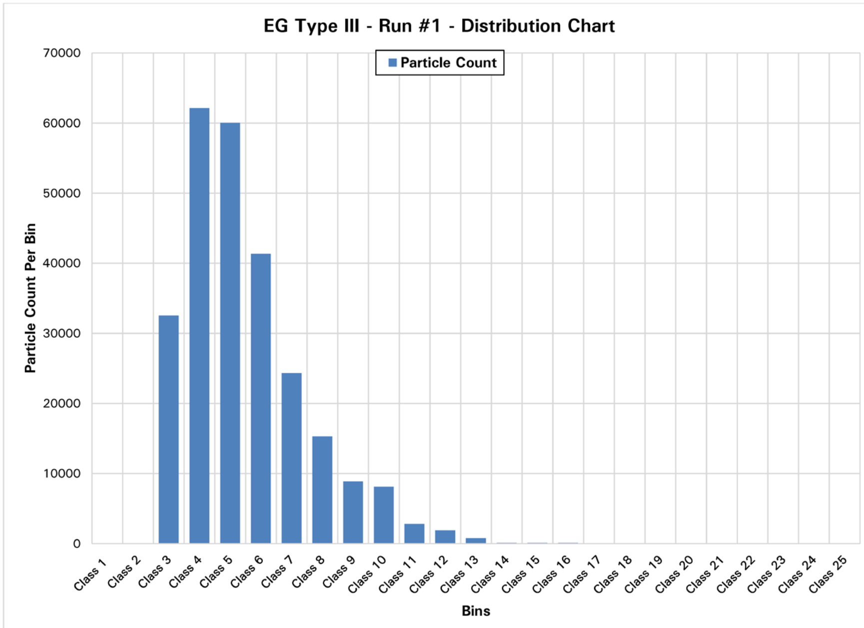

EG Type III - Run #1 - Relative Humidity
Start of Test 0:00
WS600 Sensor Relative Humidity
End of Test 2:30
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
23:55 0:05 0:15 0:25 0:36 0:46 0:56 1:06 1:16 1:26 1:36 1:46 1:56 2:06 2:16 2:26
Local Time


EG Type III - Run #1 - Barometric Pressure
Start of Test 0:00
WS600 Sensor Barometric Pressure
End of Test 2:30
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
23:55 0:05 0:15 0:25 0:36 0:46 0:56 1:06 1:16 1:26 1:36 1:46 1:56 2:06 2:16 2:26
Local Time

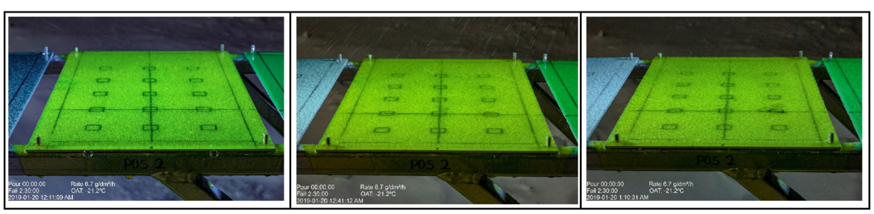


DATA PACKAGE – EG TYPE III – RUN 1

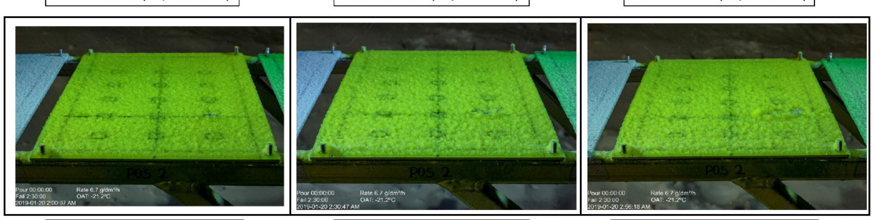




AeroClear MAX – Run 1 – Failure Progression Photos

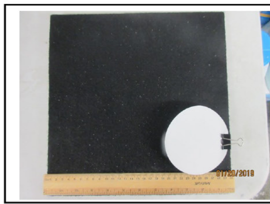


PRE-FAILURE (11/150 MIN) | PRE-FAILURE (41/150 MIN) | PRE-FAILURE (70/150 MIN)

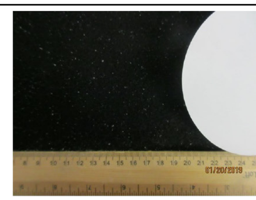


PRE-FAILURE (120/150 MIN) | AT FAILURE (150/150 MIN) | POST-FAILURE (176/150 MIN)

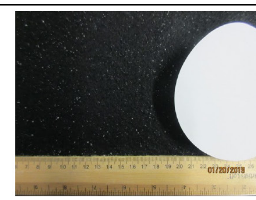
AeroClear MAX – Run 1 – Snow Characteristics Photos



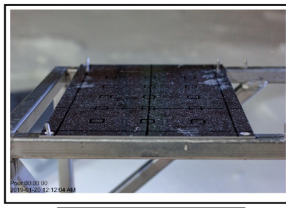
FELT PAD (13/150 MIN)



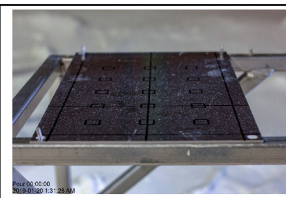
FELT PAD (60/150 MIN)



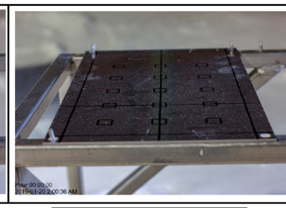
FELT PAD (144/150 MIN)



BARE PLATE (12/150 MIN)



BARE PLATE 91/150 MIN)



BARE PLATE (120/150 MIN)

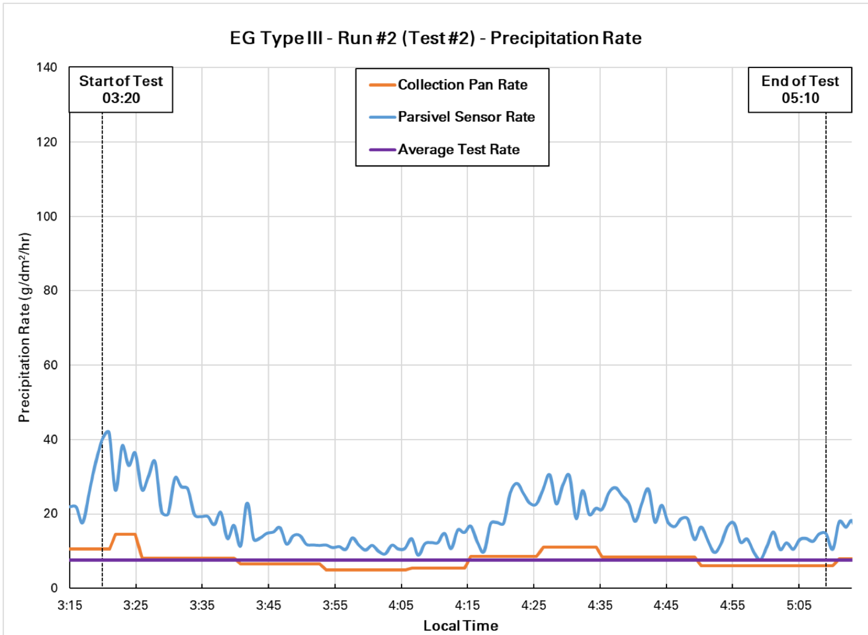
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

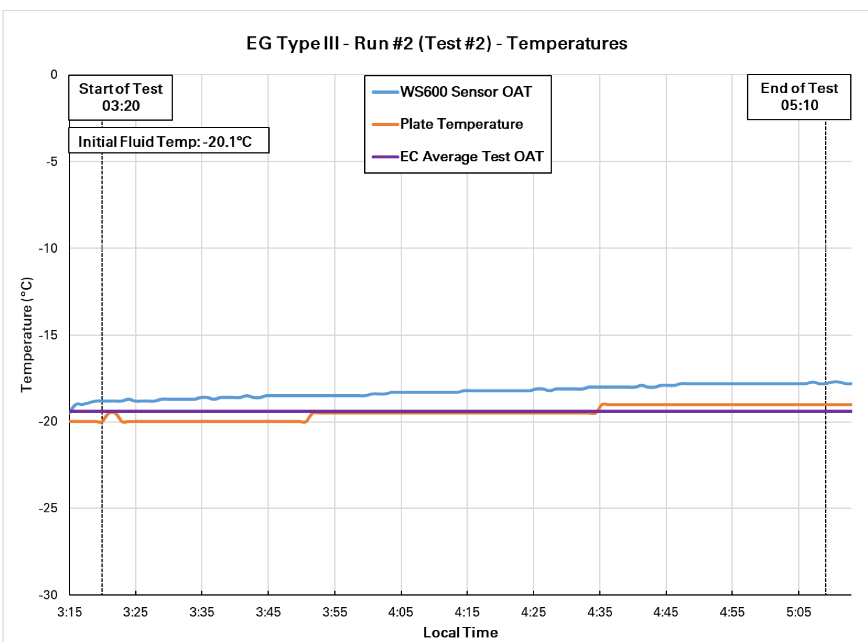
EG TYPE III
RUN #2 (TEST #2) – EG3-2

EG Type III – Run #2 (Test #2) – General Test Information

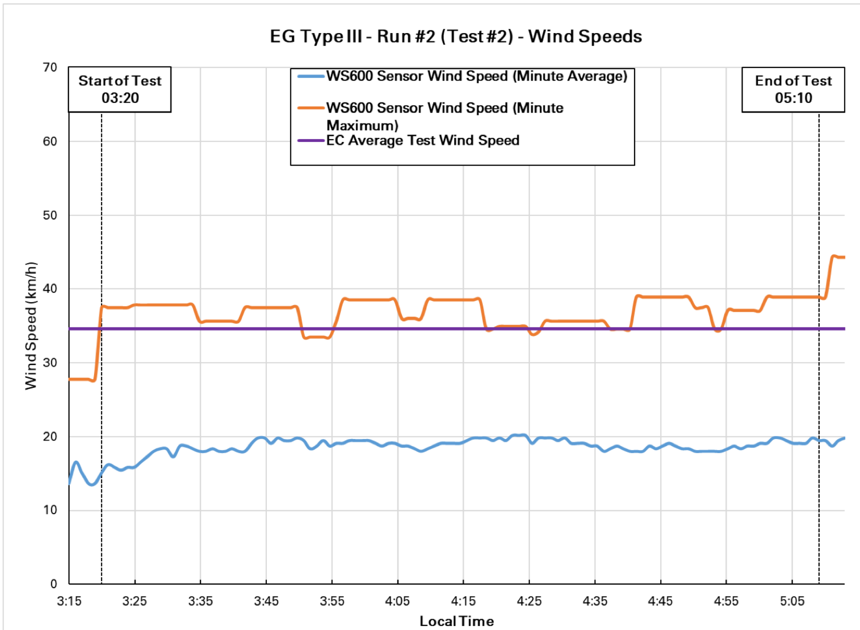
Test Number:	EG3-2
Date of Test:	January 20, 2019
Average OAT:	-19.4
Average Precipitation Rate:	7.6 g/dm²/h
Average Wind Speed:	34.6 km/h
Average Relative Humidity:	74.8%
Pour Time (Local):	03:10:00
Time of Fluid Failure (Local):	05:20:00
Fluid Brix at Failure:	21.5°
Endurance Time:	110 minutes
Expected Regression-Derived Endurance Time:	65.4 minutes
Difference (ET vs. Reg ET):	+44.6 minutes (+46.6%)

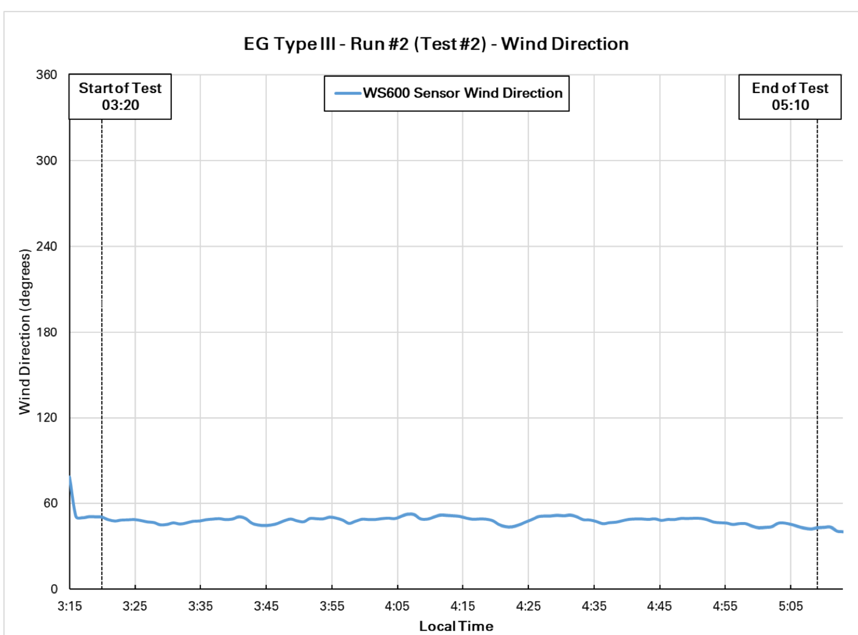


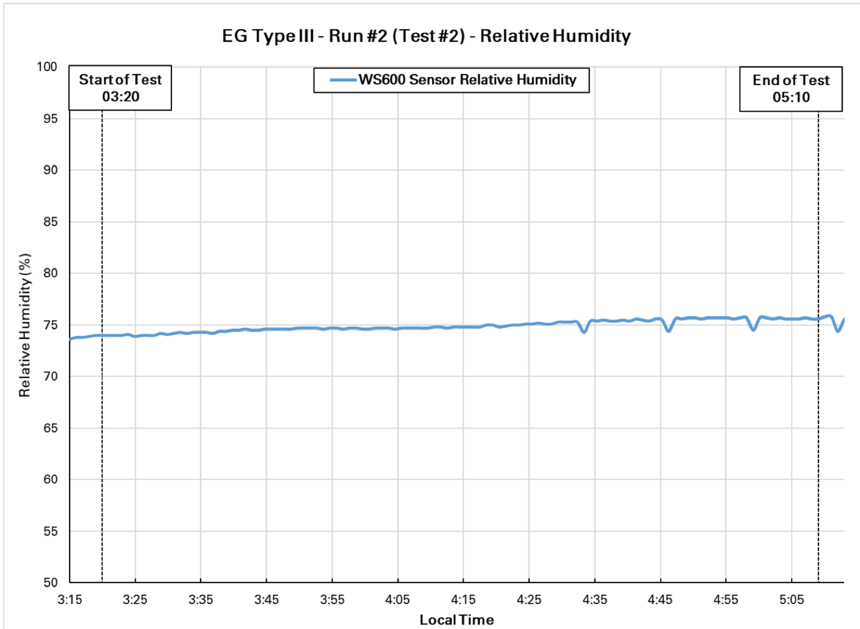
EG Type III - Run #2 (Test #2) - Precipitation Rate
Start of Test
03:20
End of Test
05:10
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
140
120
100
80
60
40
20
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
Local Time



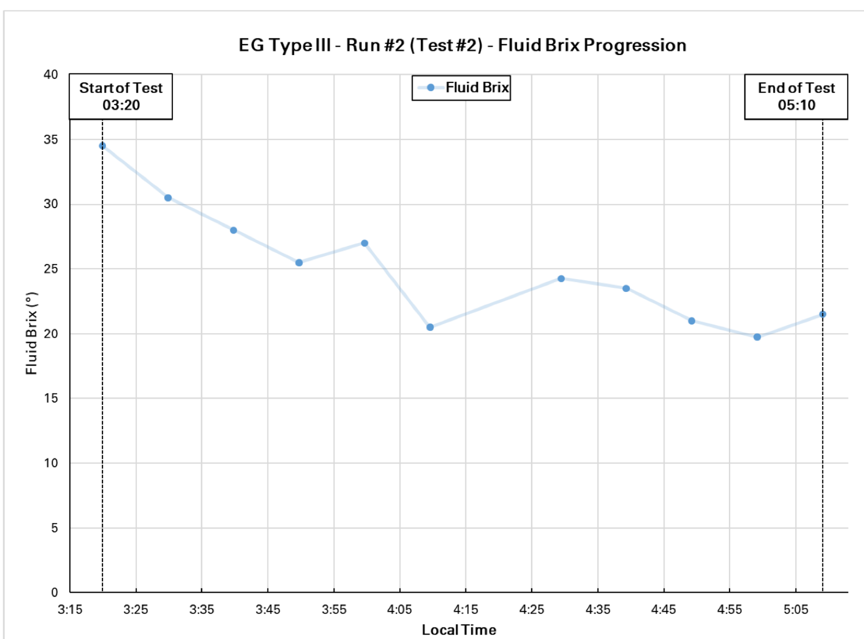
EG Type III - Run #2 (Test #2) - Temperatures
Start of Test
03:20
Initial Fluid Temp: -20.1°C
End of Test
05:10
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-5
-10
-15
-20
-25
-30
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
Local Time

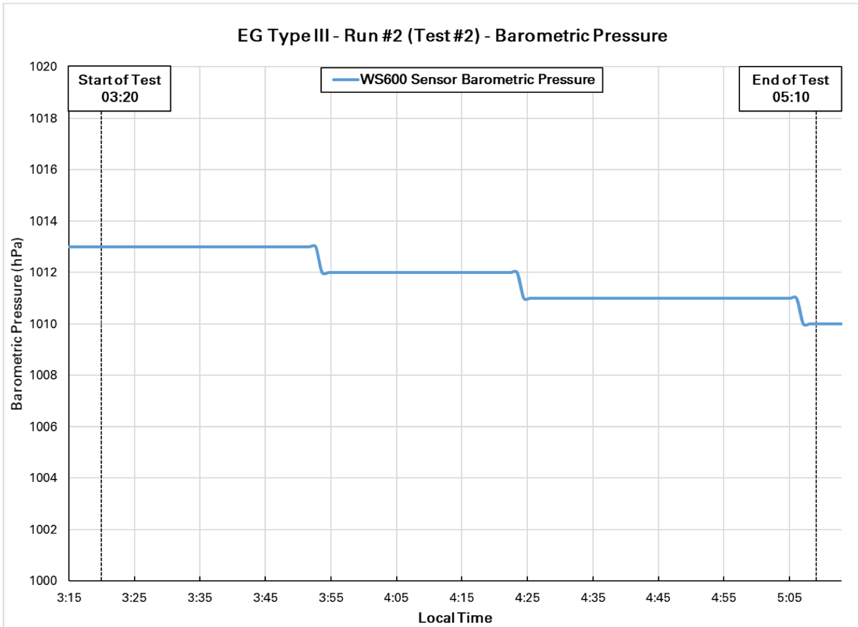

EG Type III - Run #2 (Test #2) - Wind Speeds
Start of Test 03:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 05:10
Wind Speed (km/h)
0
10
20
30
40
50
60
70
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
Local Time

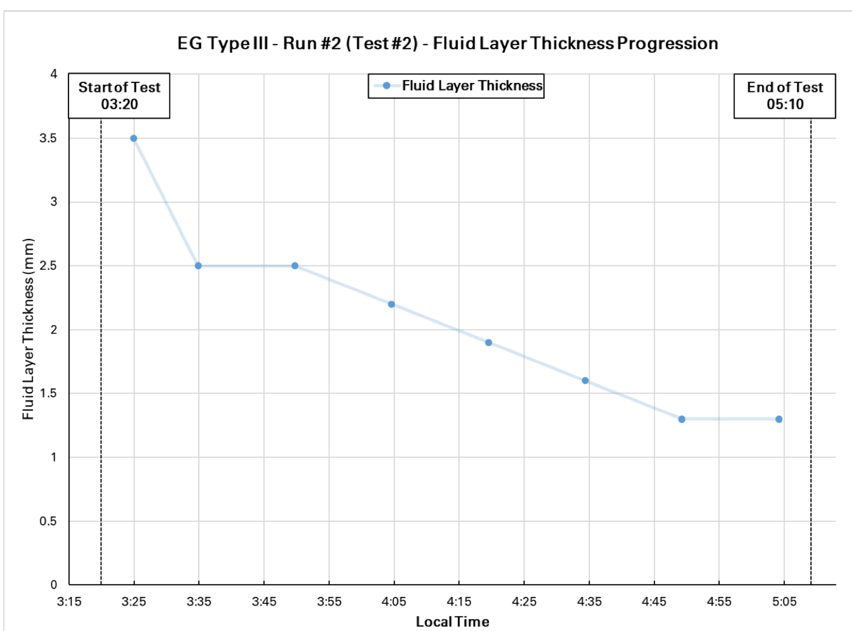

EG Type III - Run #2 (Test #2) - Wind Direction
Start of Test 03:20
WS600 Sensor Wind Direction
End of Test 05:10
Wind Direction (degrees)
0
60
120
180
240
300
360
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
Local Time

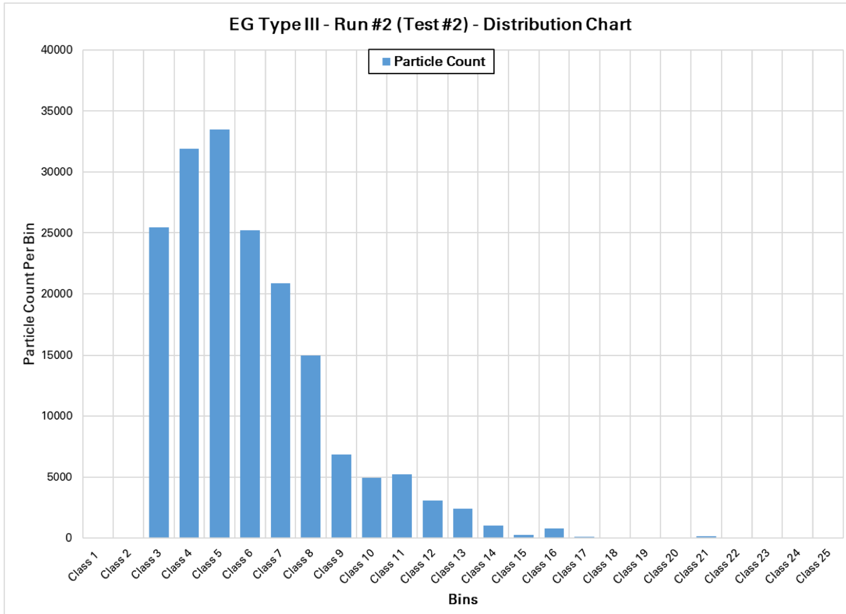


DATA PACKAGE – EG TYPE III – RUN 2 (TEST 2)

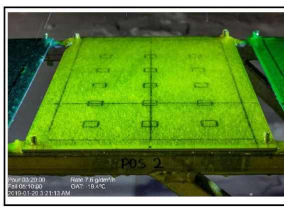



EG Type III - Run #2 (Test #2) - Barometric Pressure
Start of Test
03:20
WS600 Sensor Barometric Pressure
End of Test
05:10
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
Local Time

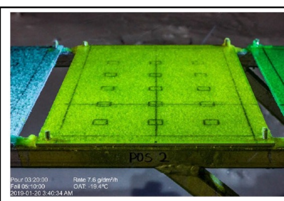

EG Type III - Run #2 (Test #2) - Fluid Layer Thickness Progression
Start of Test
03:20
Fluid Layer Thickness
End of Test
05:10
Fluid Layer Thickness (mm)
4
3.5
3
2.5
2
1.5
1
0.5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
Local Time



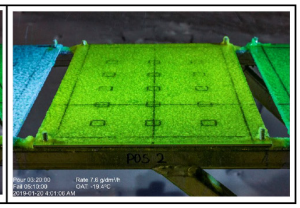
AeroClear MAX – Run 2 (Test 2) – Failure Progression Photos



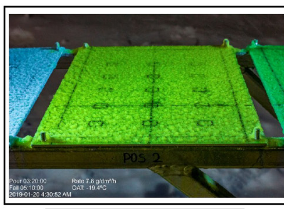
AT POUR (0/110 MIN)



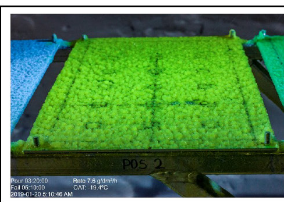
PRE-FAILURE (20/110 MIN)



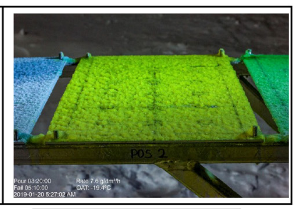
PRE-FAILURE (61/110 MIN)



PRE-FAILURE (70/110 MIN)

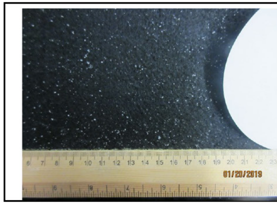


AT FAILURE (110/110 MIN)

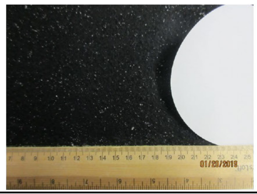


POST-FAILURE (127/110 MIN)

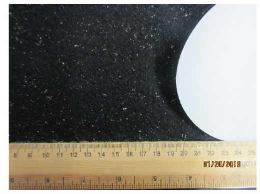
AeroClear MAX – Run 2 (Test 2) – Snow Characteristics Photos



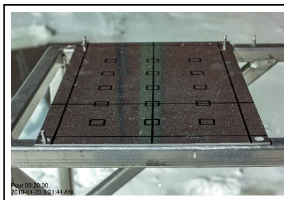
FELT PAD (20/110 MIN)



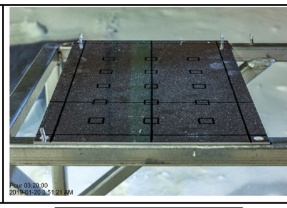
FELT PAD (53/110 MIN)



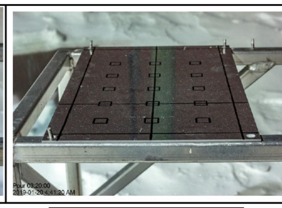
FELT PAD (91/110 MIN)



BARE PLATE (1/110 MIN)



BARE PLATE 30/110 MIN)



BARE PLATE (80/110 MIN)

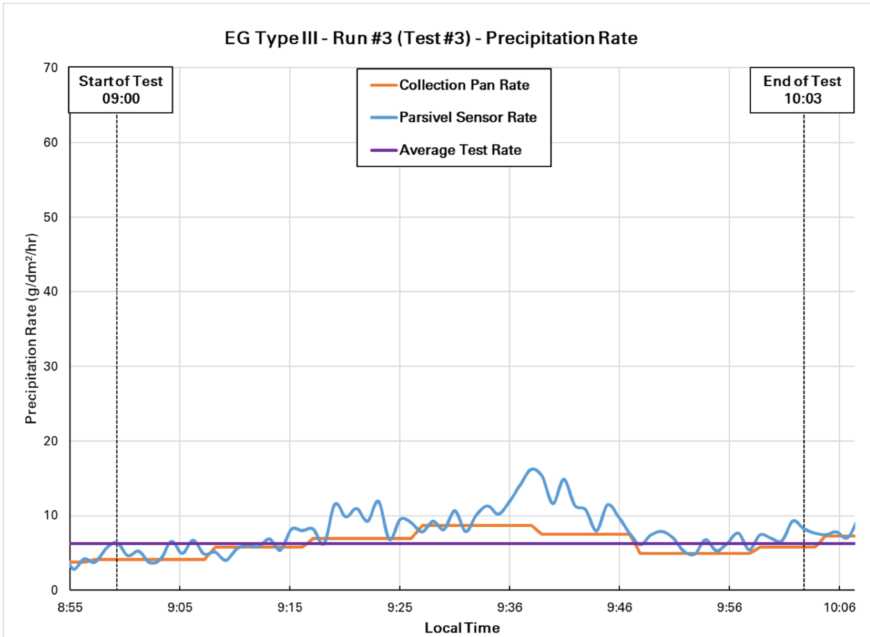
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

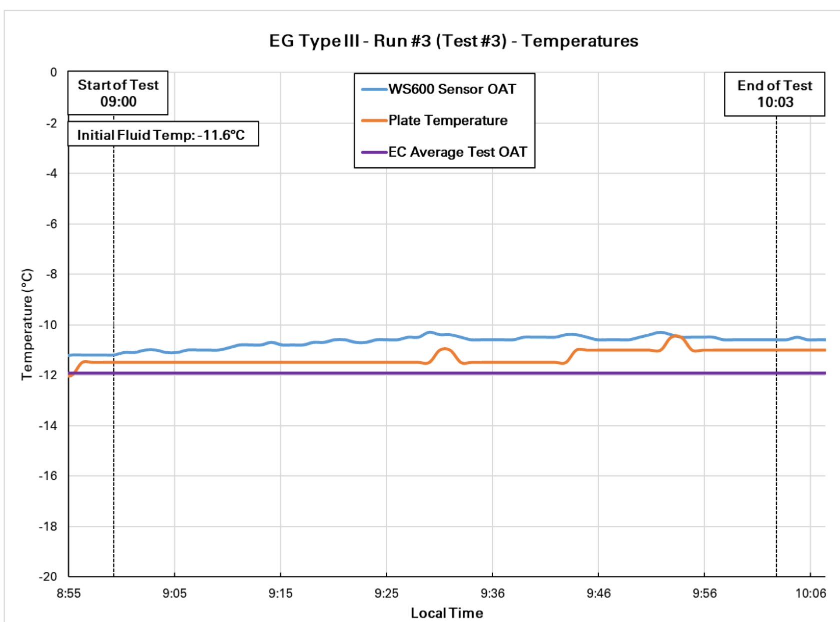
EG TYPE III
RUN #3 (TEST #3) - EG3-3

EG Type III – Run #3 (Test #3) – General Test Information

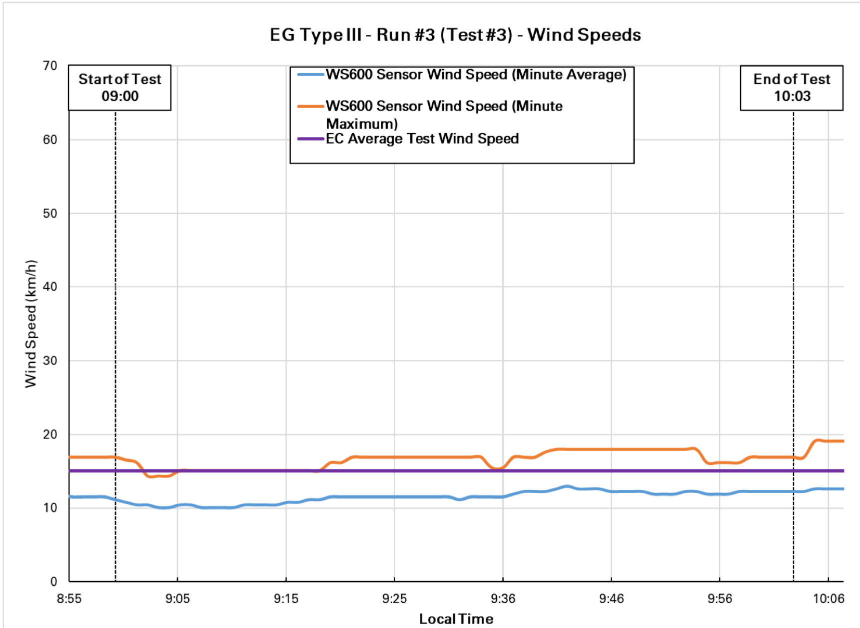
Test Number:	EG3-3
Date of Test:	January 23, 2019
Average OAT:	-11.9
Average Precipitation Rate:	6.3 g/dm²/h
Average Wind Speed:	15.1 km/h
Average Relative Humidity:	80.9%
Pour Time (Local):	09:00:00
Time of Fluid Failure (Local):	10:03:00
Fluid Brix at Failure:	12.75°
Endurance Time:	63 minutes
Expected Regression-Derived Endurance Time:	57.5 minutes
Difference (ET vs. Reg ET):	+5.5 minutes (+9.6%)

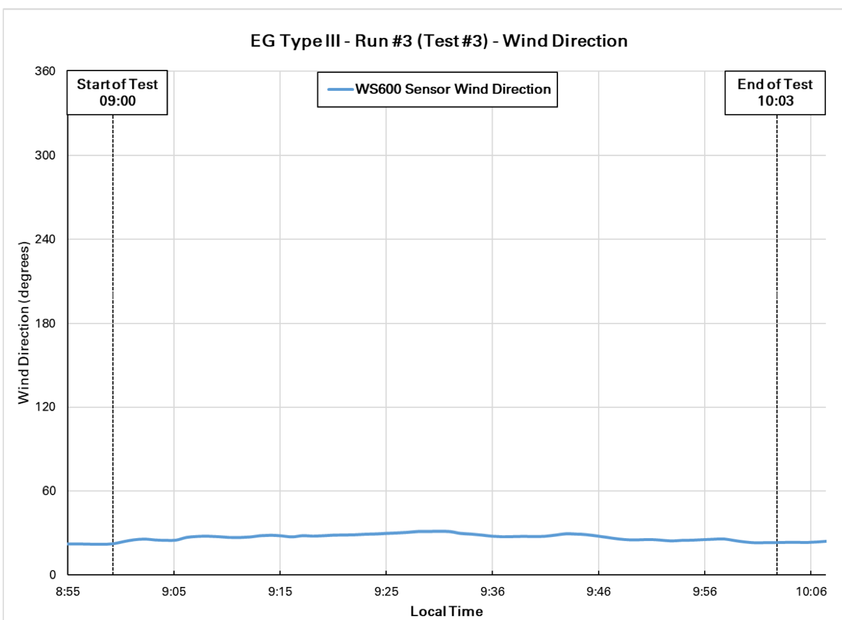


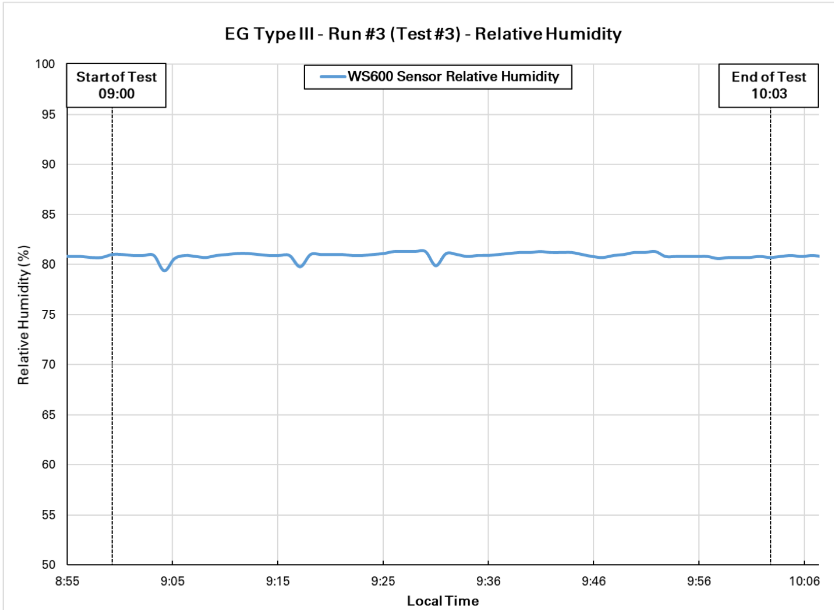
EG Type III - Run #3 (Test #3) - Precipitation Rate
Start of Test 09:00
End of Test 10:03
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
8:55
9:05
9:15
9:25
9:36
9:46
9:56
10:06
Local Time



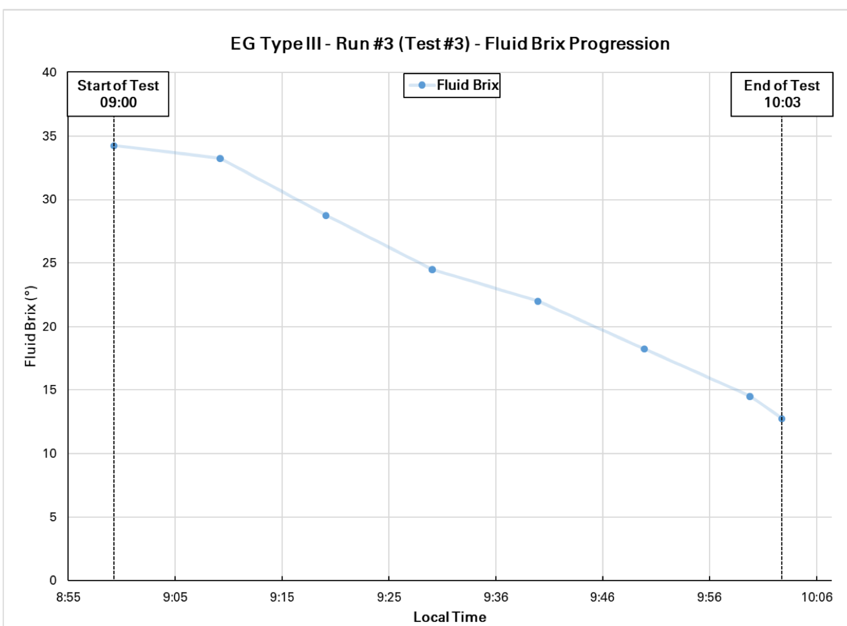
EG Type III - Run #3 (Test #3) - Temperatures
Start of Test 09:00
Initial Fluid Temp: -11.6°C
End of Test 10:03
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
8:55
9:05
9:15
9:25
9:36
9:46
9:56
10:06
Local Time


EG Type III - Run #3 (Test #3) - Wind Speeds
Start of Test 09:00
End of Test 10:03
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
8:55
9:05
9:15
9:25
9:36
9:46
9:56
10:06
Local Time


EG Type III - Run #3 (Test #3) - Wind Direction
Start of Test 09:00
End of Test 10:03
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
8:55
9:05
9:15
9:25
9:36
9:46
9:56
10:06
Local Time

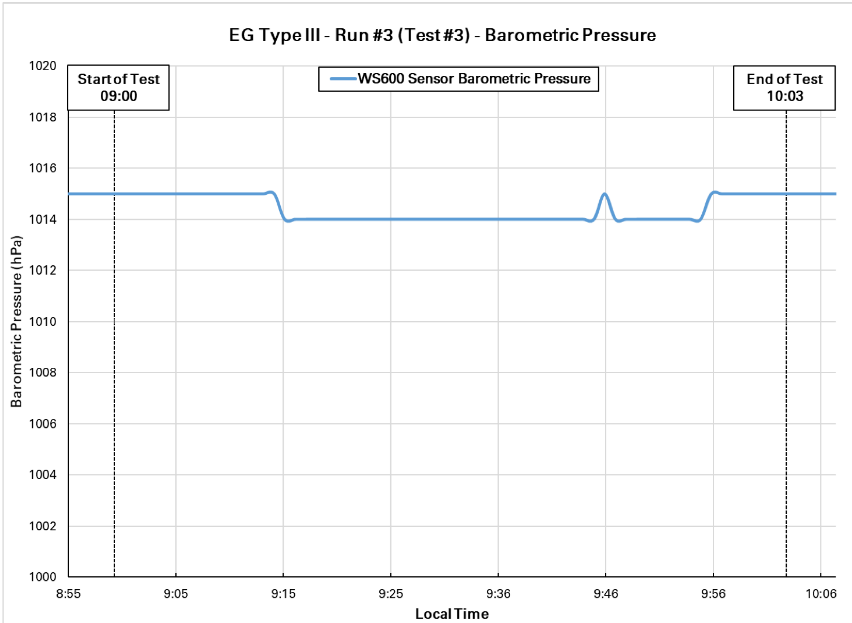


EG Type III - Run #3 (Test #3) - Relative Humidity
Start of Test 09:00
WS600 Sensor Relative Humidity
End of Test 10:03
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
8:55
9:05
9:15
9:25
9:36
9:46
9:56
10:06
Local Time



EG Type III - Run #3 (Test #3) - Fluid Brix Progression
Start of Test 09:00
Fluid Brix
End of Test 10:03
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
8:55
9:05
9:15
9:25
9:36
9:46
9:56
10:06
Local Time

DATA PACKAGE – EG TYPE III – RUN 3 (TEST 3)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 3 - Test 3/Data Package - EG Type III - Run 3 - Test 3.docx
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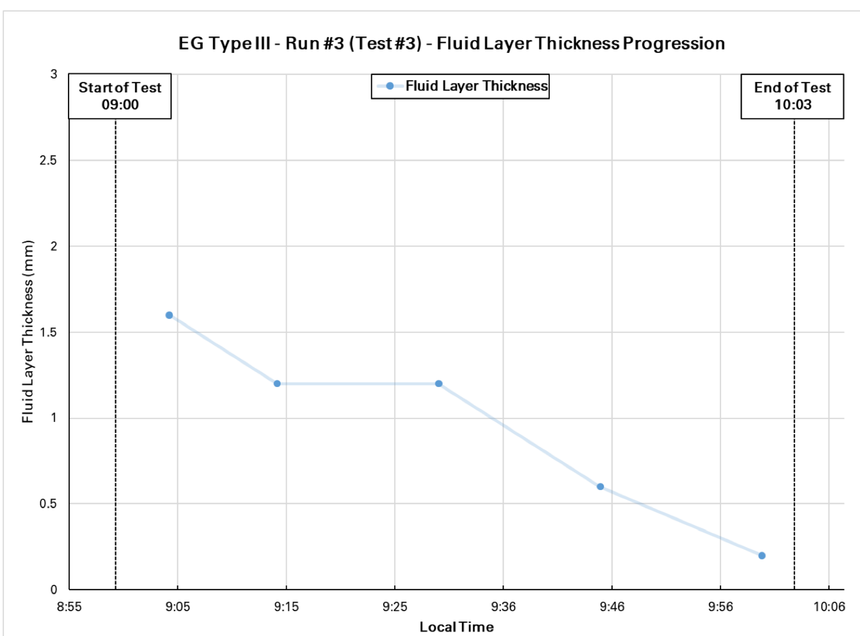
DATA PACKAGE – EG TYPE III – RUN 3 (TEST 3)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 3 - Test 3/Data Package - EG Type III - Run 3 - Test 3.docx
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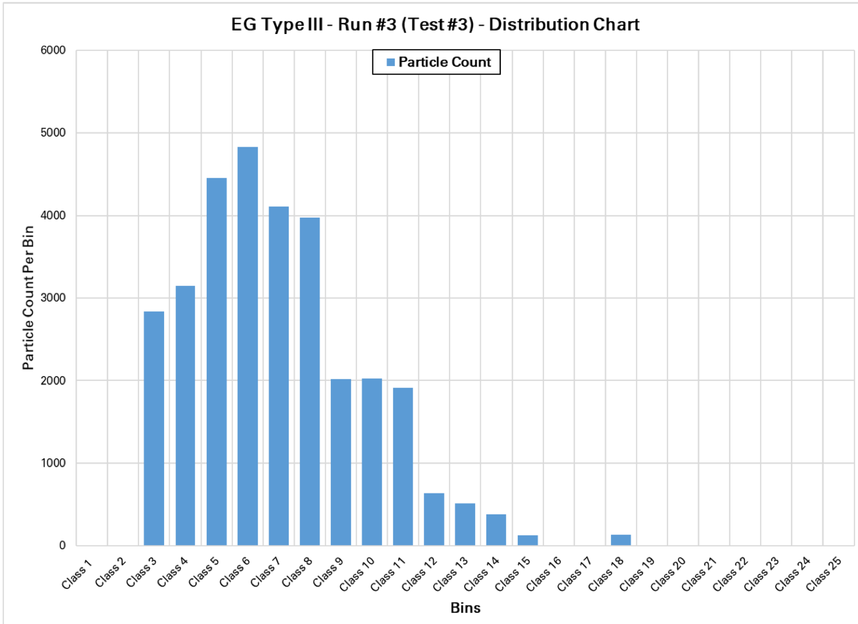
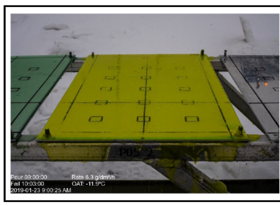
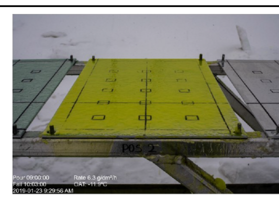
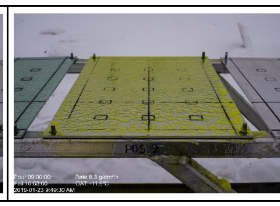
DATA PACKAGE – EG TYPE III – RUN 3 (TEST 3)

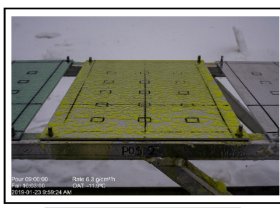


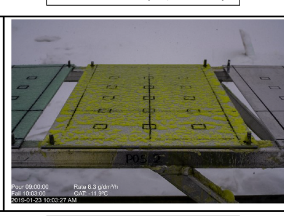
AeroClear MAX – Run 3 (Test 3) – Failure Progression Photos

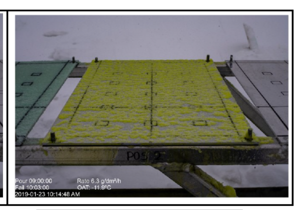

AT POUR (0/63 MIN)


PRE-FAILURE (29/63 MIN)

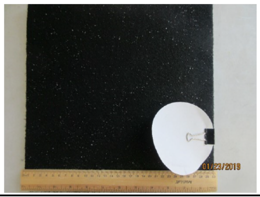

PRE-FAILURE (49/63 MIN)


PRE-FAILURE (59/63 MIN)

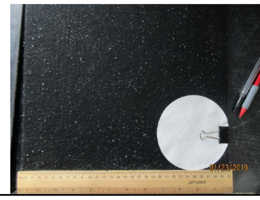

AT FAILURE (63/63 MIN)


POST-FAILURE (74/63 MIN)

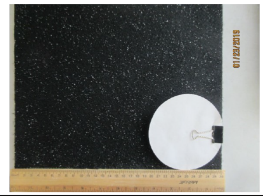
AeroClear MAX – Run 3 (Test 3) – Snow Characteristics Photos



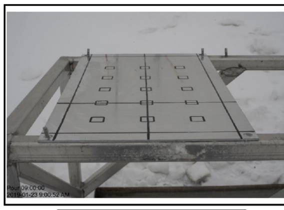
FELT PAD (12/63 MIN)



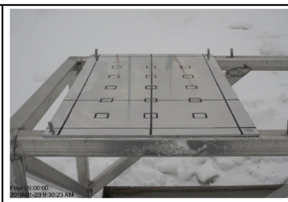
FELT PAD (39/63 MIN)



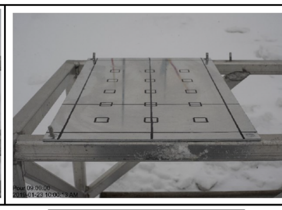
FELT PAD (59/63 MIN)



BARE PLATE (0/63 MIN)



BARE PLATE (30/63 MIN)



BARE PLATE (60/63 MIN)

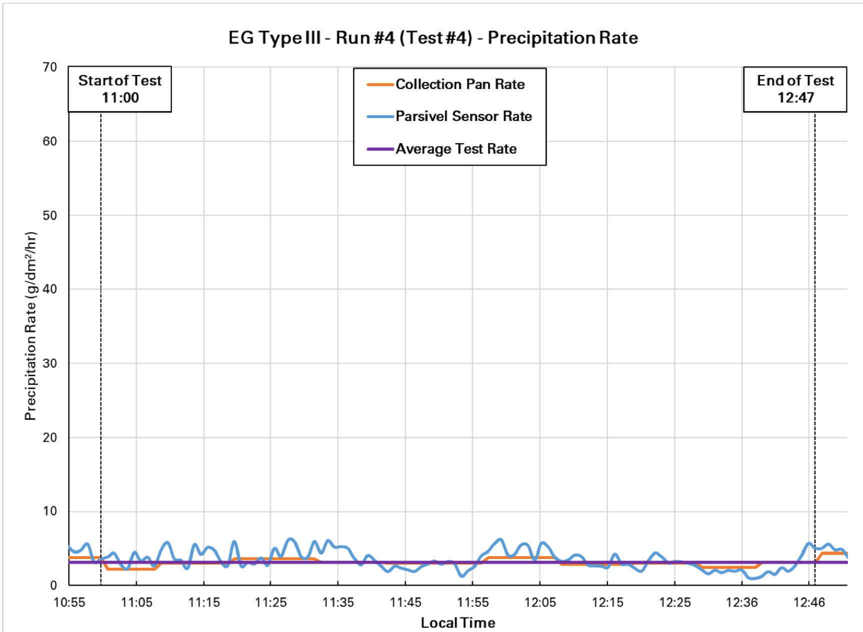
Final Bare Plate Contamination Thickness: **Not taken**

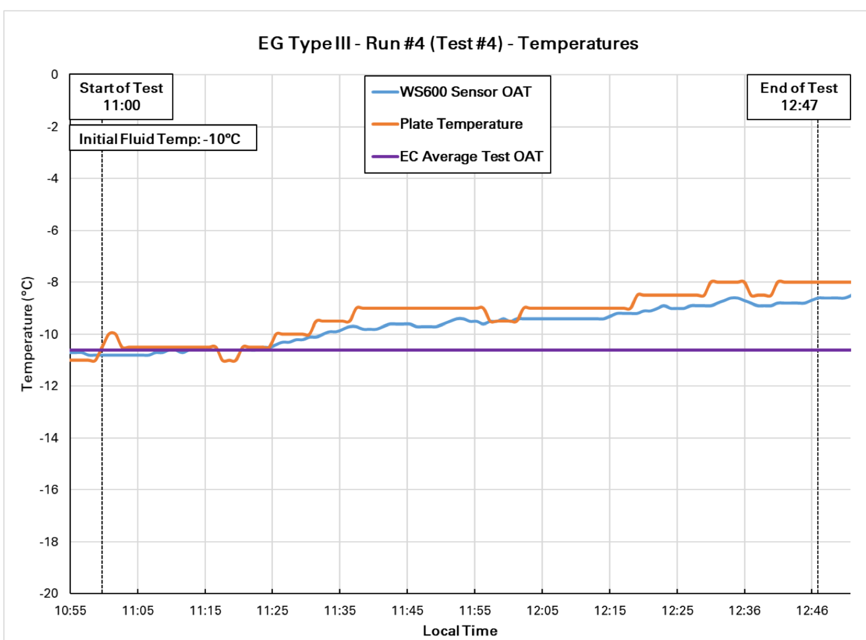
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #4 (TEST #4) – EG3-4

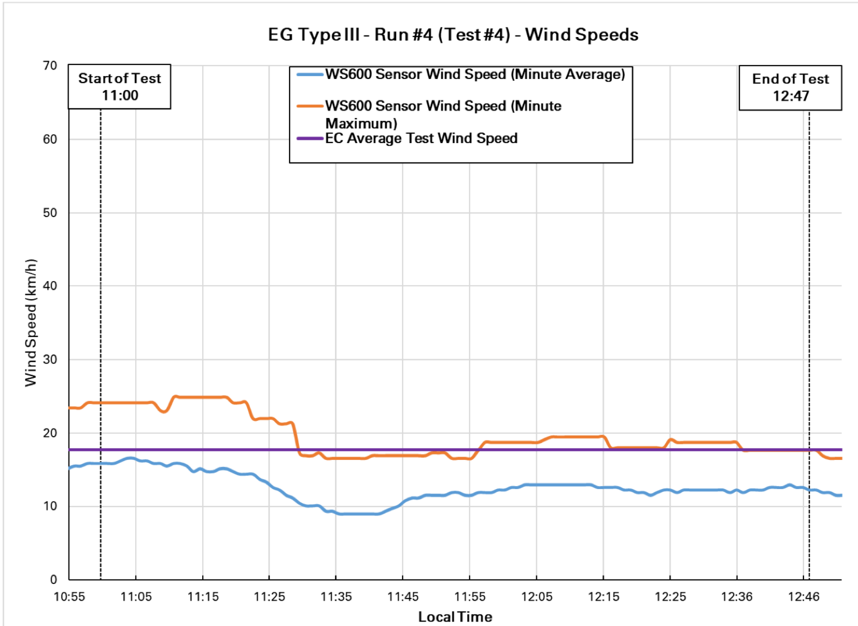
EG Type III – Run #4 (Test #4) – General Test Information

Test Number:	EG3-4
Date of Test:	January 23, 2019
Average OAT:	-10.6
Average Precipitation Rate:	3.1 g/dm²/h
Average Wind Speed:	17.7 km/h
Average Relative Humidity:	8.8%
Pour Time (Local):	11:00:00
Time of Fluid Failure (Local):	12:47:00
Fluid Brix at Failure:	12.25°
Endurance Time:	107 minutes
Expected Regression-Derived Endurance Time:	92.1 minutes
Difference (ET vs. Reg ET):	+14.9 minutes (+16.2%)


EG Type III - Run #4 (Test #4) - Precipitation Rate
Start of Test 11:00
End of Test 12:47
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
12:46
Local Time


EG Type III - Run #4 (Test #4) - Temperatures
Start of Test 11:00
Initial Fluid Temp: -10°C
End of Test 12:47
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
12:46
Local Time

DATA PACKAGE – EG TYPE III – RUN 4 (TEST 4)



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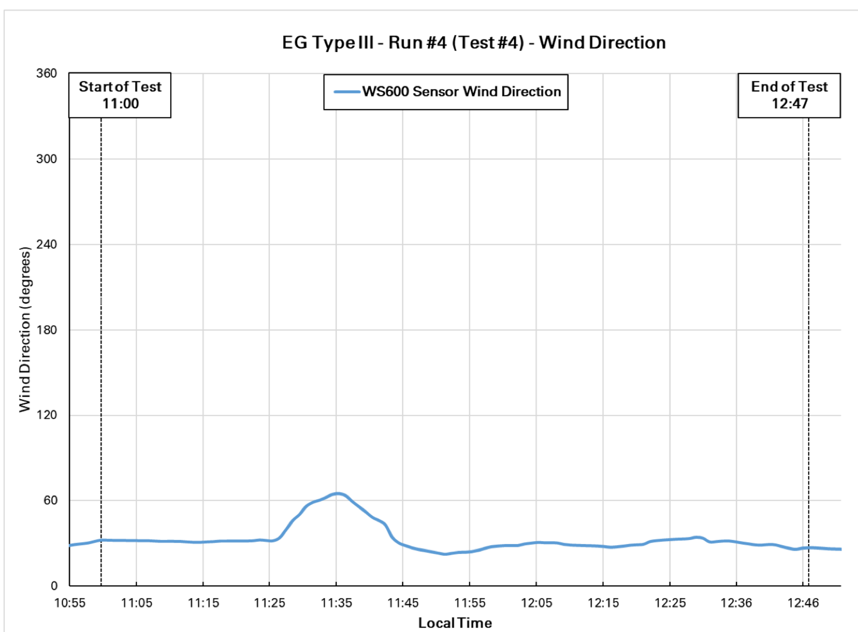
DATA PACKAGE – EG TYPE III – RUN 4 (TEST 4)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 4 - Test 4/Data Package - EG Type III - Run 4 - Test 4.docx
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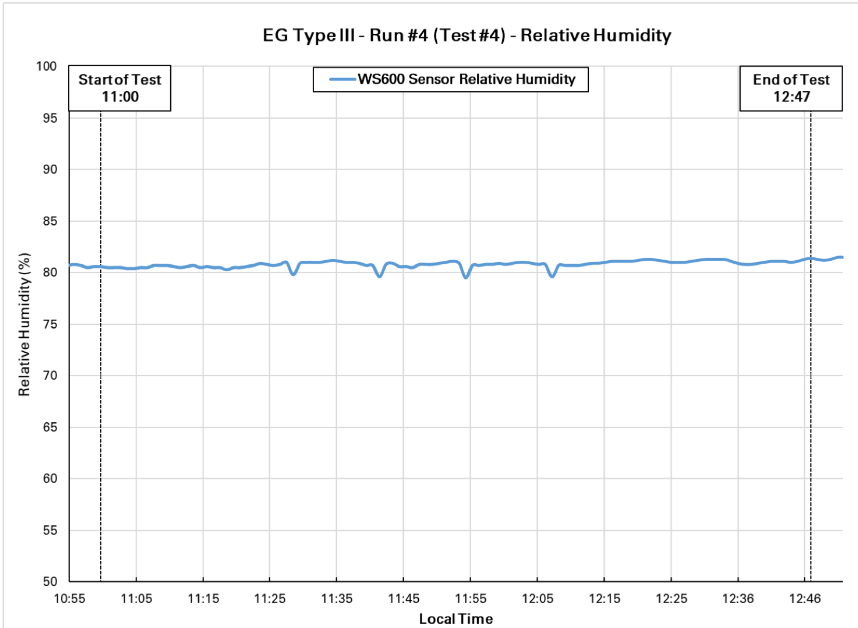
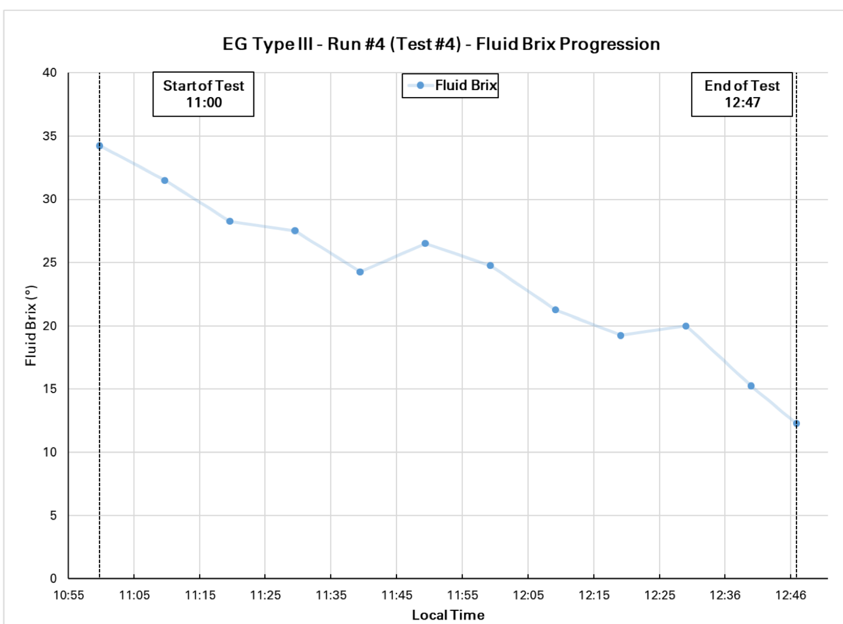
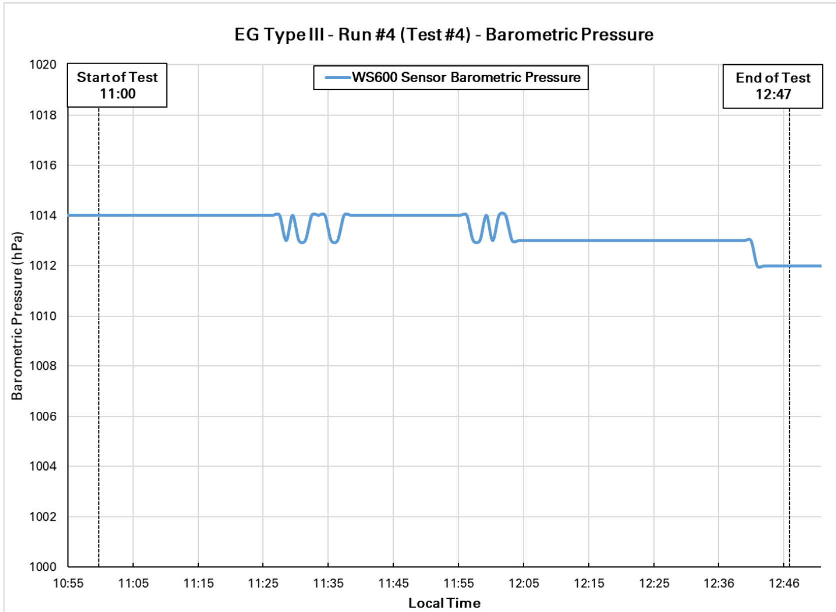
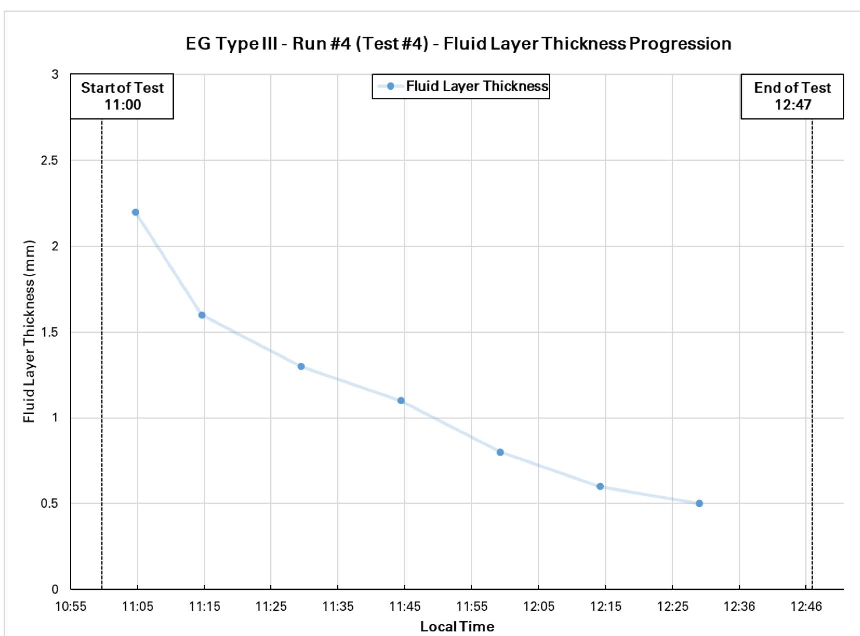
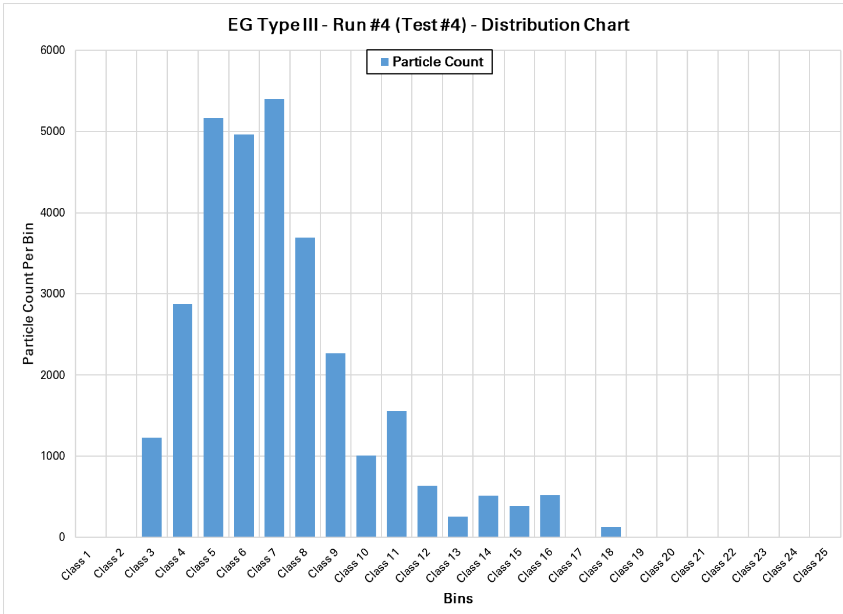

EG Type III - Run #4 (Test #4) - Relative Humidity
Start of Test 11:00
WS600 Sensor Relative Humidity
End of Test 12:47
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
12:46
Local Time

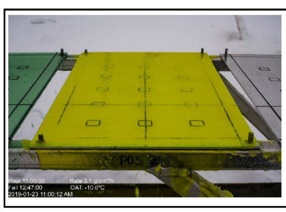

EG Type III - Run #4 (Test #4) - Fluid Brix Progression
Start of Test 11:00
Fluid Brix
End of Test 12:47
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
12:46
Local Time

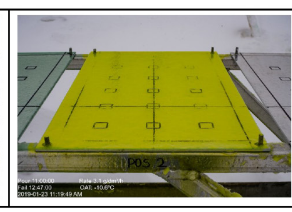

EG Type III - Run #4 (Test #4) - Barometric Pressure
Start of Test 11:00
WS600 Sensor Barometric Pressure
End of Test 12:47
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
12:46
Local Time

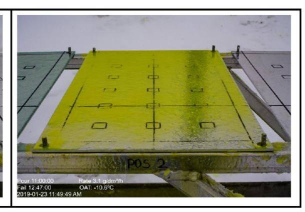

EG Type III - Run #4 (Test #4) - Fluid Layer Thickness Progression
Start of Test 11:00
Fluid Layer Thickness
End of Test 12:47
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
12:46
Local Time

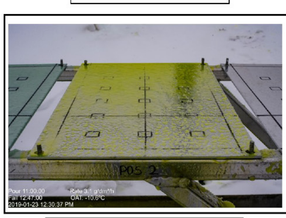


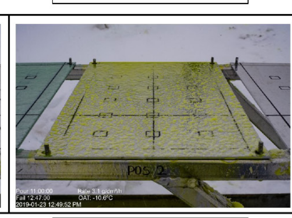
AeroClear MAX – Run 4 (Test 4) – Failure Progression Photos

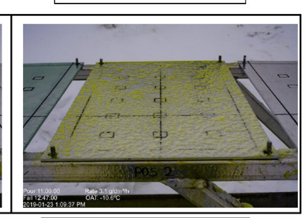

AT POUR (0/107 MIN)


PRE-FAILURE (20/107 MIN)

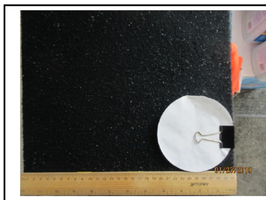

PRE-FAILURE (49/107 MIN)


PRE-FAILURE (90/107 MIN)

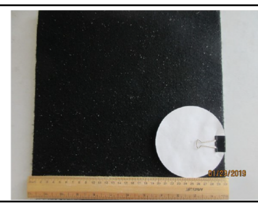

AT FAILURE (109/107 MIN)


POST-FAILURE (129/107 MIN)

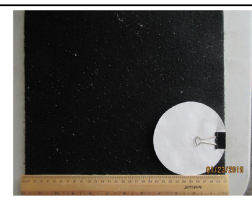
AeroClear MAX – Run 4 (Test 4) – Snow Characteristics Photos



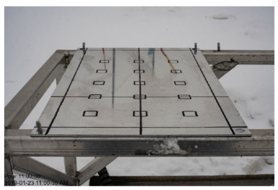
FELT PAD (29/107 MIN)



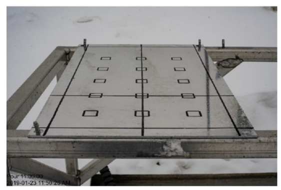
FELT PAD (60/107 MIN)



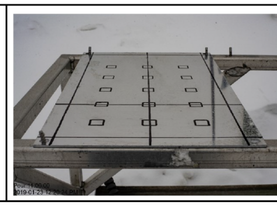
FELT PAD (100/107 MIN)



BARE PLATE (0/107 MIN)



BARE PLATE 50/107 MIN)



BARE PLATE (80/107 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

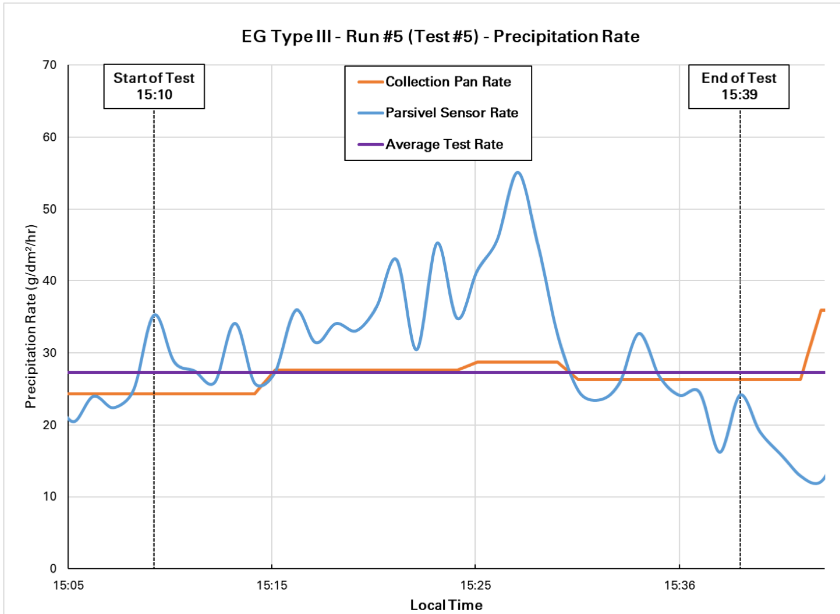
EG TYPE III
RUN #5 (TEST #5) – EG3-5

DATA PACKAGE – EG TYPE III – RUN 5 (TEST 5)

EG Type III – Run #5 (Test #5) – General Test Information

Test Number:	**EG3-5**
Date of Test:	**January 23, 2019**
Average OAT:	**-8.6**
Average Precipitation Rate:	**27.3 g/dm²/h**
Average Wind Speed:	**18.0 km/h**
Average Relative Humidity:	**85.1%**
Pour Time (Local):	**15:10:00**
Time of Fluid Failure (Local):	**15:39:00**
Fluid Brix at Failure:	**16°**
Endurance Time:	**29 minutes**
Expected Regression-Derived Endurance Time:	**22.1 minutes**
Difference (ET vs. Reg ET):	**+6.9 minutes (+31.5%)**

DATA PACKAGE – EG TYPE III – RUN 5 (TEST 5)



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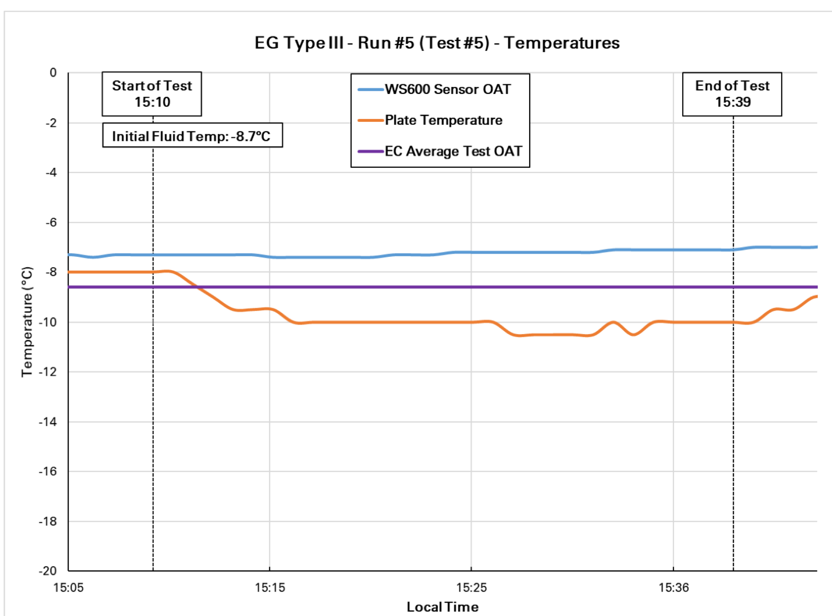
DATA PACKAGE – EG TYPE III – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 5 - Test 5/Data Package - EG Type III - Run 5 - Test 5.docx
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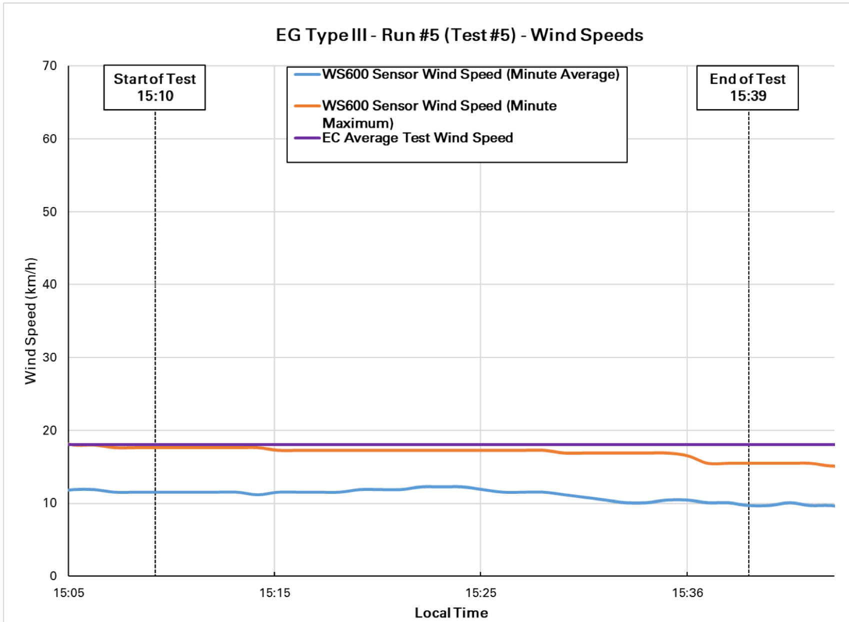
DATA PACKAGE – EG TYPE III – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 5 - Test 5/Data Package - EG Type III - Run 5 - Test 5.docx
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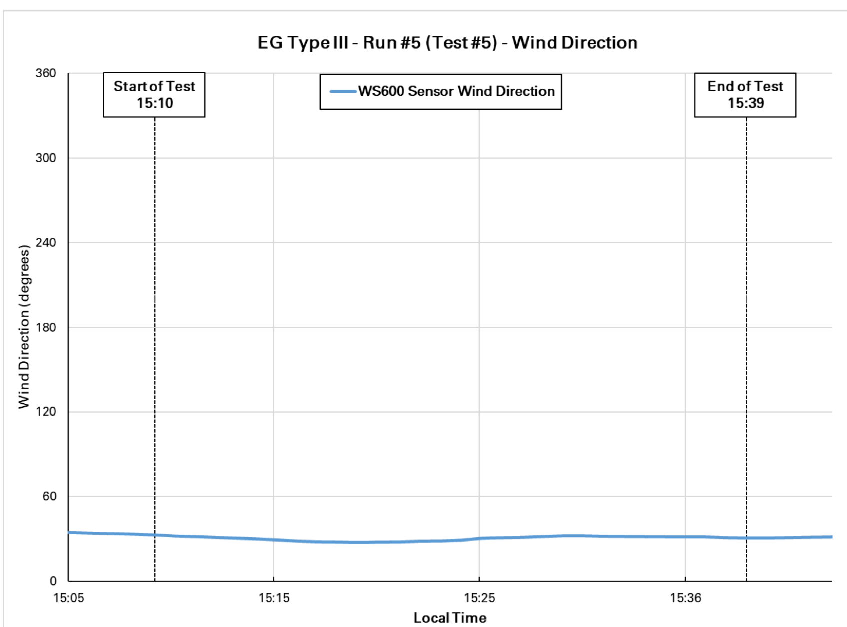
DATA PACKAGE – EG TYPE III – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 5 - Test 5/Data Package - EG Type III - Run 5 - Test 5.docx
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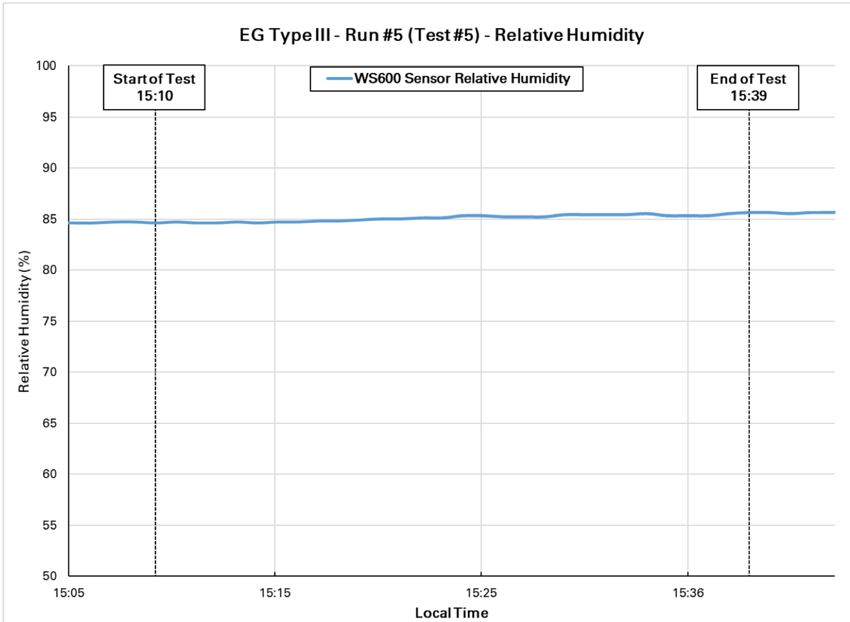
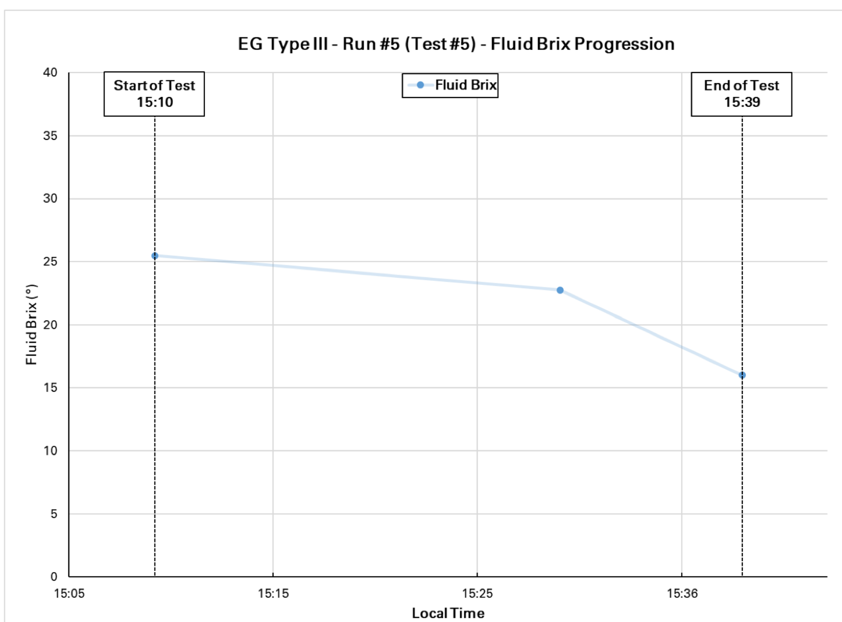
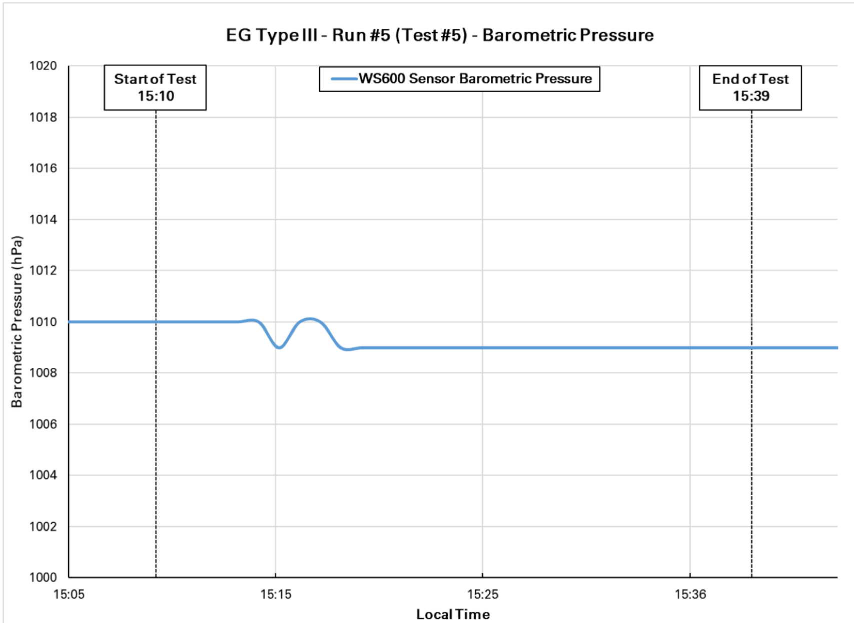
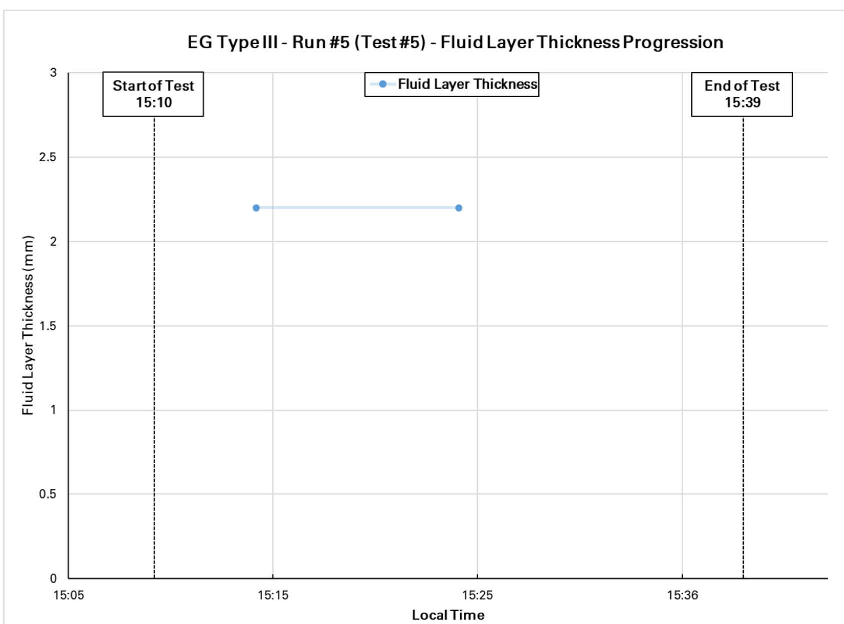


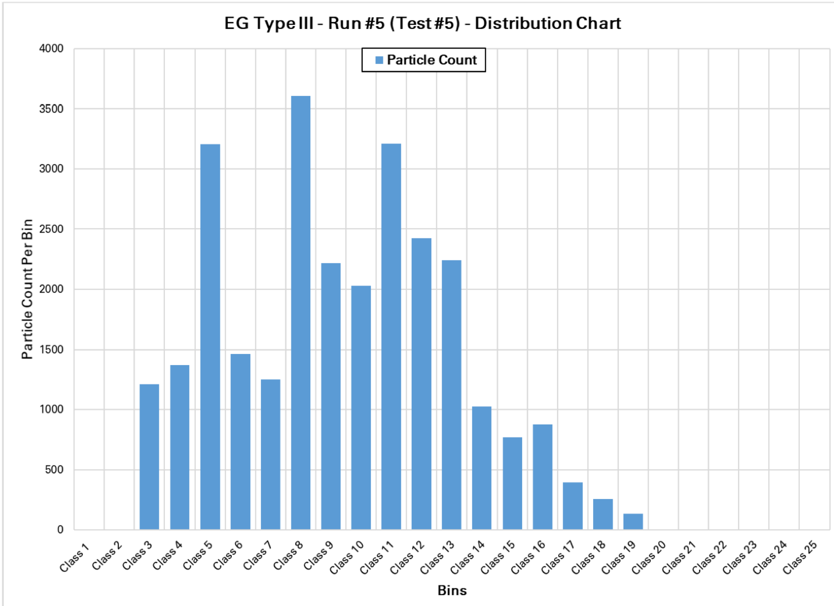
EG Type III - Run #5 (Test #5) - Relative Humidity
Start of Test 15:10
WS600 Sensor Relative Humidity
End of Test 15:39
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
15:05
15:15
15:25
15:36
Local Time



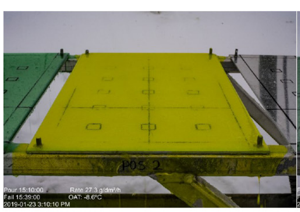
EG Type III - Run #5 (Test #5) - Fluid Brix Progression
Start of Test 15:10
Fluid Brix
End of Test 15:39
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
15:05
15:15
15:25
15:36
Local Time


EG Type III - Run #5 (Test #5) - Barometric Pressure
Start of Test
15:10
WS600 Sensor Barometric Pressure
End of Test
15:39
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
Barometric Pressure (hPa)
15:05
15:15
15:25
15:36
Local Time

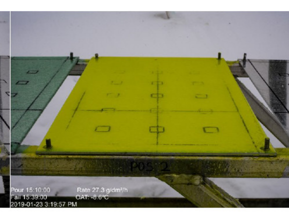

EG Type III - Run #5 (Test #5) - Fluid Layer Thickness Progression
Start of Test
15:10
Fluid Layer Thickness
End of Test
15:39
3
2.5
2
1.5
1
0.5
0
Fluid Layer Thickness (mm)
15:05
15:15
15:25
15:36
Local Time



AeroClear MAX – Run 5 (Test 5) – Failure Progression Photos

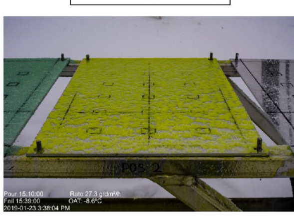


AT POUR (0/29 MIN)

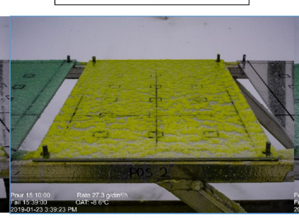


PRE-FAILURE (10/29 MIN)

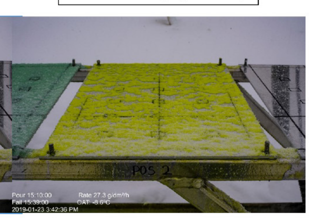
PRE-FAILURE (19/29 MIN)



PRE-FAILURE (28/29 MIN)

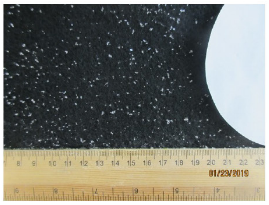


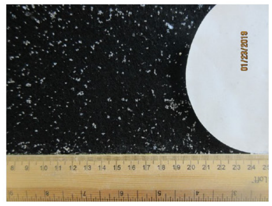
AT FAILURE (29/29 MIN)

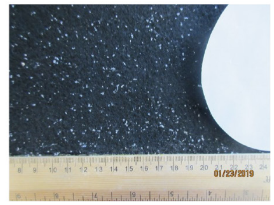


POST-FAILURE (32/29 MIN)

AeroClear MAX – Run 5 (Test 5) – Snow Characteristics Photos


FELT PAD (0/29 MIN)


FELT PAD (26/29 MIN)


FELT PAD (36/29 MIN)


BARE PLATE (0/29 MIN)


BARE PLATE (10/29 MIN)


BARE PLATE (21/29 MIN)

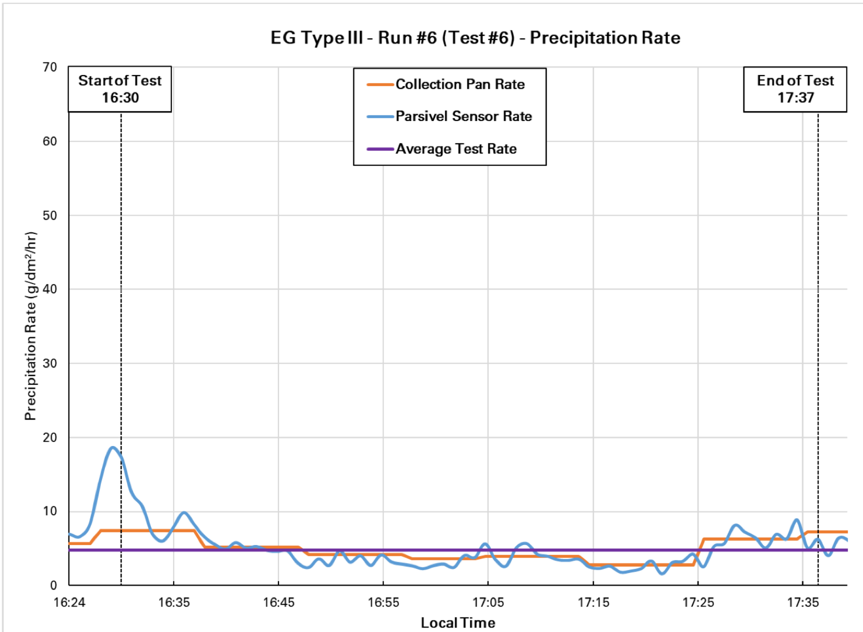
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

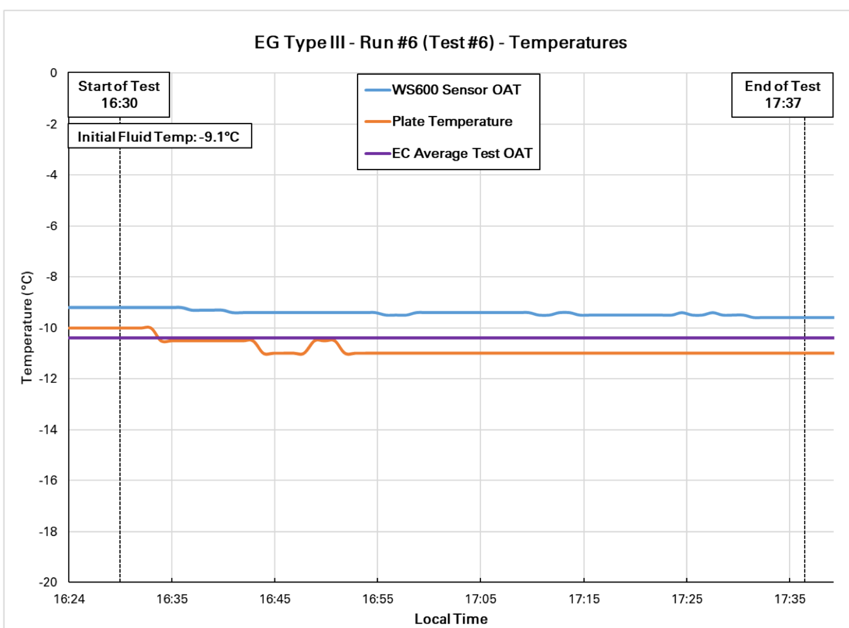
EG TYPE III
RUN #6 (TEST #6) – EG3-6

EG Type III – Run #6 (Test #6) – General Test Information

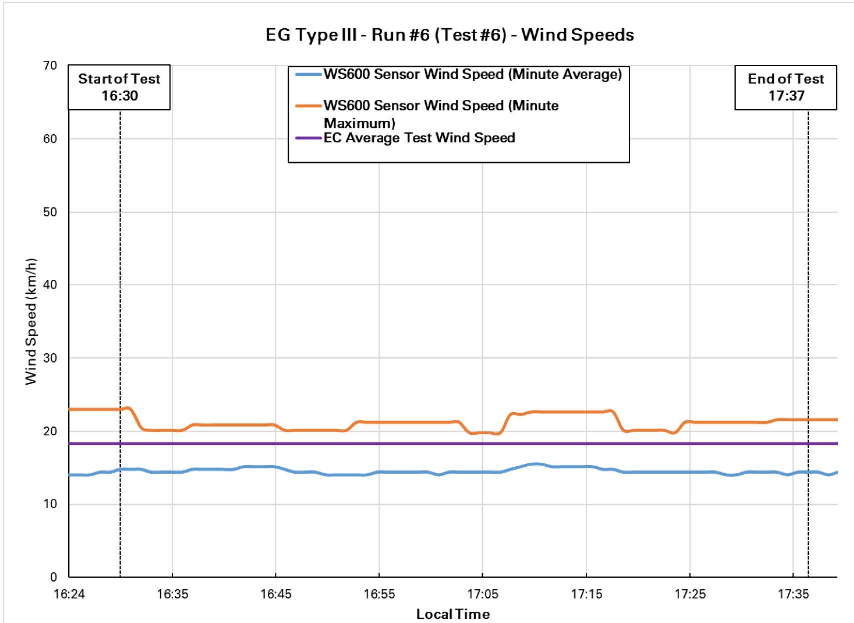
Test Number:	**EG3-6**
Date of Test:	**January 29, 2019**
Average OAT:	**-10.4**
Average Precipitation Rate:	**4.8 g/dm²/h**
Average Wind Speed:	**18.3 km/h**
Average Relative Humidity:	**82.7%**
Pour Time (Local):	**16:30:00**
Time of Fluid Failure (Local):	**17:37:00**
Fluid Brix at Failure:	**15°**
Endurance Time:	**67 minutes**
Expected Regression-Derived Endurance Time:	**69.3 minutes**
Difference (ET vs. Reg ET):	**-2.3 minutes (-3.3%)**

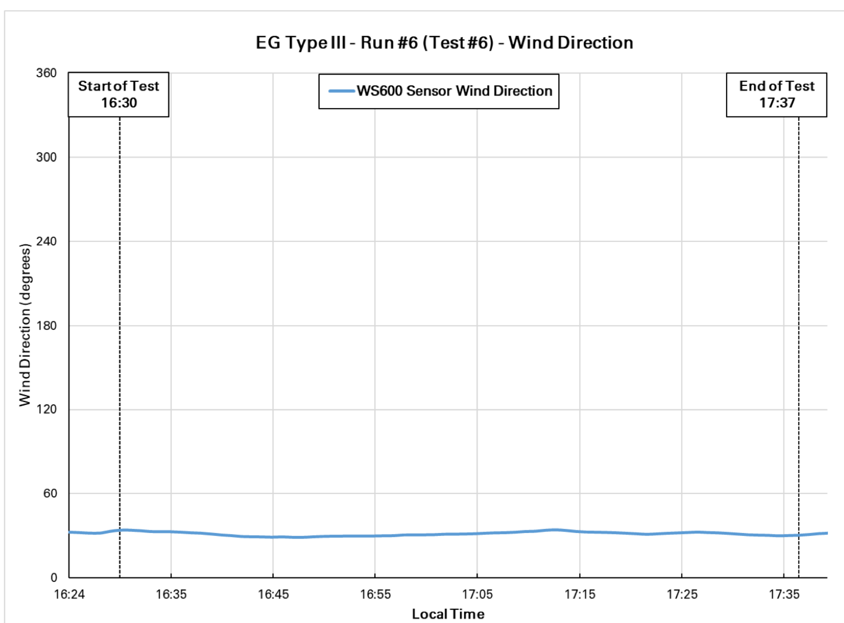


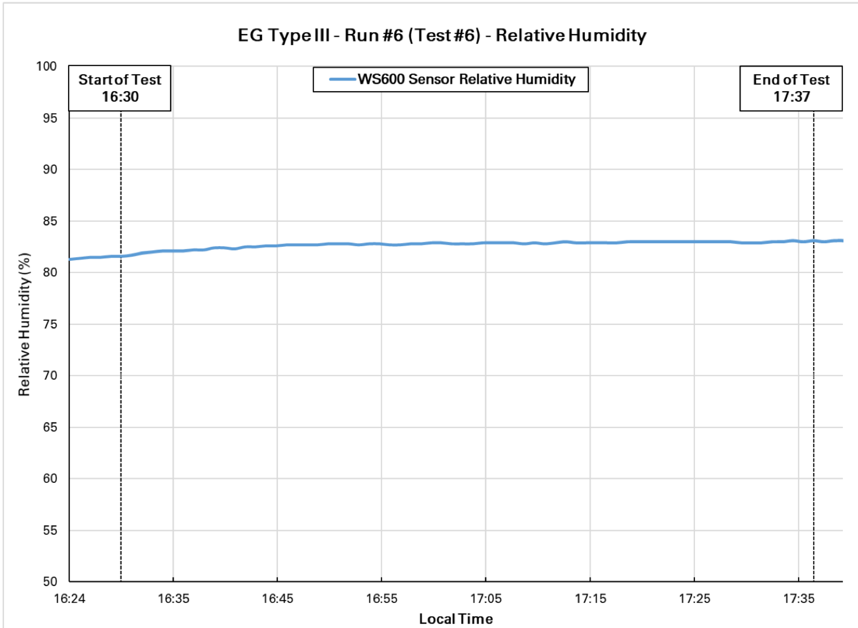
EG Type III - Run #6 (Test #6) - Precipitation Rate
Start of Test
16:30
End of Test
17:37
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time



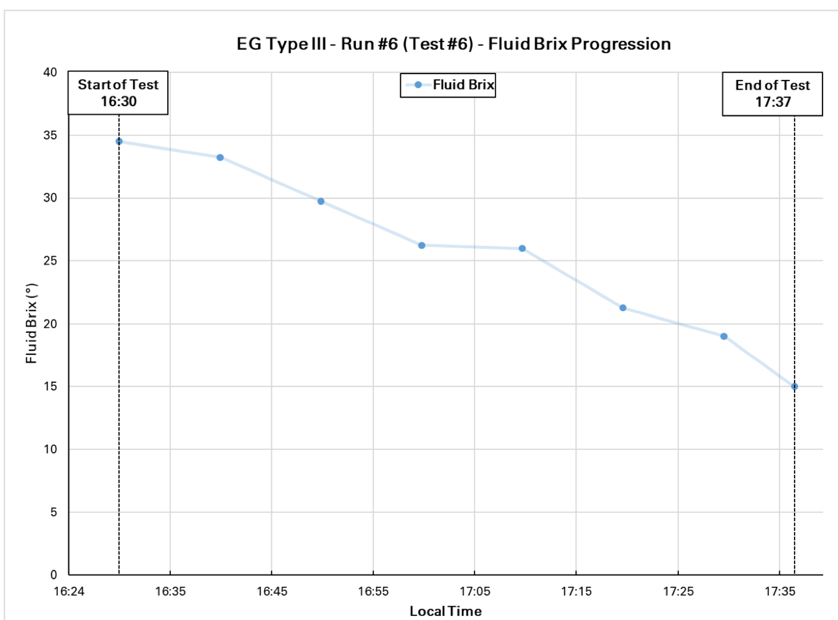
EG Type III - Run #6 (Test #6) - Temperatures
Start of Test
16:30
Initial Fluid Temp: -9.1°C
End of Test
17:37
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time


EG Type III - Run #6 (Test #6) - Wind Speeds
Start of Test 16:30
End of Test 17:37
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time

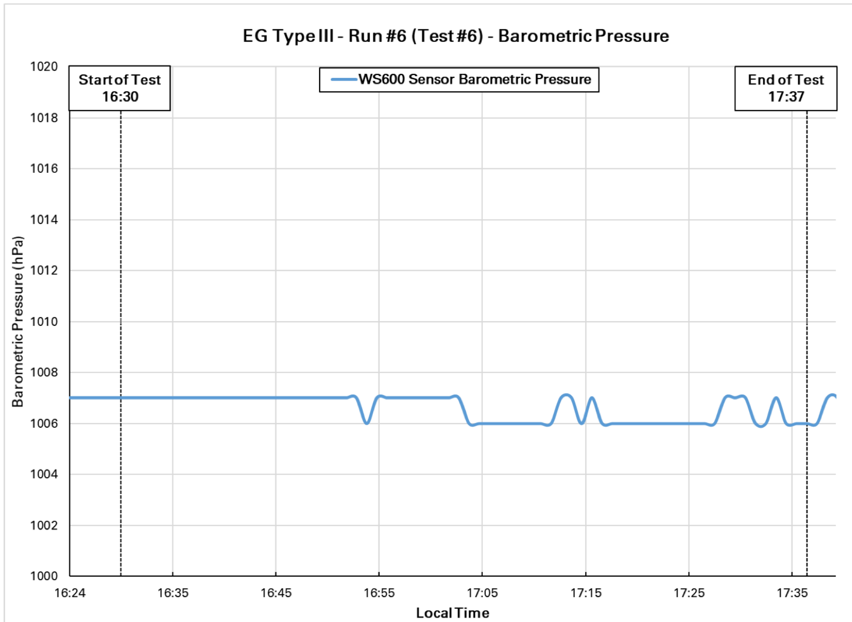

EG Type III - Run #6 (Test #6) - Wind Direction
Start of Test 16:30
End of Test 17:37
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
Local Time



DATA PACKAGE – EG TYPE III – RUN 6 (TEST 6)



DATA PACKAGE – EG TYPE III – RUN 6 (TEST 6)



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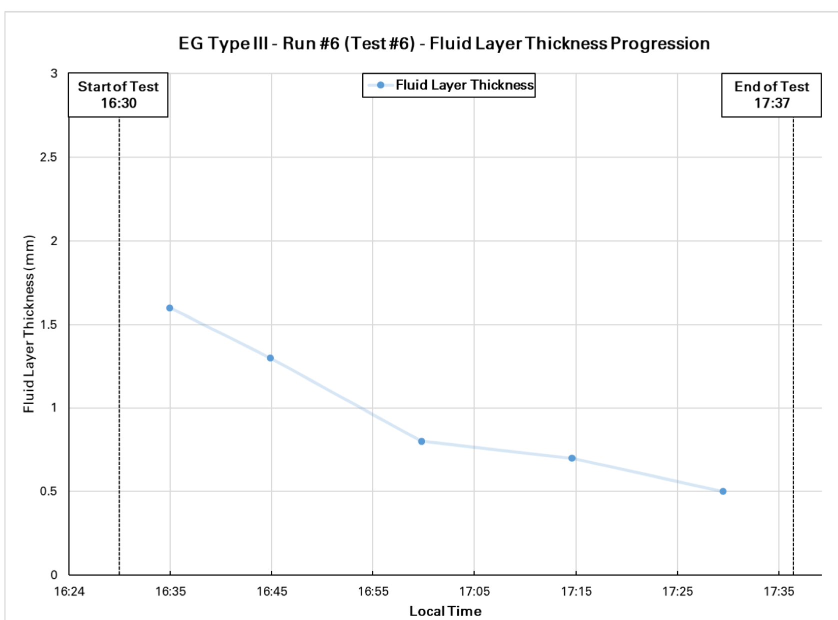
DATA PACKAGE – EG TYPE III – RUN 6 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 6 - Test 6/Data Package - EG Type III - Run 6 - Test 6.docx
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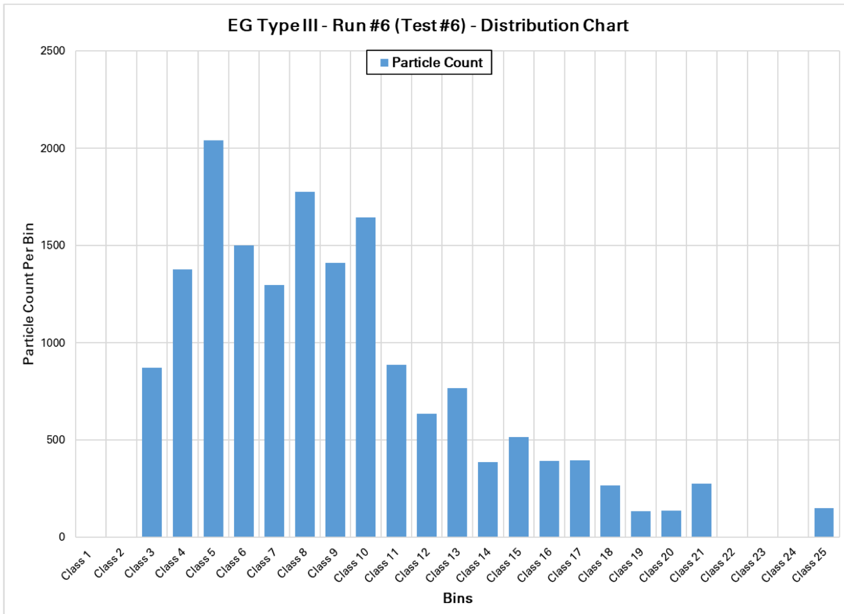
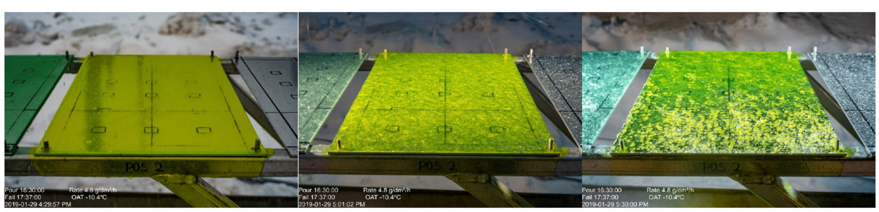
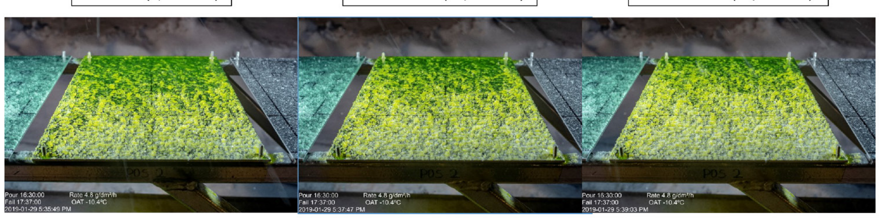


AeroClear MAX – Run 6 (Test 6) – Failure Progression Photos



AT POUR (0/67 MIN) | PRE-FAILURE (31/67 MIN) | PRE-FAILURE (60/67 MIN)



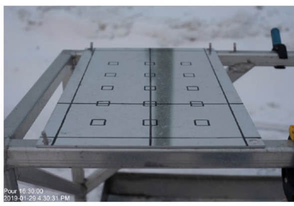
PRE-FAILURE (65/67 MIN) | AT FAILURE (67/67 MIN) | POST-FAILURE (69/67 MIN)

AeroClear MAX – Run 6 (Test 6) – Snow Characteristics Photos

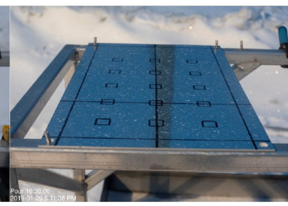
FELT PAD (1/67 MIN)

FELT PAD (40/67 MIN)

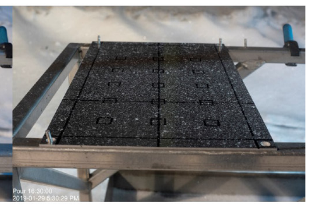
FELT PAD (70/67 MIN)



BARE PLATE (0/67 MIN)



BARE PLATE (41/67 MIN)



BARE PLATE (60/67 MIN)

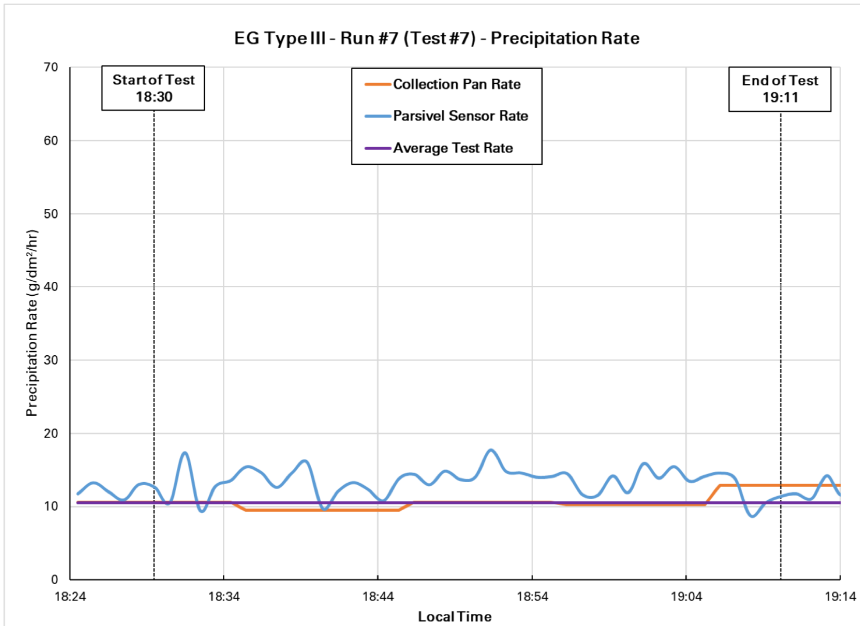
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

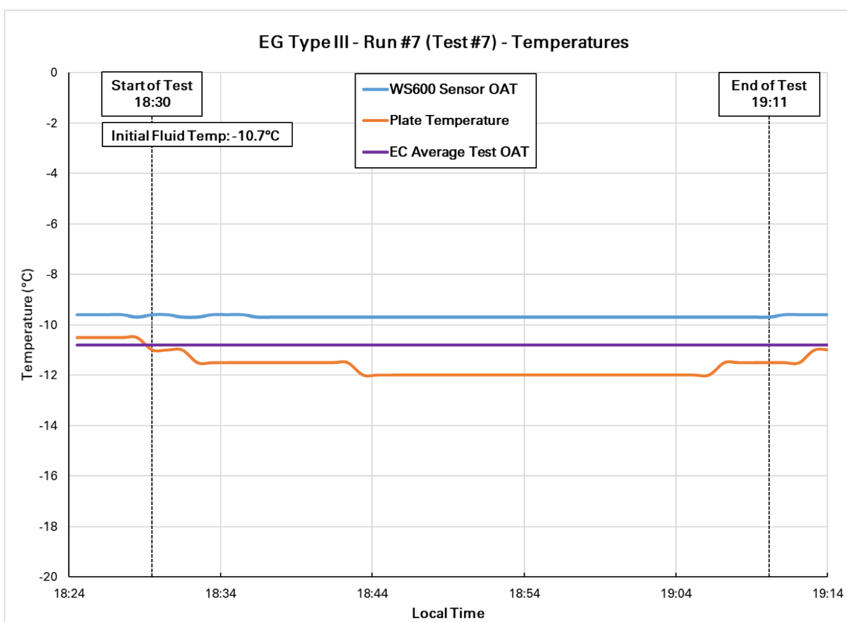
EG TYPE III
RUN #7 (TEST #7) – EG3-7

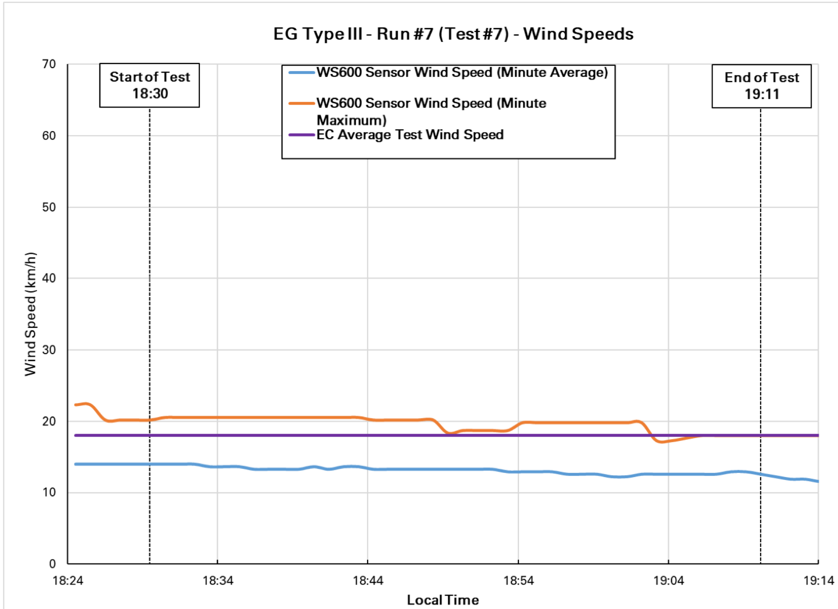
EG Type III – Run #7 (Test #7) – General Test Information

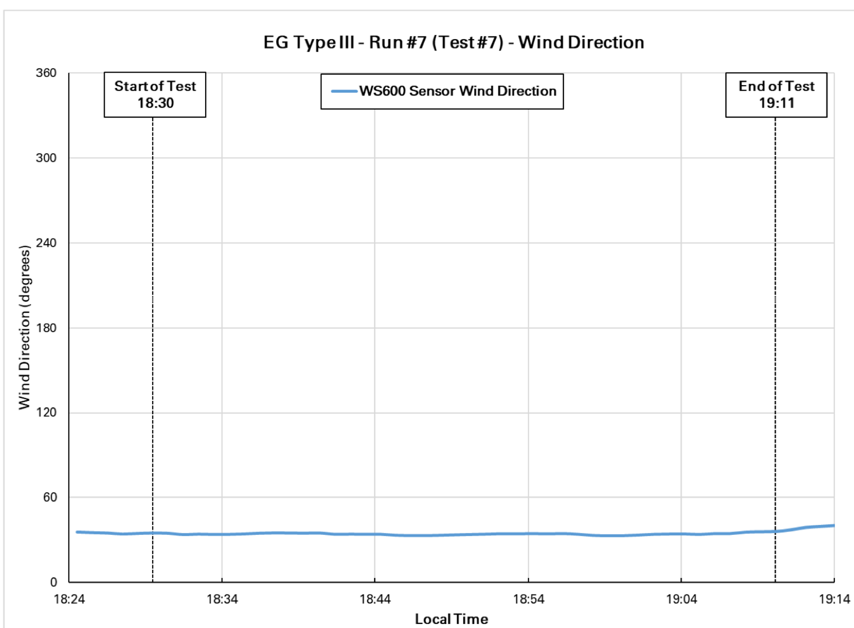
Test Number:	EG3-7
Date of Test:	January 29, 2019
Average OAT:	-10.8
Average Precipitation Rate:	10.5 g/dm²/h
Average Wind Speed:	18 km/h
Average Relative Humidity:	82.9%
Pour Time (Local):	18:30:00
Time of Fluid Failure (Local):	19:11:00
Fluid Brix at Failure:	16.25°
Endurance Time:	41 minutes
Expected Regression-Derived Endurance Time:	41.3 minutes
Difference (ET vs. Reg ET):	-0.3 minutes (-0.7%)

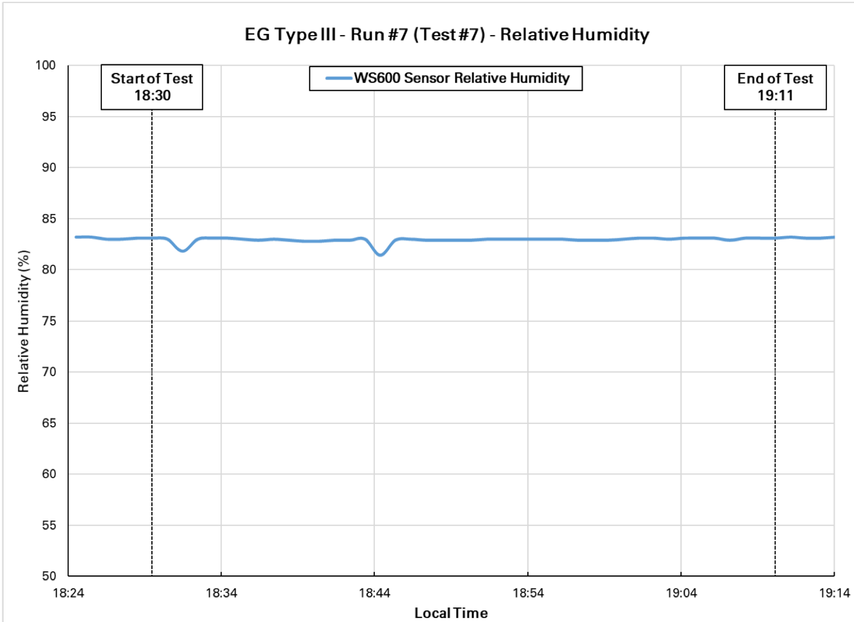


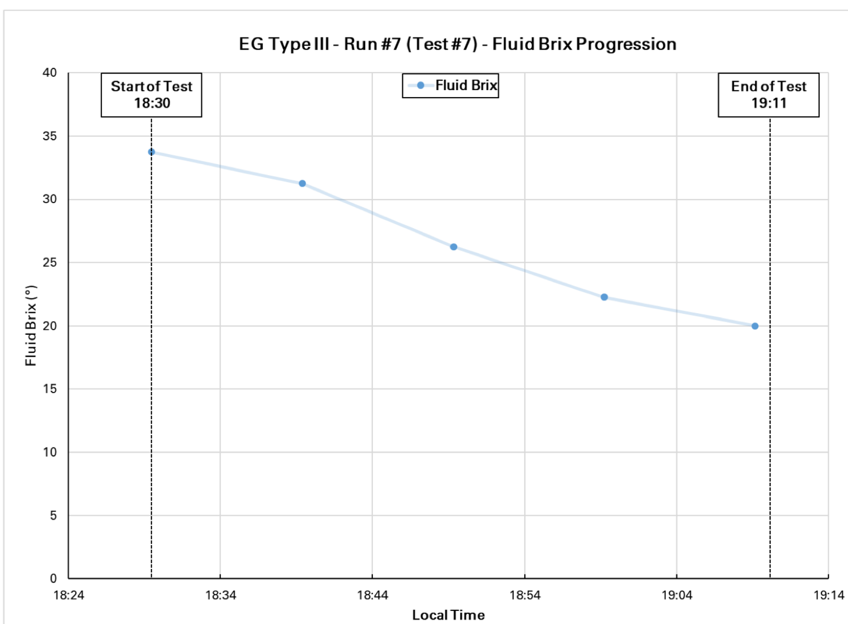
DATA PACKAGE – EG TYPE III – RUN 7 (TEST 7)

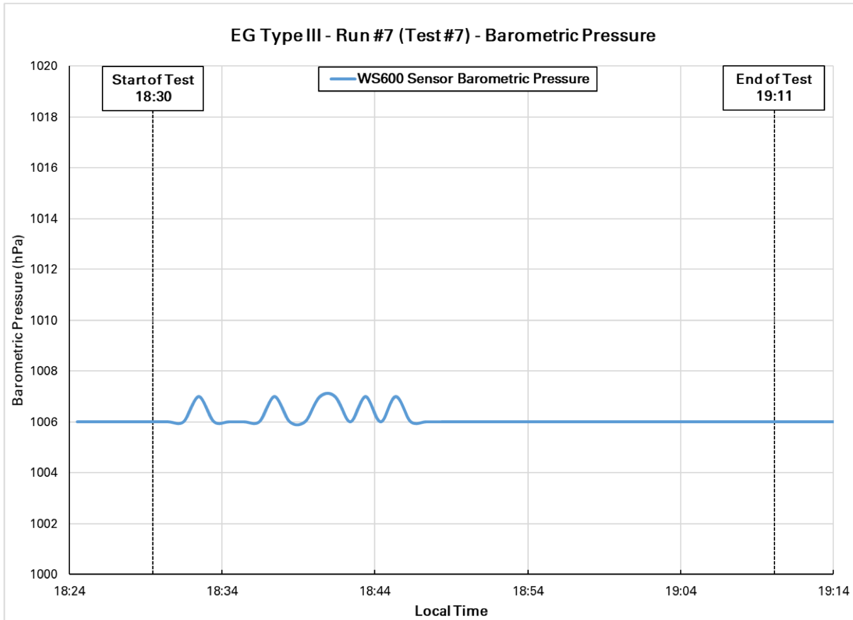


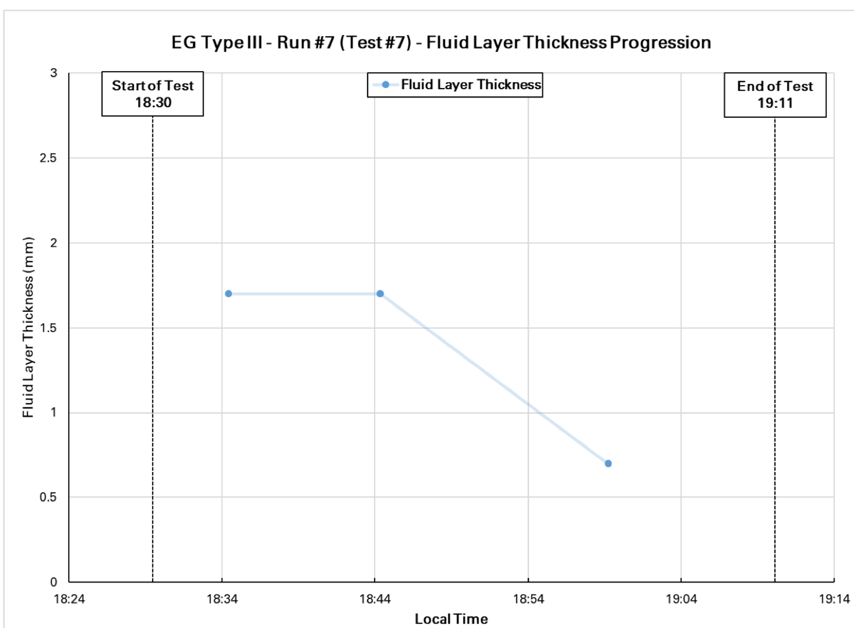

EG Type III - Run #7 (Test #7) - Wind Speeds
Start of Test 18:30
End of Test 19:11
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
18:24
18:34
18:44
18:54
19:04
19:14
Local Time

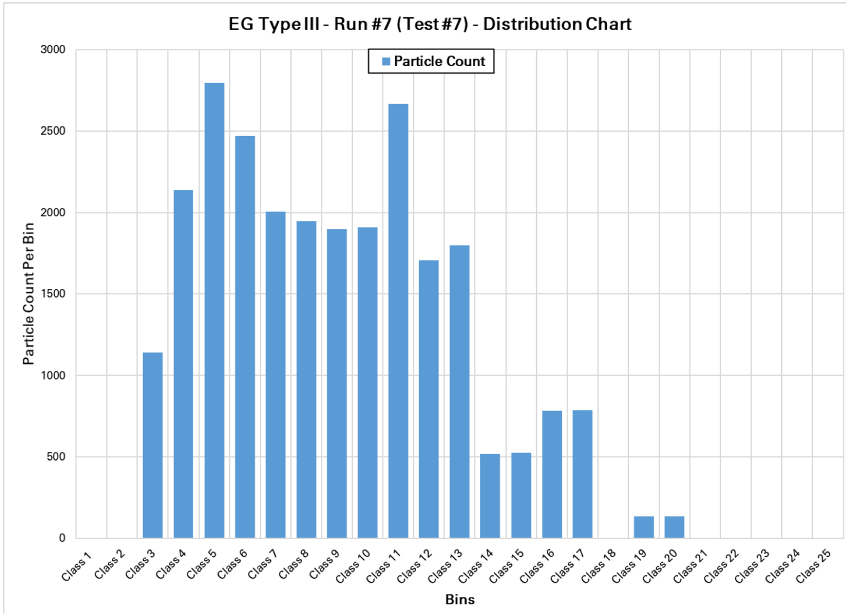

EG Type III - Run #7 (Test #7) - Wind Direction
Start of Test 18:30
End of Test 19:11
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
18:24
18:34
18:44
18:54
19:04
19:14
Local Time


EG Type III - Run #7 (Test #7) - Relative Humidity
Start of Test 18:30
WS600 Sensor Relative Humidity
End of Test 19:11
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
18:24
18:34
18:44
18:54
19:04
19:14
Local Time

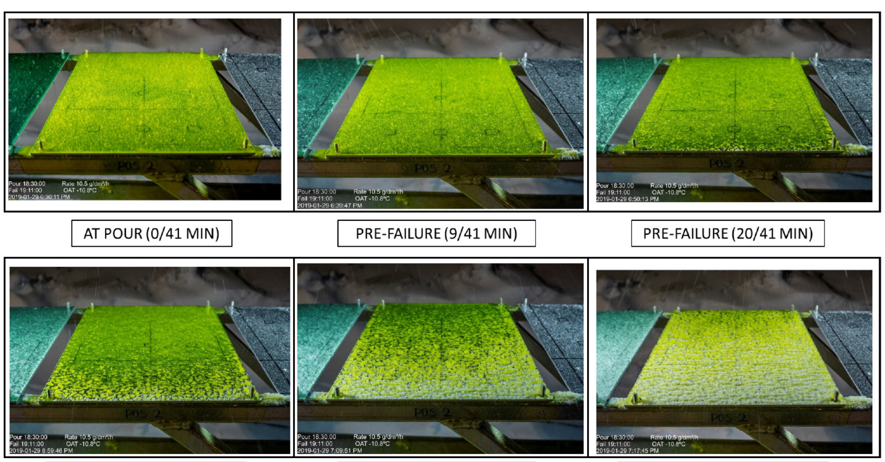

EG Type III - Run #7 (Test #7) - Fluid Brix Progression
Start of Test 18:30
Fluid Brix
End of Test 19:11
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
18:24
18:34
18:44
18:54
19:04
19:14
Local Time


EG Type III - Run #7 (Test #7) - Barometric Pressure
Start of Test
18:30
WS600 Sensor Barometric Pressure
End of Test
19:11
Barometric Pressure (hPa)
1000
1002
1004
1006
1008
1010
1012
1014
1016
1018
1020
18:24
18:34
18:44
18:54
19:04
19:14
Local Time


EG Type III - Run #7 (Test #7) - Fluid Layer Thickness Progression
Start of Test
18:30
Fluid Layer Thickness
End of Test
19:11
Fluid Layer Thickness (mm)
0
0.5
1
1.5
2
2.5
3
18:24
18:34
18:44
18:54
19:04
19:14
Local Time



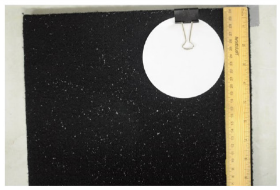
AeroClear MAX – Run 7 (Test 7) – Failure Progression Photos



AT POUR (0/41 MIN) | PRE-FAILURE (9/41 MIN) | PRE-FAILURE (20/41 MIN)

PRE-FAILURE (30/41 MIN) | AT FAILURE (40/41 MIN) | POST-FAILURE (47/41 MIN)

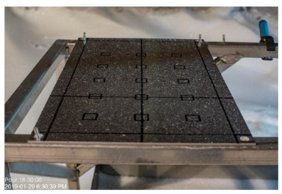
AeroClear MAX – Run 7 (Test 7) – Snow Characteristics Photos



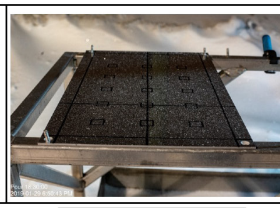
FELT PAD (0/41 MIN)

FELT PAD (10/41 MIN)

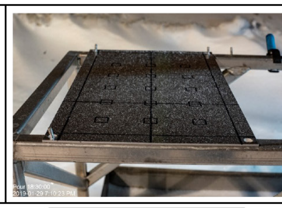
FELT PAD (30/41 MIN)



BARE PLATE (30/41 MIN)



BARE PLATE (20/41 MIN)



BARE PLATE (40/41 MIN)

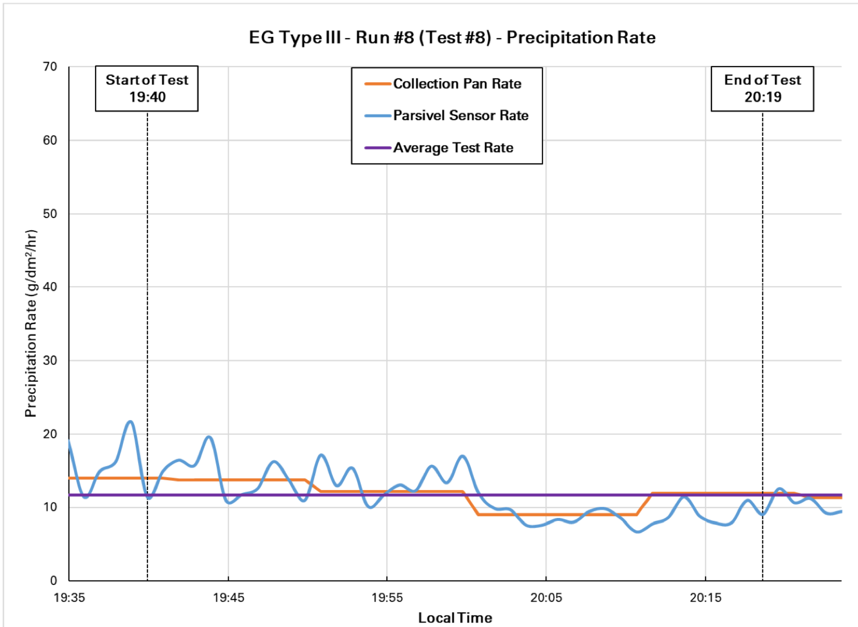
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

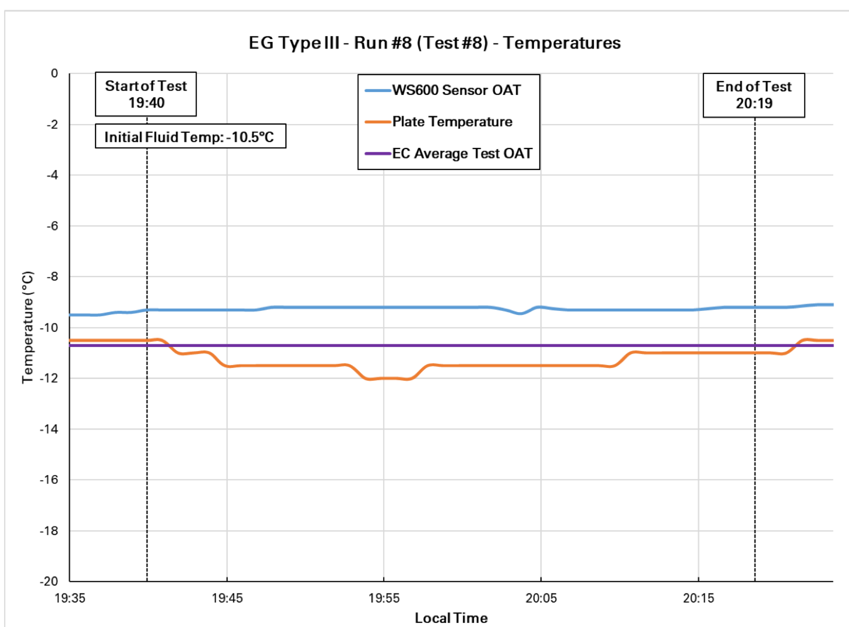
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

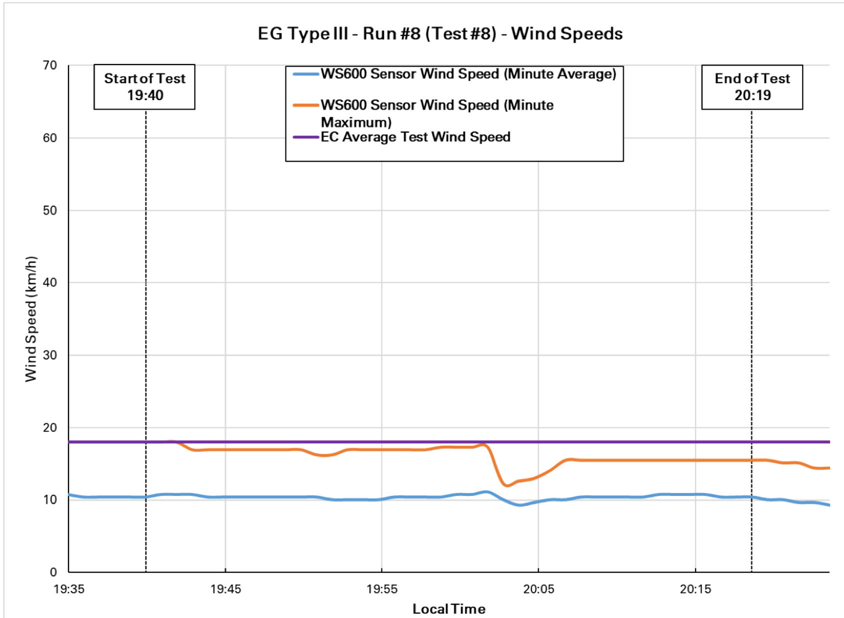
EG TYPE III
RUN #8 (TEST #8) – EG3-8

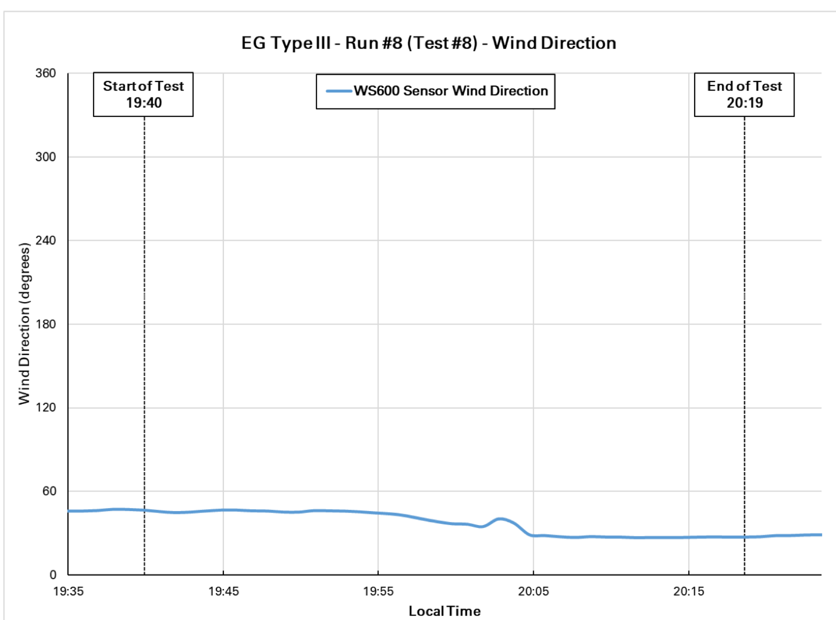
EG Type III – Run #8 (Test #8) – General Test Information

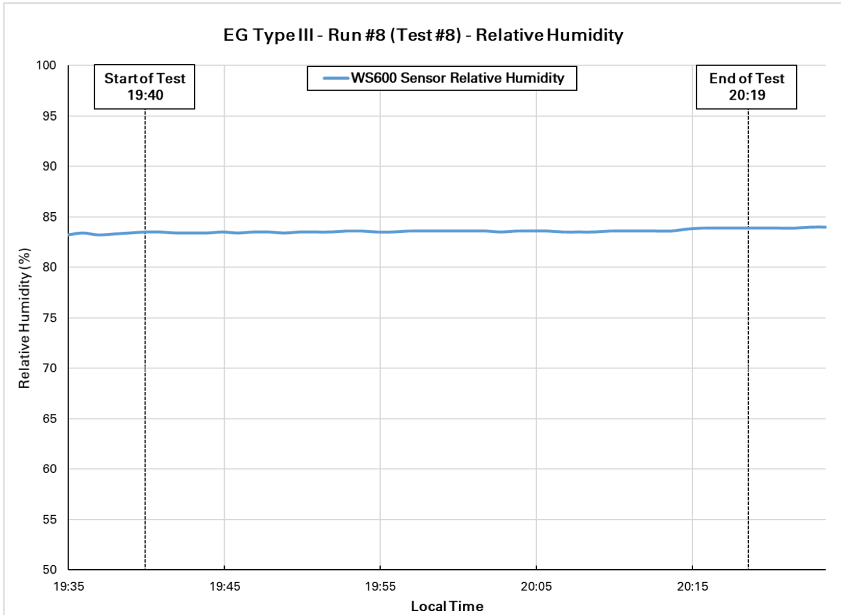
Test Number:	EG3-8
Date of Test:	January 29, 2019
Average OAT:	-10.7
Average Precipitation Rate:	11.7 g/dm²/h
Average Wind Speed:	18 km/h
Average Relative Humidity:	83.5%
Pour Time (Local):	19:40:00
Time of Fluid Failure (Local):	20:19:00
Fluid Brix at Failure:	14.5°
Endurance Time:	39 minutes
Expected Regression-Derived Endurance Time:	38.5 minutes
Difference (ET vs. Reg ET):	+0.5 minutes (+1.3%)

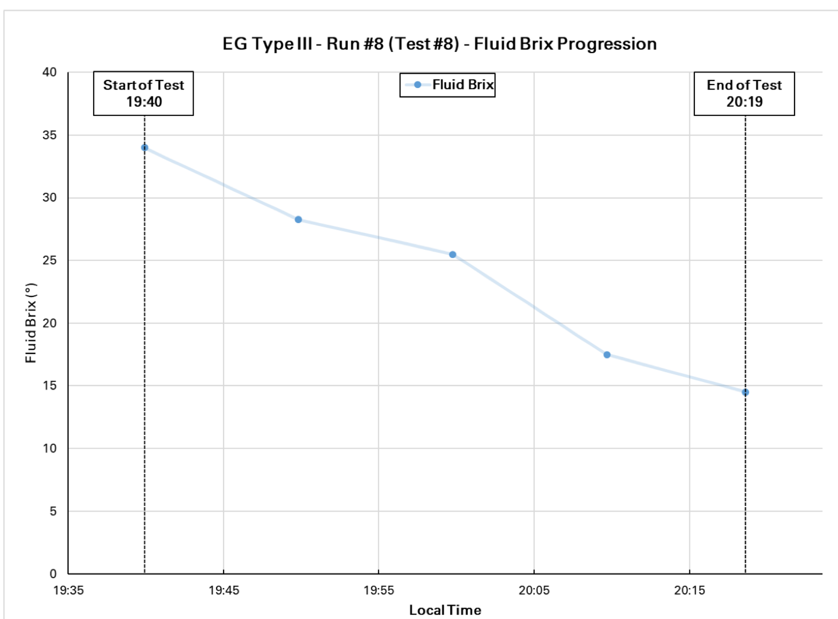

EG Type III - Run #8 (Test #8) - Precipitation Rate
Start of Test 19:40
End of Test 20:19
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
19:35
19:45
19:55
20:05
20:15
Local Time

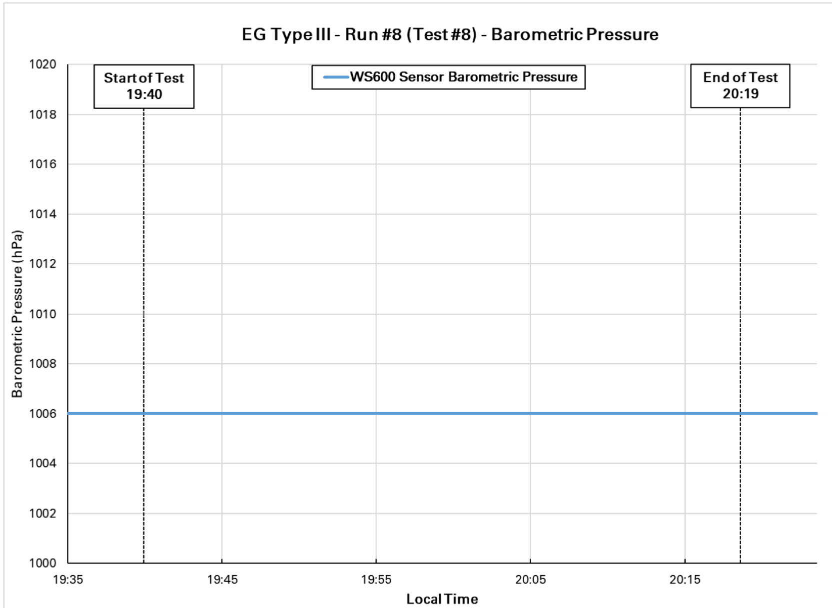

EG Type III - Run #8 (Test #8) - Temperatures
Start of Test 19:40
Initial Fluid Temp: -10.5°C
End of Test 20:19
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
19:35
19:45
19:55
20:05
20:15
Local Time

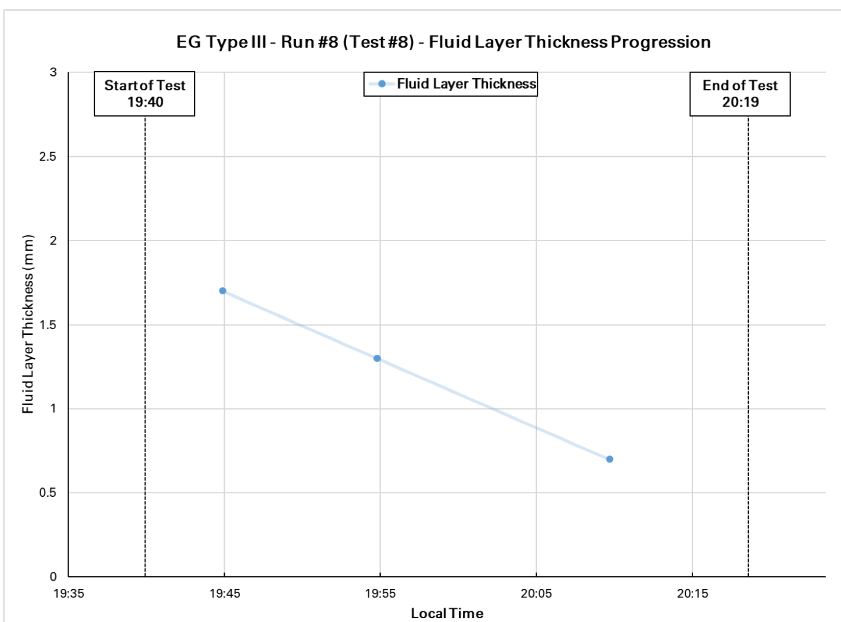

EG Type III - Run #8 (Test #8) - Wind Speeds
Start of Test 19:40
End of Test 20:19
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
19:35
19:45
19:55
20:05
20:15
Local Time

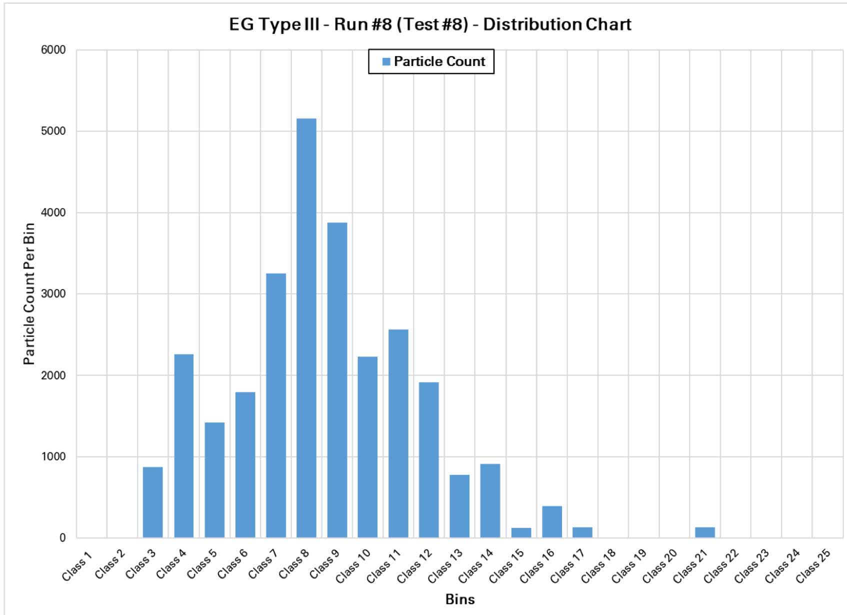

EG Type III - Run #8 (Test #8) - Wind Direction
Start of Test 19:40
WS600 Sensor Wind Direction
End of Test 20:19
Wind Direction (degrees)
360
300
240
180
120
60
0
19:35
19:45
19:55
20:05
20:15
Local Time


EG Type III - Run #8 (Test #8) - Relative Humidity
Start of Test 19:40
WS600 Sensor Relative Humidity
End of Test 20:19
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
19:35
19:45
19:55
20:05
20:15
Local Time


EG Type III - Run #8 (Test #8) - Fluid Brix Progression
Start of Test 19:40
Fluid Brix
End of Test 20:19
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
19:35
19:45
19:55
20:05
20:15
Local Time

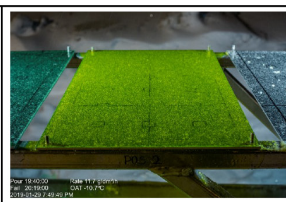

EG Type III - Run #8 (Test #8) - Barometric Pressure
Start of Test 19:40
WS600 Sensor Barometric Pressure
End of Test 20:19
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
19:35
19:45
19:55
20:05
20:15
Local Time

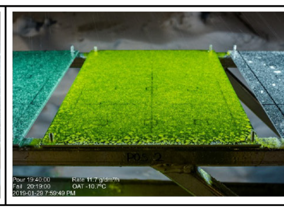

EG Type III - Run #8 (Test #8) - Fluid Layer Thickness Progression
Start of Test 19:40
Fluid Layer Thickness
End of Test 20:19
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
19:35
19:45
19:55
20:05
20:15
Local Time

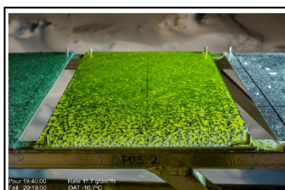


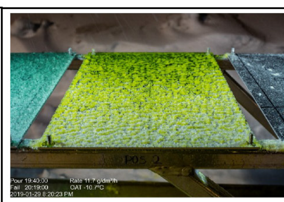
AeroClear MAX – Run 8 (Test 8) – Failure Progression Photos


AT POUR (0/39 MIN)


PRE-FAILURE (10/39 MIN)

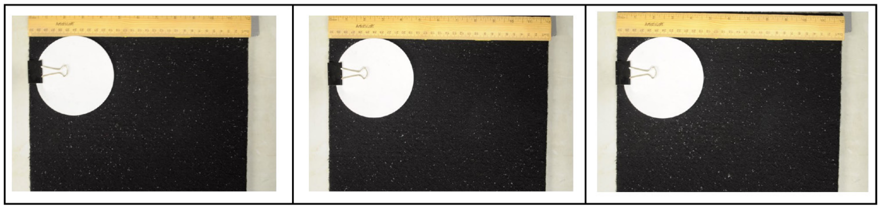

PRE-FAILURE (19/39 MIN)


PRE-FAILURE (29/39 MIN)

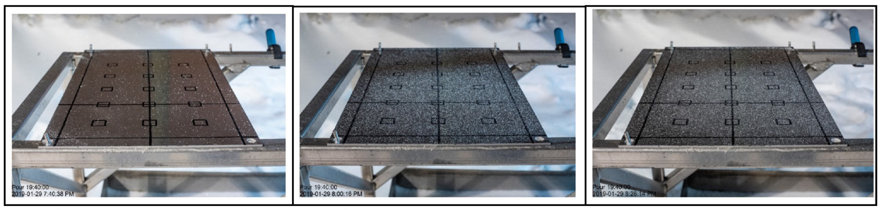

AT FAILURE (40/39 MIN)


POST-FAILURE (45/39 MIN)

AeroClear MAX – Run 8 (Test 8) – Snow Characteristics Photos



FELT PAD (0/39 MIN) | FELT PAD (10/39 MIN) | FELT PAD (30/39 MIN)



BARE PLATE (0/39 MIN) | BARE PLATE 20/39 MIN) | BARE PLATE (46/39 MIN)

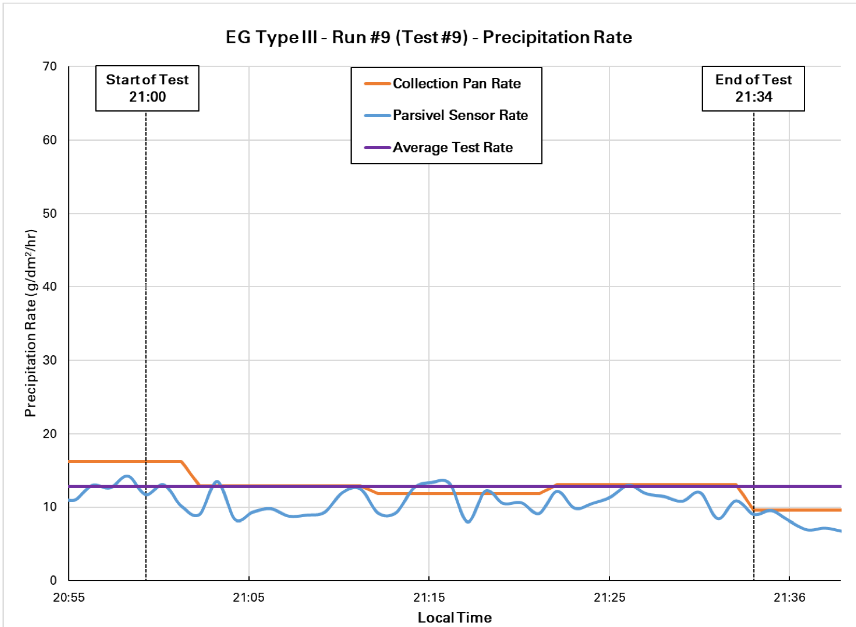
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

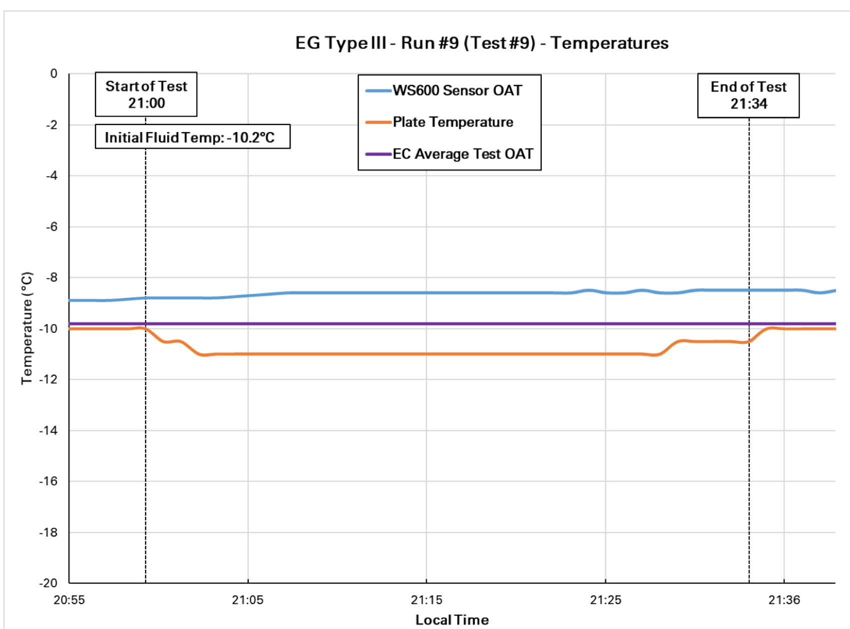
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

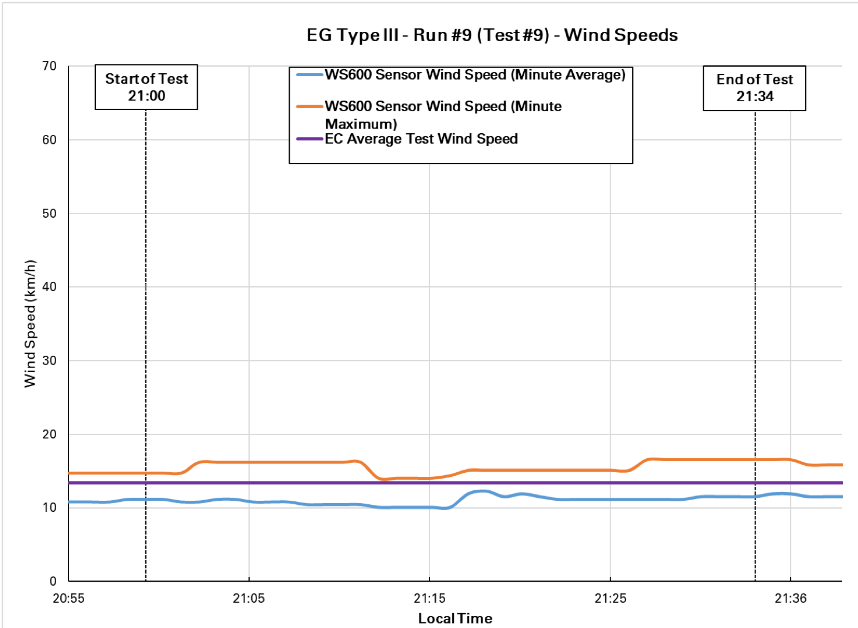
EG TYPE III
RUN #9 (TEST#9) – EG3-9

EG Type III – Run #9 (Test #9) – General Test Information

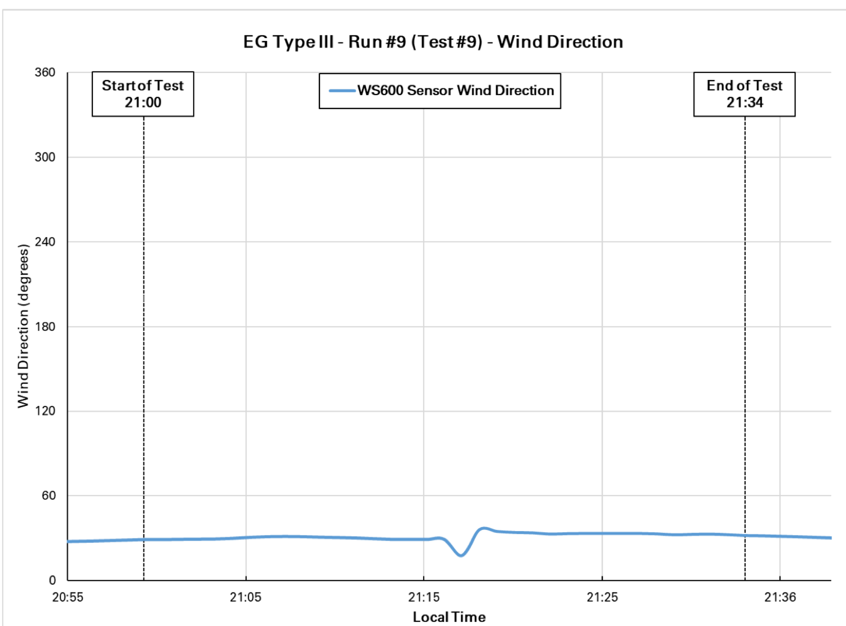
Test Number:	EG3-9
Date of Test:	January 29, 2019
Average OAT:	-9.8
Average Precipitation Rate:	12.8 g/dm²/h
Average Wind Speed:	13.4 km/h
Average Relative Humidity:	84.64%
Pour Time (Local):	21:00:00
Time of Fluid Failure (Local):	21:34:00
Fluid Brix at Failure:	14°
Endurance Time:	34 minutes
Expected Regression-Derived Endurance Time:	36.2 minutes
Difference (ET vs. Reg ET):	-2.2 minutes (-6.2%)


EG Type III - Run #9 (Test #9) - Precipitation Rate
Start of Test 21:00
End of Test 21:34
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
20:55
21:05
21:15
21:25
21:36
Local Time

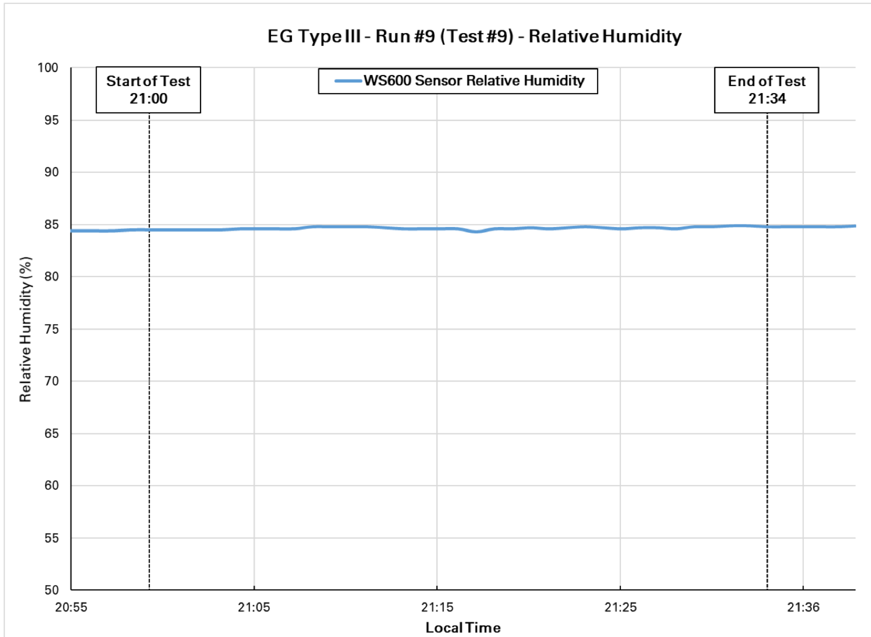

EG Type III - Run #9 (Test #9) - Temperatures
Start of Test 21:00
Initial Fluid Temp: -10.2°C
End of Test 21:34
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
20:55
21:05
21:15
21:25
21:36
Local Time

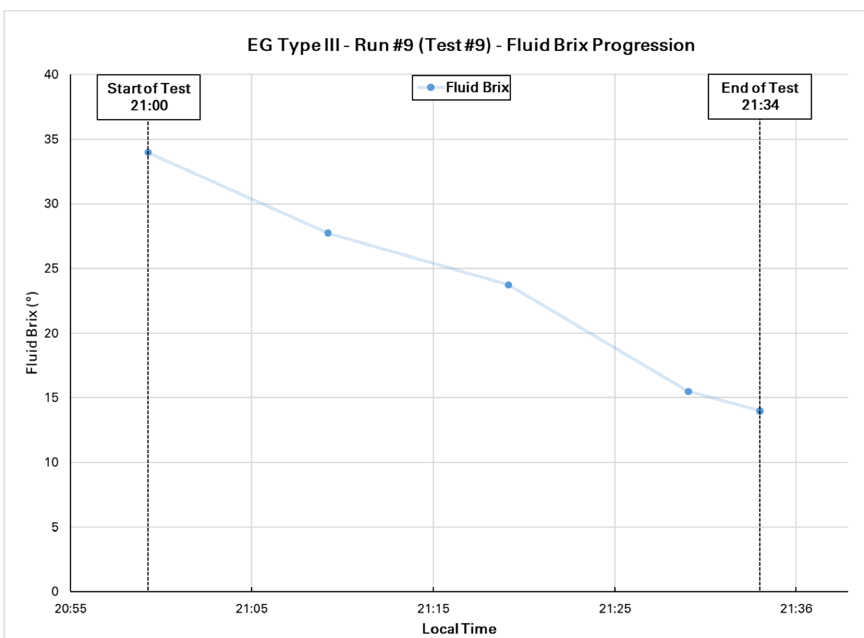


EG Type III - Run #9 (Test #9) - Wind Speeds
Start of Test 21:00
End of Test 21:34
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
20:55
21:05
21:15
21:25
21:36

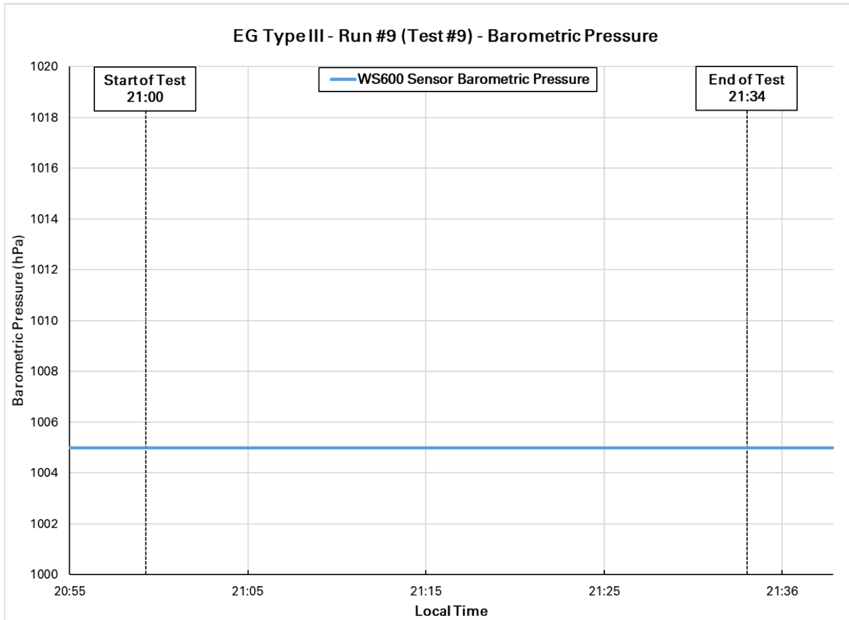


EG Type III - Run #9 (Test #9) - Wind Direction
Start of Test 21:00
WS600 Sensor Wind Direction
End of Test 21:34
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
20:55
21:05
21:15
21:25
21:36


EG Type III - Run #9 (Test #9) - Relative Humidity
Start of Test 21:00
WS600 Sensor Relative Humidity
End of Test 21:34
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:55
21:05
21:15
21:25
21:36
Local Time


EG Type III - Run #9 (Test #9) - Fluid Brix Progression
Start of Test 21:00
Fluid Brix
End of Test 21:34
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:55
21:05
21:15
21:25
21:36
Local Time

DATA PACKAGE – EG TYPE III – RUN 9 (TEST 9)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 9 - Test 9/Data Package - EG Type III - Run 9 - Test 9.docx
Final Version 1.0, February 2021

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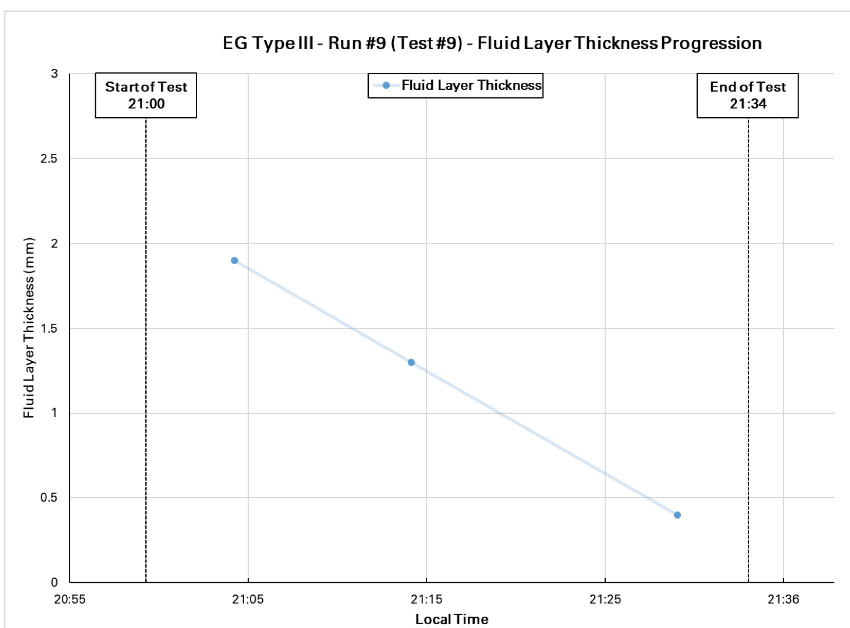
DATA PACKAGE – EG TYPE III – RUN 9 (TEST 9)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 9 - Test 9/Data Package - EG Type III - Run 9 - Test 9.docx
Final Version 1.0, February 2021

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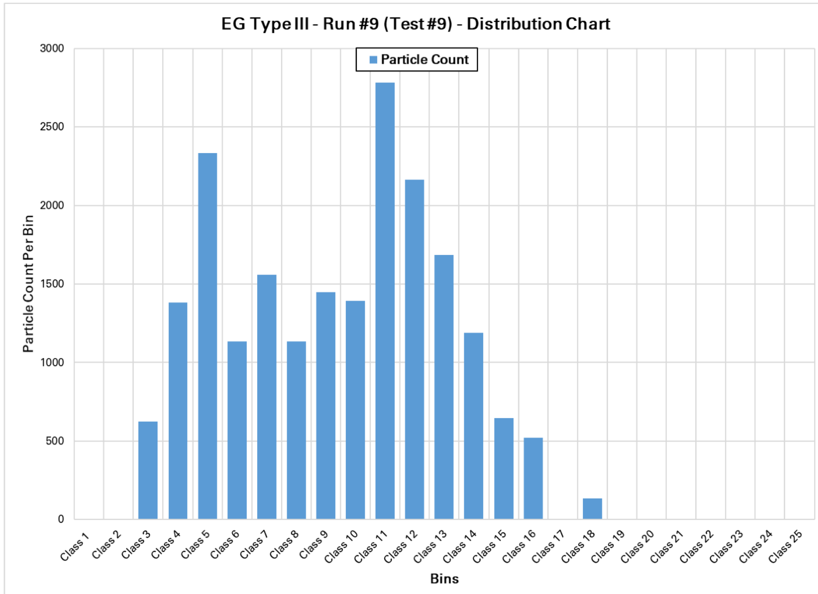
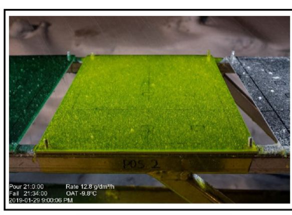
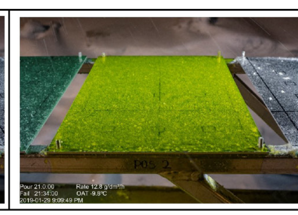
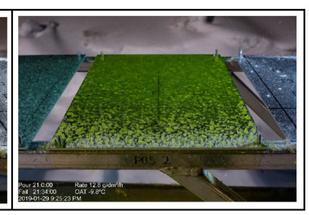


DATA PACKAGE – EG TYPE III – RUN 9 (TEST 9)

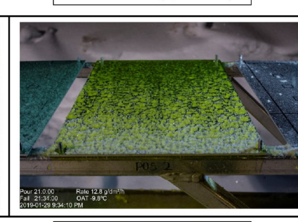
AeroClear MAX – Run 9 (Test 9) – Failure Progression Photos


AT POUR (0/34 MIN)


PRE-FAILURE (9/34 MIN)


PRE-FAILURE (25/34 MIN)


PRE-FAILURE (20/34 MIN)


AT FAILURE (34/34 MIN)


POST-FAILURE (40/34 MIN)

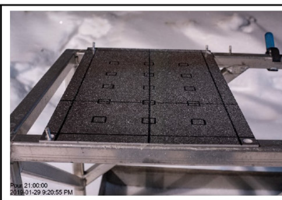
AeroClear MAX – Run 9 (Test 9) – Snow Characteristics Photos

FELT PAD (10/34 MIN)

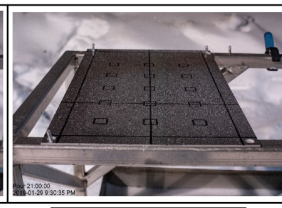
FELT PAD (19/34 MIN)

FELT PAD (31/34 MIN)

BARE PLATE (0/34 MIN)



BARE PLATE (20/34 MIN)



BARE PLATE (30/34 MIN)

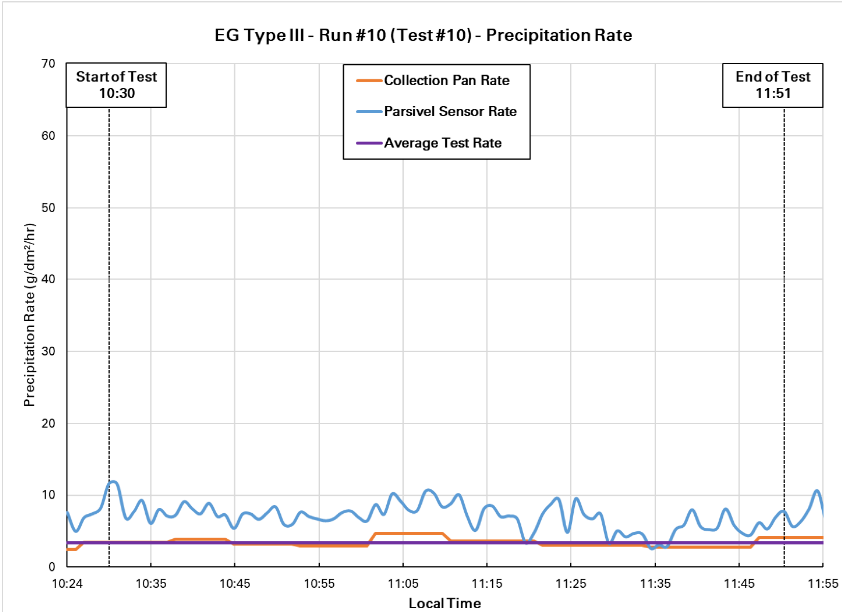
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

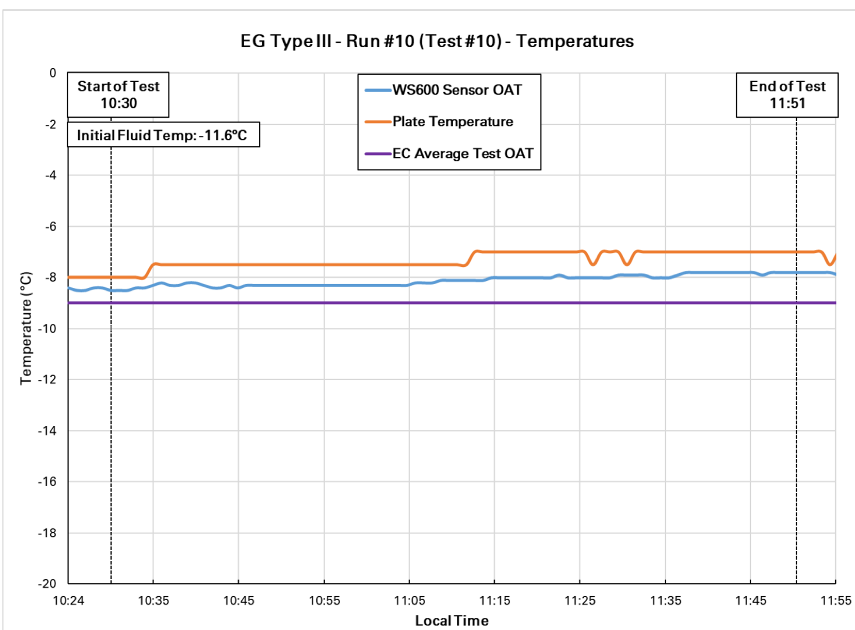
EG TYPE III
RUN #10 (TEST #10) – EG3-10

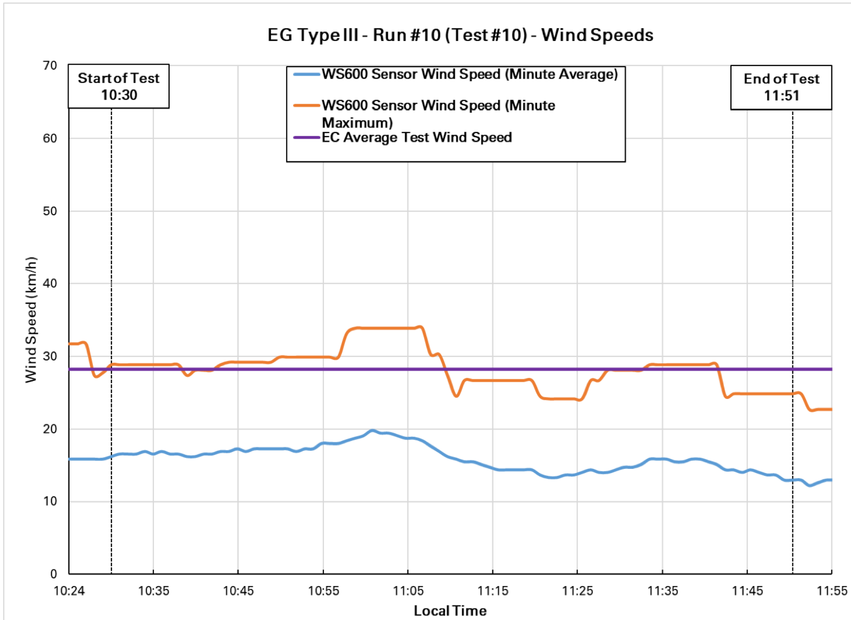
EG Type III – Run #10 (Test #10) – General Test Information

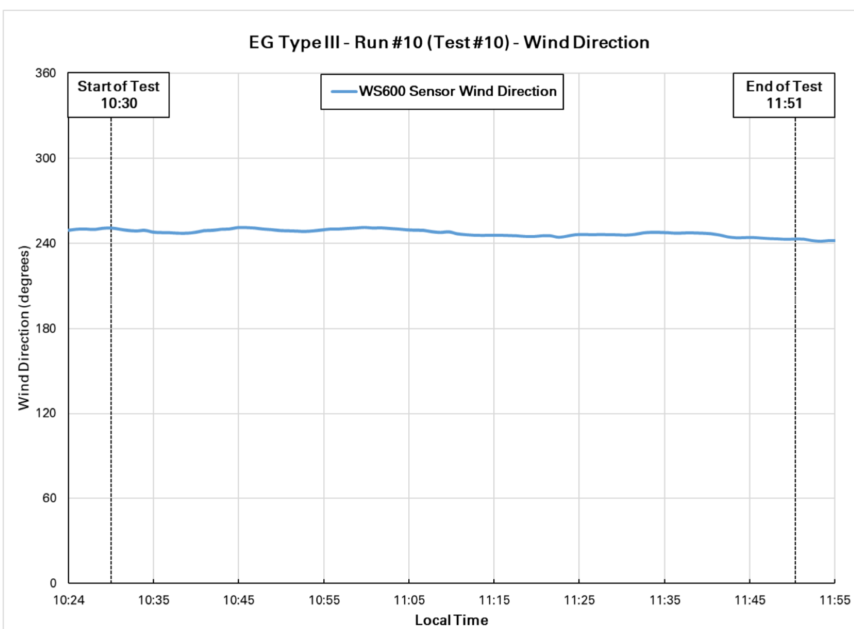
Test Number:	EG3-10
Date of Test:	February 2, 2019
Average OAT:	-9.0
Average Precipitation Rate:	3.4 g/dm²/h
Average Wind Speed:	28.2 km/h
Average Relative Humidity:	79.3%
Pour Time (Local):	10:30:00
Time of Fluid Failure (Local):	11:51:00
Fluid Brix at Failure:	12.5°
Endurance Time:	81 minutes
Expected Regression-Derived Endurance Time:	86 minutes
Difference (ET vs. Reg ET):	-4.8 minutes (-5.6%)

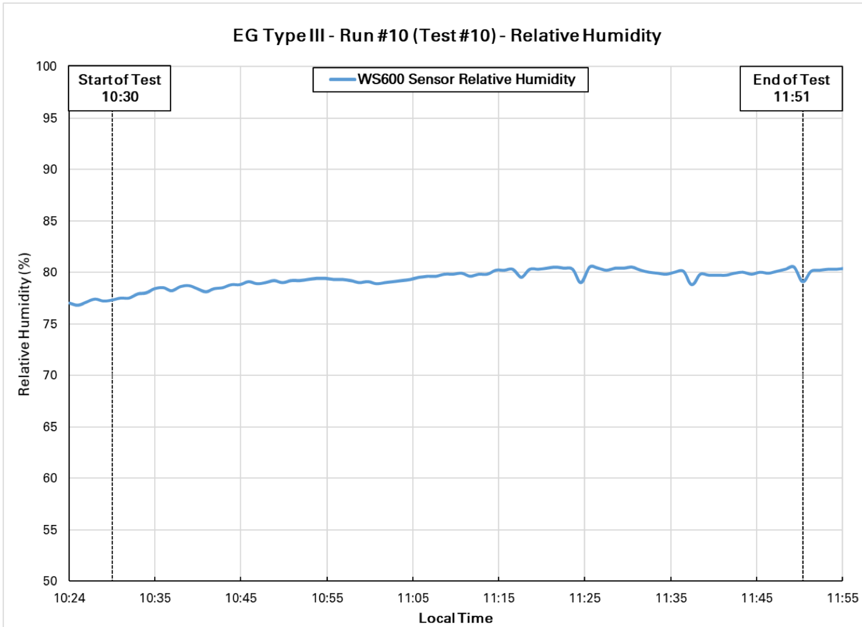


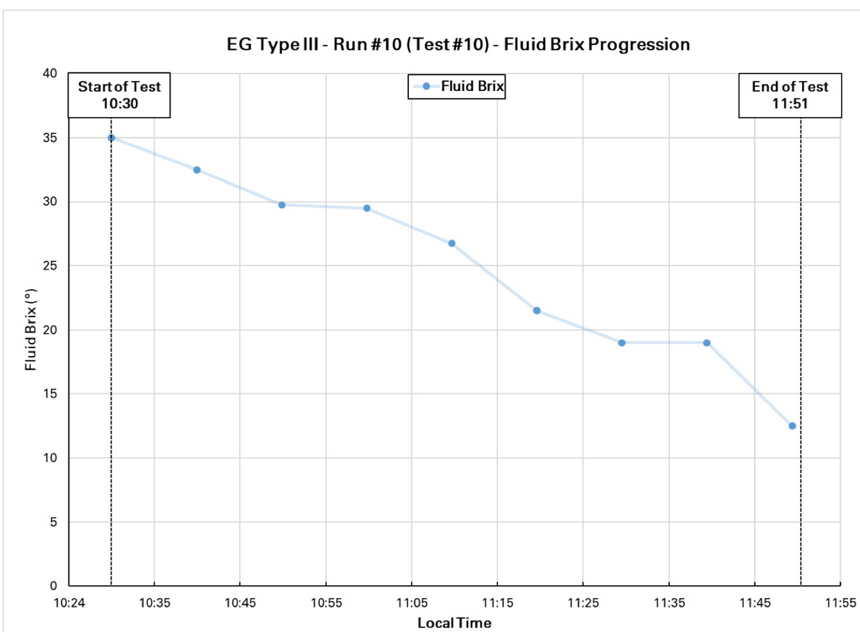
DATA PACKAGE – EG TYPE III – RUN 10 (TEST 10)

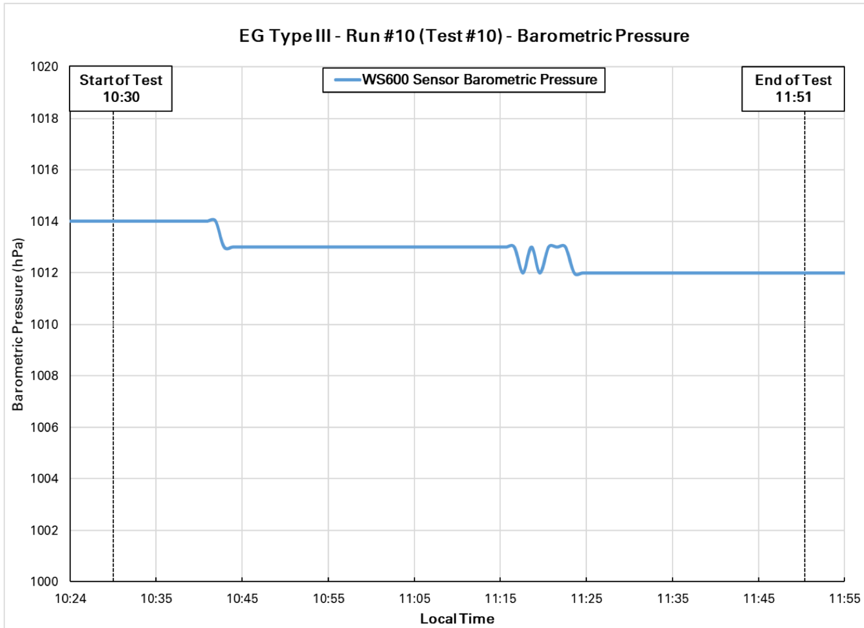


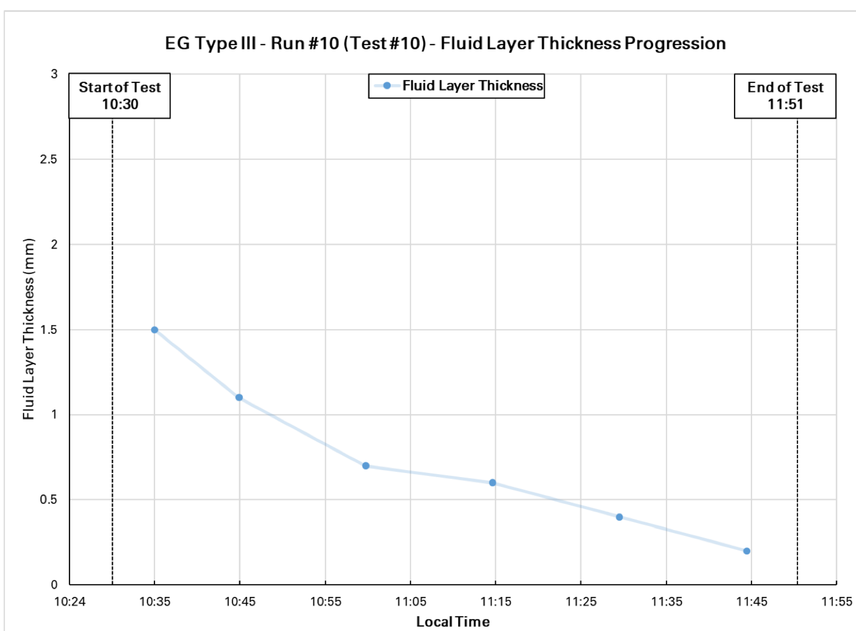

EG Type III - Run #10 (Test #10) - Wind Speeds
Start of Test 10:30
End of Test 11:51
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55

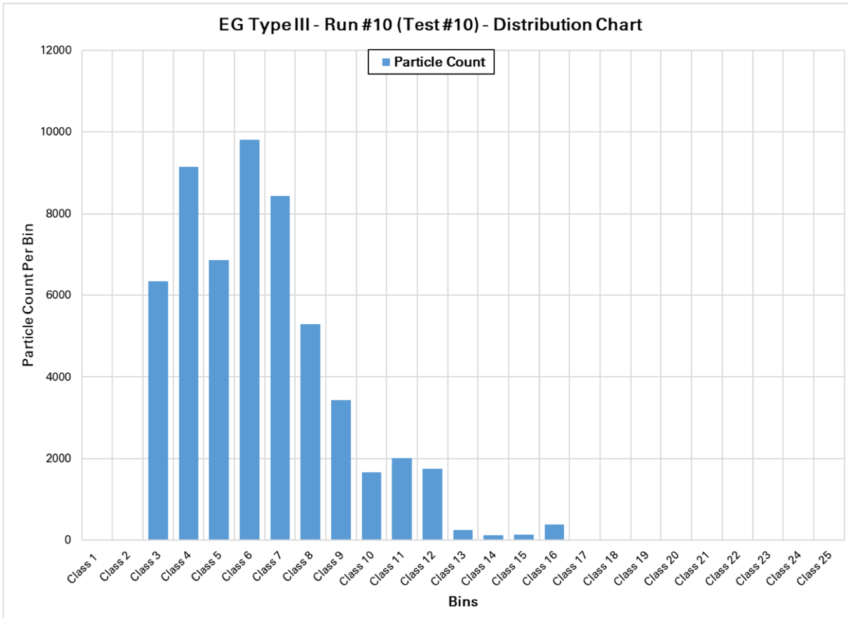

EG Type III - Run #10 (Test #10) - Wind Direction
Start of Test 10:30
End of Test 11:51
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55


EG Type III - Run #10 (Test #10) - Relative Humidity
Start of Test 10:30
WS600 Sensor Relative Humidity
End of Test 11:51
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
Local Time

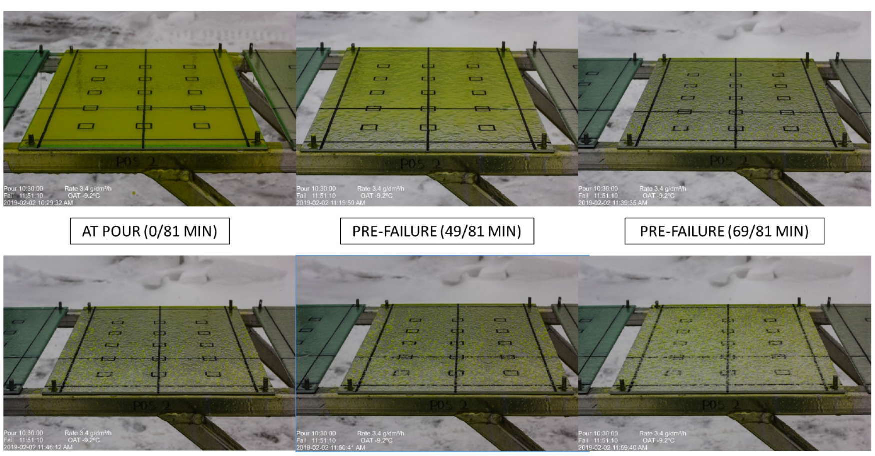

EG Type III - Run #10 (Test #10) - Fluid Brix Progression
Start of Test 10:30
Fluid Brix
End of Test 11:51
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
Local Time


EG Type III - Run #10 (Test #10) - Barometric Pressure
Start of Test 10:30
WS600 Sensor Barometric Pressure
End of Test 11:51
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
Local Time


EG Type III - Run #10 (Test #10) - Fluid Layer Thickness Progression
Start of Test 10:30
Fluid Layer Thickness
End of Test 11:51
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
Local Time



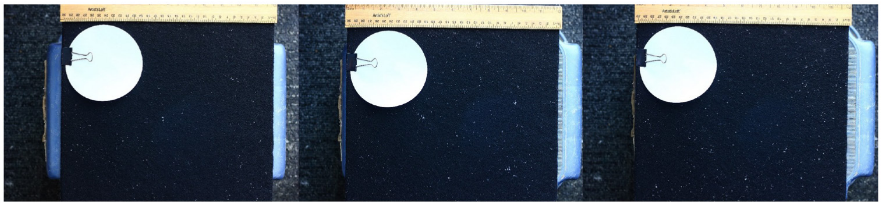
AeroClear MAX – Run 10 (Test 10) – Failure Progression Photos



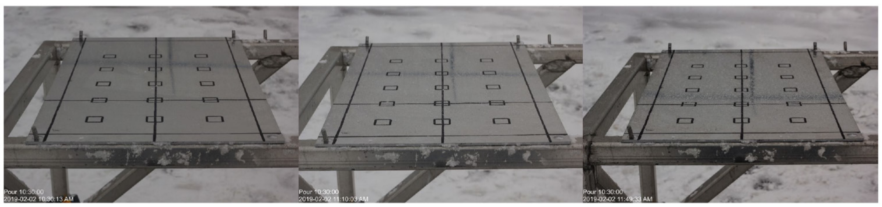
AT POUR (0/81 MIN) | PRE-FAILURE (49/81 MIN) | PRE-FAILURE (69/81 MIN)

PRE-FAILURE (76/81 MIN) | PRE-FAILURE (80/81 MIN) | POST-FAILURE (89/81 MIN)

AeroClear MAX – Run 10 (Test 10) – Snow Characteristics Photos



FELT PAD (2/81 MIN) | FELT PAD (42/81 MIN) | FELT PAD (75/81 MIN)



BARE PLATE (0/81 MIN) | BARE PLATE (40/81 MIN) | BARE PLATE (79/81 MIN)

Final Bare Plate Contamination Thickness: **0.25mm**

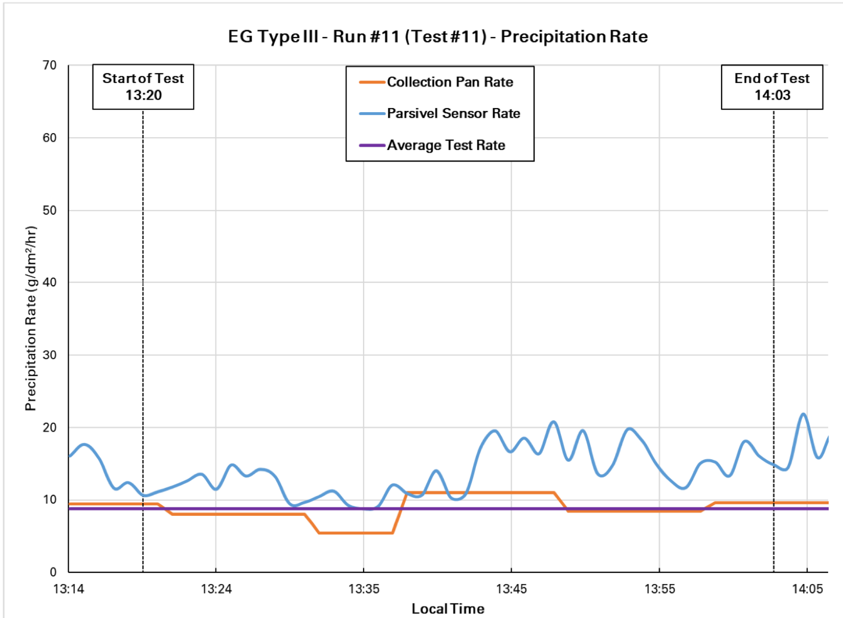
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #11 (TEST #11) – EG3-11

EG Type III – Run #11 (Test #11) – General Test Information

Test Number:	EG3-11
Date of Test:	February 2, 2019
Average OAT:	-8.1
Average Precipitation Rate:	8.8 g/dm²/h
Average Wind Speed:	19.1 km/h
Average Relative Humidity:	82.6%
Pour Time (Local):	13:20:00
Time of Fluid Failure (Local):	14:03:00
Fluid Brix at Failure:	11.25°
Endurance Time:	43 minutes
Expected Regression-Derived Endurance Time:	46.4 minutes
Difference (ET vs. Reg ET):	-3.2 minutes (-6.8%)

DATA PACKAGE – EG TYPE III – RUN 11 (TEST 11)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 11 - Test 11/Data Package - EG Type III - Run 11 - Test 11.docx
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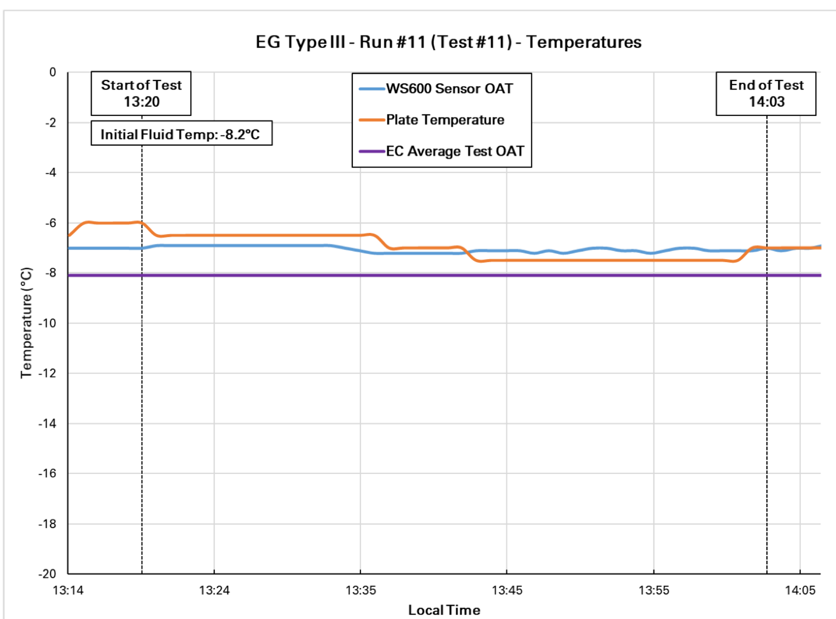
DATA PACKAGE – EG TYPE III – RUN 11 (TEST 11)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 11 - Test 11/Data Package - EG Type III - Run 11 - Test 11.docx
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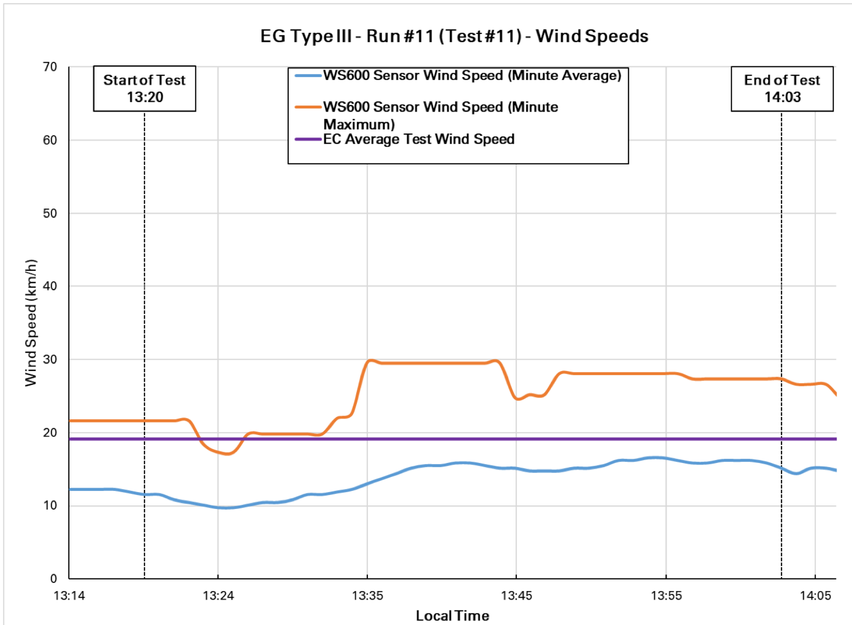
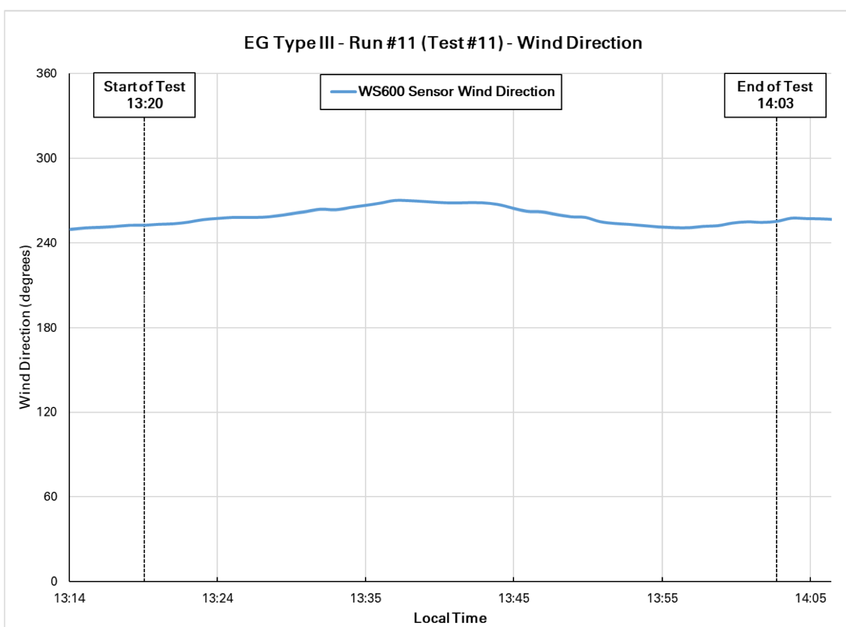
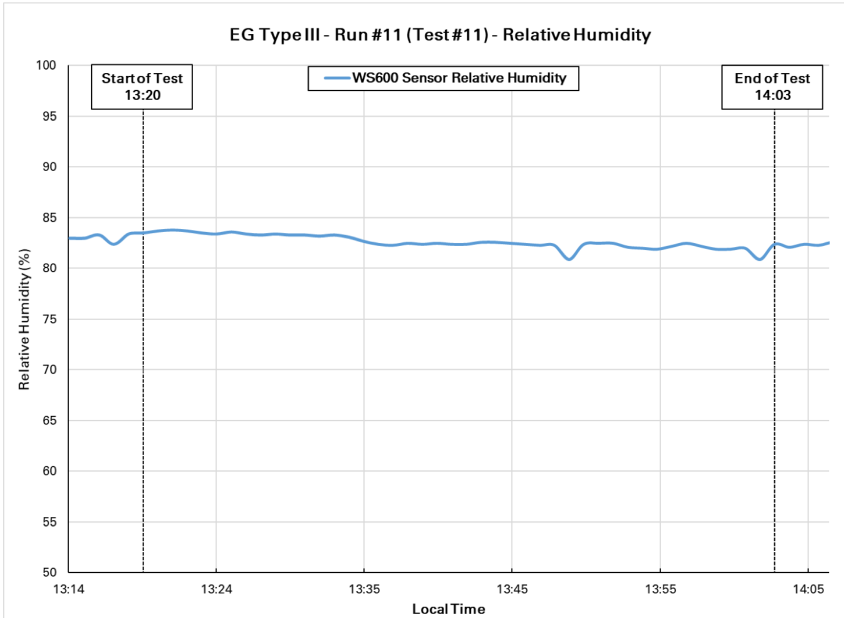


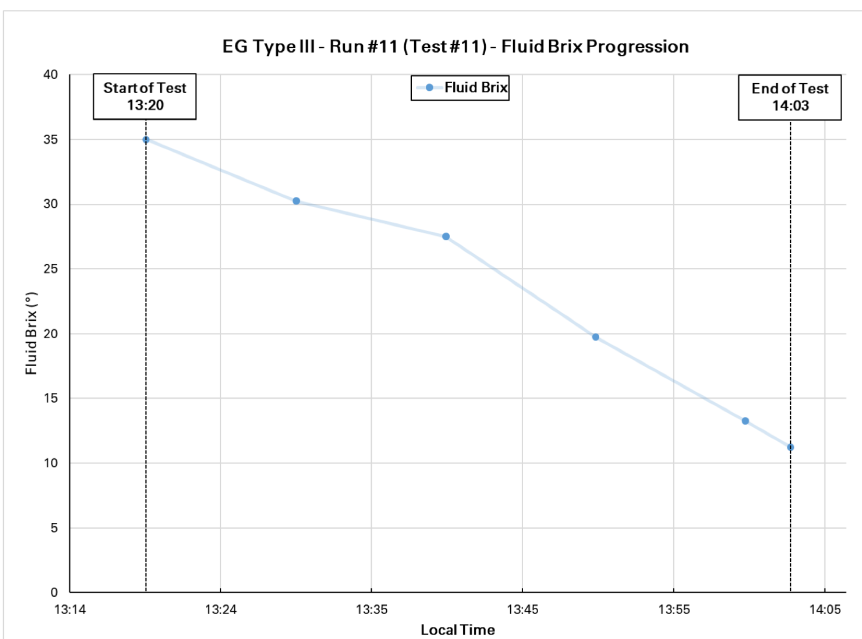
EG Type III - Run #11 (Test #11) - Wind Speeds
Start of Test 13:20
End of Test 14:03
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
13:14
13:24
13:35
13:45
13:55
14:05
Local Time



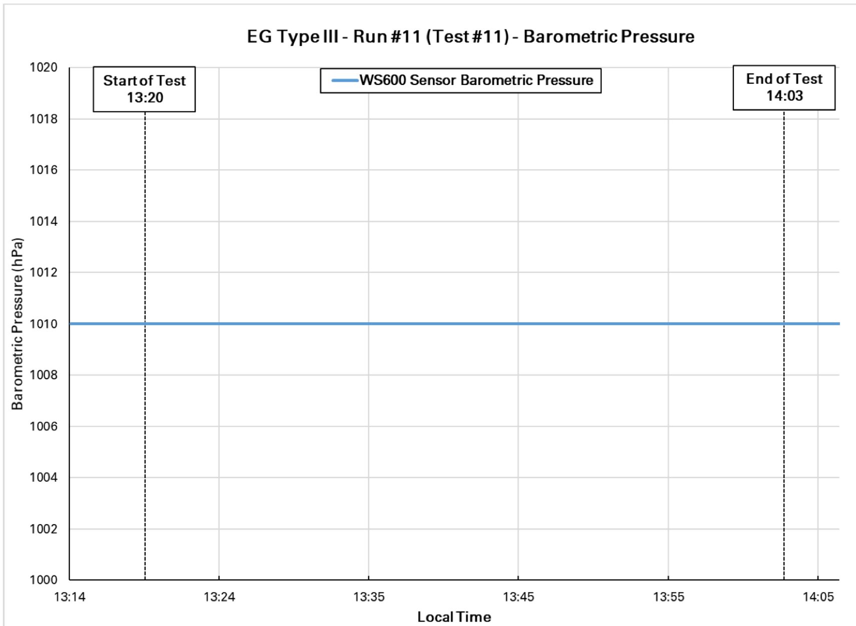
EG Type III - Run #11 (Test #11) - Wind Direction
Start of Test 13:20
End of Test 14:03
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
13:14
13:24
13:35
13:45
13:55
14:05
Local Time

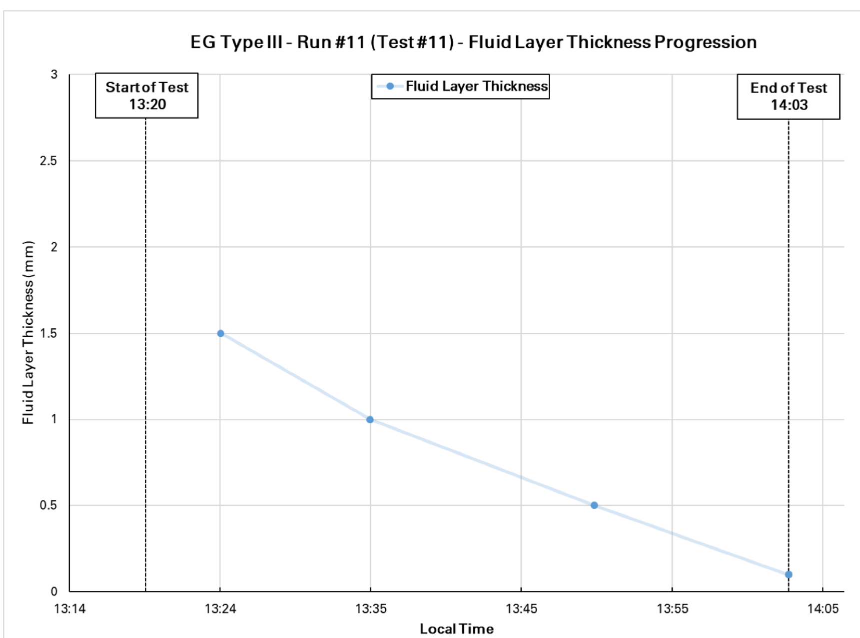


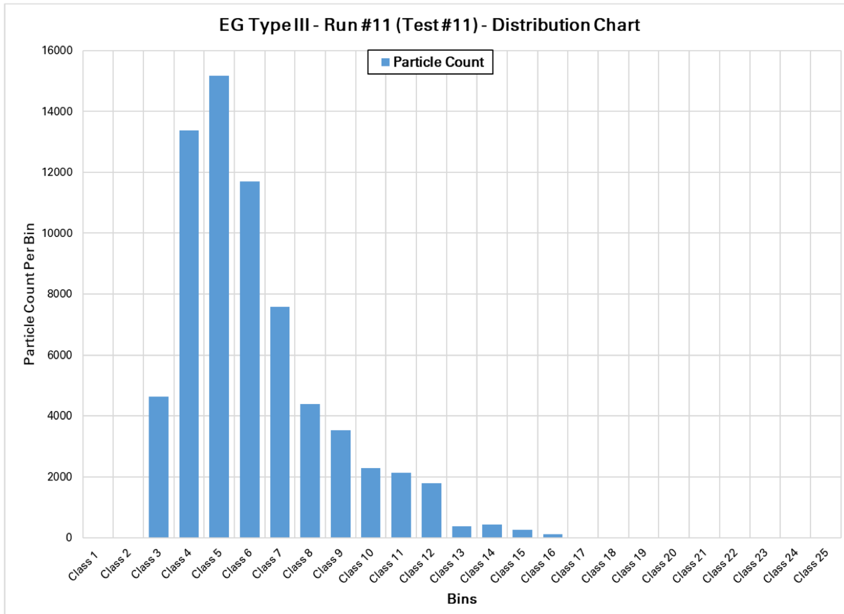
EG Type III - Run #11 (Test #11) - Relative Humidity
Start of Test 13:20
WS600 Sensor Relative Humidity
End of Test 14:03
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
13:14
13:24
13:35
13:45
13:55
14:05
Local Time



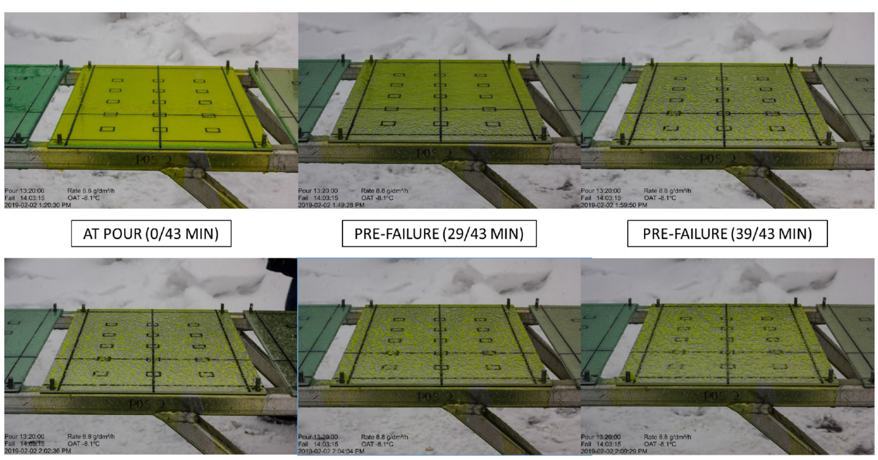
EG Type III - Run #11 (Test #11) - Fluid Brix Progression
Start of Test 13:20
Fluid Brix
End of Test 14:03
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
13:14
13:24
13:35
13:45
13:55
14:05
Local Time


EG Type III - Run #11 (Test #11) - Barometric Pressure
Start of Test 13:20
WS600 Sensor Barometric Pressure
End of Test 14:03
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
Barometric Pressure (hPa)
13:14
13:24
13:35
13:45
13:55
14:05
Local Time


EG Type III - Run #11 (Test #11) - Fluid Layer Thickness Progression
Start of Test 13:20
Fluid Layer Thickness
End of Test 14:03
3
2.5
2
1.5
1
0.5
0
Fluid Layer Thickness (mm)
13:14
13:24
13:35
13:45
13:55
14:05
Local Time



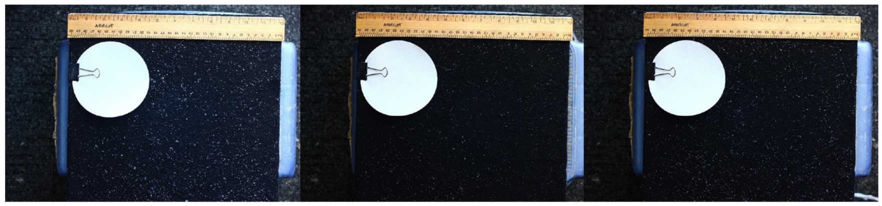
AeroClear MAX – Run 11 (Test 11) – Failure Progression Photos



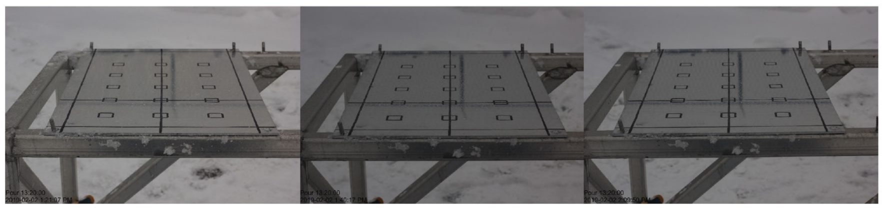
AT POUR (0/43 MIN) | PRE-FAILURE (29/43 MIN) | PRE-FAILURE (39/43 MIN)

PRE-FAILURE (42/43 MIN) | POST-FAILURE (44/43 MIN) | POST-FAILURE (49/43 MIN)

AeroClear MAX – Run 11 (Test 11) – Snow Characteristics Photos



FELT PAD (3/43 MIN) | FELT PAD (22/43 MIN) | FELT PAD (42/43 MIN)



BARE PLATE (1/43 MIN) | BARE PLATE (20/43 MIN) | BARE PLATE 49/43 MIN)

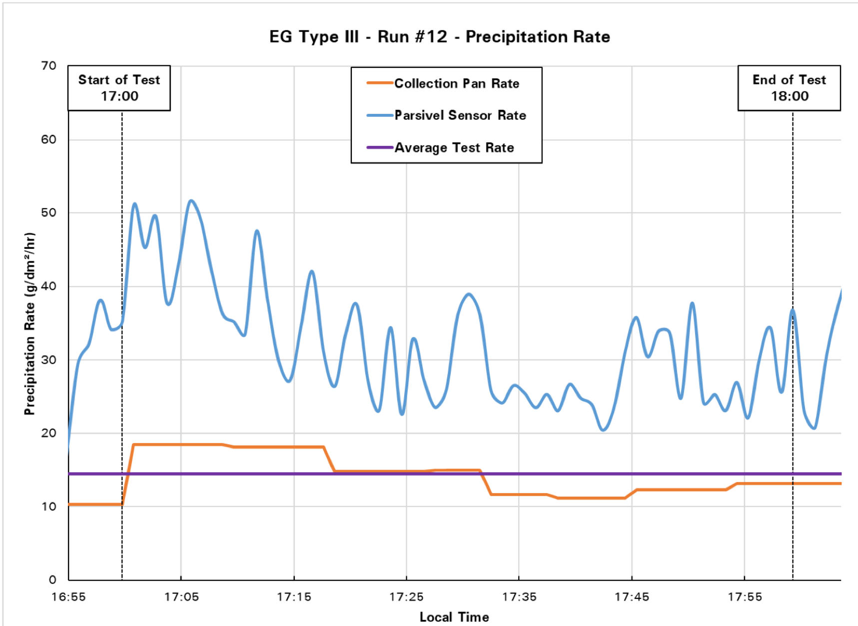
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

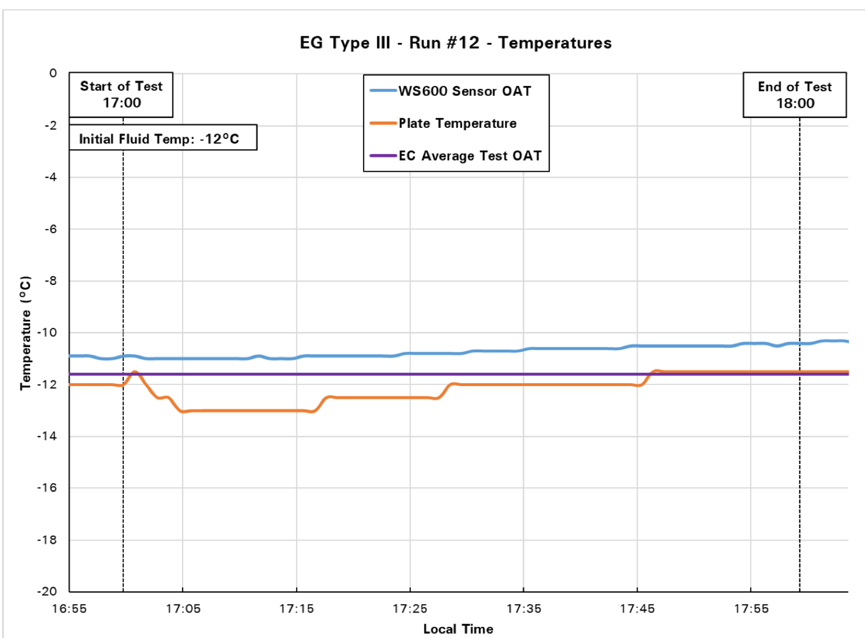
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

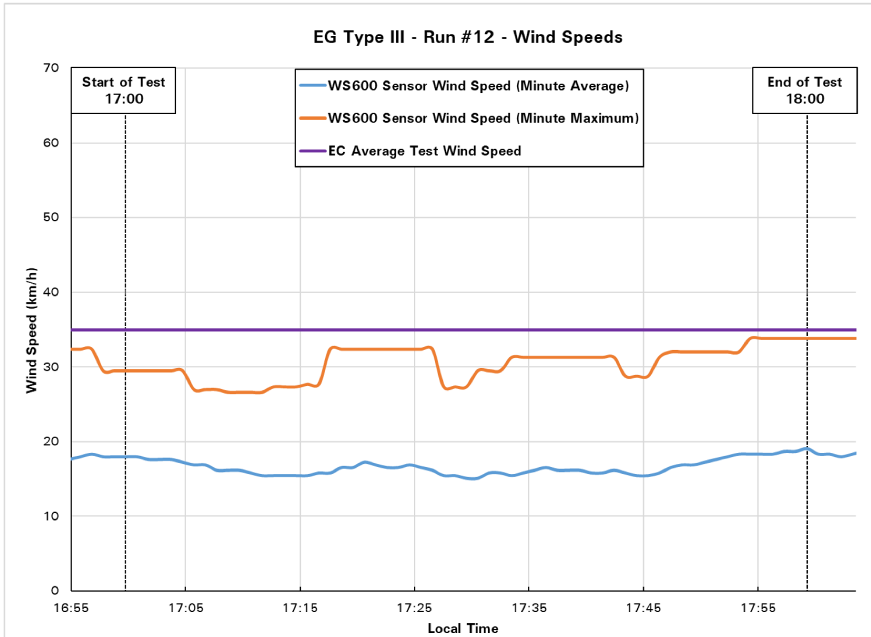
EG TYPE III
RUN #12 – TEST EG3-12

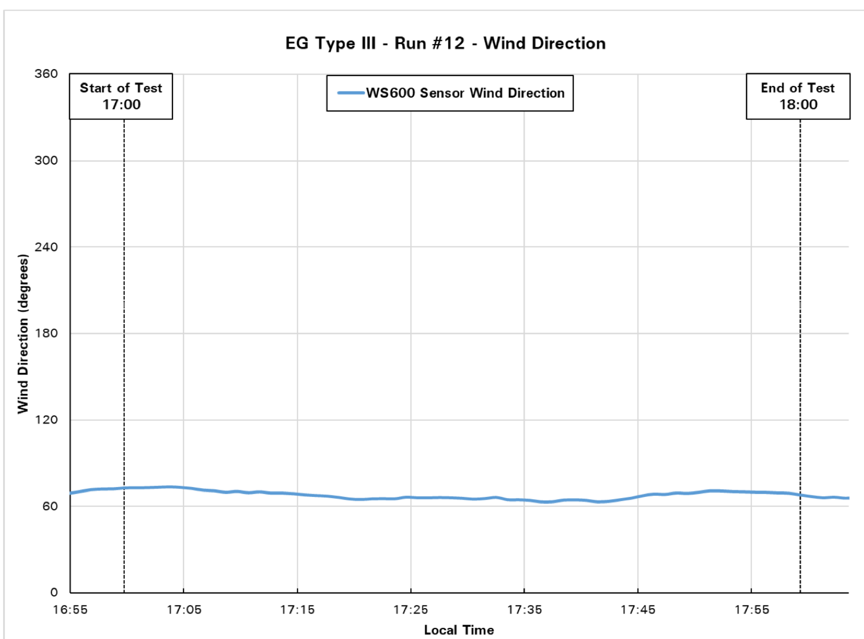
EG Type III – Run #12 – General Test Information

Test Number:	**EG3-12**
Date of Test:	**February 12, 2019**
Average OAT:	**-11.6**
Average Precipitation Rate:	**14.5 g/dm²/h**
Average Wind Speed:	**35 km/h**
Average Relative Humidity:	**78%**
Pour Time (Local):	**17:00:00**
Time of Fluid Failure (Local):	**18:00:00**
Fluid Brix at Failure:	**15.25°**
Endurance Time:	**60 minutes**
Expected Regression-Derived Endurance Time:	**33.3 minutes**
Difference (ET vs. Reg ET):	**+26.7 minutes (+80.0%)**

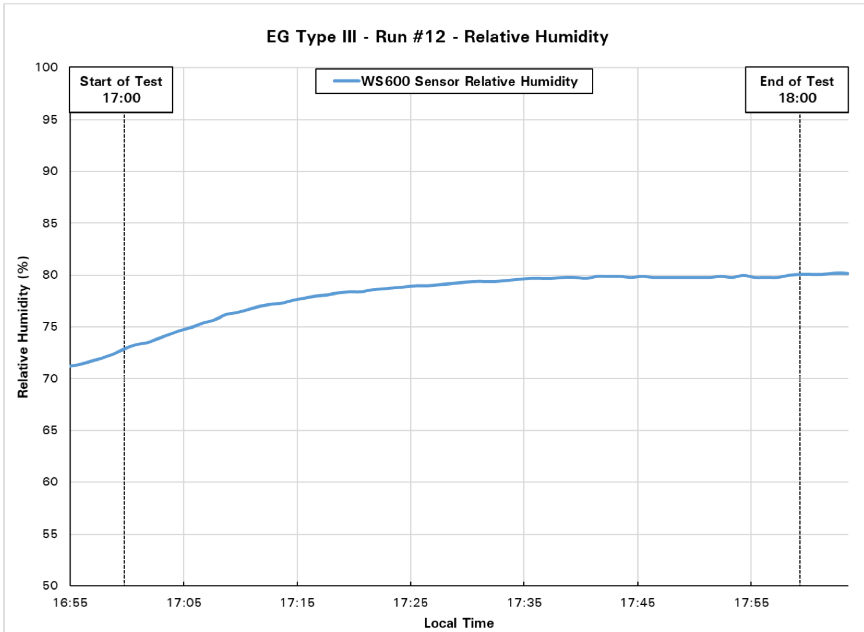

EG Type III - Run #12 - Precipitation Rate
Start of Test 17:00
End of Test 18:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:55
17:05
17:15
17:25
17:35
17:45
17:55
Local Time


EG Type III - Run #12 - Temperatures
Start of Test 17:00
Initial Fluid Temp: -12°C
End of Test 18:00
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:55
17:05
17:15
17:25
17:35
17:45
17:55
Local Time


EG Type III - Run #12 - Wind Speeds
Start of Test 17:00
End of Test 18:00
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:55
17:05
17:15
17:25
17:35
17:45
17:55
Local Time


EG Type III - Run #12 - Wind Direction
Start of Test 17:00
End of Test 18:00
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
16:55
17:05
17:15
17:25
17:35
17:45
17:55
Local Time

DATA PACKAGE – EG TYPE III – RUN 12



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 12 - Test 12/Data Package - EG Type III - Run 12 - Test 12.docx
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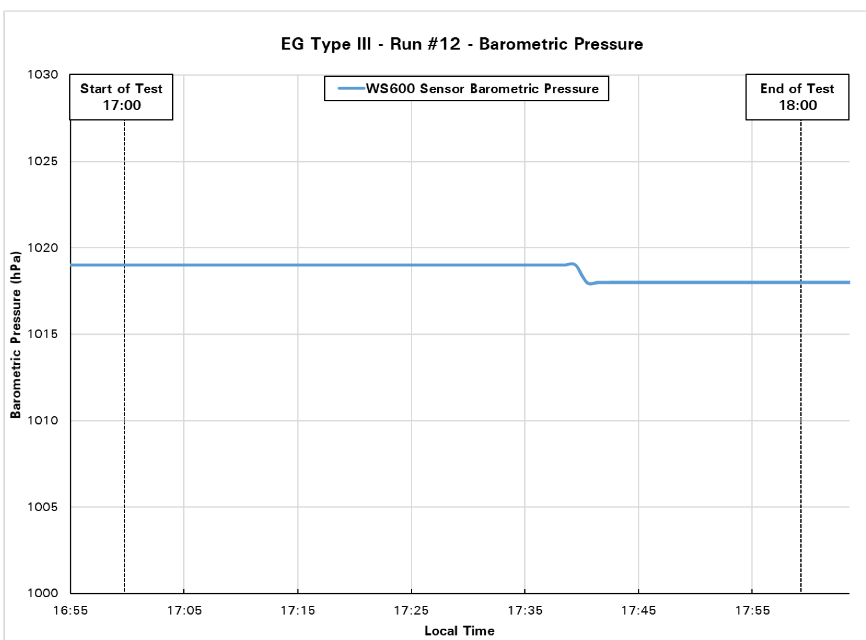
DATA PACKAGE – EG TYPE III – RUN 12



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 12 - Test 12/Data Package - EG Type III - Run 12 - Test 12.docx
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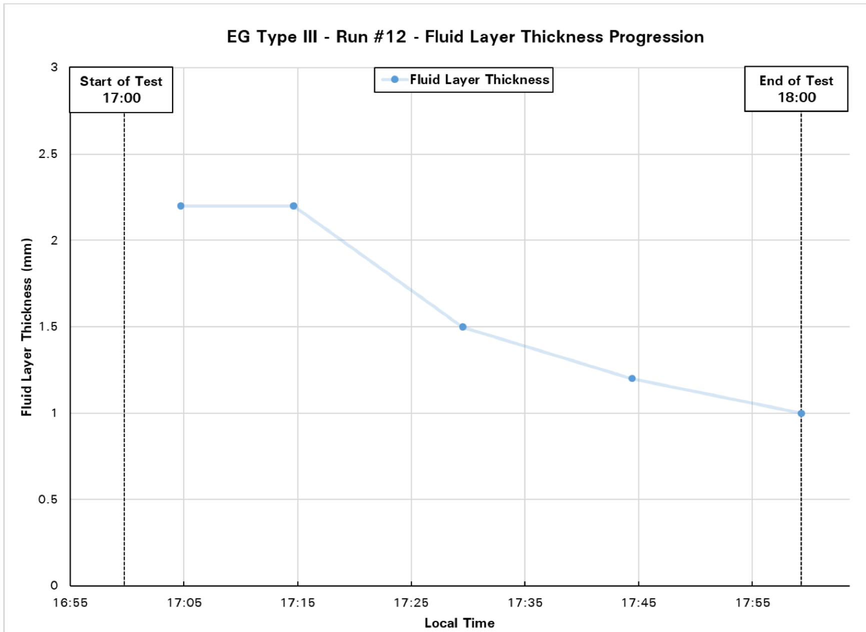
DATA PACKAGE – EG TYPE III – RUN 12



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 12 - Test 12/Data Package - EG Type III - Run 12 - Test 12.docx
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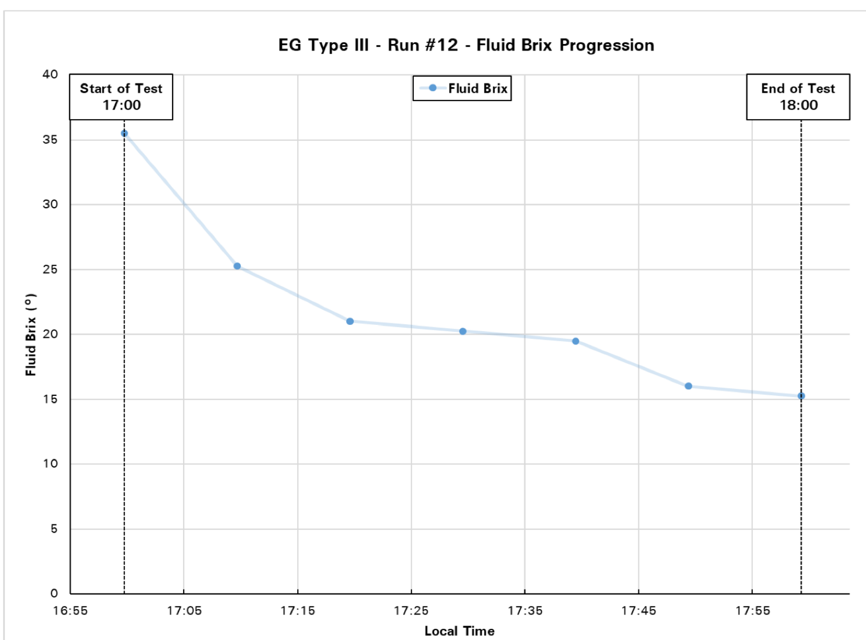
DATA PACKAGE – EG TYPE III – RUN 12



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 12 - Test 12/Data Package - EG Type III - Run 12 - Test 12.docx
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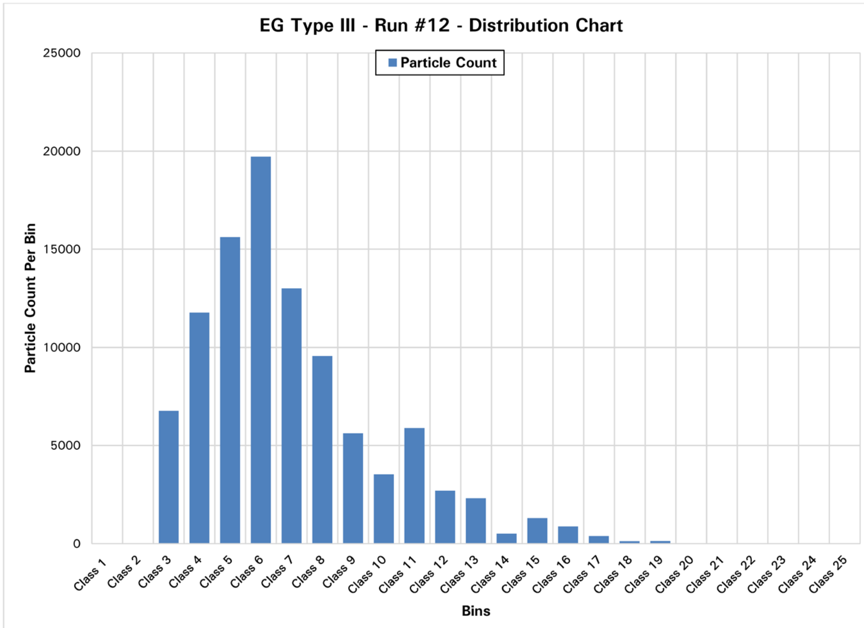
DATA PACKAGE – EG TYPE III – RUN 12



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 12 - Test 12/Data Package - EG Type III - Run 12 - Test 12.docx
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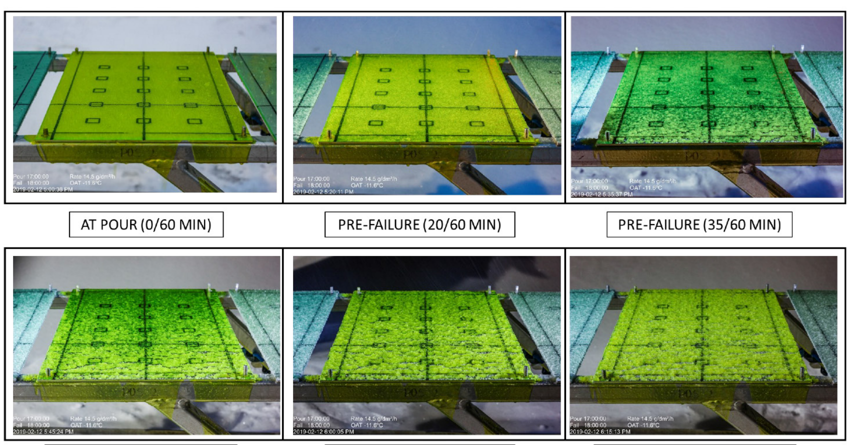
DATA PACKAGE – EG TYPE III – RUN 12

AeroClear MAX – Run 12 – Failure Progression Photos



AT POUR (0/60 MIN) | PRE-FAILURE (20/60 MIN) | PRE-FAILURE (35/60 MIN)

PRE-FAILURE (45/60 MIN) | AT FAILURE (60/60 MIN) | POST-FAILURE (75/60 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 12 - Test 12/Data Package - EG Type III - Run 12 - Test 12.docx
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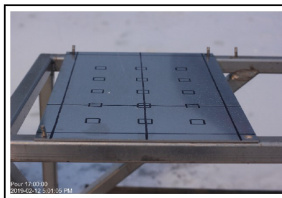
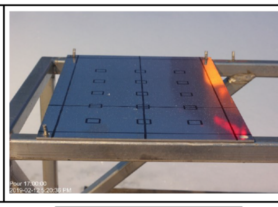
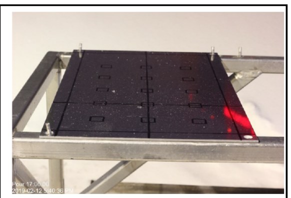
AeroClear MAX – Run 12 – Snow Characteristics Photos

No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (1/60 MIN)	BARE PLATE (20/60 MIN)	BARE PLATE (40/60 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

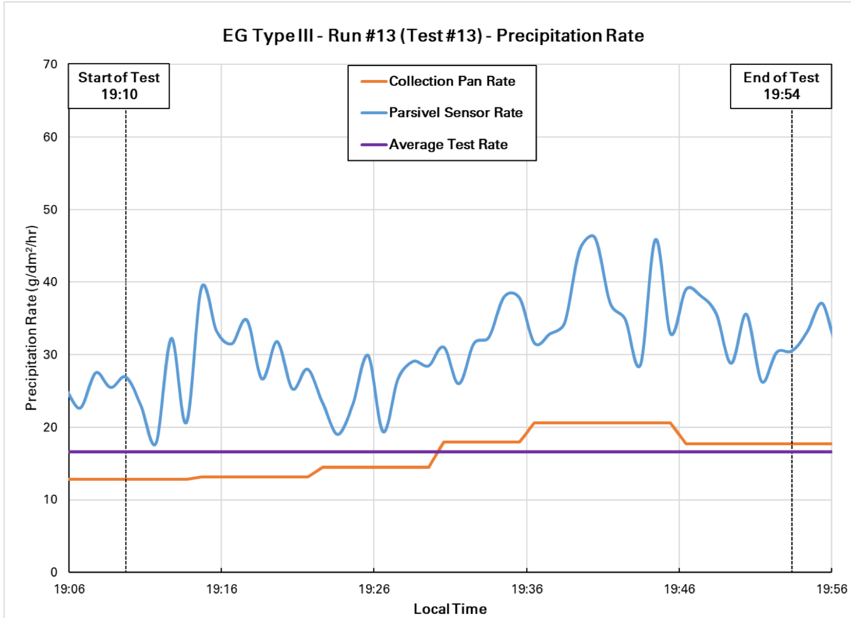
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #13 (TEST #13) – EG3-13

EG Type III – Run #13 (Test #13) – General Test Information

Test Number:	**EG3-13**
Date of Test:	**February 13, 2019**
Average OAT:	**-10.0**
Average Precipitation Rate:	**16.6 g/dm²/h**
Average Wind Speed:	**26.8 km/h**
Average Relative Humidity:	**82.7%**
Pour Time (Local):	**19:10:00**
Time of Fluid Failure (Local):	**19:54:00**
Fluid Brix at Failure:	**13.5°**
Endurance Time:	**44 minutes**
Expected Regression-Derived Endurance Time:	**30.6 minutes**
Difference (ET vs. Reg ET):	**+14.3 minutes (+46.7%)**

DATA PACKAGE – EG TYPE III – RUN 13 (TEST 13)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 13 - Test 13/Data Package - EG Type III - Run 13 - Test 13.docx
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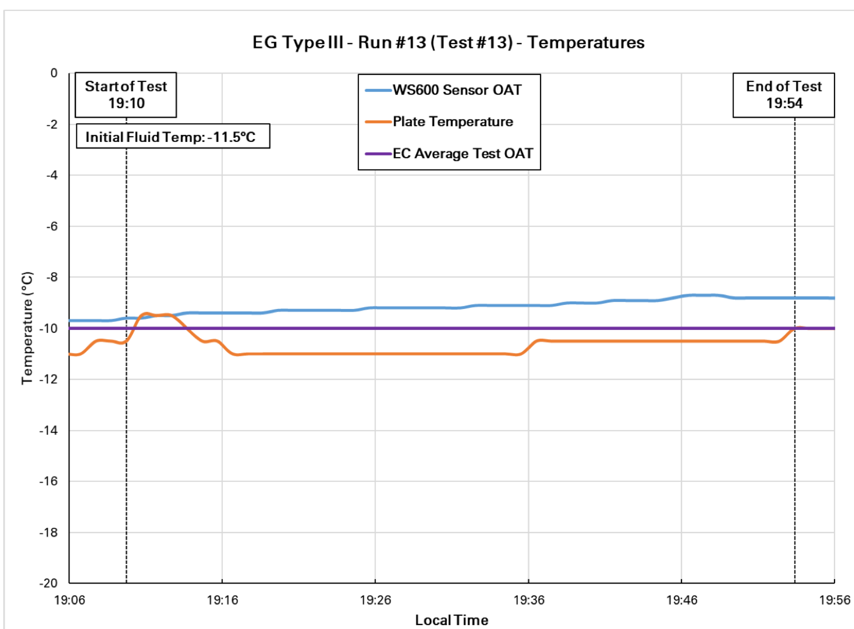
DATA PACKAGE – EG TYPE III – RUN 13 (TEST 13)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 13 - Test 13/Data Package - EG Type III - Run 13 - Test 13.docx
Final Version 1.0, February 2021

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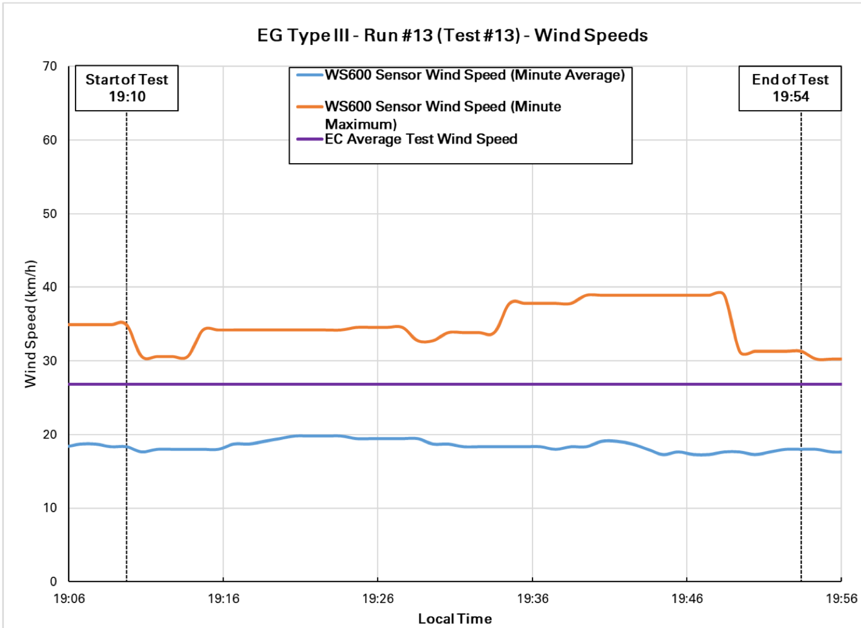
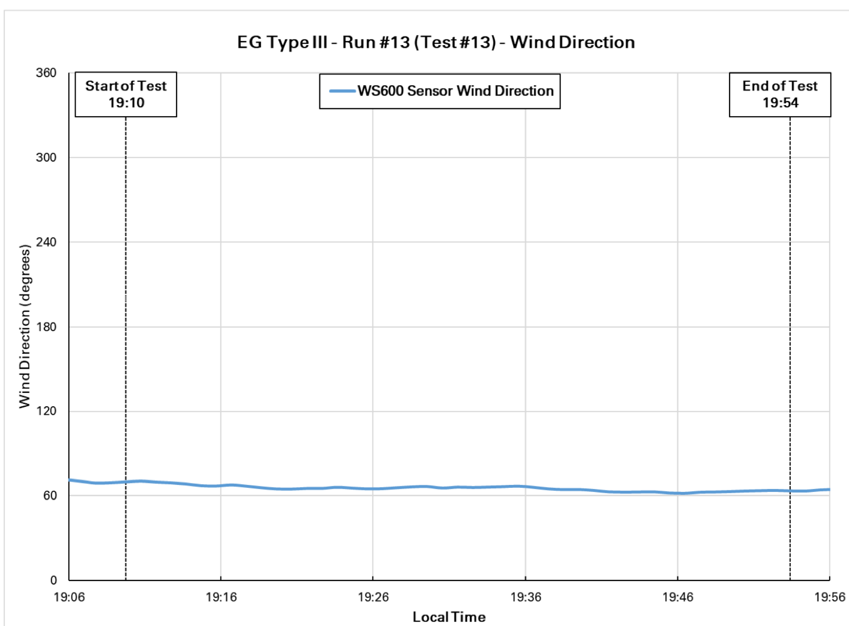
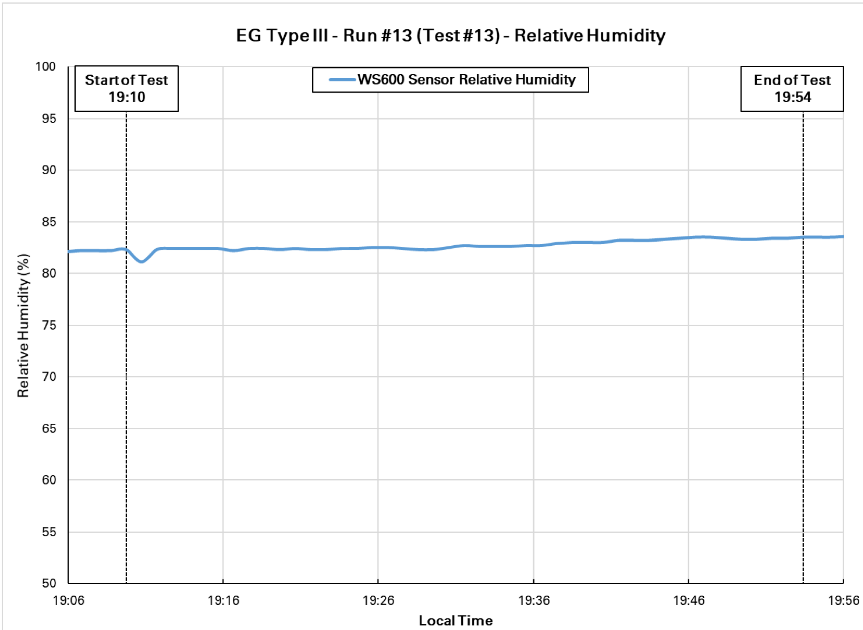
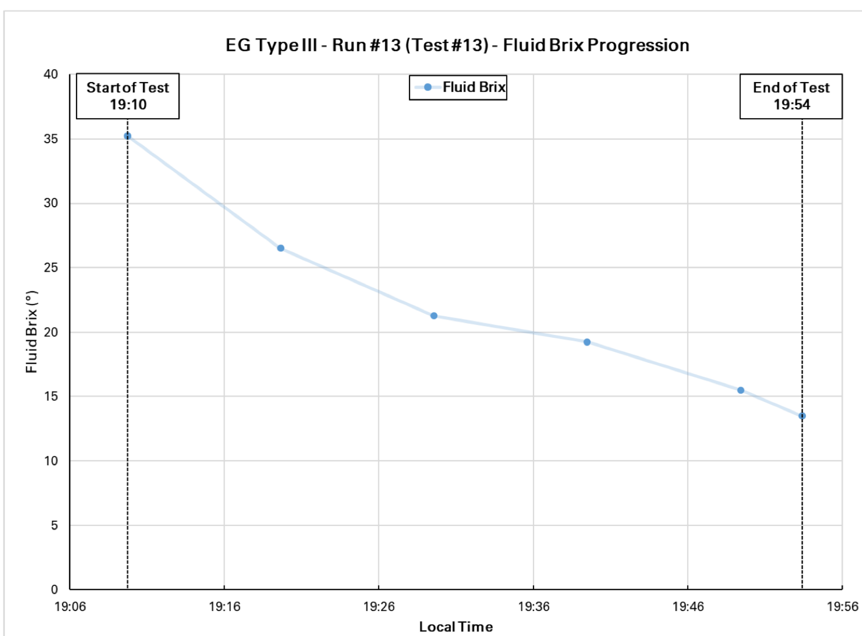


EG Type III - Run #13 (Test #13) - Wind Speeds
Start of Test 19:10
End of Test 19:54
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
19:06
19:16
19:26
19:36
19:46
19:56
Local Time

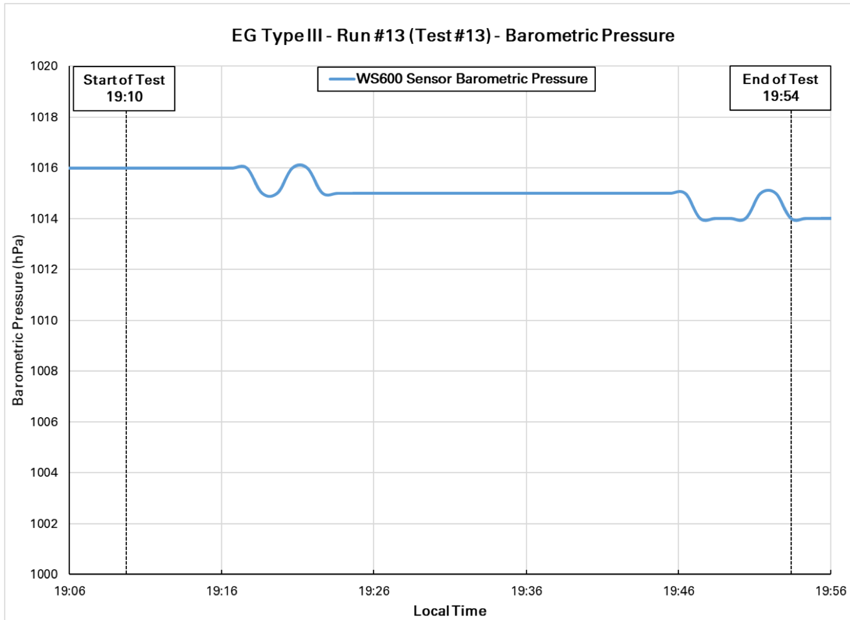


EG Type III - Run #13 (Test #13) - Wind Direction
Start of Test 19:10
WS600 Sensor Wind Direction
End of Test 19:54
Wind Direction (degrees)
0
60
120
180
240
300
360
19:06
19:16
19:26
19:36
19:46
19:56
Local Time


EG Type III - Run #13 (Test #13) - Relative Humidity
Start of Test 19:10
WS600 Sensor Relative Humidity
End of Test 19:54
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
19:06
19:16
19:26
19:36
19:46
19:56
Local Time


EG Type III - Run #13 (Test #13) - Fluid Brix Progression
Start of Test 19:10
Fluid Brix
End of Test 19:54
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
19:06
19:16
19:26
19:36
19:46
19:56
Local Time

DATA PACKAGE – EG TYPE III – RUN 13 (TEST 13)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 13 - Test 13/Data Package - EG Type III - Run 13 - Test 13.docx
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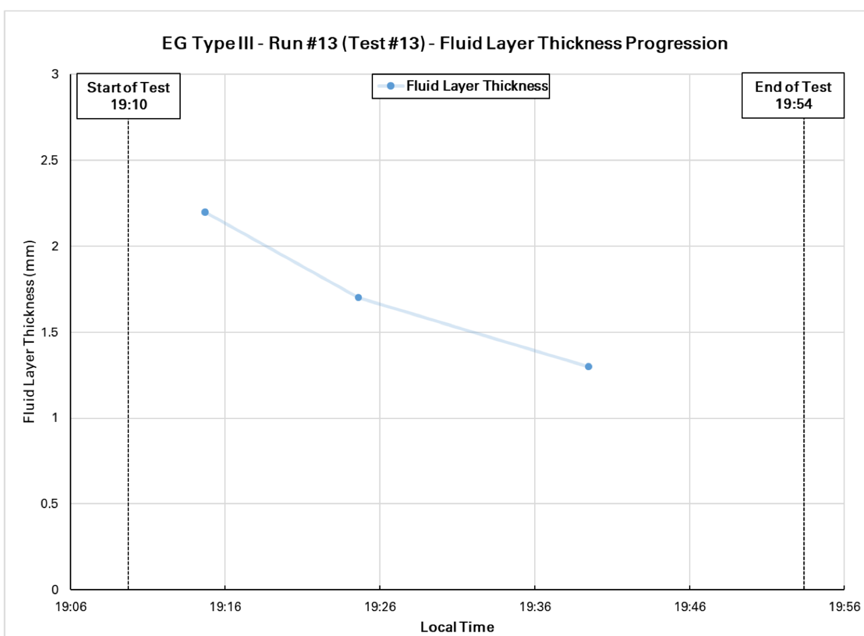
DATA PACKAGE – EG TYPE III – RUN 13 (TEST 13)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 13 - Test 13/Data Package - EG Type III - Run 13 - Test 13.docx
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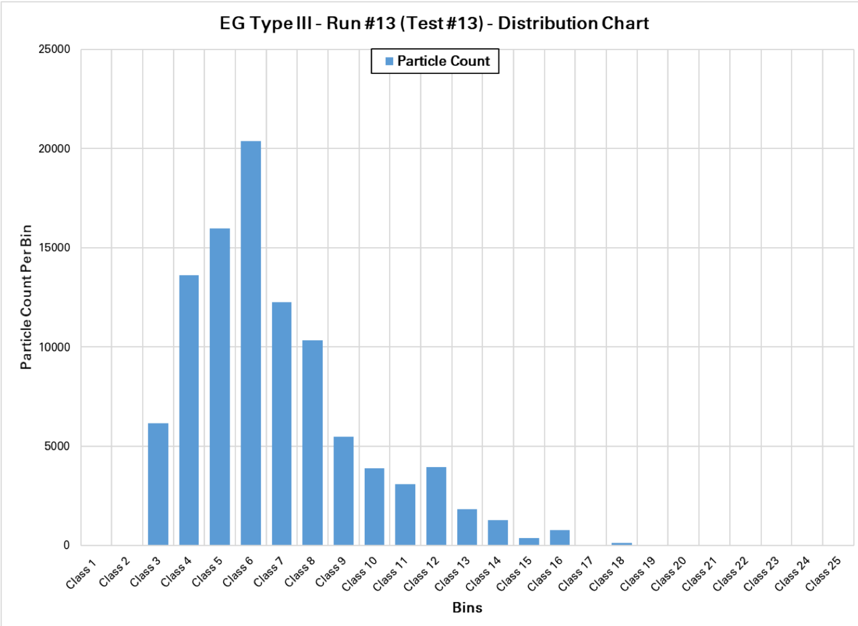
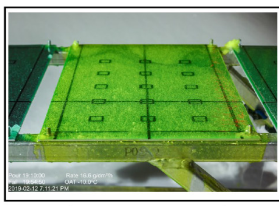
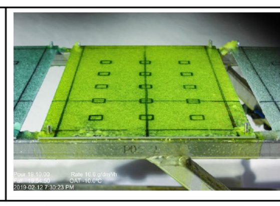


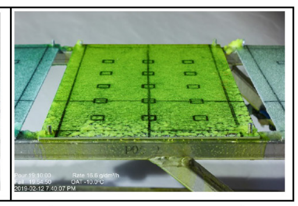
AeroClear MAX – Run 13 (Test 13) – Failure Progression Photos



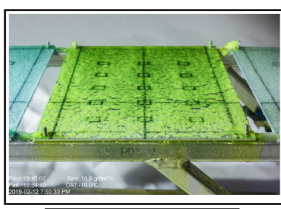
AT POUR (1/44 MIN)



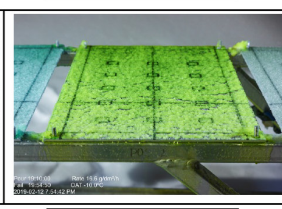
PRE-FAILURE (20/44 MIN)



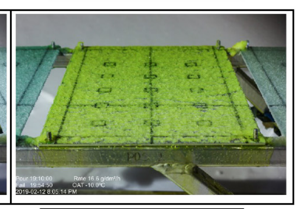
PRE-FAILURE (30/44 MIN)



PRE-FAILURE (40/44 MIN)



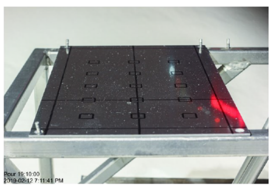
AT FAILURE (44/44 MIN)

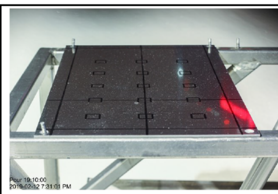


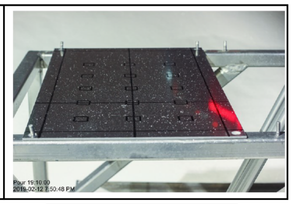
POST-FAILURE (55/44 MIN)

AeroClear MAX – Run 13 (Test 13) – Snow Characteristics Photos

No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)


BARE PLATE (1/44 MIN)


BARE PLATE 21/44 MIN)


BARE PLATE (50/44 MIN)

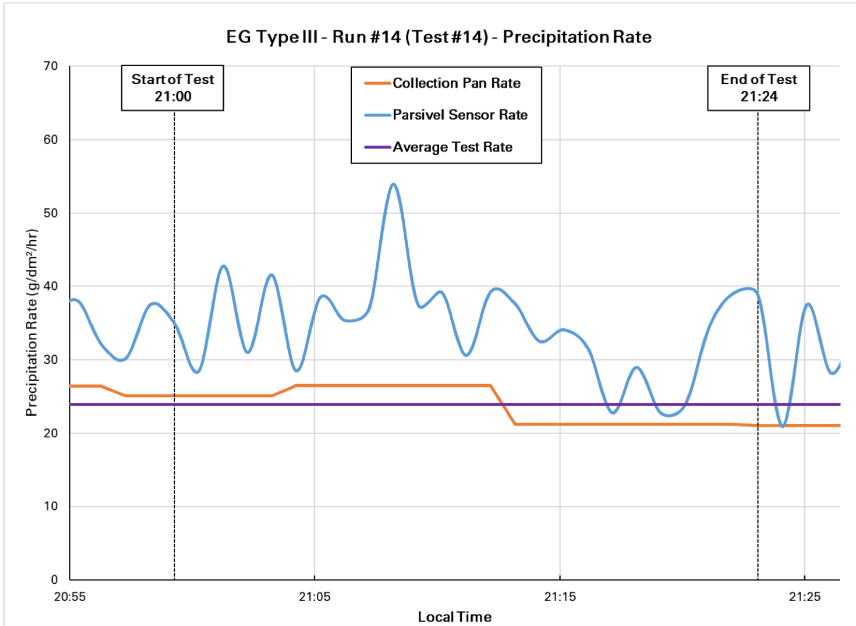
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

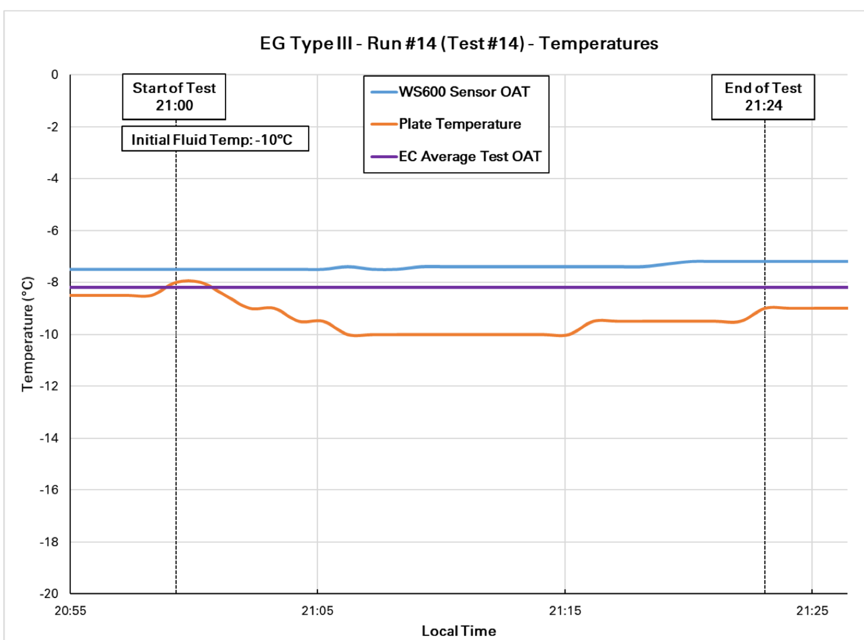
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

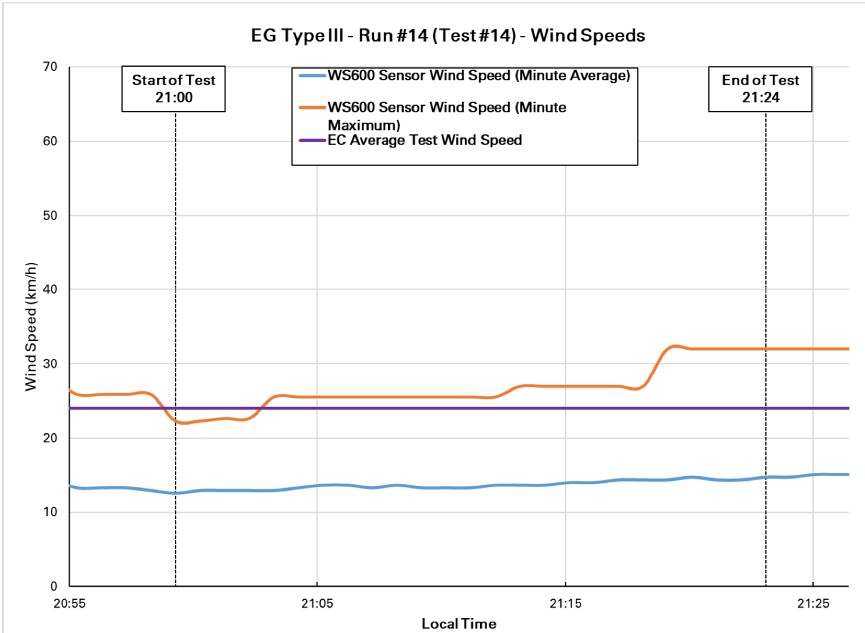
EG TYPE III
RUN #14 (TEST #14) – EG3-14

EG Type III – Run #14 (Test #14) – General Test Information

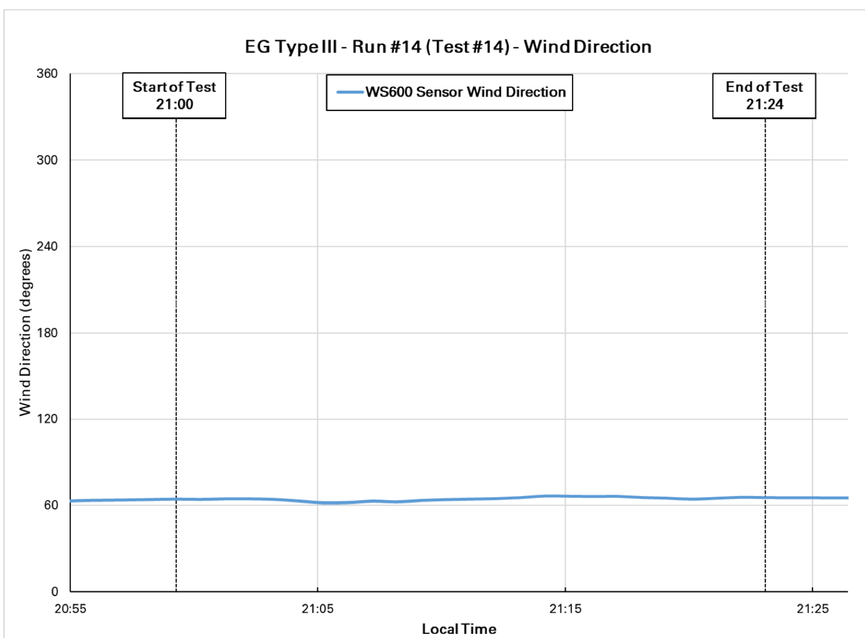
Test Number:	EG3-14
Date of Test:	February 12, 2019
Average OAT:	-8.2
Average Precipitation Rate:	23.9 g/dm²/h
Average Wind Speed:	24 km/h
Average Relative Humidity:	86.1%
Pour Time (Local):	21:00:00
Time of Fluid Failure (Local):	21:24:00
Fluid Brix at Failure:	11.5°
Endurance Time:	24.8 minutes
Expected Regression-Derived Endurance Time:	24.1 minutes
Difference (ET vs. Reg ET):	0.8 minutes (3.2%)


EG Type III - Run #14 (Test #14) - Precipitation Rate
Start of Test
21:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test
21:24
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
20:55
21:05
21:15
21:25
Local Time

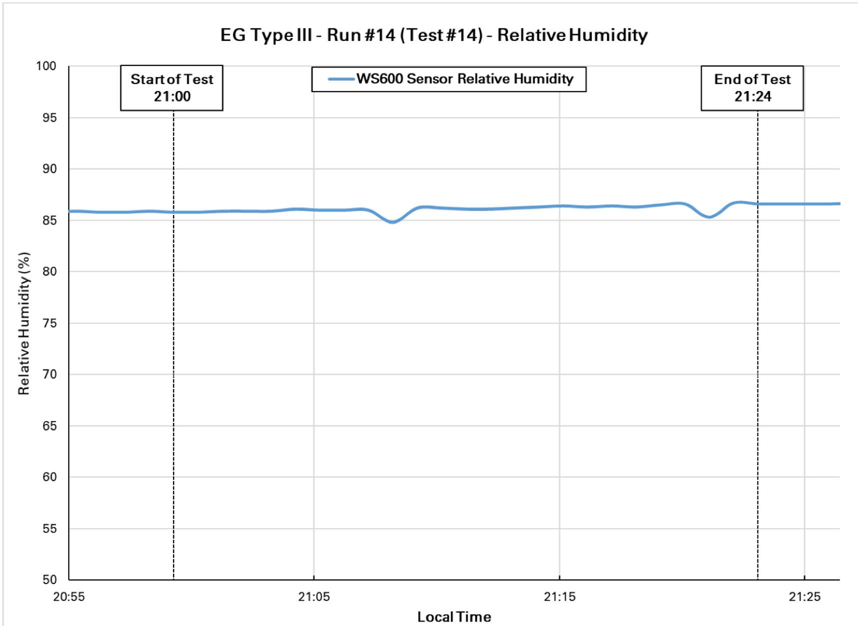

EG Type III - Run #14 (Test #14) - Temperatures
Start of Test
21:00
Initial Fluid Temp: -10°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test
21:24
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
20:55
21:05
21:15
21:25
Local Time

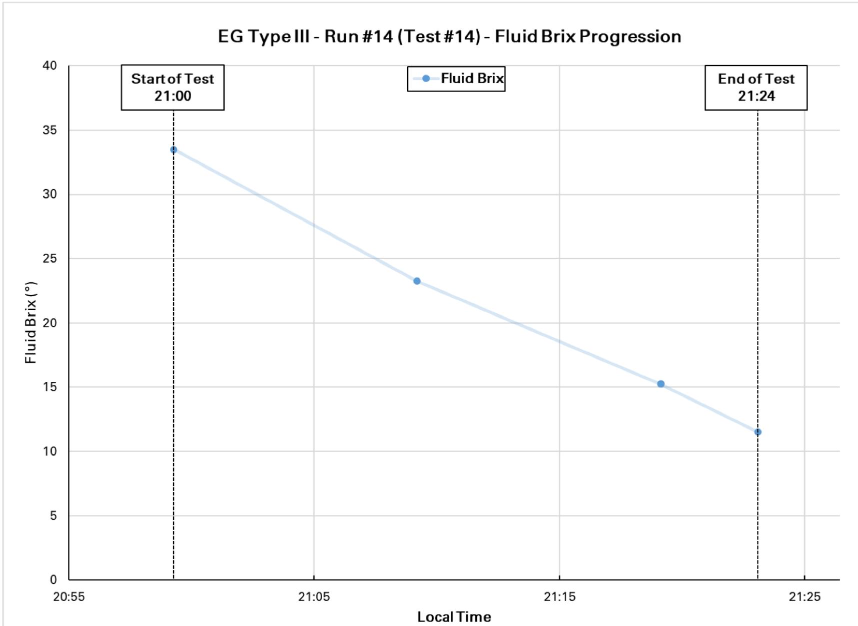


EG Type III - Run #14 (Test #14) - Wind Speeds
Start of Test 21:00
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 21:24
Wind Speed (km/h)
0
10
20
30
40
50
60
70
20:55
21:05
21:15
21:25
Local Time

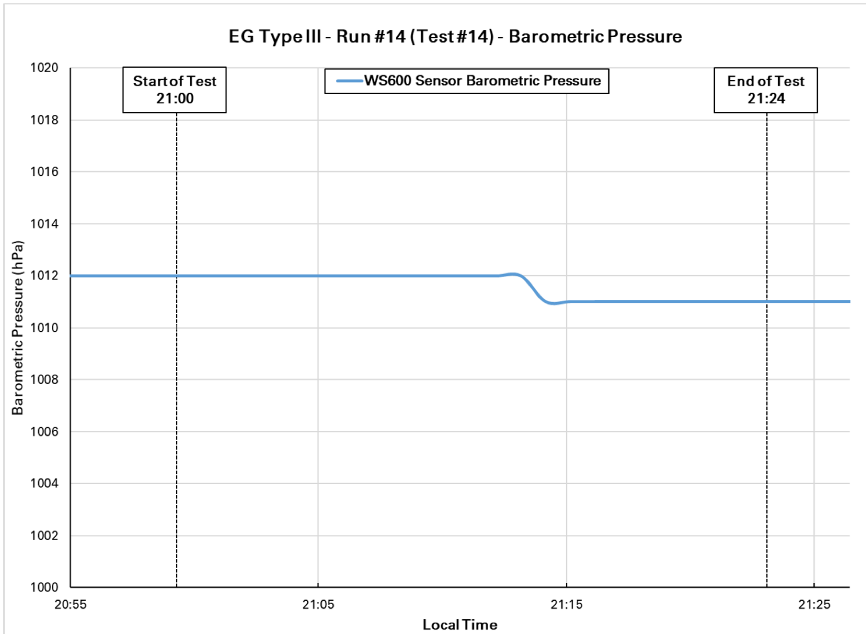


EG Type III - Run #14 (Test #14) - Wind Direction
Start of Test 21:00
WS600 Sensor Wind Direction
End of Test 21:24
Wind Direction (degrees)
0
60
120
180
240
300
360
20:55
21:05
21:15
21:25
Local Time


EG Type III - Run #14 (Test #14) - Relative Humidity
Start of Test 21:00
WS600 Sensor Relative Humidity
End of Test 21:24
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:55
21:05
21:15
21:25
Local Time


EG Type III - Run #14 (Test #14) - Fluid Brix Progression
Start of Test 21:00
Fluid Brix
End of Test 21:24
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:55
21:05
21:15
21:25
Local Time

DATA PACKAGE – EG TYPE III – RUN 14 (TEST 14)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 14 - Test 14/Data Package - EG Type III - Run 14 - Test 14.docx
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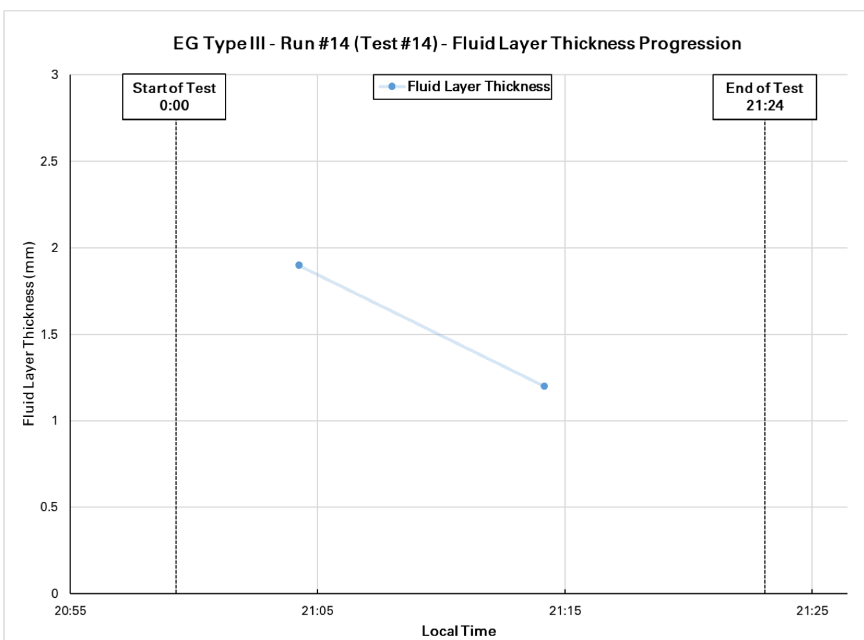
DATA PACKAGE – EG TYPE III – RUN 14 (TEST 14)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 14 - Test 14/Data Package - EG Type III - Run 14 - Test 14.docx
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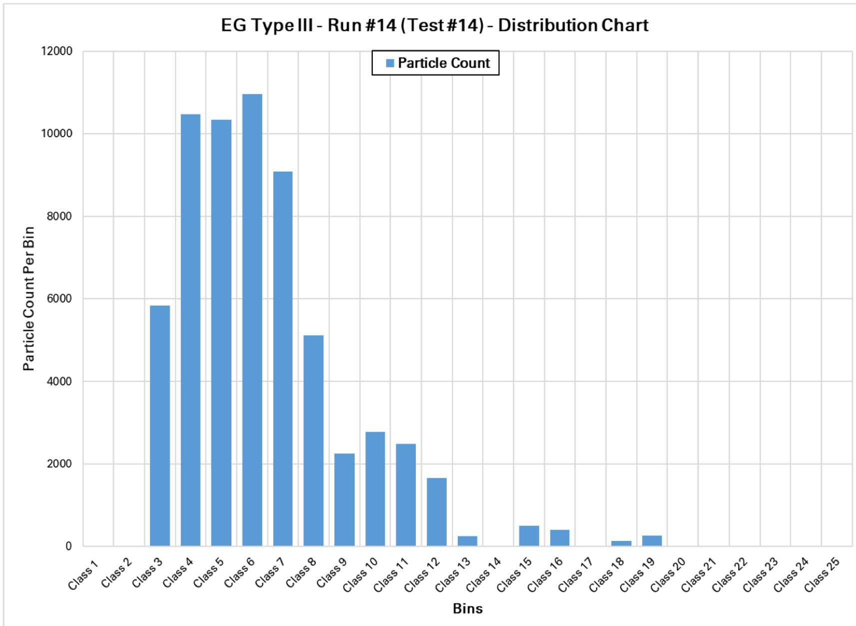
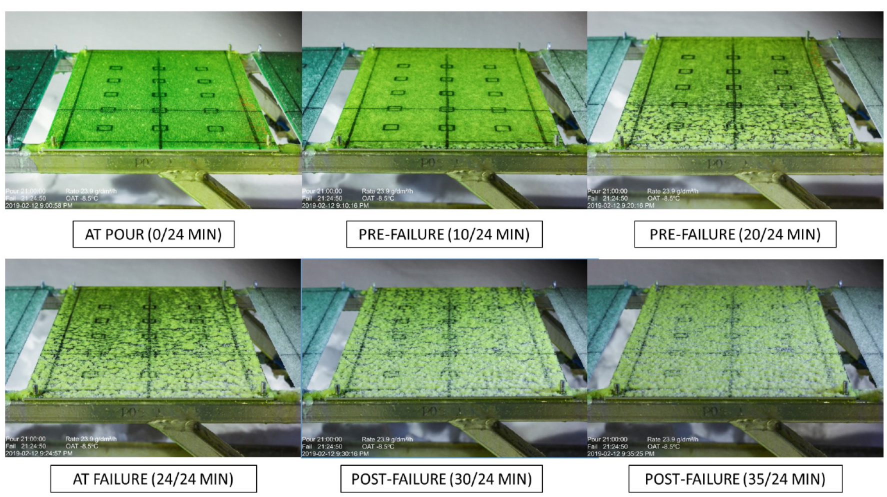
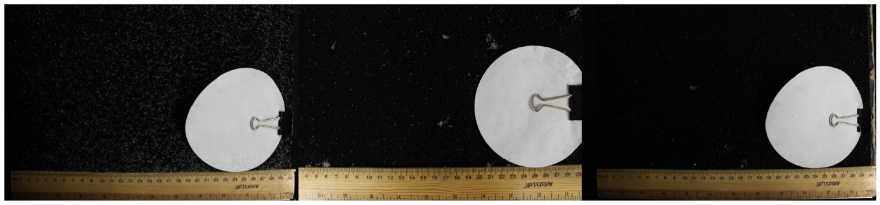


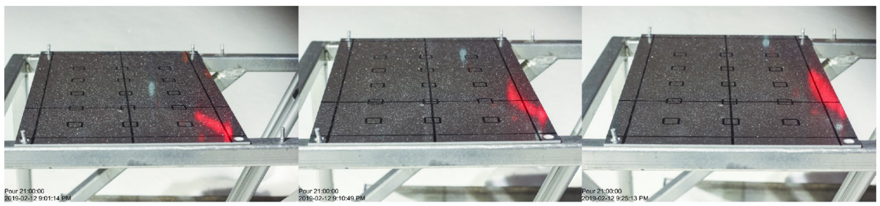
AeroClear MAX – Run 14 (Test 14) – Failure Progression Photos



AeroClear MAX – Run 14 (Test 14) – Snow Characteristics Photos



FELT PAD (1/24 MIN) FELT PAD (10/24 MIN) FELT PAD (20/24 MIN)



BARE PLATE (1/24 MIN) BARE PLATE (10/24 MIN) BARE PLATE (25/24 MIN)

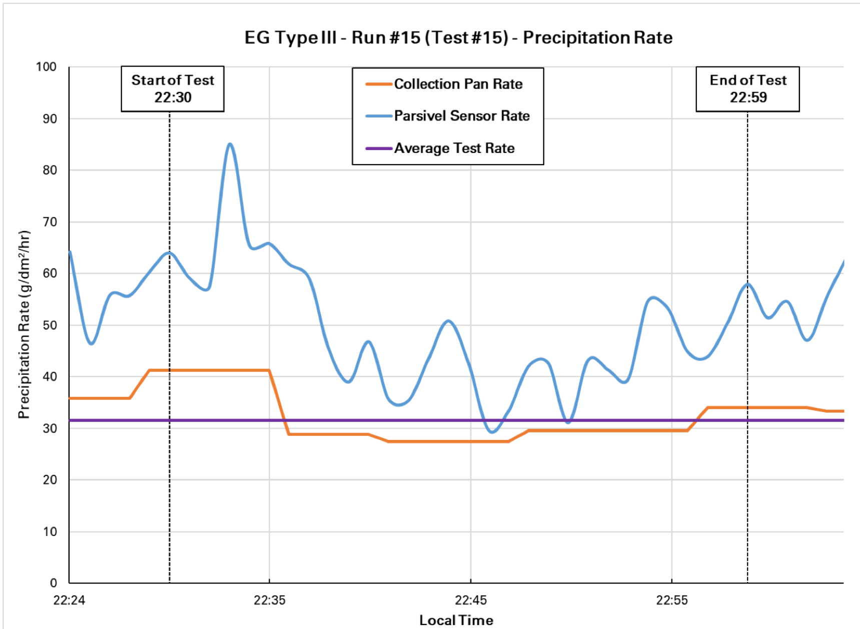
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

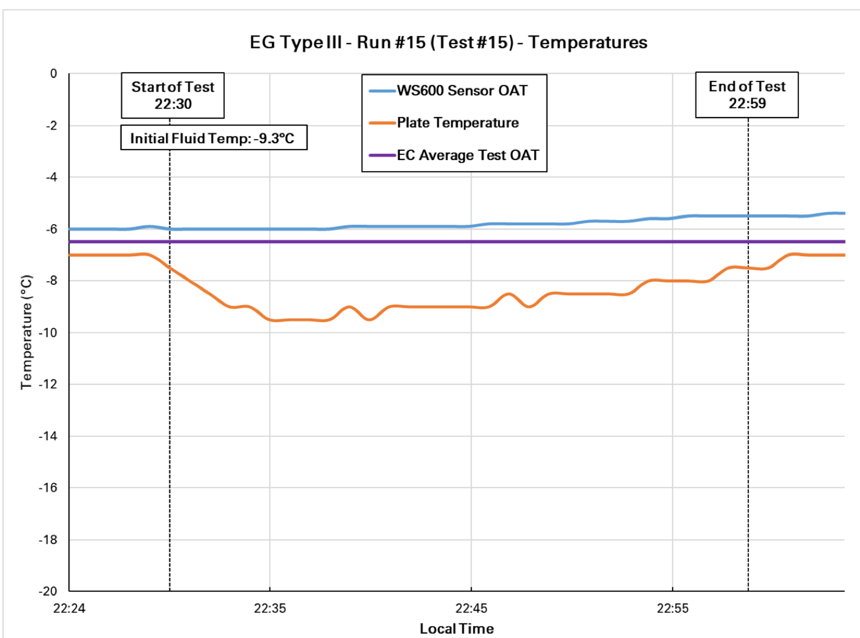
EG TYPE III
RUN #15 (TEST #15) – EG3-15

EG Type III – Run #15 (Test #15) – General Test Information

Test Number:	**EG3-15**
Date of Test:	**February 12, 2019**
Average OAT:	**-6.5**
Average Precipitation Rate:	**31.6 g/dm²/h**
Average Wind Speed:	**23 km/h**
Average Relative Humidity:	**88.8%**
Pour Time (Local):	**22:30:00**
Time of Fluid Failure (Local):	**22:59:00**
Fluid Brix at Failure:	**15.5°**
Endurance Time:	**29.7 minutes**
Expected Regression-Derived Endurance Time:	**20 minutes**
Difference (ET vs. Reg ET):	**+9.7 minutes (+48.3%)**

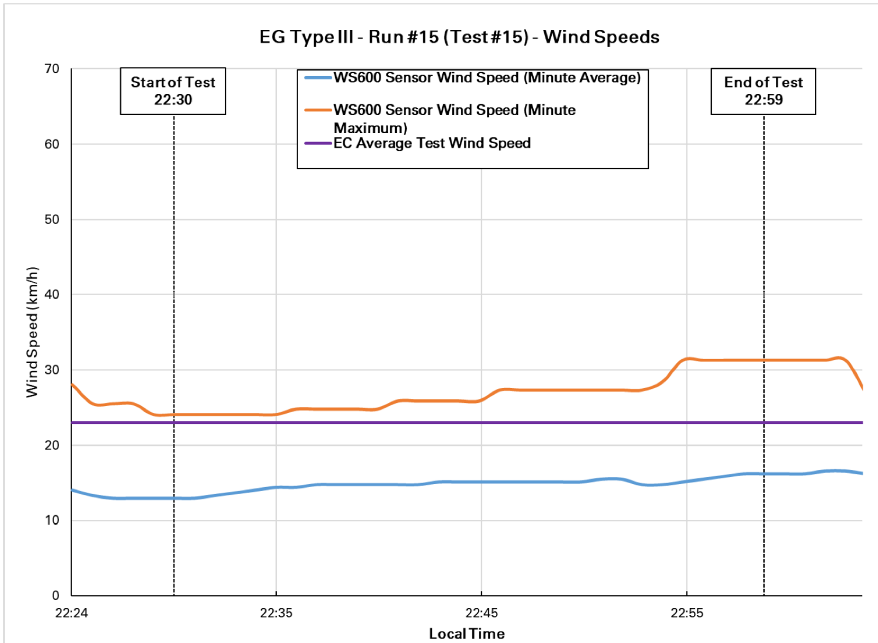


EG Type III - Run #15 (Test #15) - Precipitation Rate
Start of Test 22:30
End of Test 22:59
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
100
90
80
70
60
50
40
30
20
10
0
22:24
22:35
22:45
22:55
Local Time



EG Type III - Run #15 (Test #15) - Temperatures
Start of Test 22:30
Initial Fluid Temp: -9.3°C
End of Test 22:59
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
22:24
22:35
22:45
22:55
Local Time

DATA PACKAGE – EG TYPE III – RUN 15 (TEST 15)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 15 - Test 15/Data Package - EG Type III - Run 15 - Test 15.docx
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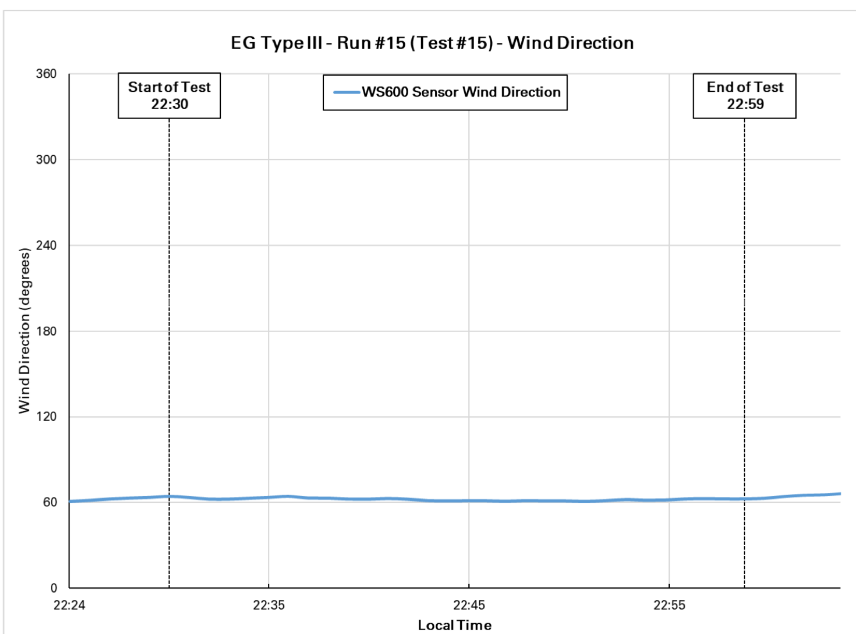
DATA PACKAGE – EG TYPE III – RUN 15 (TEST 15)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 15 - Test 15/Data Package - EG Type III - Run 15 - Test 15.docx
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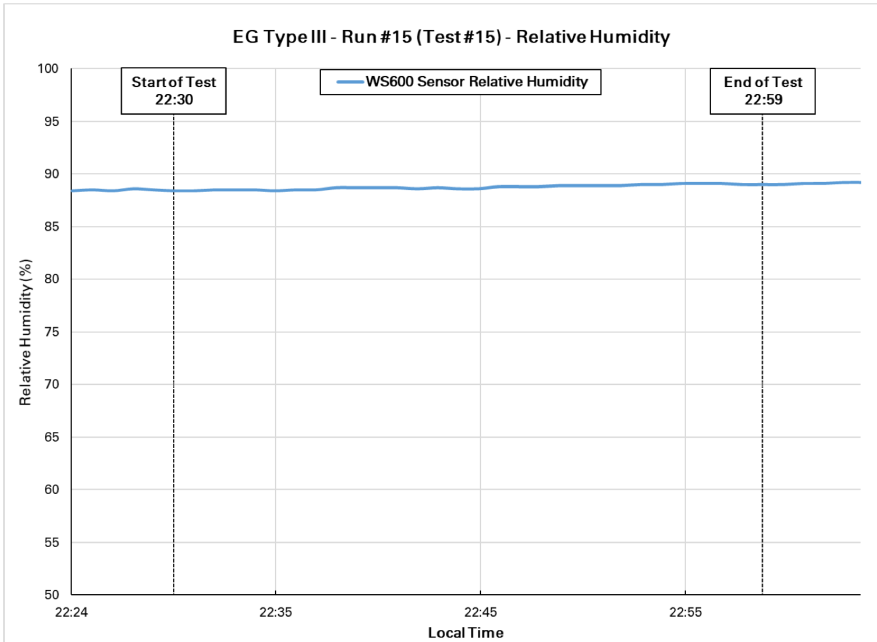
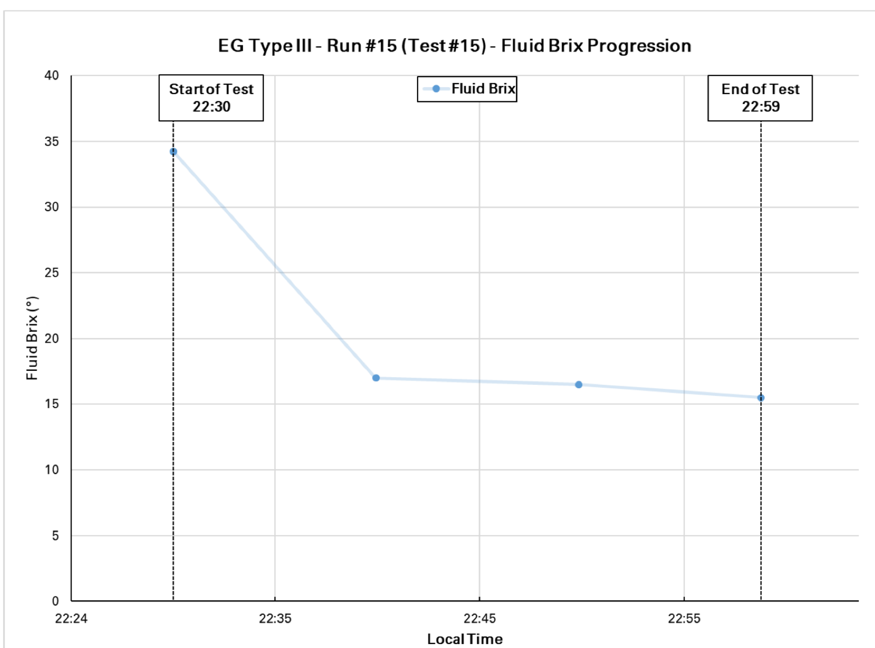
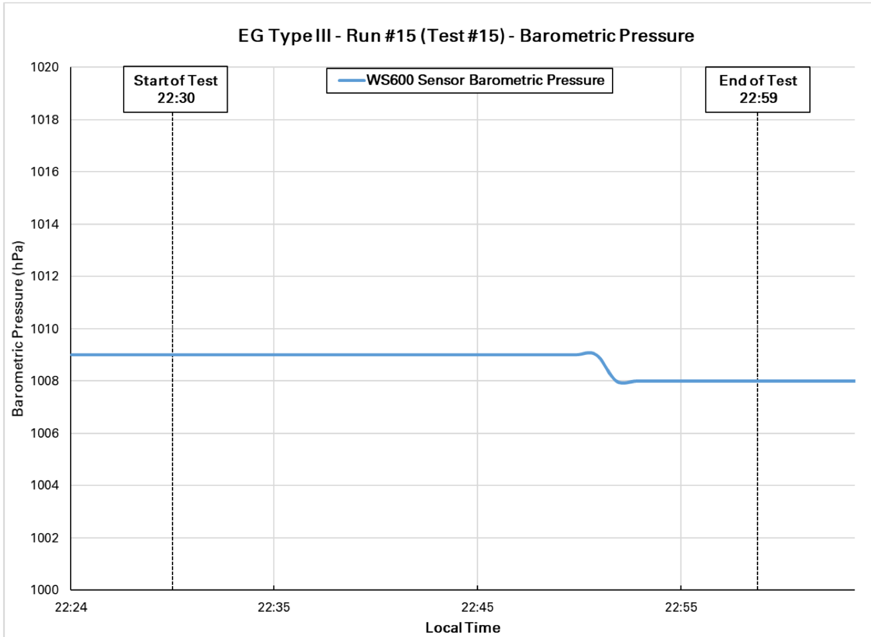
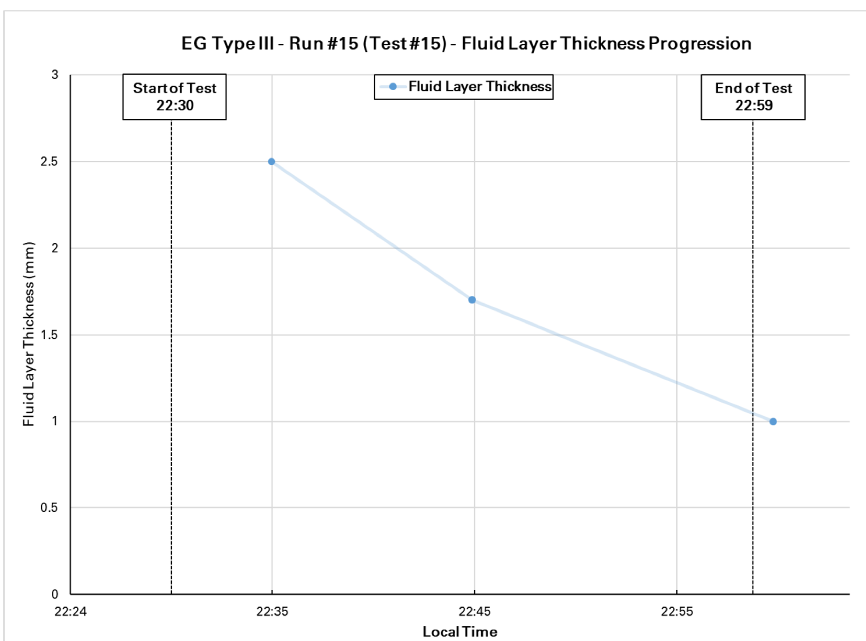

EG Type III - Run #15 (Test #15) - Relative Humidity
Start of Test 22:30
WS600 Sensor Relative Humidity
End of Test 22:59
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
22:24
22:35
22:45
22:55
Local Time

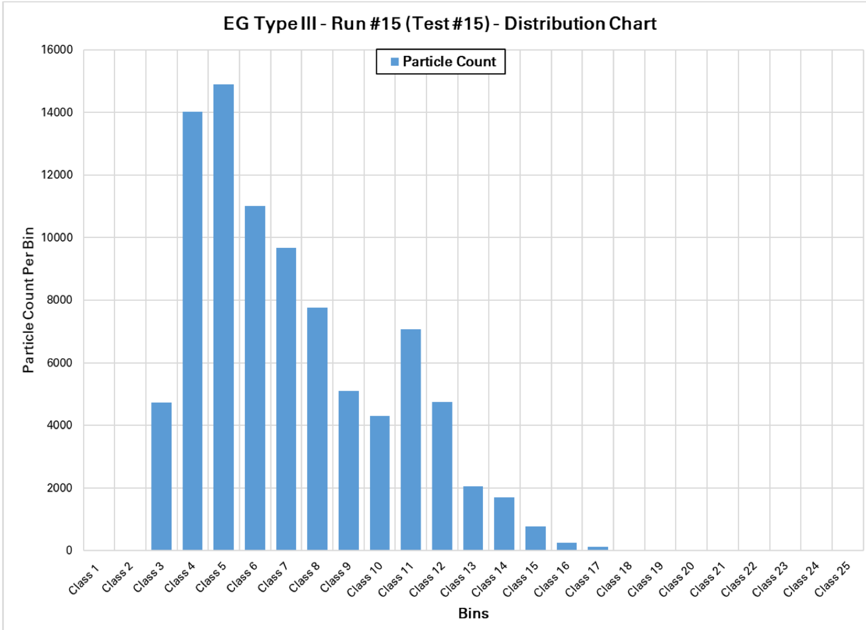

EG Type III - Run #15 (Test #15) - Fluid Brix Progression
Start of Test 22:30
Fluid Brix
End of Test 22:59
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
22:24
22:35
22:45
22:55
Local Time



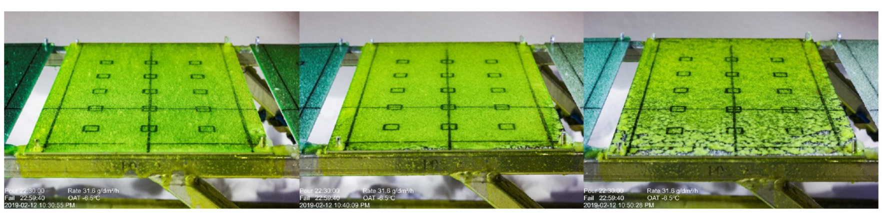
EG Type III - Run #15 (Test #15) - Barometric Pressure
Start of Test 22:30
WS600 Sensor Barometric Pressure
End of Test 22:59
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
22:24
22:35
22:45
22:55
Local Time



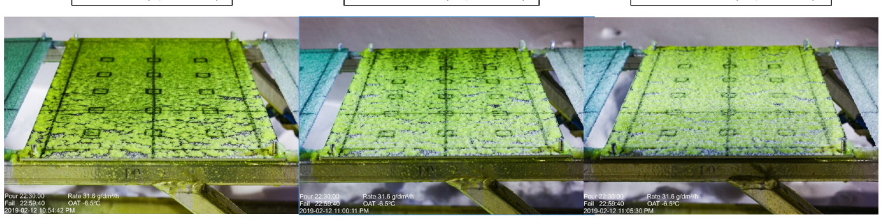
EG Type III - Run #15 (Test #15) - Fluid Layer Thickness Progression
Start of Test 22:30
Fluid Layer Thickness
End of Test 22:59
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
22:24
22:35
22:45
22:55
Local Time



AeroClear MAX – Run 15 (Test 15) – Failure Progression Photos

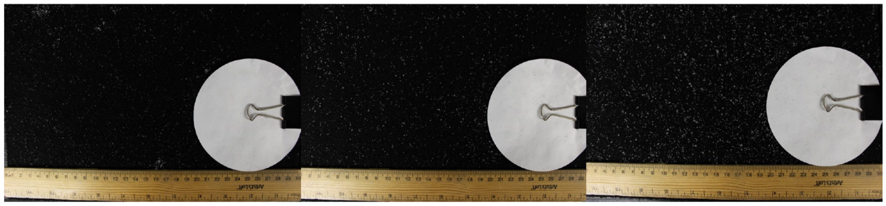


AT POUR (0/29 MIN) | PRE-FAILURE (10/29 MIN) | PRE-FAILURE (20/29 MIN)



PRE-FAILURE (24/29 MIN) | POST-FAILURE (30/29 MIN) | POST-FAILURE (35/29 MIN)

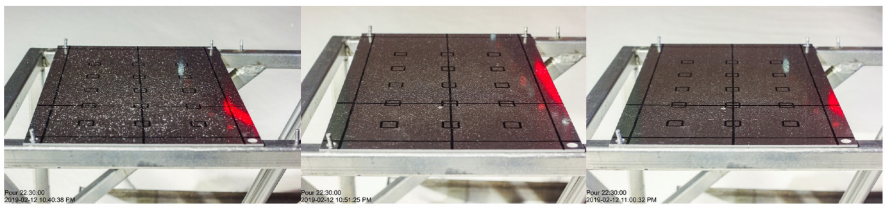
AeroClear MAX – Run 15 (Test 15) – Snow Characteristics Photos



FELT PAD (0/29 MIN)

FELT PAD (20/29 MIN)

FELT PAD (30/29 MIN)



BARE PLATE (10/29 MIN)

BARE PLATE (21/29 MIN)

BARE PLATE (30/29 MIN)

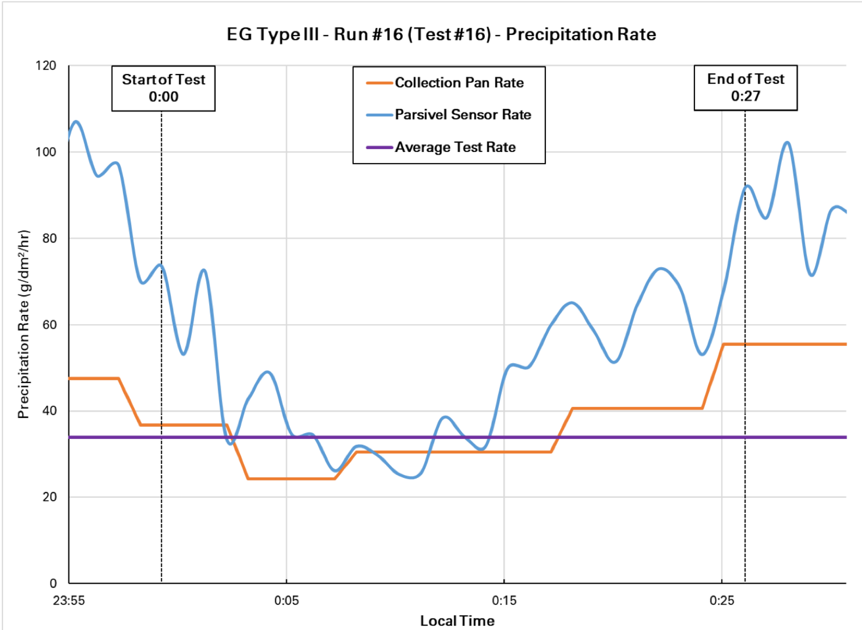
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

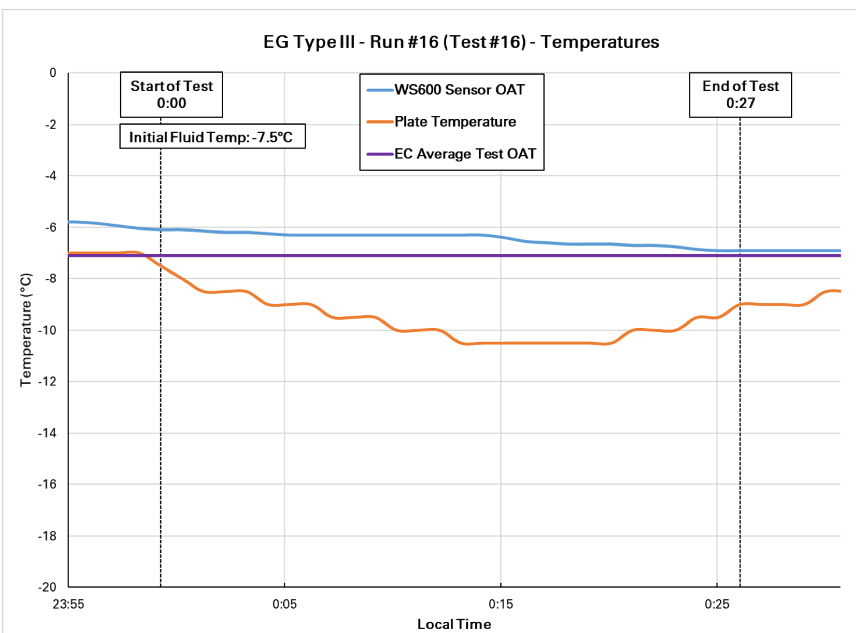
EG TYPE III
RUN #16 (TEST #16) – EG3-16

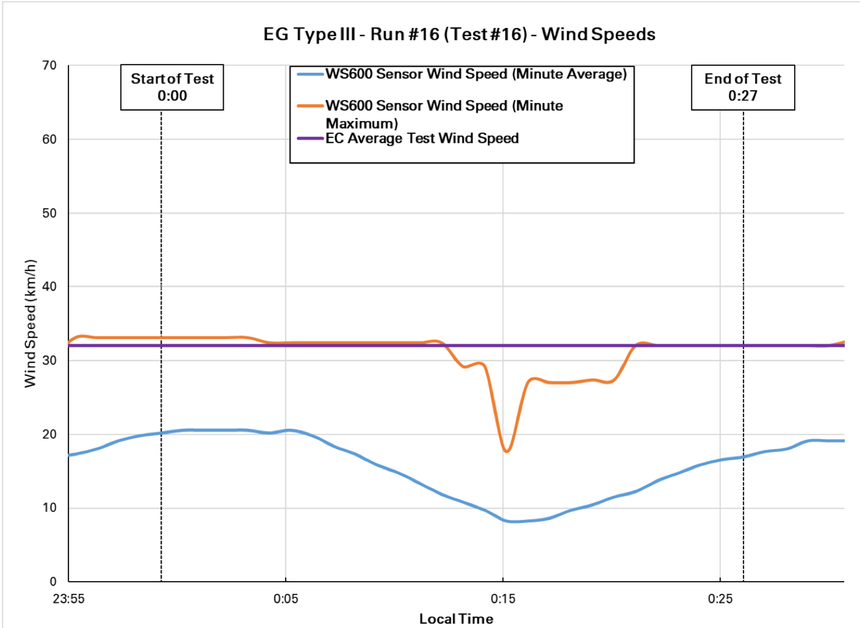
EG Type III – Run #16 (Test #16) – General Test Information

Test Number:	EG3-16
Date of Test:	February 13, 2019
Average OAT:	-7.1
Average Precipitation Rate:	33.9 g/dm²/h
Average Wind Speed:	32 km/h
Average Relative Humidity:	88.6%
Pour Time (Local):	0:00:00
Time of Fluid Failure (Local):	0:27:00
Fluid Brix at Failure:	13.25°
Endurance Time:	27.5 minutes
Expected Regression-Derived Endurance Time:	19.1 minutes
Difference (ET vs. Reg ET):	+8.4 minutes (+43.9%)

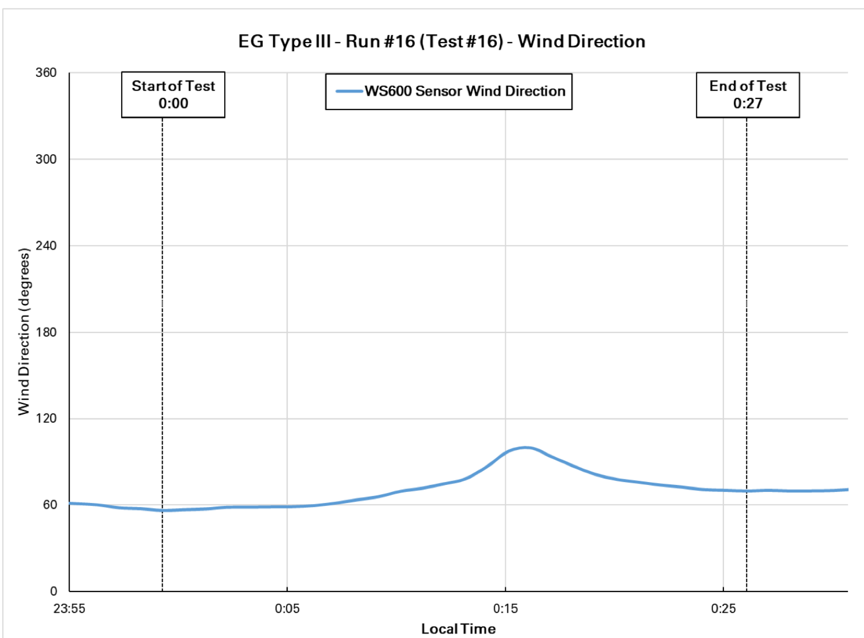


DATA PACKAGE – EG TYPE III – RUN 16 (TEST 16)

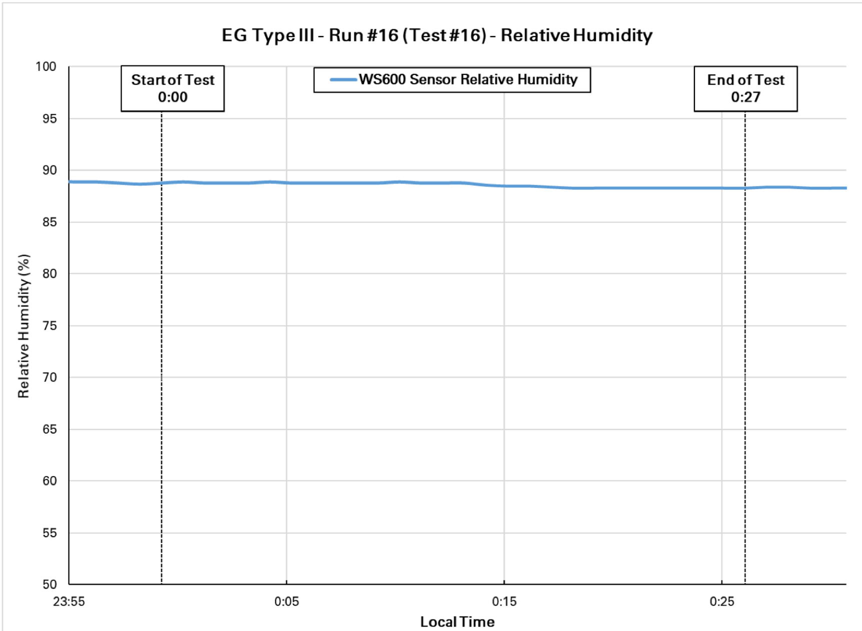




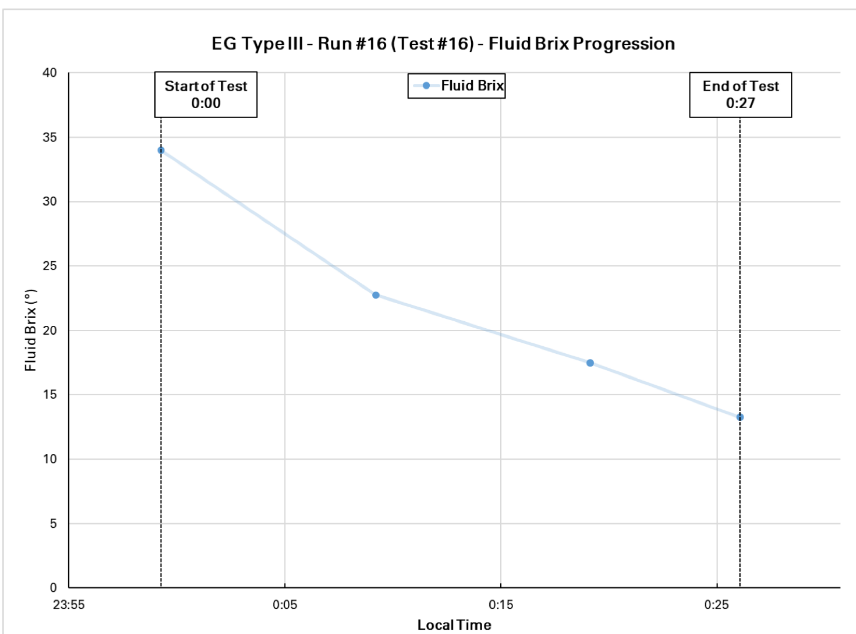
EG Type III - Run #16 (Test #16) - Wind Speeds
Start of Test 0:00
End of Test 0:27
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
23:55
0:05
0:15
0:25
Local Time



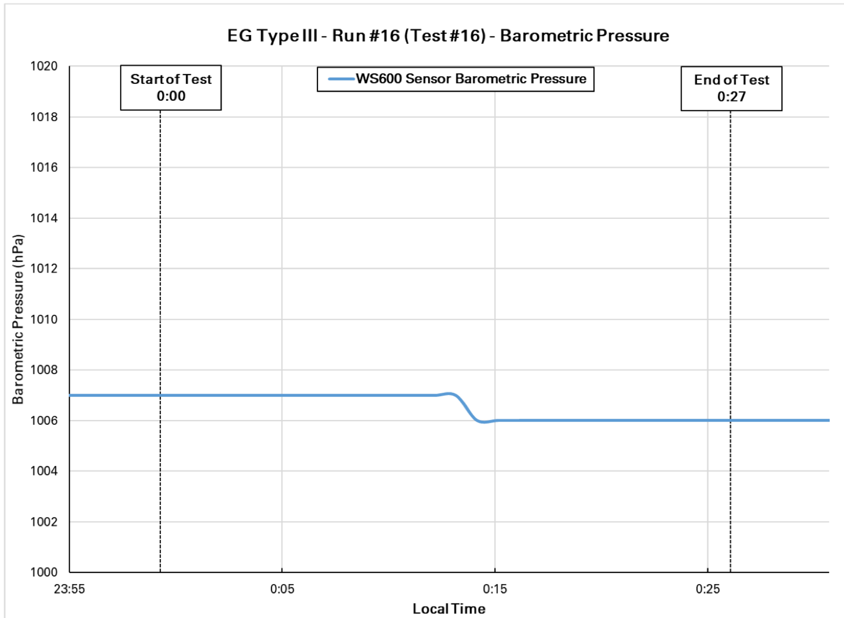
EG Type III - Run #16 (Test #16) - Wind Direction
Start of Test 0:00
WS600 Sensor Wind Direction
End of Test 0:27
Wind Direction (degrees)
360
300
240
180
120
60
0
23:55
0:05
0:15
0:25
Local Time



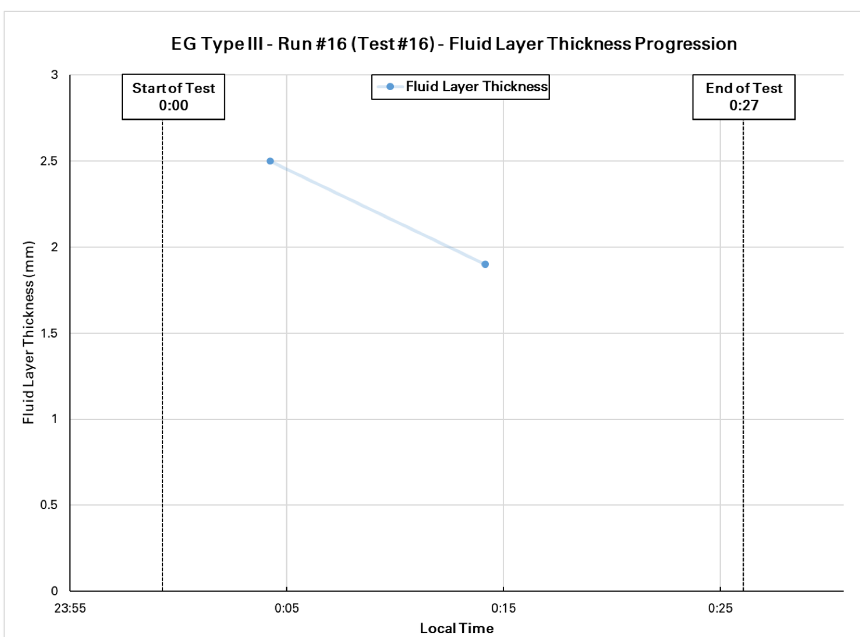
EG Type III - Run #16 (Test #16) - Relative Humidity
Start of Test 0:00
WS600 Sensor Relative Humidity
End of Test 0:27
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
23:55
0:05
0:15
0:25
Local Time



EG Type III - Run #16 (Test #16) - Fluid Brix Progression
Start of Test 0:00
Fluid Brix
End of Test 0:27
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
23:55
0:05
0:15
0:25
Local Time

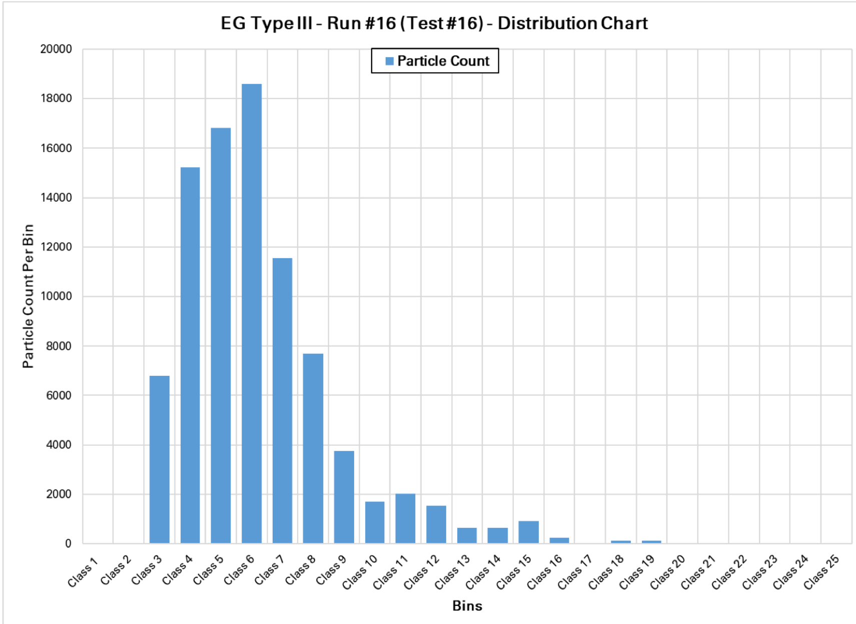


EG Type III - Run #16 (Test #16) - Barometric Pressure
Start of Test 0:00
WS600 Sensor Barometric Pressure
End of Test 0:27
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
23:55
0:05
0:15
0:25
Local Time



EG Type III - Run #16 (Test #16) - Fluid Layer Thickness Progression
Start of Test 0:00
Fluid Layer Thickness
End of Test 0:27
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
23:55
0:05
0:15
0:25
Local Time

DATA PACKAGE – EG TYPE III – RUN 16 (TEST 16)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 16 - Test 16/Data Package - EG Type III - Run 16 - Test 16.docx
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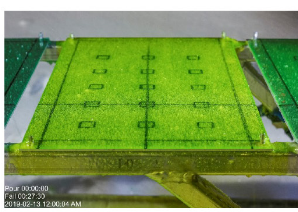
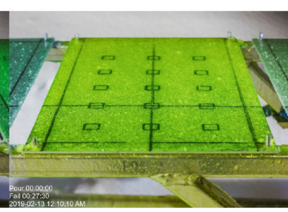
DATA PACKAGE – EG TYPE III – RUN 16 (TEST 16)

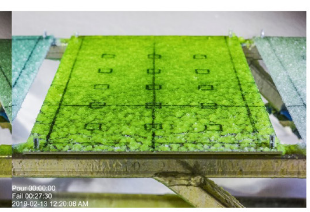
AeroClear MAX – Run 16 (Test 16) – Failure Progression Photos



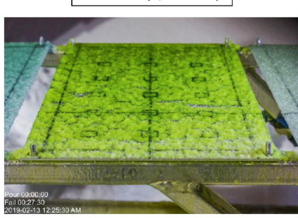
AT POUR (0/27 MIN)



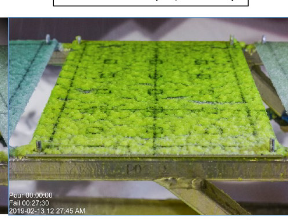
PRE-FAILURE (10/27 MIN)



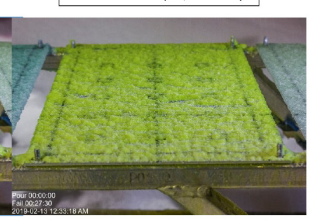
PRE-FAILURE (20/27 MIN)



PRE-FAILURE (25/27 MIN)



AT FAILURE (27/27 MIN)



POST-FAILURE (33/27 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 16 - Test 16/Data Package - EG Type III - Run 16 - Test 16.docx
Final Version 1.0, February 2021

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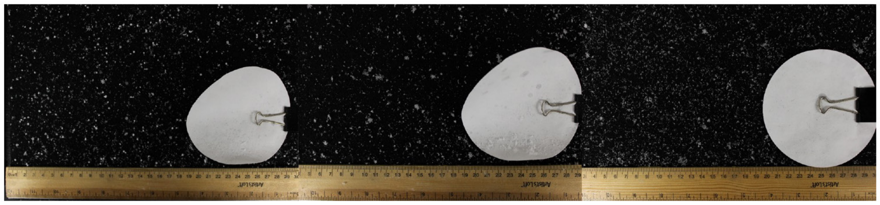
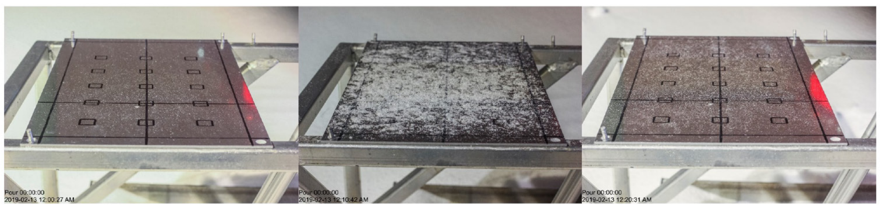
AeroClear MAX – Run 16 (Test 16) – Snow Characteristics Photos



FELT PAD (0/27 MIN) | FELT PAD (19/27 MIN) | FELT PAD (30/27 MIN)



BARE PLATE (0/27 MIN) | BARE PLATE (10/27 MIN) | BARE PLATE (20/27 MIN)

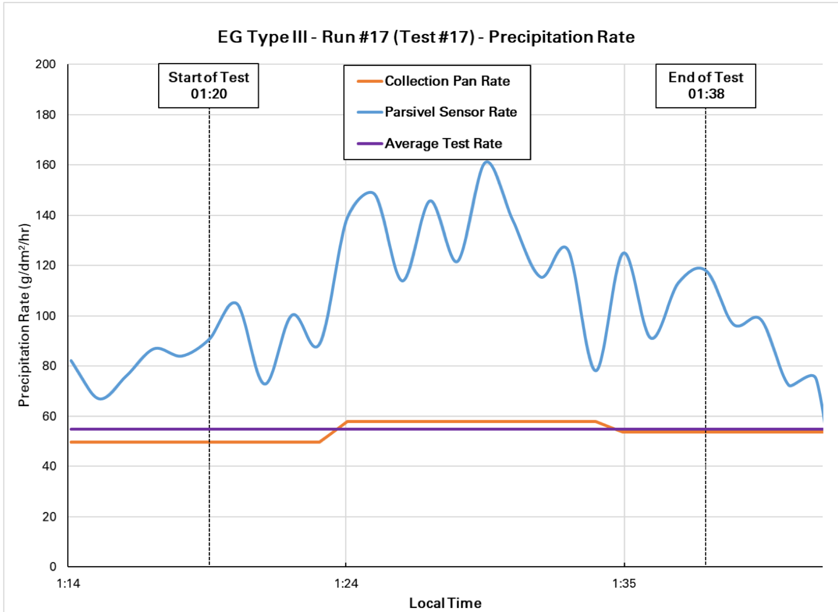
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

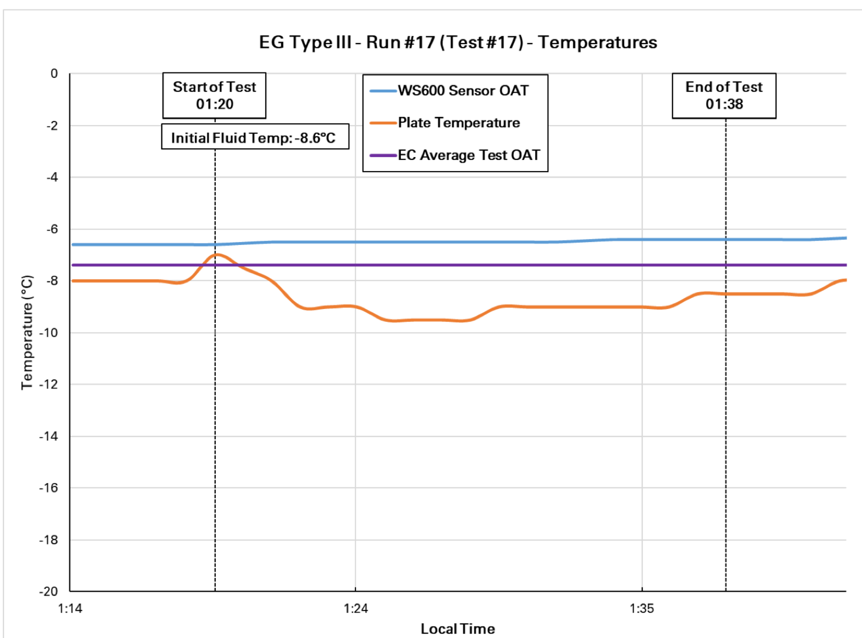
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

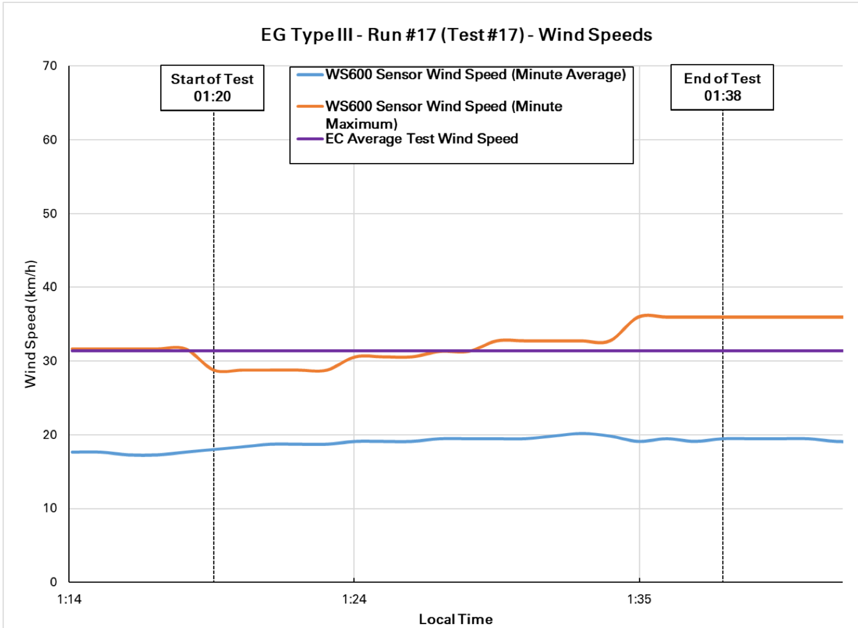
EG TYPE III
RUN #17 (TEST #17) – EG3-17

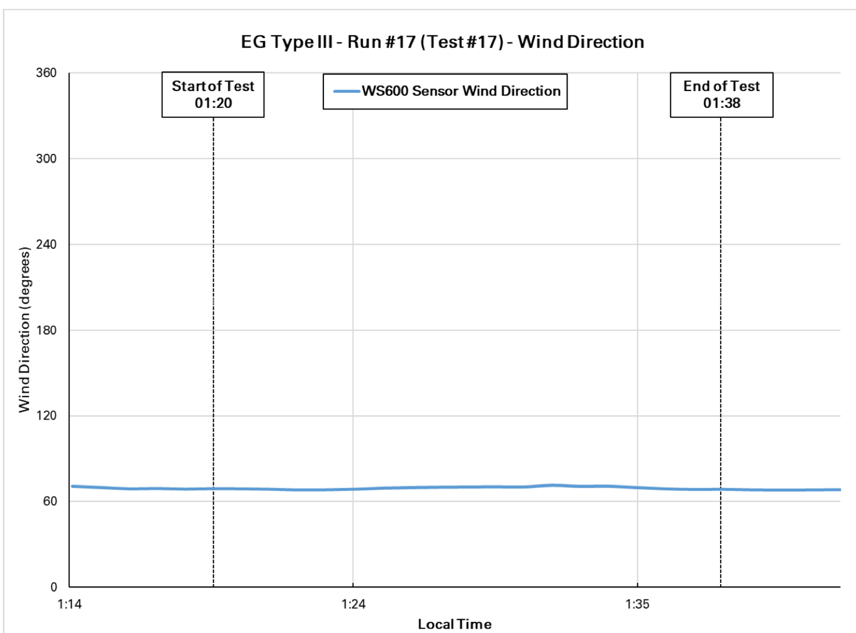
EG Type III – Run #17 (Test #17) – General Test Information

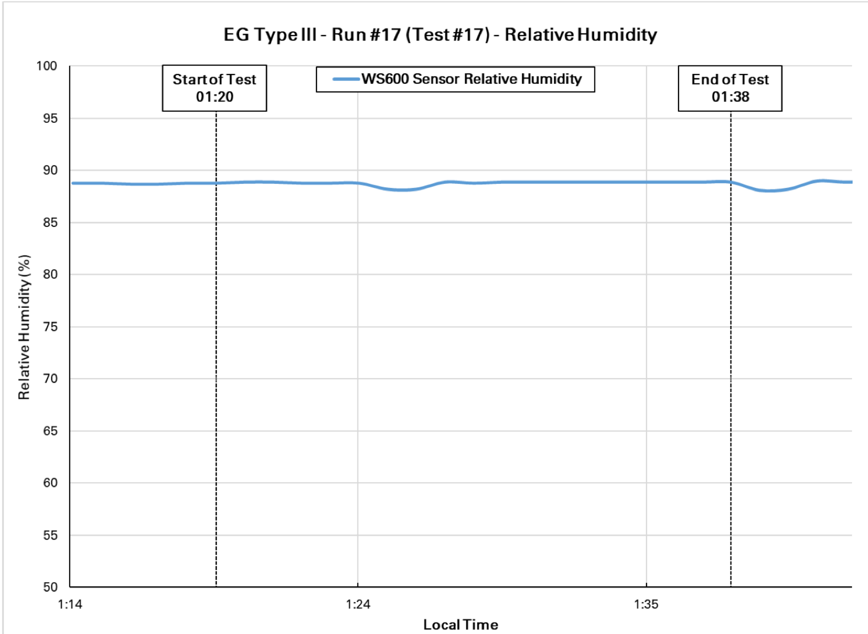
Test Number:	**EG3-17**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.4**
Average Precipitation Rate:	**54.9 g/dm²/h**
Average Wind Speed:	**31.4 km/h**
Average Relative Humidity:	**88.7%**
Pour Time (Local):	**01:20:00**
Time of Fluid Failure (Local):	**01:38:00**
Fluid Brix at Failure:	**13.25°**
Endurance Time:	**18 minutes**
Expected Regression-Derived Endurance Time:	**13.9 minutes**
Difference (ET vs. Reg ET):	**+4.4 minutes (+31.6%)**


EG Type III - Run #17 (Test #17) - Precipitation Rate
Start of Test 01:20
End of Test 01:38
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
200
180
160
140
120
100
80
60
40
20
0
1:14
1:24
1:35
Local Time

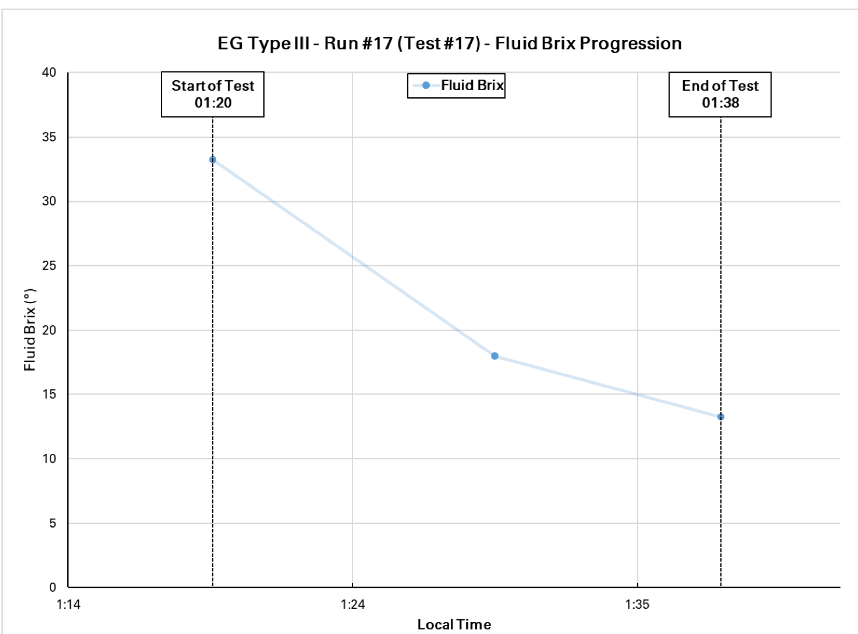

EG Type III - Run #17 (Test #17) - Temperatures
Start of Test 01:20
Initial Fluid Temp: -8.6°C
End of Test 01:38
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
1:14
1:24
1:35
Local Time

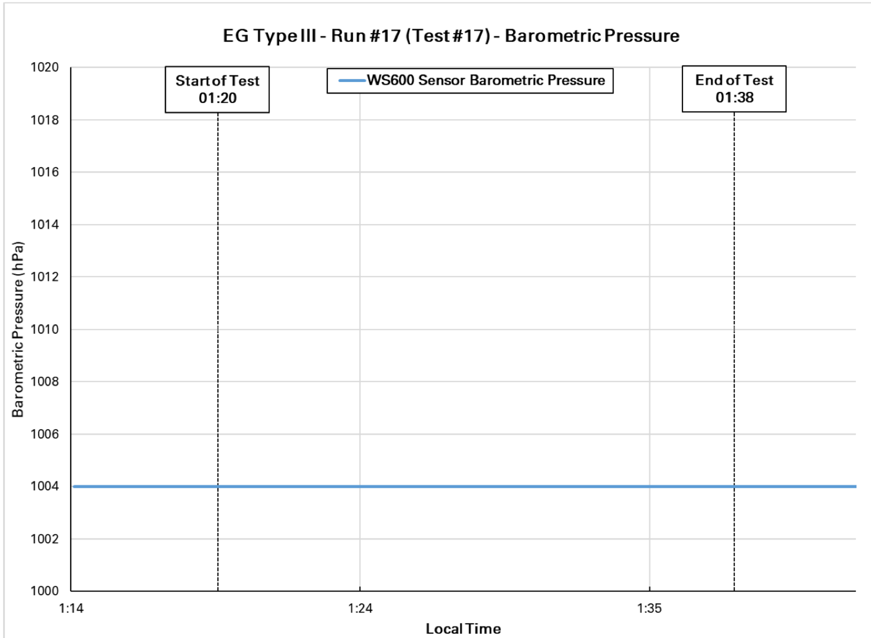

EG Type III - Run #17 (Test #17) - Wind Speeds
Start of Test 01:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 01:38
Wind Speed (km/h)
70
60
50
40
30
20
10
0
1:14
1:24
1:35
Local Time


EG Type III - Run #17 (Test #17) - Wind Direction
Start of Test 01:20
WS600 Sensor Wind Direction
End of Test 01:38
Wind Direction (degrees)
360
300
240
180
120
60
0
1:14
1:24
1:35
Local Time

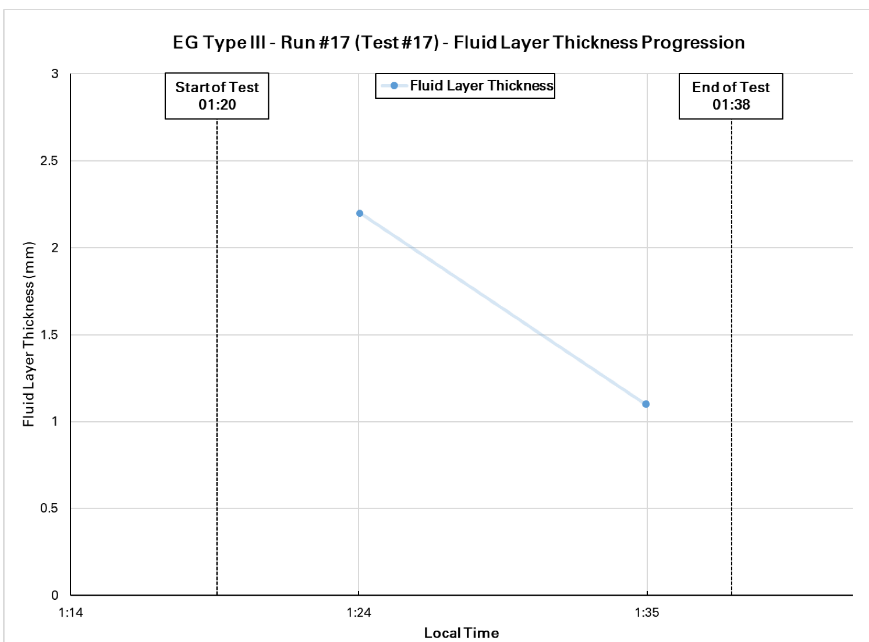


DATA PACKAGE – EG TYPE III – RUN 17 (TEST 17)

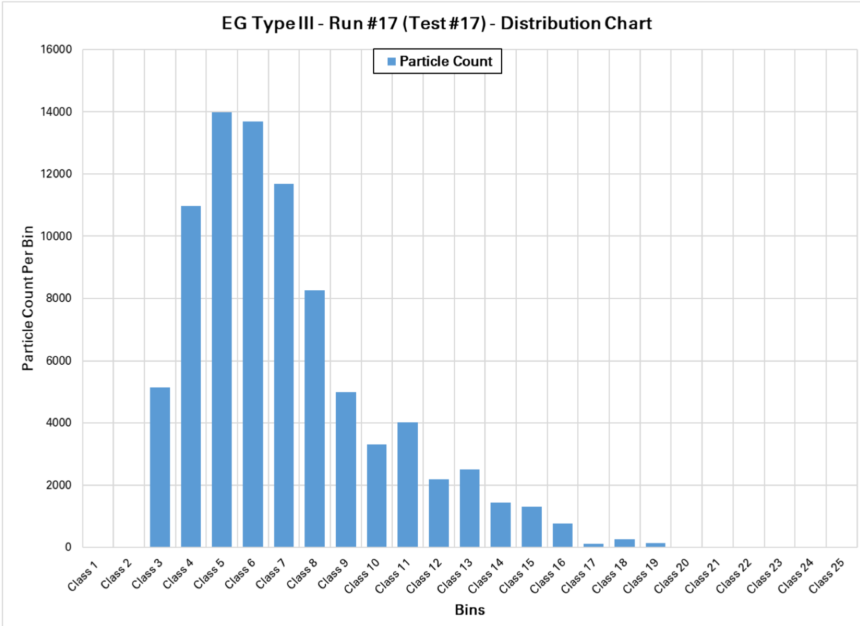




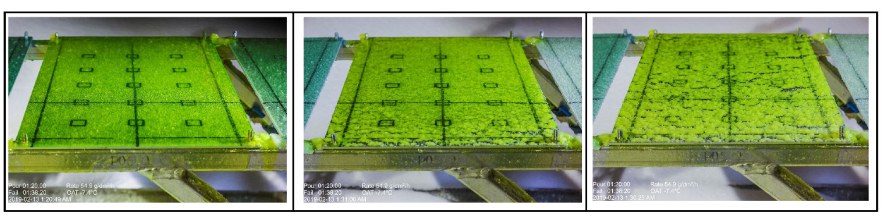
EG Type III - Run #17 (Test #17) - Barometric Pressure
Start of Test 01:20
WS600 Sensor Barometric Pressure
End of Test 01:38
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
1:14
1:24
1:35
Local Time



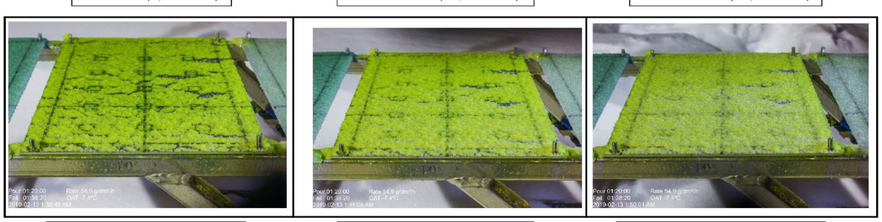
EG Type III - Run #17 (Test #17) - Fluid Layer Thickness Progression
Start of Test 01:20
Fluid Layer Thickness
End of Test 01:38
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
1:14
1:24
1:35
Local Time



AeroClear MAX – Run 17 (Test 17) – Failure Progression Photos

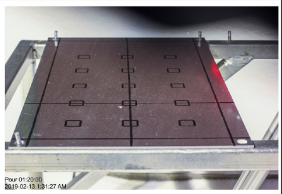


AT POUR (0/18 MIN) | PRE-FAILURE (11/18 MIN) | PRE-FAILURE (16/18 MIN)



AT FAILURE (18/18 MIN) | POST-FAILURE (24/18 MIN) | POST-FAILURE (30/18 MIN)

AeroClear MAX – Run 17 (Test 17) – Snow Characteristics Photos

No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
	No Bare Plate photos exist	No Bare Plate photos exist
BARE PLATE (11/18 MIN)	BARE PLATE XX/XX MIN)	BARE PLATE (XX/XX MIN)

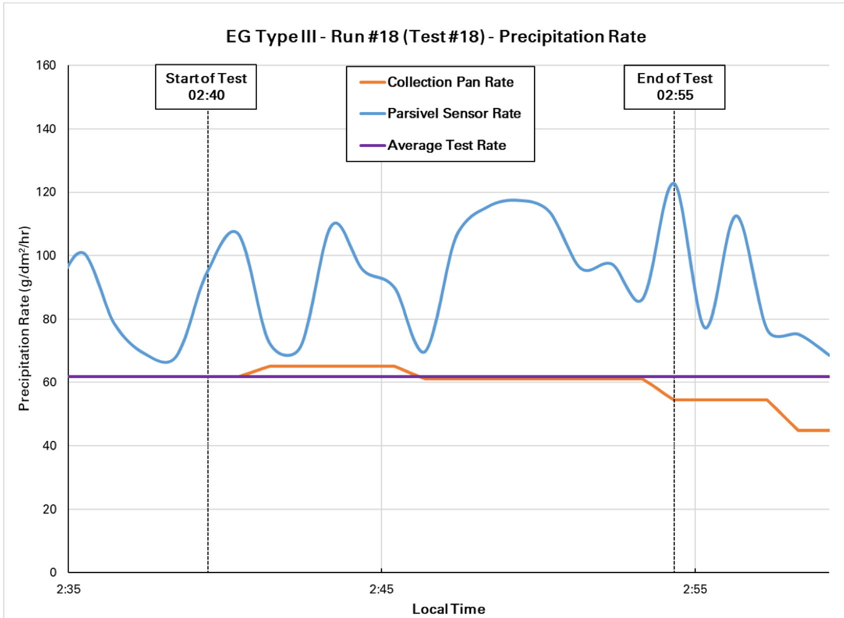
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

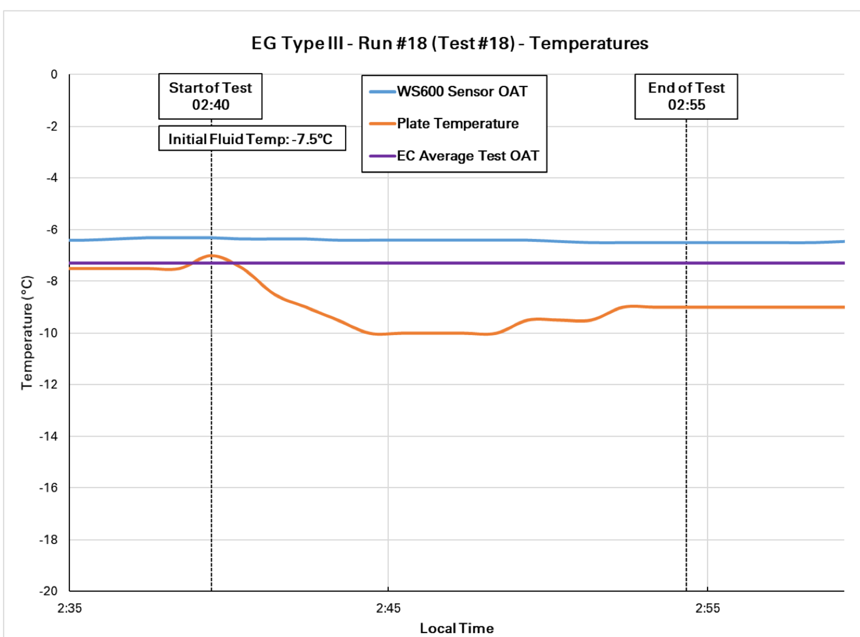
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

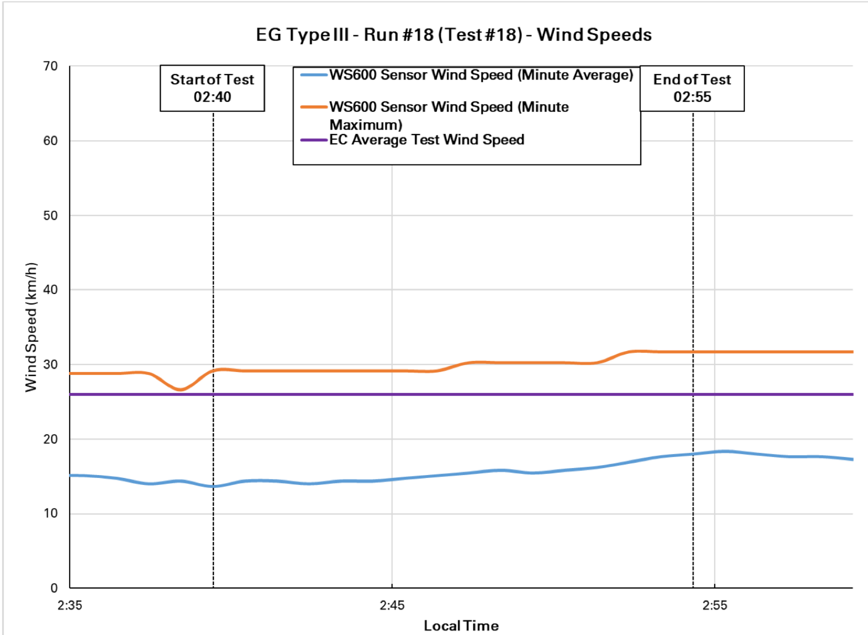
EG TYPE III
RUN #18 (TEST #18) – EG3-18

EG Type III – Run #18 (Test #18) – General Test Information

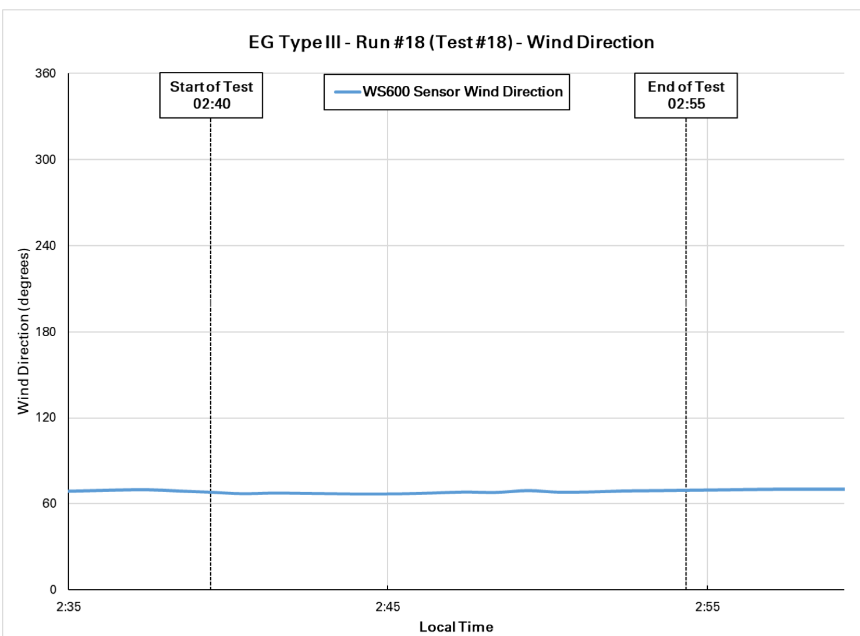
Test Number:	**EG3-18**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.3**
Average Precipitation Rate:	**61.9 g/dm²/h**
Average Wind Speed:	**26 km/h**
Average Relative Humidity:	**89.1%**
Pour Time (Local):	**02:40:00**
Time of Fluid Failure (Local):	**02:55:00**
Fluid Brix at Failure:	**13°**
Endurance Time:	**15 minutes**
Expected Regression-Derived Endurance Time:	**12.9 minutes**
Difference (ET vs. Reg ET):	**2.9 minutes (22.3%)**

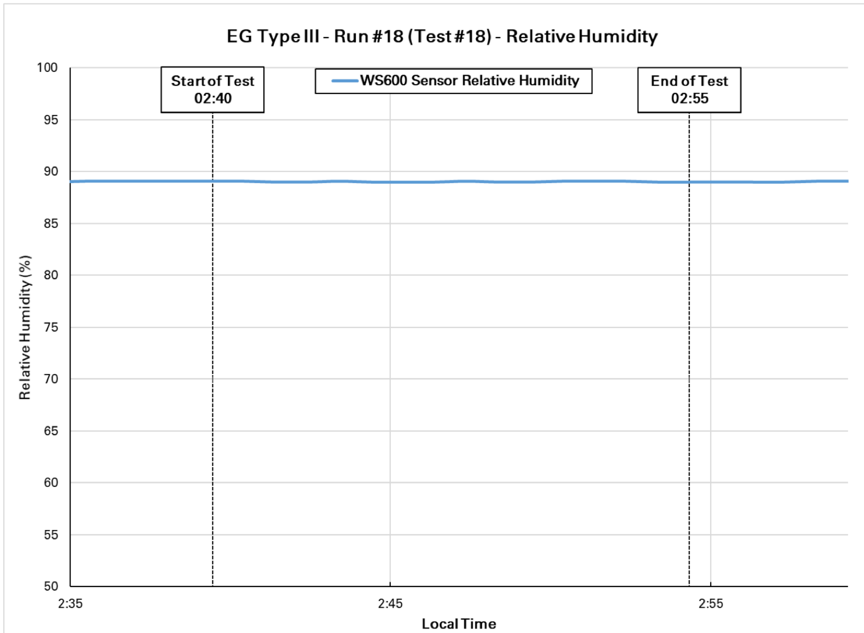

EG Type III - Run #18 (Test #18) - Precipitation Rate
Start of Test 02:40
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 02:55
Precipitation Rate (g/dm²/hr)
160
140
120
100
80
60
40
20
0
2:35
2:45
2:55
Local Time

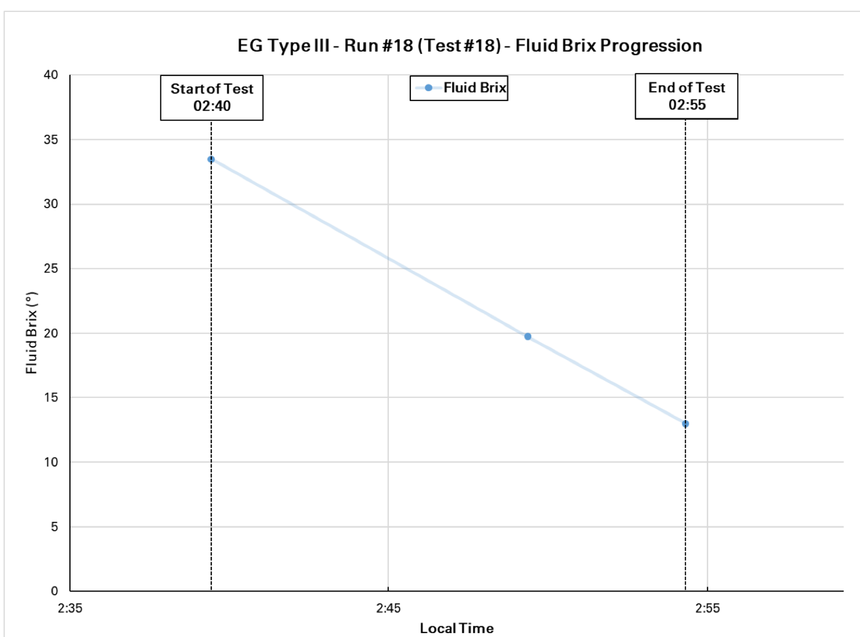

EG Type III - Run #18 (Test #18) - Temperatures
Start of Test 02:40
Initial Fluid Temp: -7.5°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 02:55
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
2:35
2:45
2:55
Local Time

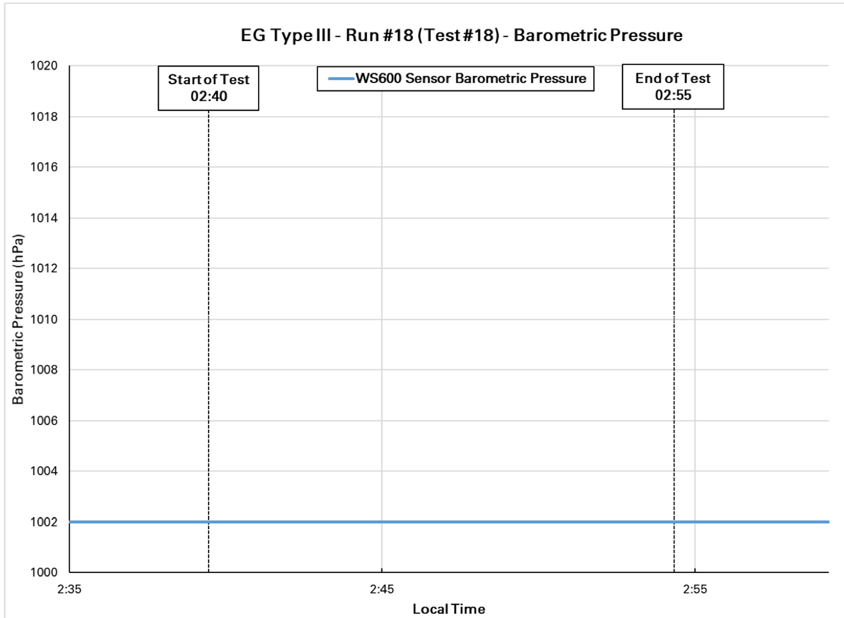


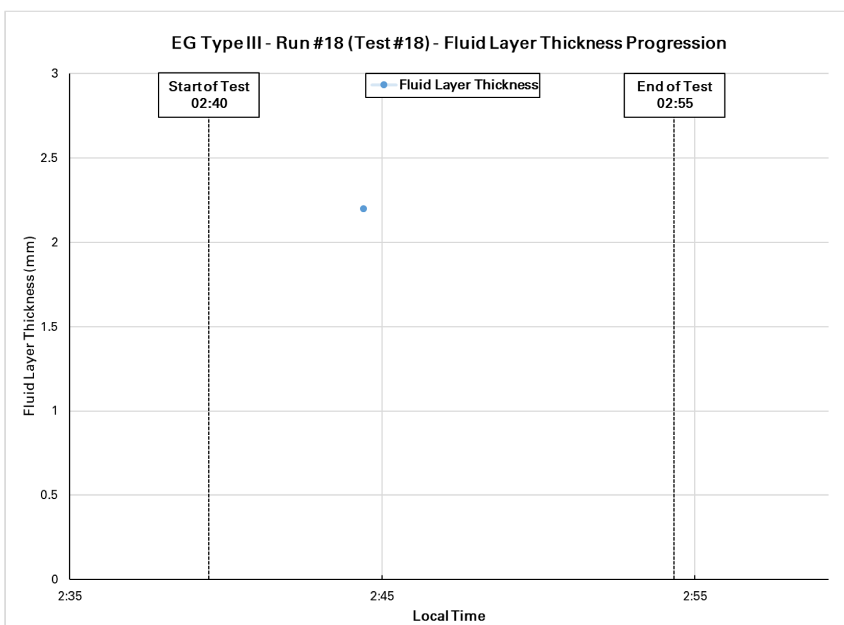
DATA PACKAGE – EG TYPE III – RUN 18 (TEST 18)

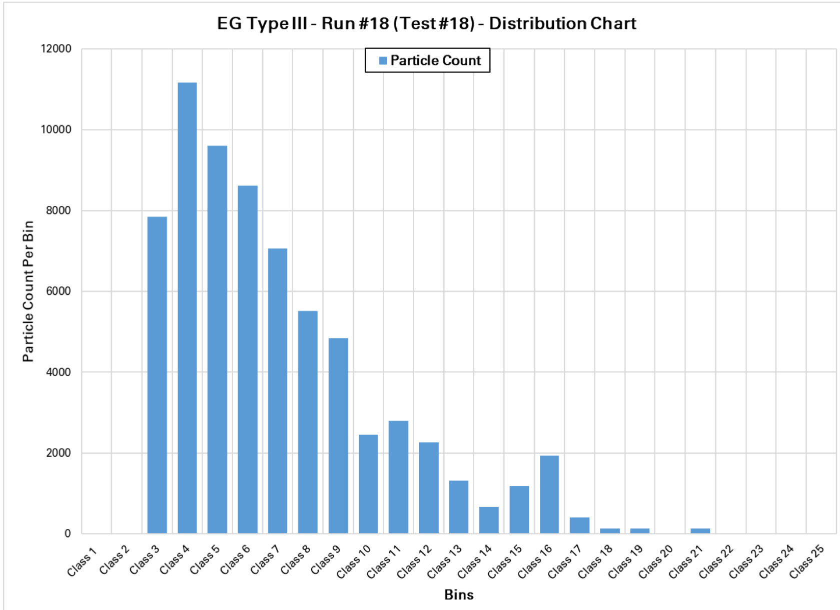



EG Type III - Run #18 (Test #18) - Relative Humidity
Start of Test 02:40
WS600 Sensor Relative Humidity
End of Test 02:55
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:35
2:45
2:55
Local Time

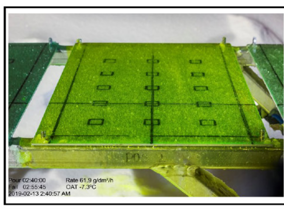

EG Type III - Run #18 (Test #18) - Fluid Brix Progression
Start of Test 02:40
Fluid Brix
End of Test 02:55
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
2:35
2:45
2:55
Local Time


EG Type III - Run #18 (Test #18) - Barometric Pressure
Start of Test 02:40
WS600 Sensor Barometric Pressure
End of Test 02:55
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
2:35
2:45
2:55
Local Time

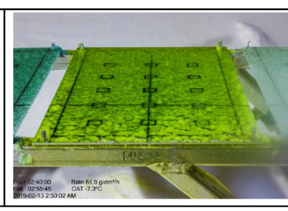

EG Type III - Run #18 (Test #18) - Fluid Layer Thickness Progression
Start of Test 02:40
Fluid Layer Thickness
End of Test 02:55
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
2:35
2:45
2:55
Local Time



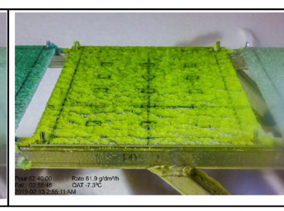
AeroClear MAX – Run 18 (Test 18) – Failure Progression Photos



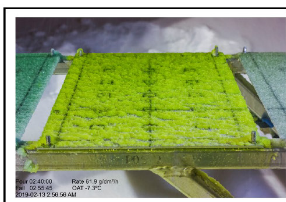
AT POUR (0/15 MIN)



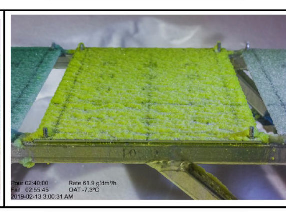
PRE-FAILURE (10/15 MIN)



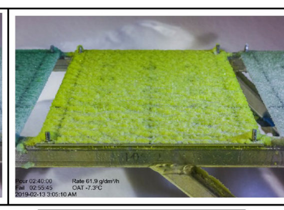
AT FAILURE (15/15 MIN)



POST-FAILURE (16/15 MIN)



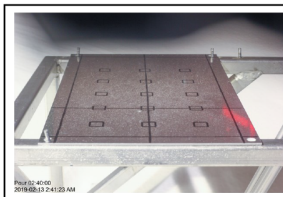
POST-FAILURE (20/15 MIN)



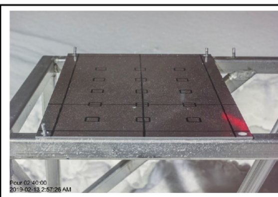
POST-FAILURE (25/15 MIN)

AeroClear MAX – Run 18 (Test 18) – Snow Characteristics Photos

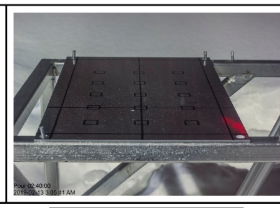
No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)



BARE PLATE (1/15 MIN)



BARE PLATE 17/15 MIN)



BARE PLATE (25/15 MIN)

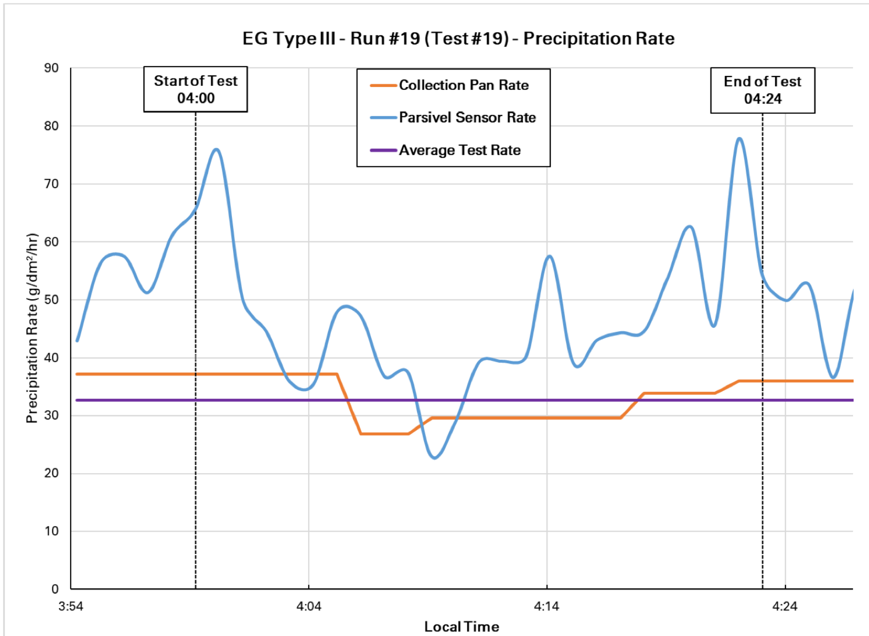
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

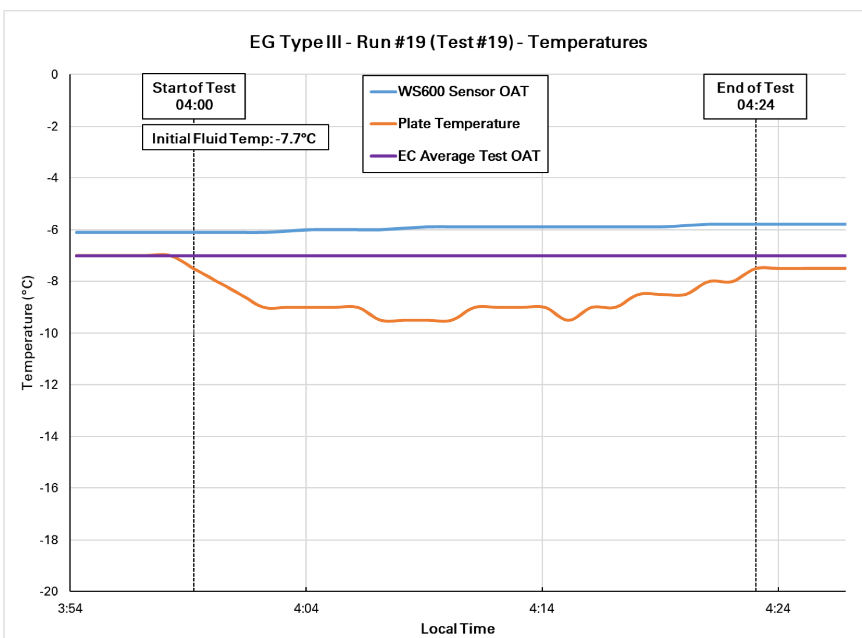
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

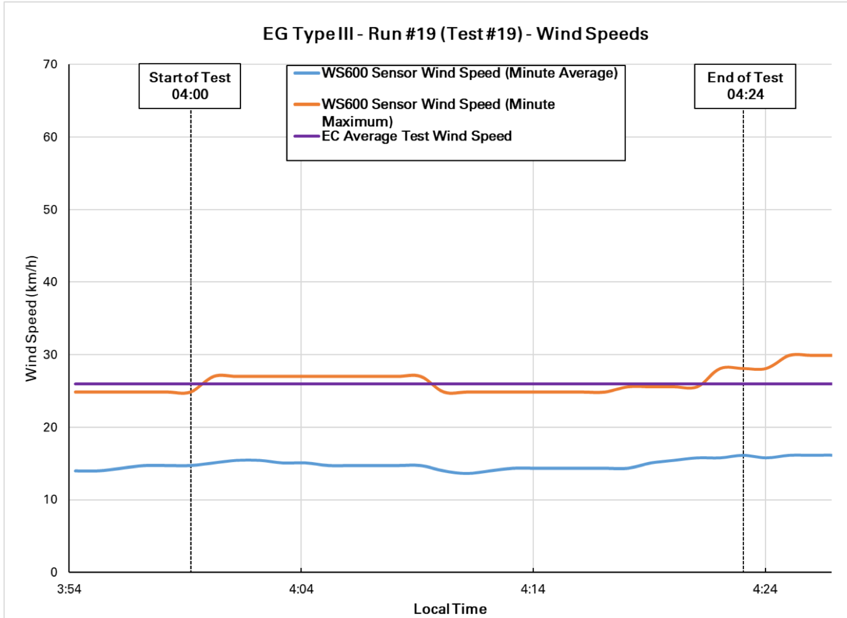
EG TYPE III
RUN #19 (TEST #19) – EG3-19

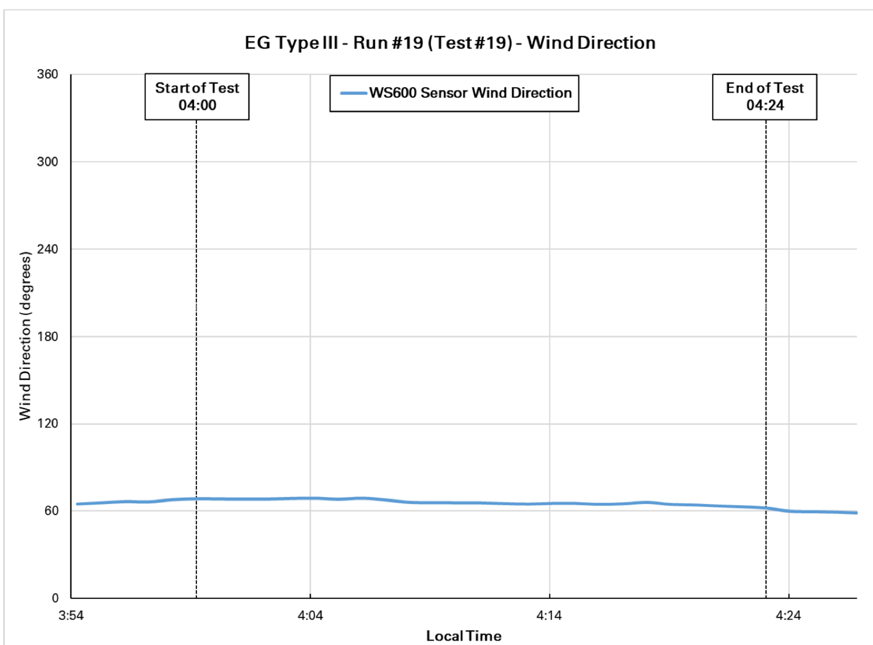
EG Type III – Run #19 (Test #19) – General Test Information

Test Number:	**EG3-19**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.0**
Average Precipitation Rate:	**32.7 g/dm²/h**
Average Wind Speed:	**26 km/h**
Average Relative Humidity:	**89.5%**
Pour Time (Local):	**04:00:00**
Time of Fluid Failure (Local):	**04:24:00**
Fluid Brix at Failure:	**13°**
Endurance Time:	**24 minutes**
Expected Regression-Derived Endurance Time:	**19.6 minutes**
Difference (ET vs. Reg ET):	**+4.6 minutes (+23.5%)**

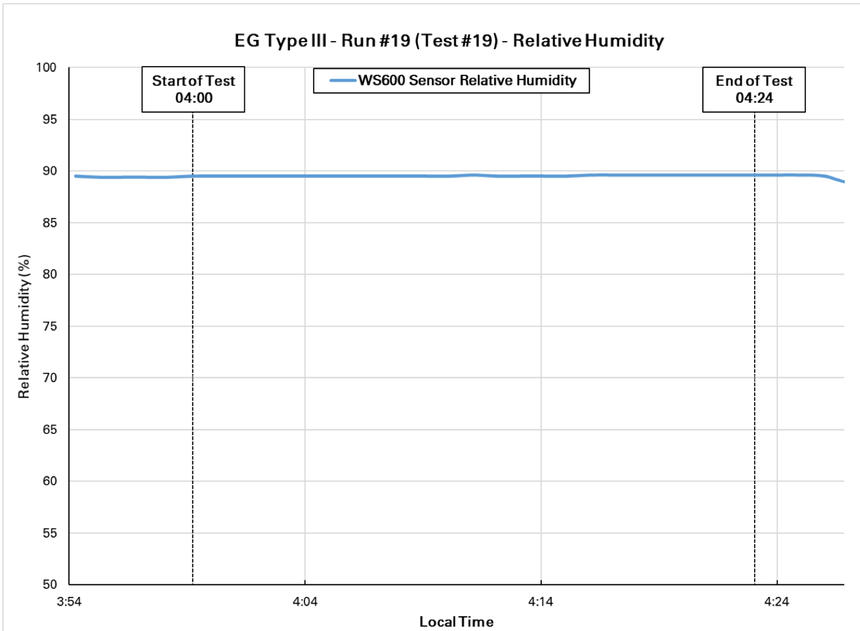

EG Type III - Run #19 (Test #19) - Precipitation Rate
Start of Test 04:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 04:24
Precipitation Rate (g/dm²/hr)
90
80
70
60
50
40
30
20
10
0
3:54
4:04
4:14
4:24
Local Time


EG Type III - Run #19 (Test #19) - Temperatures
Start of Test 04:00
Initial Fluid Temp: -7.7°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 04:24
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:54
4:04
4:14
4:24
Local Time


EG Type III - Run #19 (Test #19) - Wind Speeds
Start of Test 04:00
End of Test 04:24
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
3:54
4:04
4:14
4:24
Local Time


EG Type III - Run #19 (Test #19) - Wind Direction
Start of Test 04:00
End of Test 04:24
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
3:54
4:04
4:14
4:24
Local Time

DATA PACKAGE – EG TYPE III – RUN 19 (TEST 19)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 19 - Test 19/Data Package - EG Type III - Run 19 - Test 19.docx
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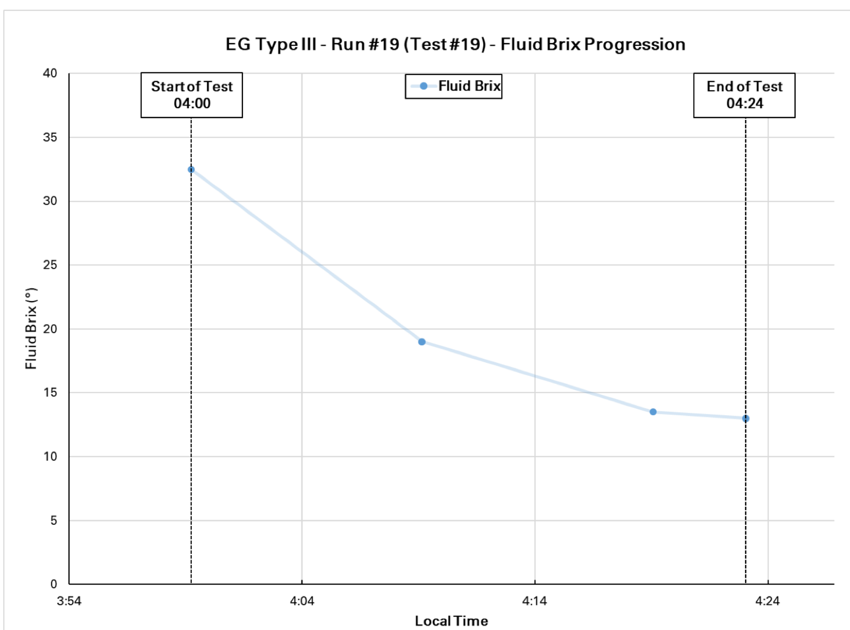
DATA PACKAGE – EG TYPE III – RUN 19 (TEST 19)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 19 - Test 19/Data Package - EG Type III - Run 19 - Test 19.docx
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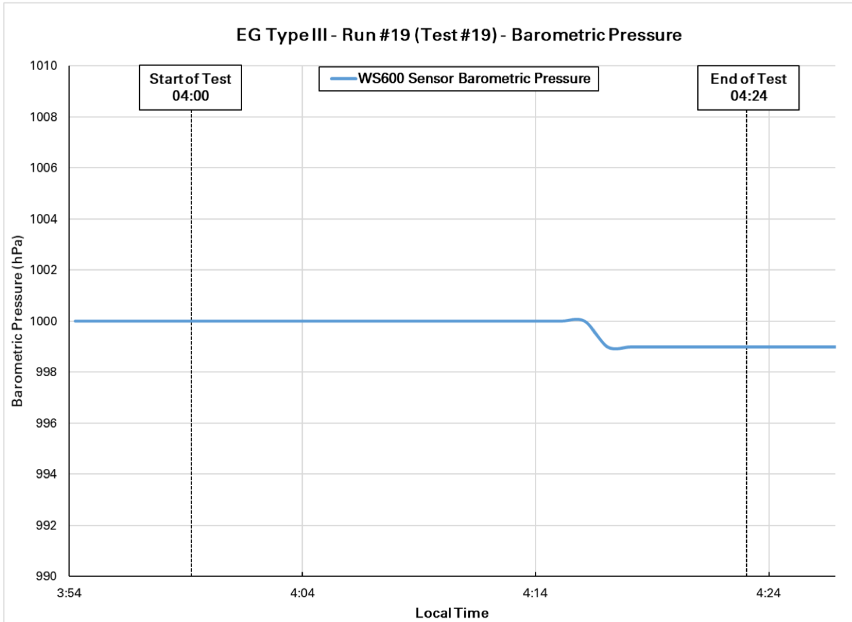
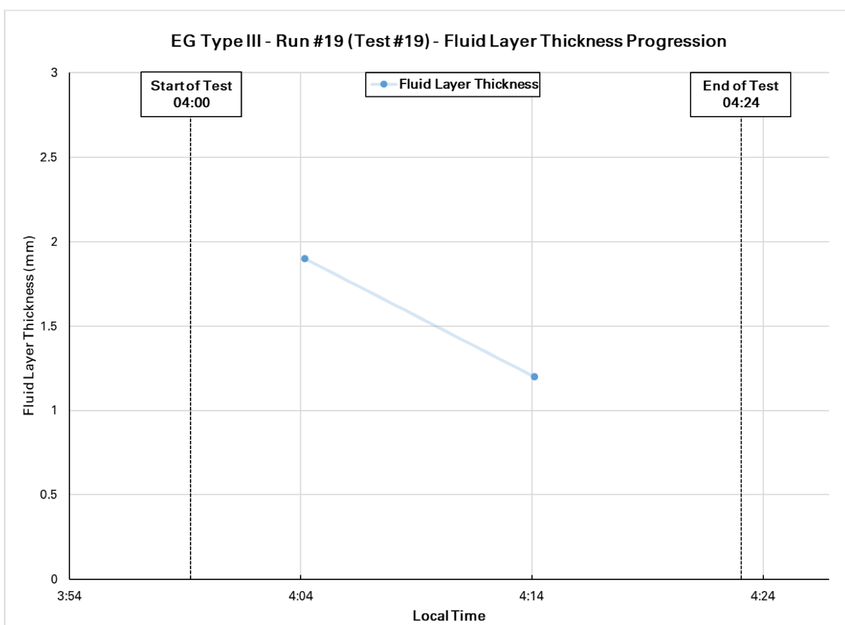
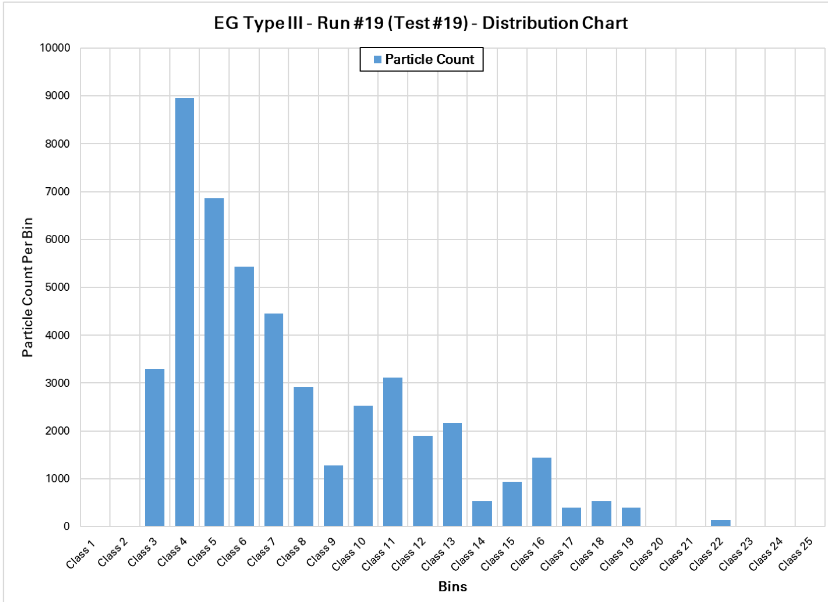
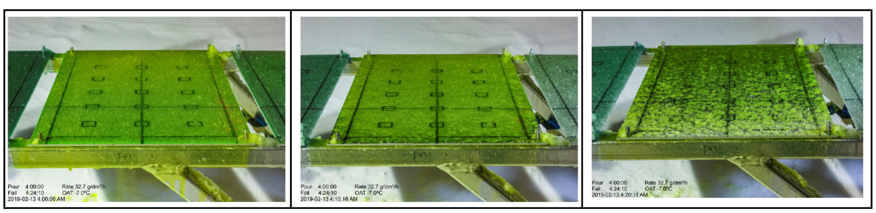


DATA PACKAGE – EG TYPE III – RUN 19 (TEST 19)

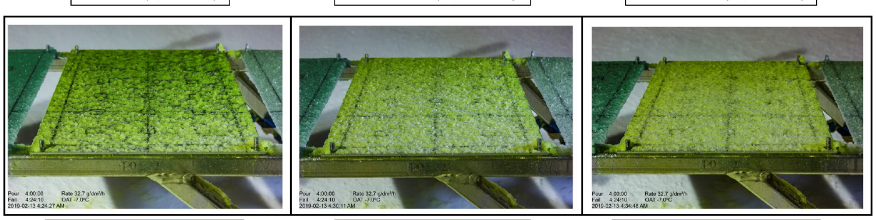




AeroClear MAX – Run 19 (Test 19) – Failure Progression Photos



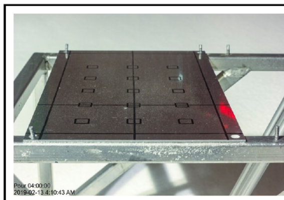
AT POUR (0/24 MIN)	PRE-FAILURE (10/24 MIN)	PRE-FAILURE (20/24 MIN)



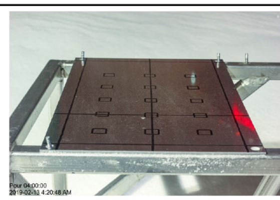
AT FAILURE (24/24 MIN)	POST-FAILURE (30/24 MIN)	POST-FAILURE (34/24 MIN)

AeroClear MAX – Run 19 (Test 19) – Snow Characteristics Photos

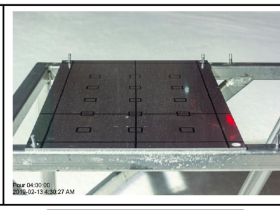
No Felt Pad photos exist	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)



BARE PLATE (10/24 MIN)



BARE PLATE 20/24 MIN)



BARE PLATE (30/24 MIN)

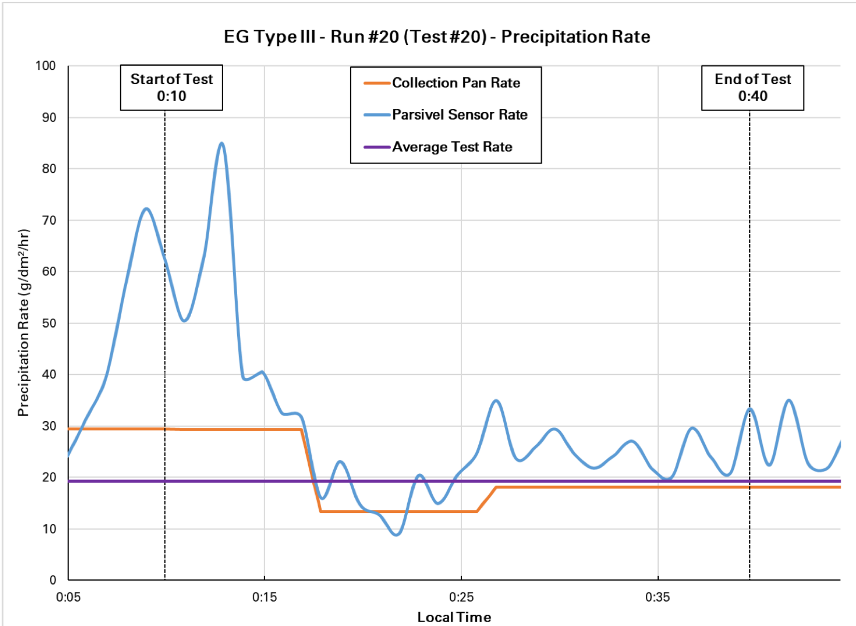
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

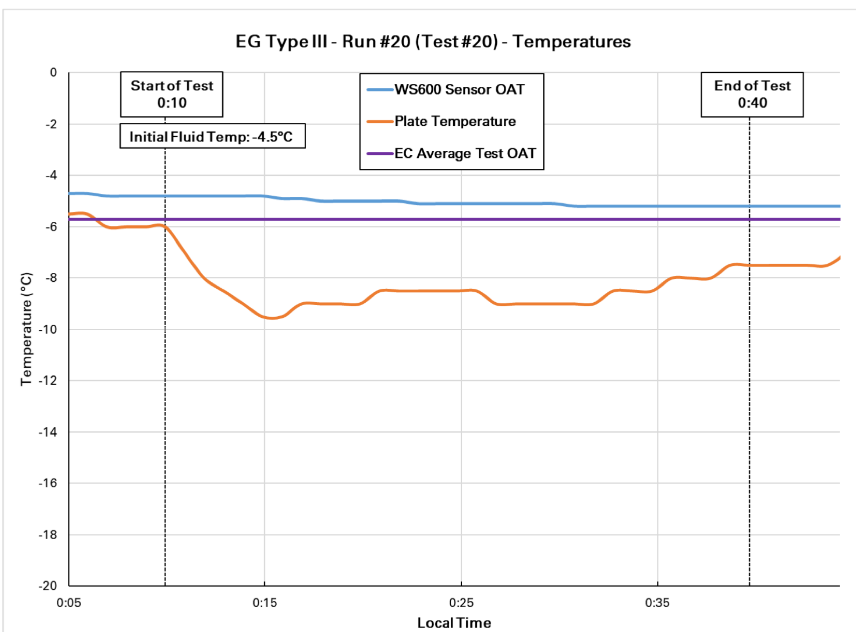
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

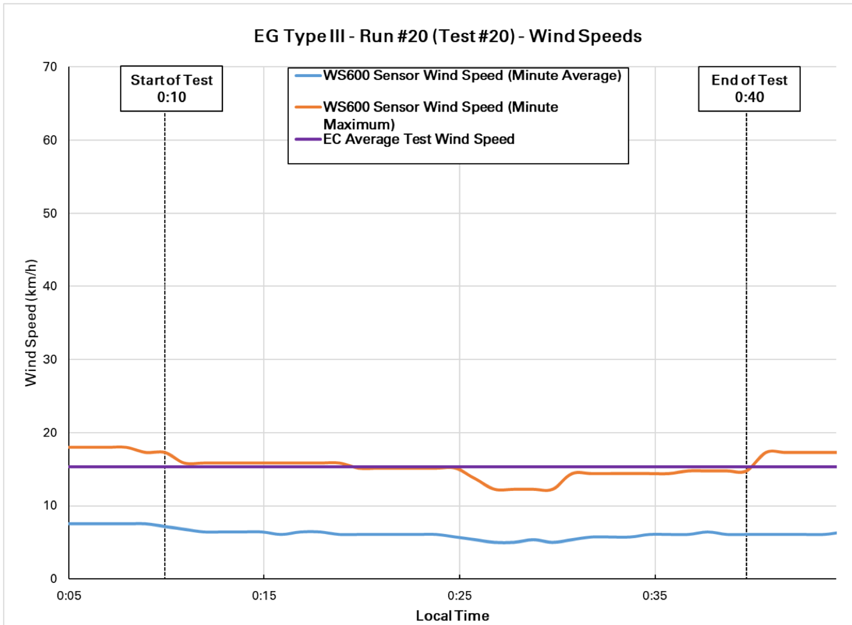
EG TYPE III
RUN #20 (TEST #20) – EG3-20

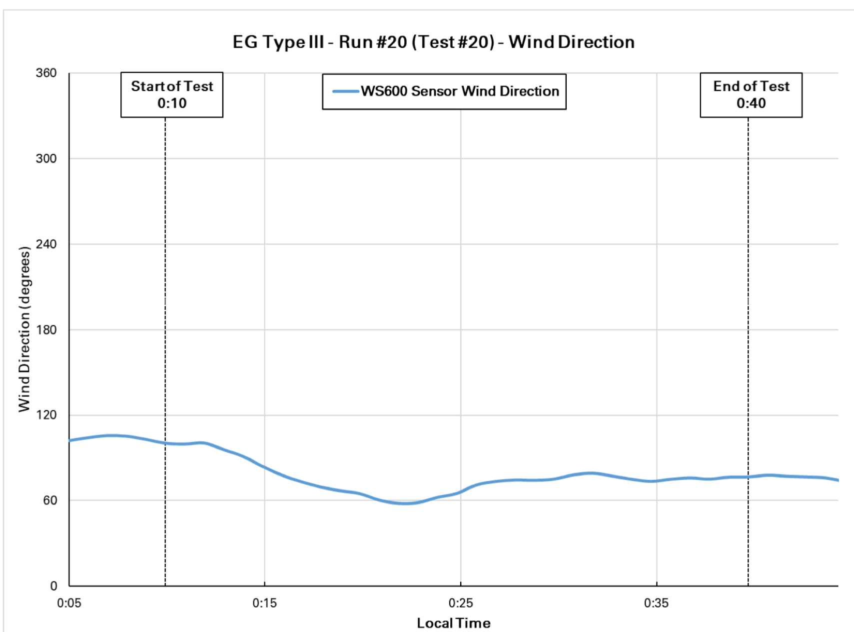
EG Type III – Run #20 (Test #20) – General Test Information

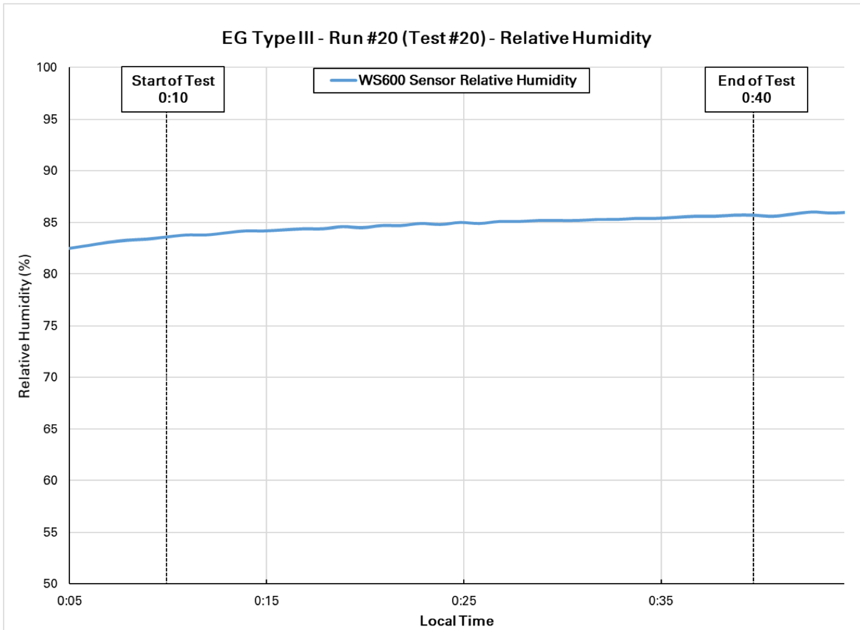
Test Number:	**EG3-20**
Date of Test:	**February 21, 2019**
Average OAT:	**-5.7**
Average Precipitation Rate:	**19.3 g/dm²/h**
Average Wind Speed:	**15.3 km/h**
Average Relative Humidity:	**84.74%**
Pour Time (Local):	**0:10:00**
Time of Fluid Failure (Local):	**0:40:00**
Fluid Brix at Failure:	**14°**
Endurance Time:	**30 minutes**
Expected Regression-Derived Endurance Time:	**27.6 minutes**
Difference (ET vs. Reg ET):	**+2.4 minutes (+8.6%)**

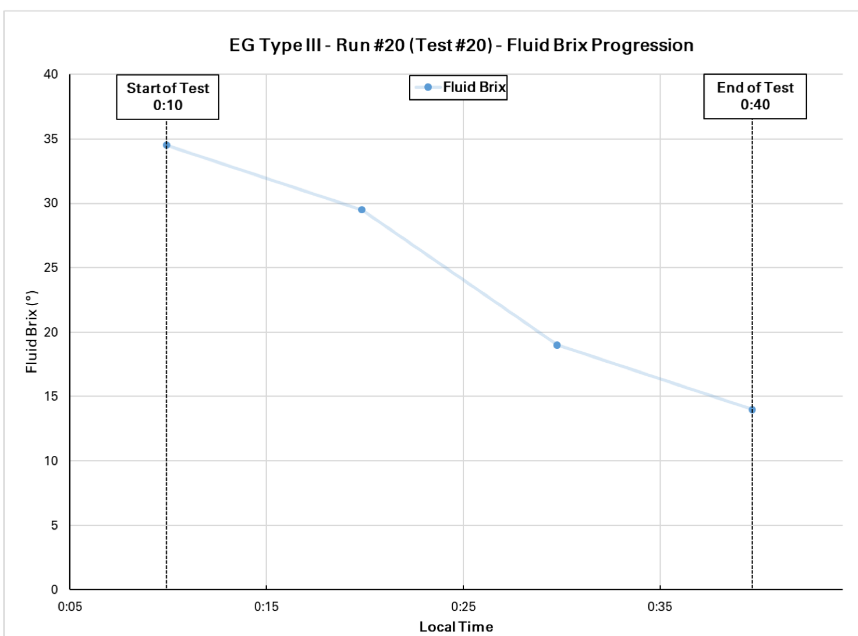

EG Type III - Run #20 (Test #20) - Precipitation Rate
Start of Test 0:10
End of Test 0:40
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
100
90
80
70
60
50
40
30
20
10
0
0:05
0:15
0:25
0:35
Local Time


EG Type III - Run #20 (Test #20) - Temperatures
Start of Test 0:10
Initial Fluid Temp: -4.5°C
End of Test 0:40
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0:05
0:15
0:25
0:35
Local Time

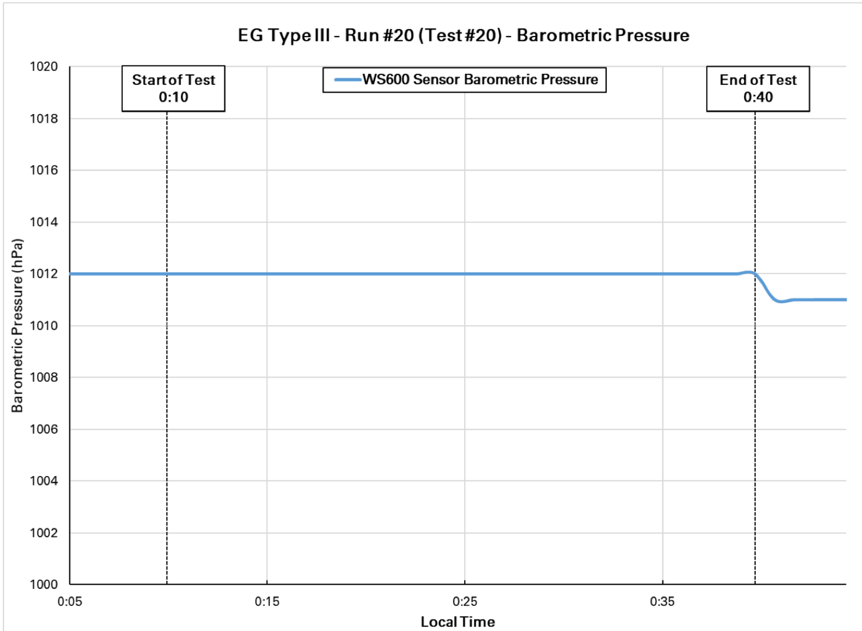

EG Type III - Run #20 (Test #20) - Wind Speeds
Start of Test
0:10
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test
0:40
Wind Speed (km/h)
70
60
50
40
30
20
10
0
0:05
0:15
0:25
0:35
Local Time


EG Type III - Run #20 (Test #20) - Wind Direction
Start of Test
0:10
WS600 Sensor Wind Direction
End of Test
0:40
Wind Direction (degrees)
360
300
240
180
120
60
0
0:05
0:15
0:25
0:35
Local Time


EG Type III - Run #20 (Test #20) - Relative Humidity
Start of Test 0:10
WS600 Sensor Relative Humidity
End of Test 0:40
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
0:05
0:15
0:25
0:35
Local Time


EG Type III - Run #20 (Test #20) - Fluid Brix Progression
Start of Test 0:10
Fluid Brix
End of Test 0:40
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
0:05
0:15
0:25
0:35
Local Time

DATA PACKAGE – EG TYPE III – RUN 20 (TEST 20)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 20 - Test 20/Data Package - EG Type III - Run 20 - Test 20.docx
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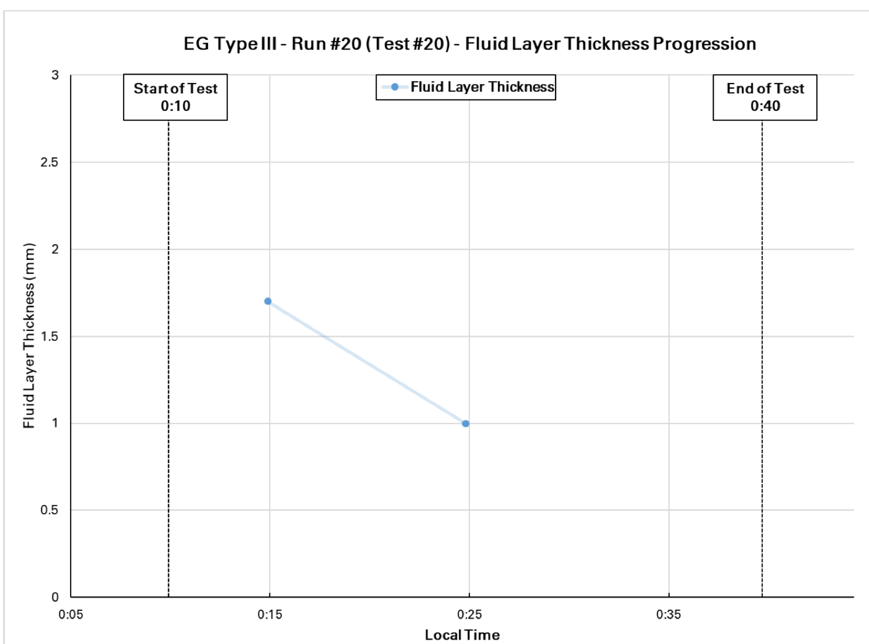
DATA PACKAGE – EG TYPE III – RUN 20 (TEST 20)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 20 - Test 20/Data Package - EG Type III - Run 20 - Test 20.docx
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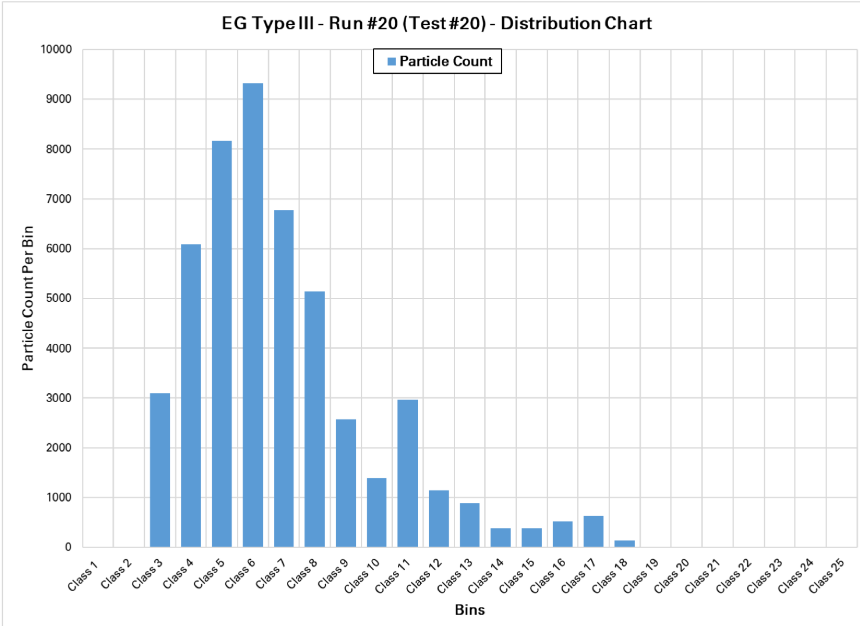
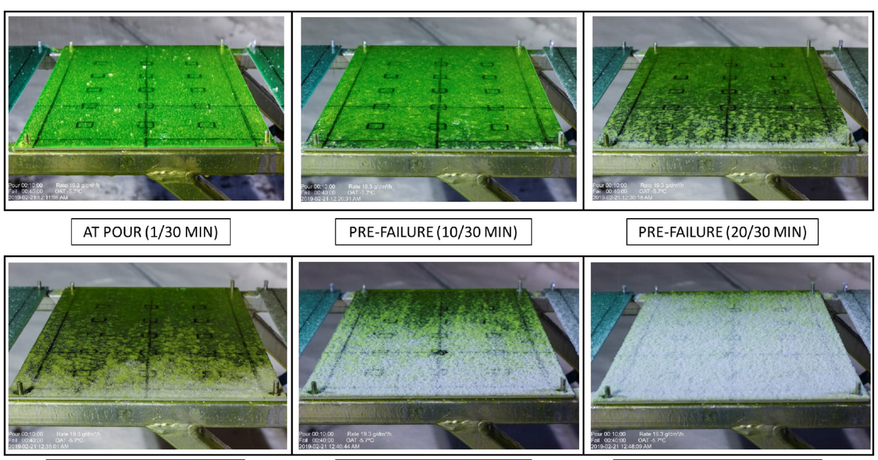


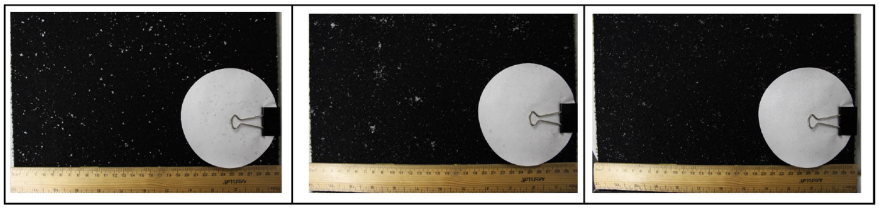
AeroClear MAX – Run 20 (Test 20) – Failure Progression Photos



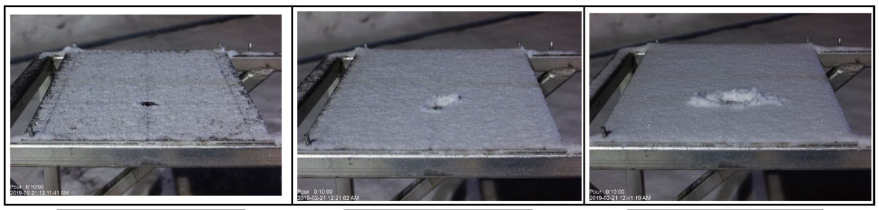
AT POUR (1/30 MIN) | PRE-FAILURE (10/30 MIN) | PRE-FAILURE (20/30 MIN)

PRE-FAILURE (25/30 MIN) | AT FAILURE (30/30 MIN) | POST-FAILURE (38/30 MIN)

AeroClear MAX – Run 20 (Test 20) – Snow Characteristics Photos



FELT PAD (0/30 MIN) | FELT PAD (19/30 MIN) | FELT PAD (29/30 MIN)



BARE PLATE (1/30 MIN) | BARE PLATE 11/30 MIN) | BARE PLATE (31/30 MIN)

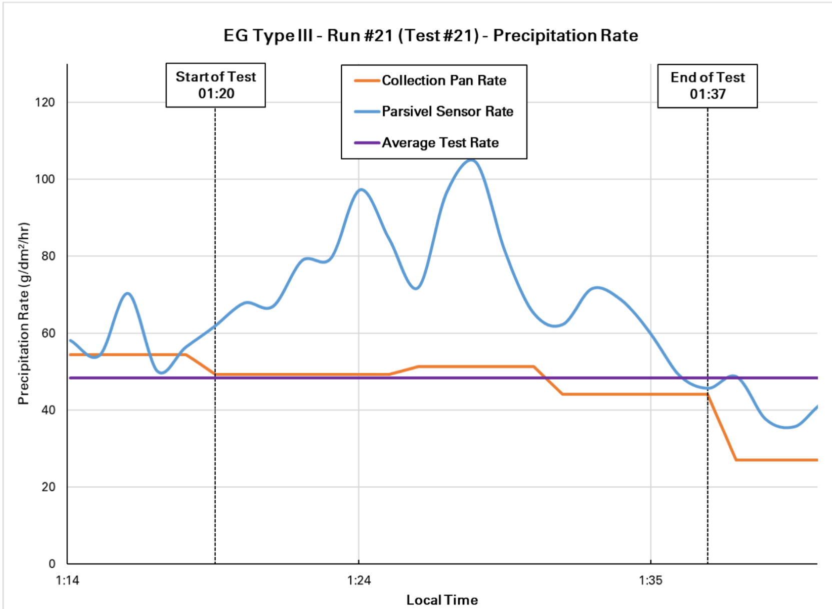
Final Bare Plate Contamination Thickness: **1.25mm**

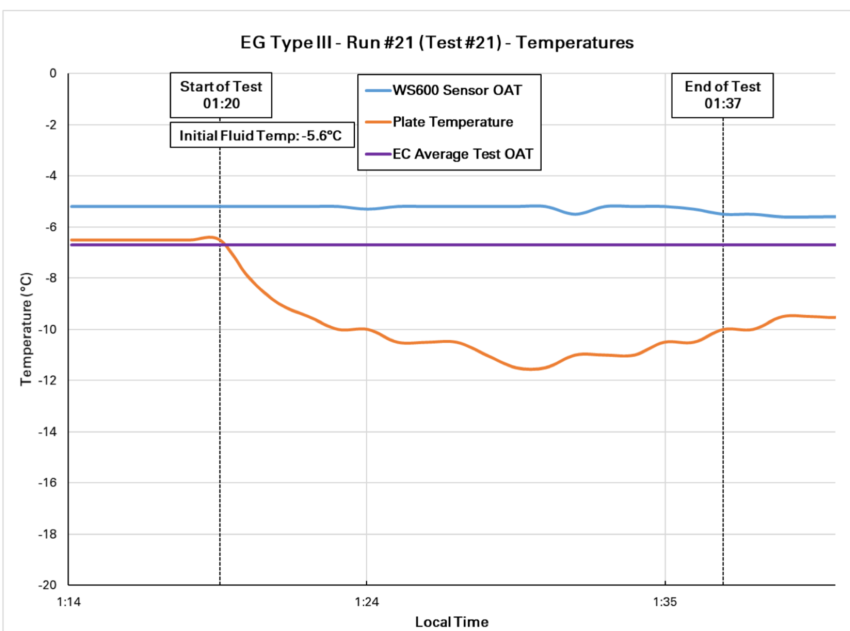
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

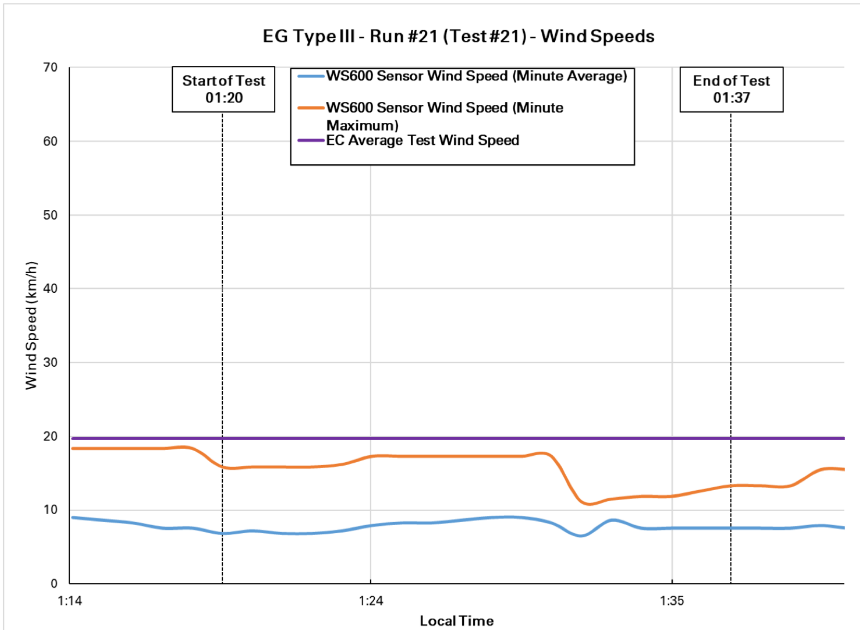
EG TYPE III
RUN #21(TEST #21) – EG3-21

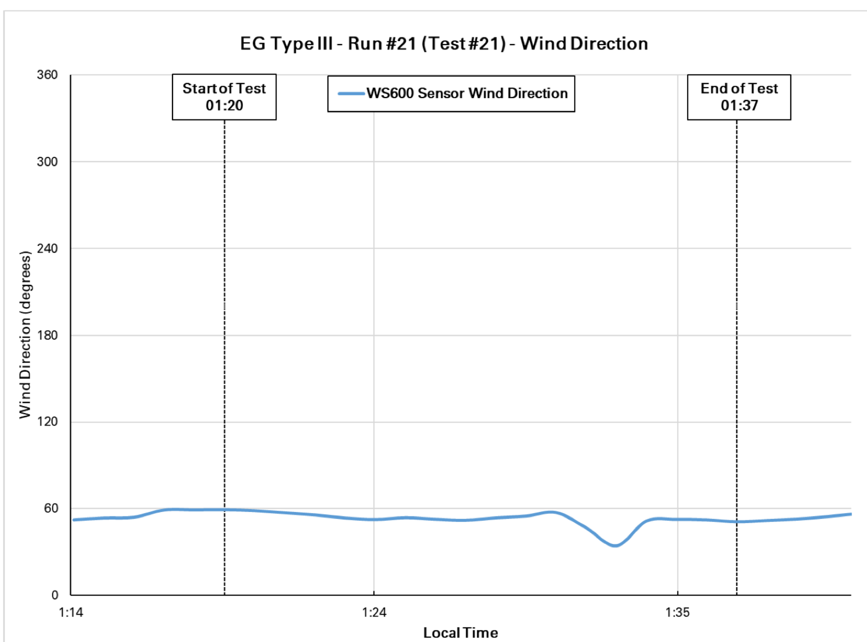
EG Type III – Run #21 (Test #21) – General Test Information

Test Number:	**EG3-21**
Date of Test:	**February 21, 2019**
Average OAT:	**-6.7**
Average Precipitation Rate:	**48.4 g/dm²/h**
Average Wind Speed:	**19.7 km/h**
Average Relative Humidity:	**87.6%**
Pour Time (Local):	**01:20:00**
Time of Fluid Failure (Local):	**01:37:00**
Fluid Brix at Failure:	**15°**
Endurance Time:	**17 minutes**
Expected Regression-Derived Endurance Time:	**15.1 minutes**
Difference (ET vs. Reg ET):	**+1.9 minutes (+12.3%)**

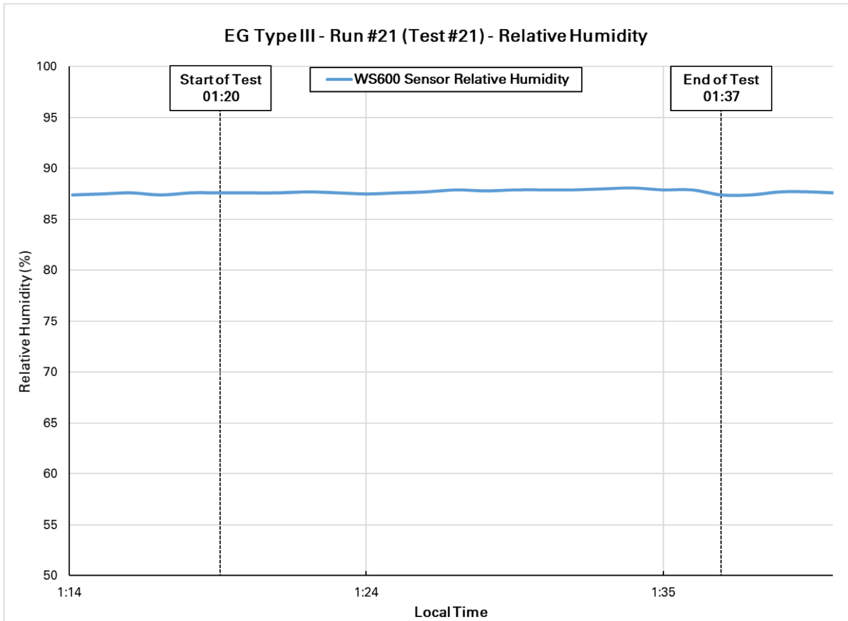

EG Type III - Run #21 (Test #21) - Precipitation Rate
Start of Test
01:20
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test
01:37
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
120
1:14
1:24
1:35
Local Time


EG Type III - Run #21 (Test #21) - Temperatures
Start of Test
01:20
Initial Fluid Temp: -5.6°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test
01:37
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
1:14
1:24
1:35
Local Time


EG Type III - Run #21 (Test #21) - Wind Speeds
Start of Test 01:20
End of Test 01:37
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
1:14
1:24
1:35
Local Time


EG Type III - Run #21 (Test #21) - Wind Direction
Start of Test 01:20
WS600 Sensor Wind Direction
End of Test 01:37
Wind Direction (degrees)
0
60
120
180
240
300
360
1:14
1:24
1:35
Local Time

DATA PACKAGE – EG TYPE III – RUN 21 (TEST 21)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 21 - Test 21/Data Package - EG Type III - Run 21 - Test 21.docx
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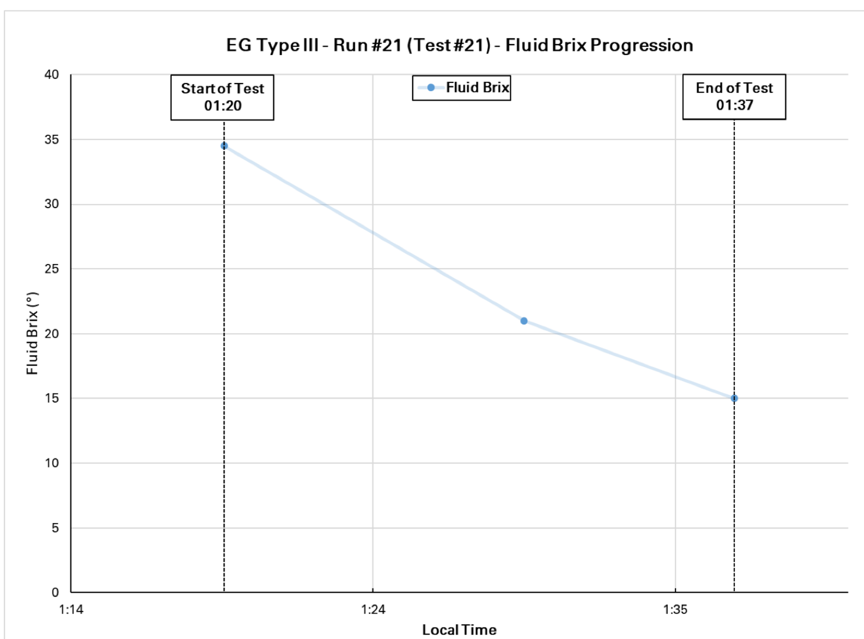
DATA PACKAGE – EG TYPE III – RUN 21 (TEST 21)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 21 - Test 21/Data Package - EG Type III - Run 21 - Test 21.docx
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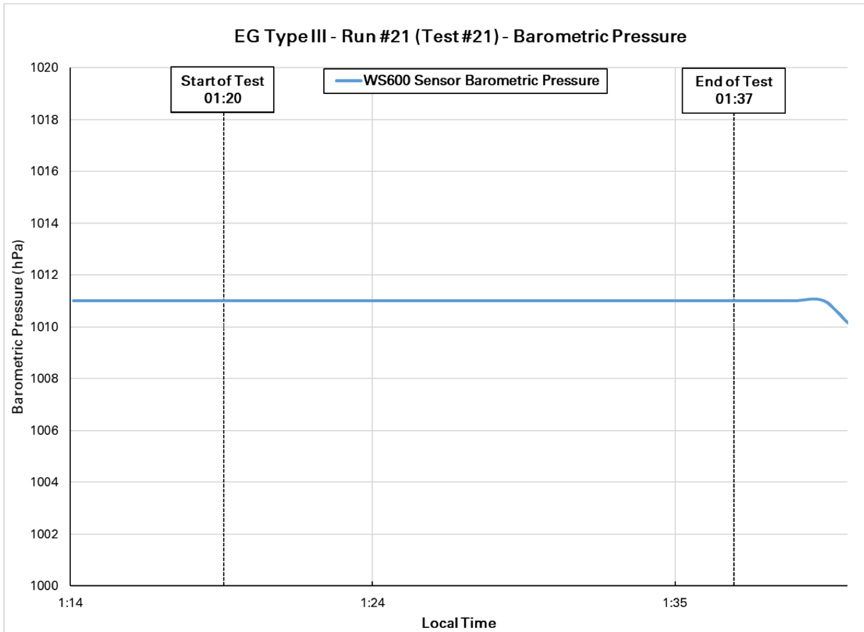
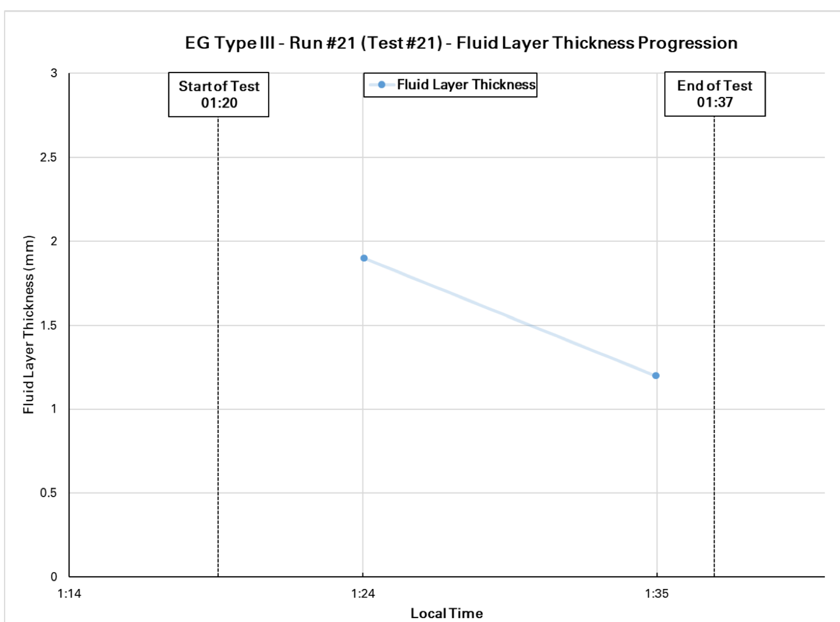
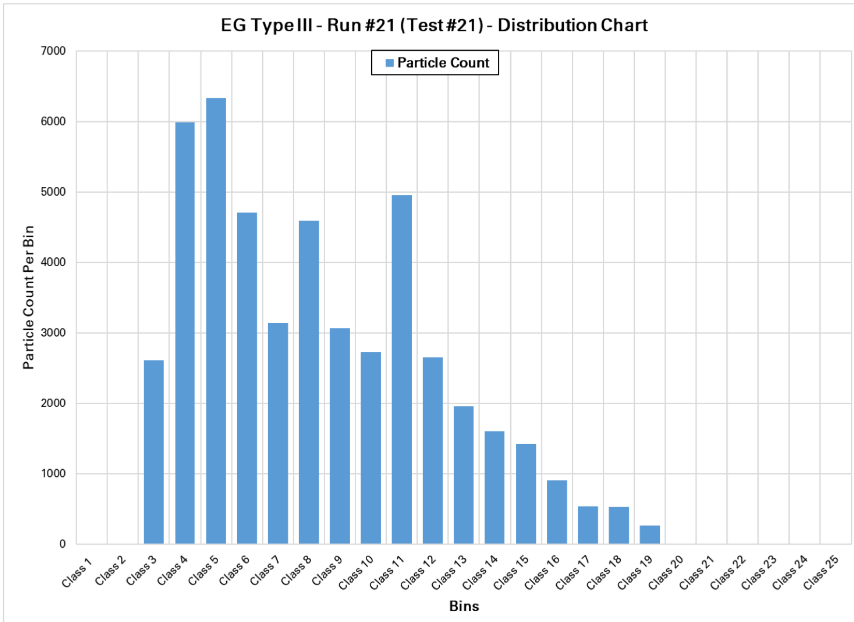
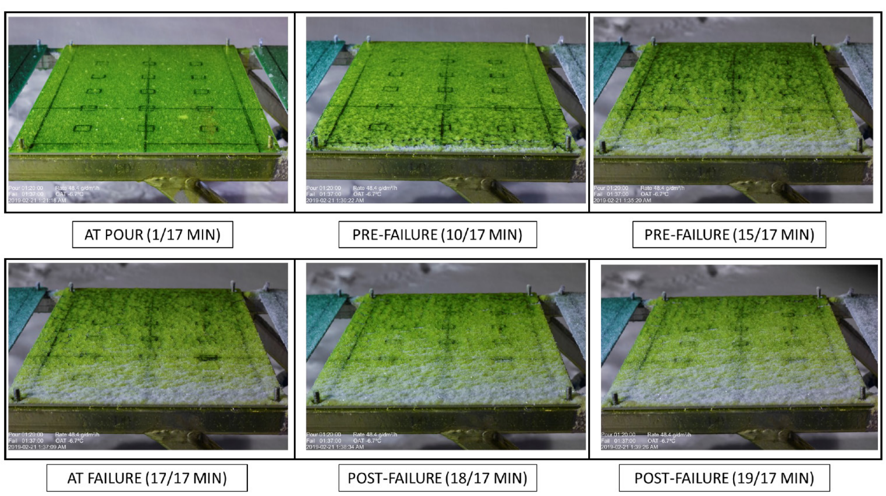

EG Type III - Run #21 (Test #21) - Barometric Pressure
Start of Test 01:20
WS600 Sensor Barometric Pressure
End of Test 01:37
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
1:14
1:24
1:35
Local Time

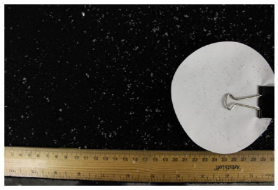

EG Type III - Run #21 (Test #21) - Fluid Layer Thickness Progression
Start of Test 01:20
Fluid Layer Thickness
End of Test 01:37
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
1:14
1:24
1:35
Local Time



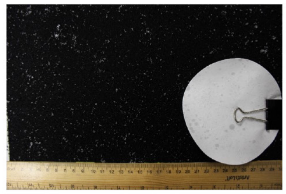
AeroClear MAX – Run 21 (Test 21) – Failure Progression Photos



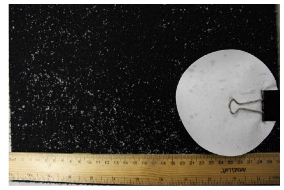
AeroClear MAX – Run 21 (Test 21) – Snow Characteristics Photos



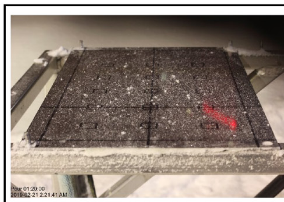
FELT PAD (-4/17 MIN)



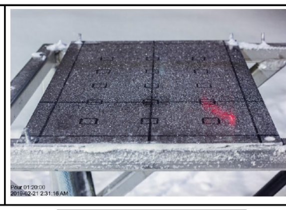
FELT PAD (0/17 MIN)



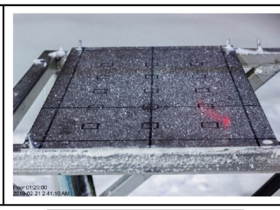
FELT PAD (10/17 MIN)



BARE PLATE (1/17 MIN)



BARE PLATE 11/17 MIN)



BARE PLATE (21/17 MIN)

Final Bare Plate Contamination Thickness: **0.6mm**

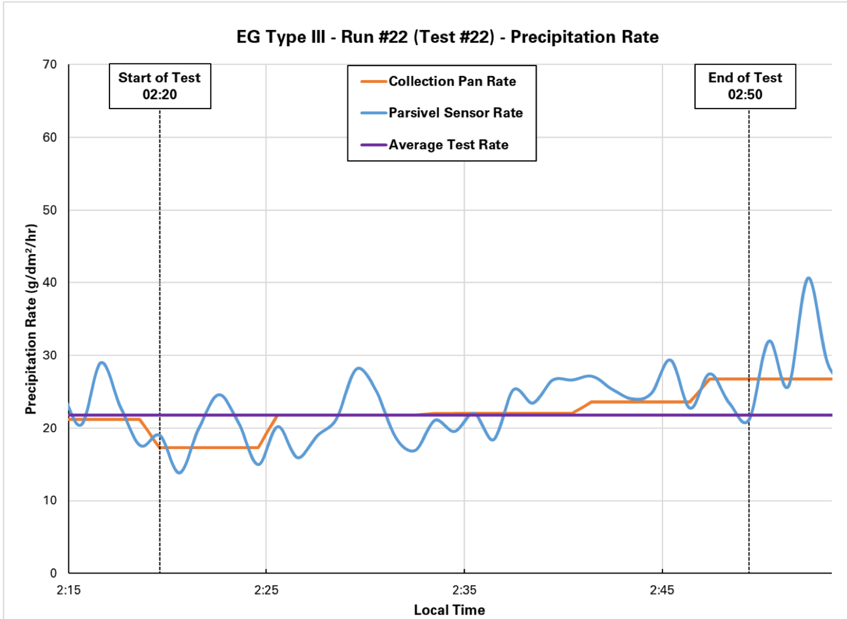
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #22 (TEST #22) – EG3-22

EG Type III – Run #22 (Test #22) – General Test Information

Test Number:	EG3-22
Date of Test:	February 21, 2019
Average OAT:	-7.4
Average Precipitation Rate:	21.8 g/dm²/h
Average Wind Speed:	20.3 km/h
Average Relative Humidity:	87.6%
Pour Time (Local):	02:20:00
Time of Fluid Failure (Local):	02:50:00
Fluid Brix at Failure:	12°
Endurance Time:	30 minutes
Expected Regression-Derived Endurance Time:	25.5 minutes
Difference (ET vs. Reg ET):	+4.5 minutes (+17.5%)

DATA PACKAGE – EG TYPE III – RUN 22 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 22 - Test 22/Data Package - EG Type III - Run 22 - Test 22.docx
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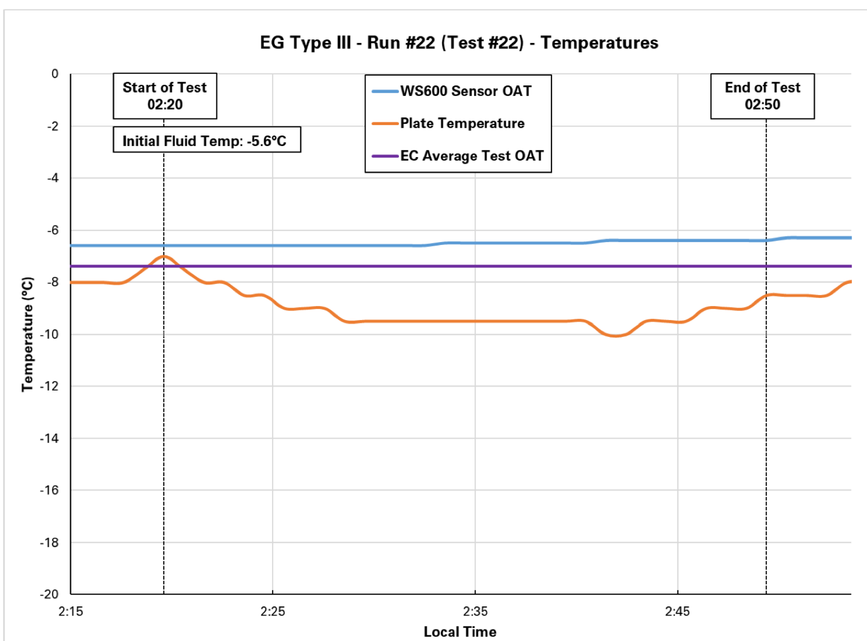
DATA PACKAGE – EG TYPE III – RUN 22 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 22 - Test 22/Data Package - EG Type III - Run 22 - Test 22.docx
Final Version 1.0, February 2021

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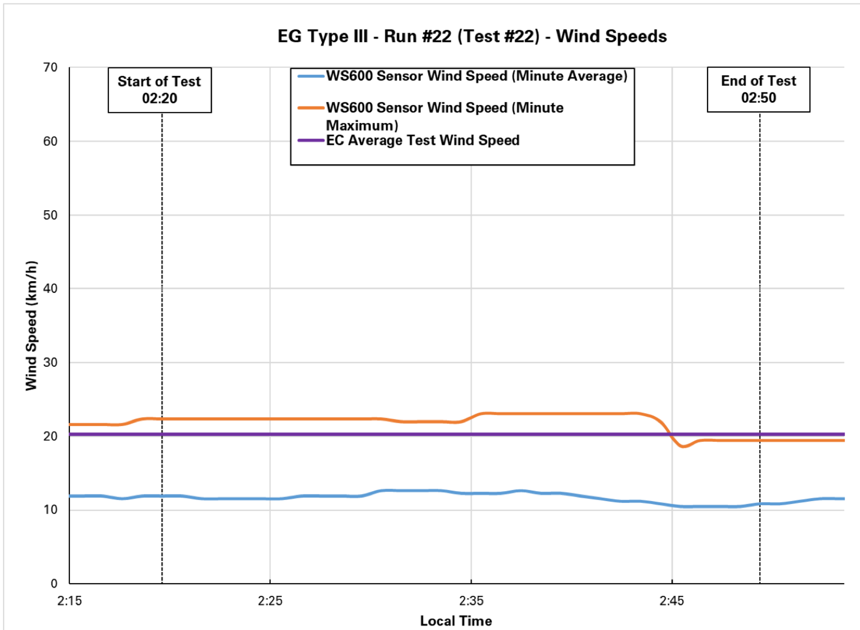
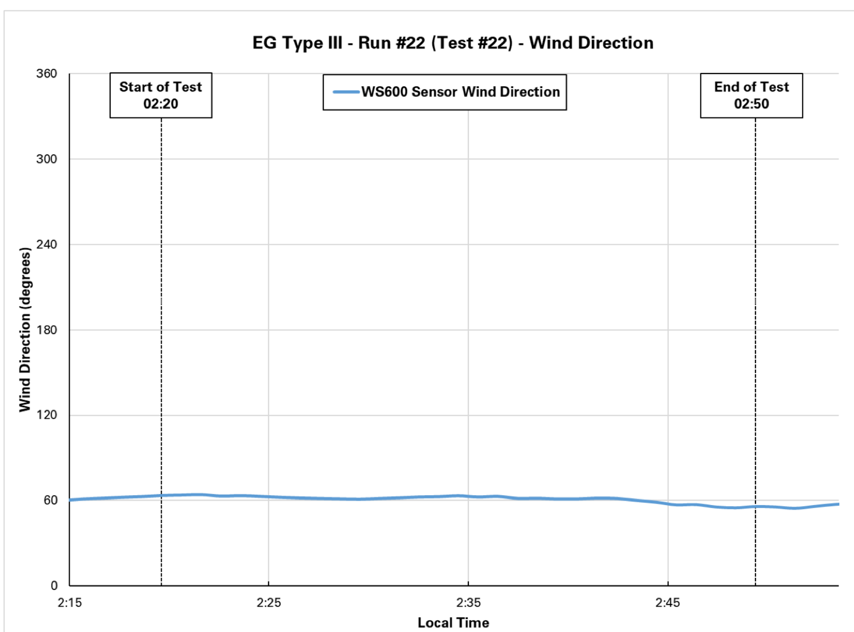
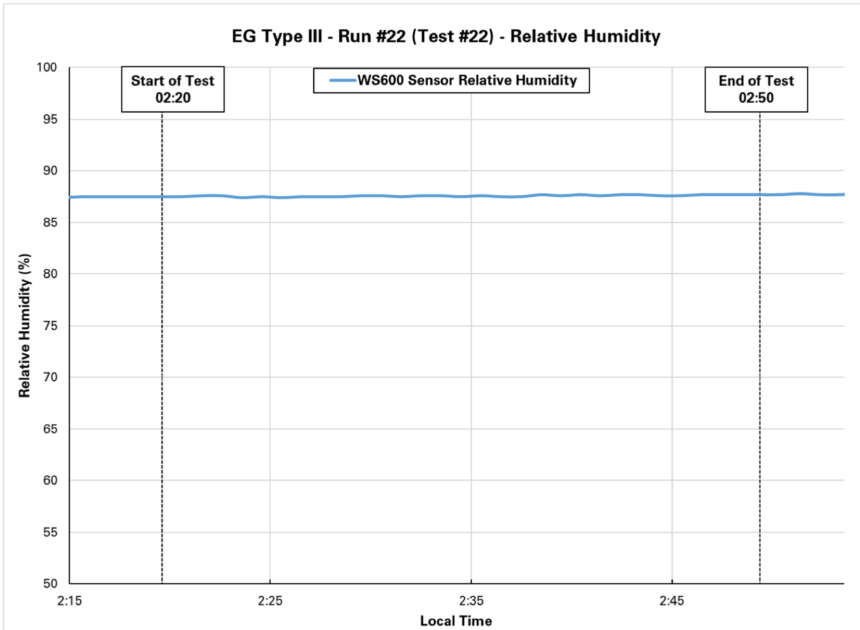
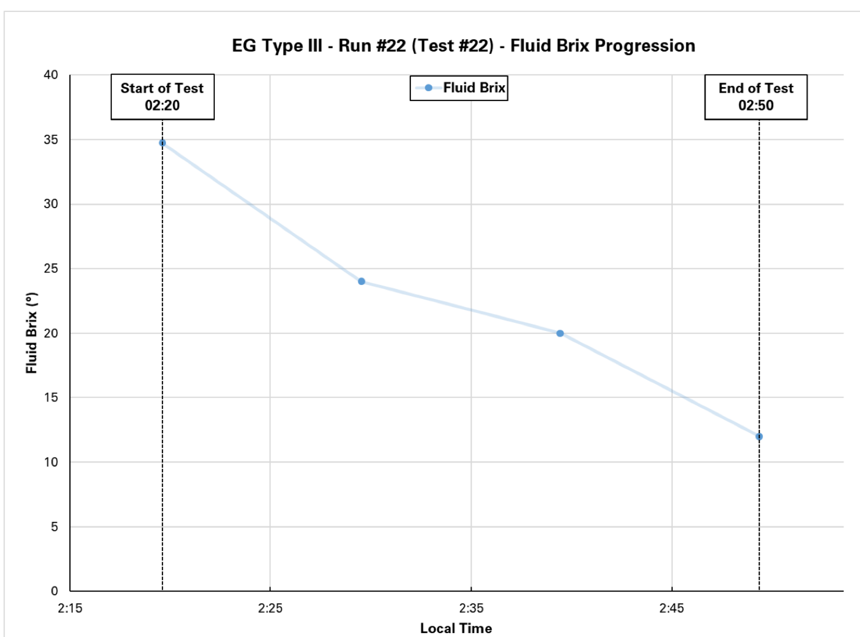
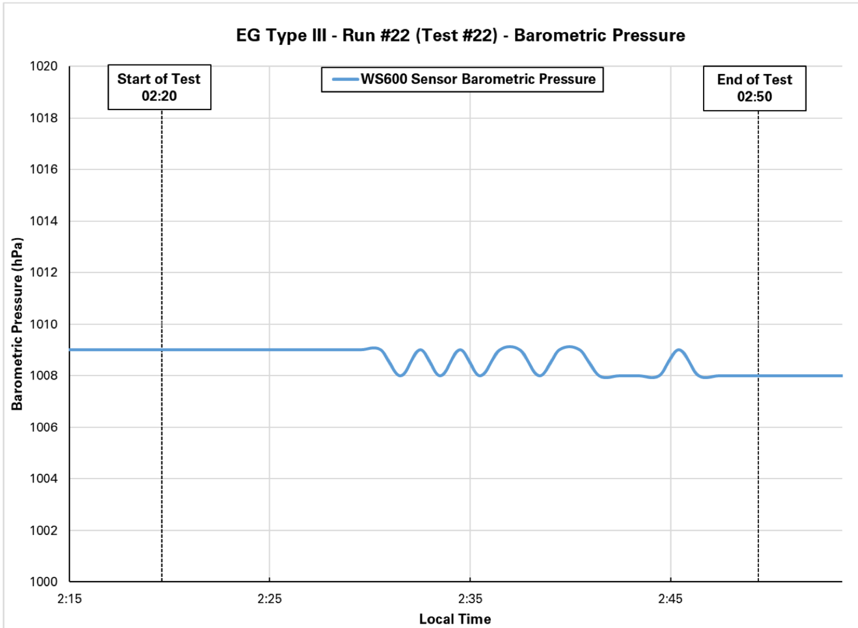


DATA PACKAGE – EG TYPE III – RUN 22 (TEST 22)

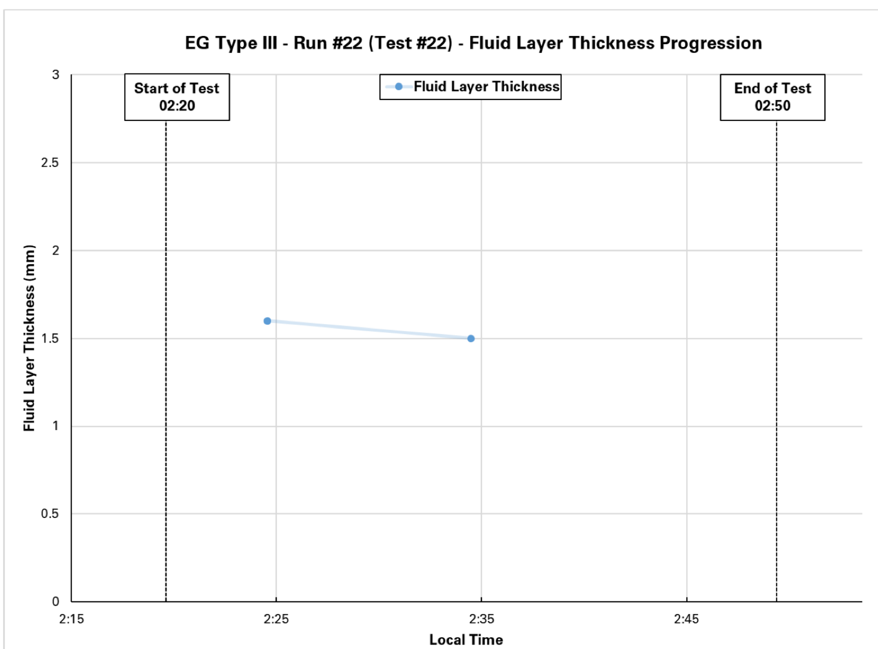


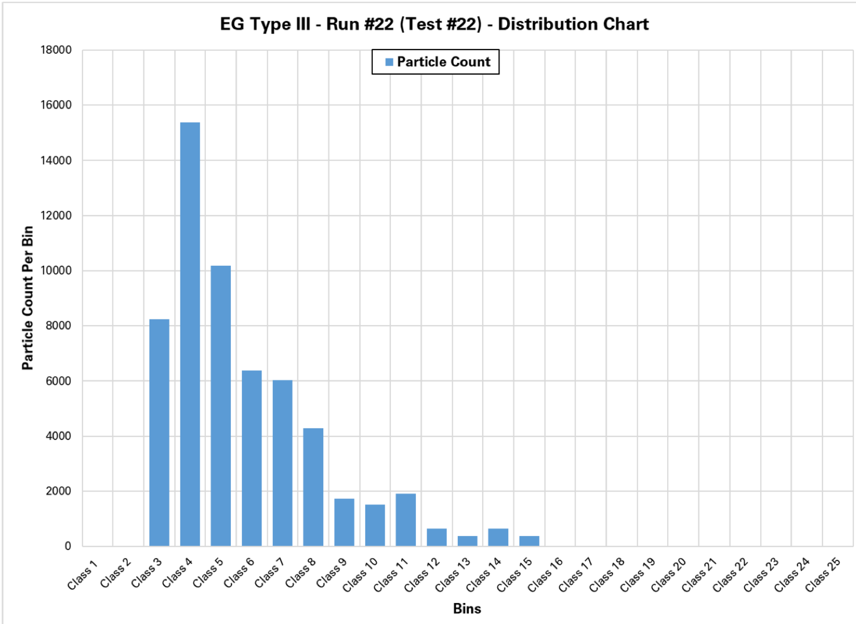

EG Type III - Run #22 (Test #22) - Relative Humidity
Start of Test 02:20
WS600 Sensor Relative Humidity
End of Test 02:50
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:15
2:25
2:35
2:45
Local Time


EG Type III - Run #22 (Test #22) - Fluid Brix Progression
Start of Test 02:20
Fluid Brix
End of Test 02:50
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
2:15
2:25
2:35
2:45
Local Time

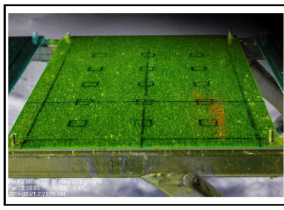


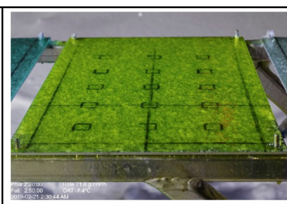
DATA PACKAGE – EG TYPE III – RUN 22 (TEST 22)

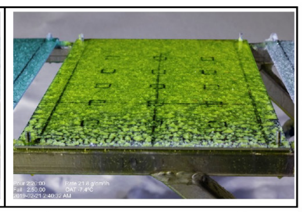


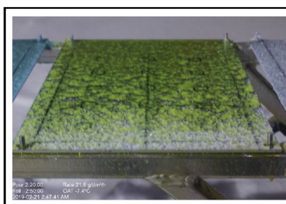


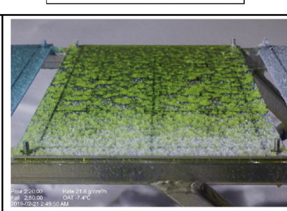
AeroClear MAX – Run 22 (Test 22) – Failure Progression Photos


AT POUR (1/30 MIN)


PRE-FAILURE (10/30 MIN)

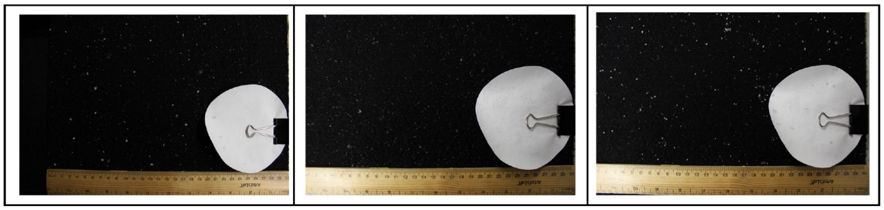

PRE-FAILURE (20/30 MIN)


PRE-FAILURE (27/30 MIN)

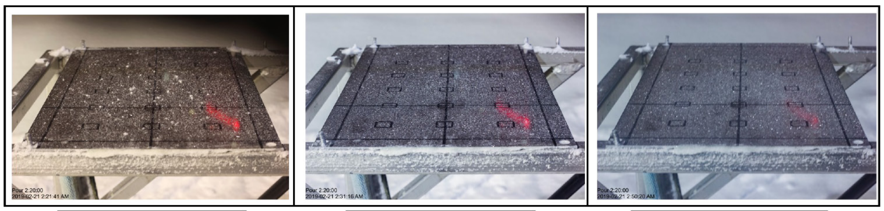

AT FAILURE (30/30 MIN)


POST-FAILURE (35/30 MIN)

AeroClear MAX – Run 22 (Test 22) – Snow Characteristics Photos



FELT PAD (XX/XX MIN) | FELT PAD (XX/XX MIN) | FELT PAD (XX/XX MIN)



BARE PLATE (1/30 MIN) | BARE PLATE 11/30 MIN) | BARE PLATE (30/30 MIN)

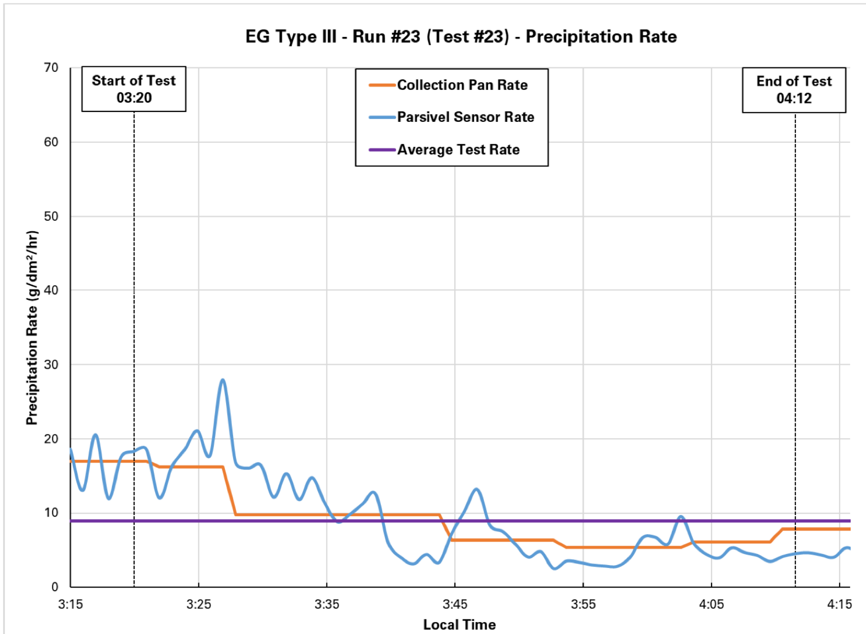
Final Bare Plate Contamination Thickness: **0.4mm**

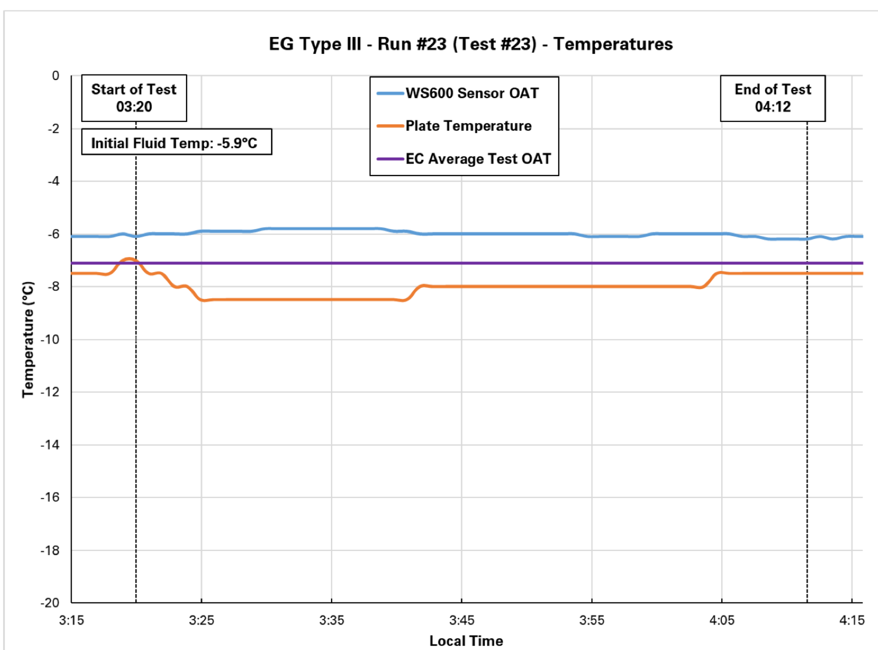
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #23 (TEST #23) – EG3-23

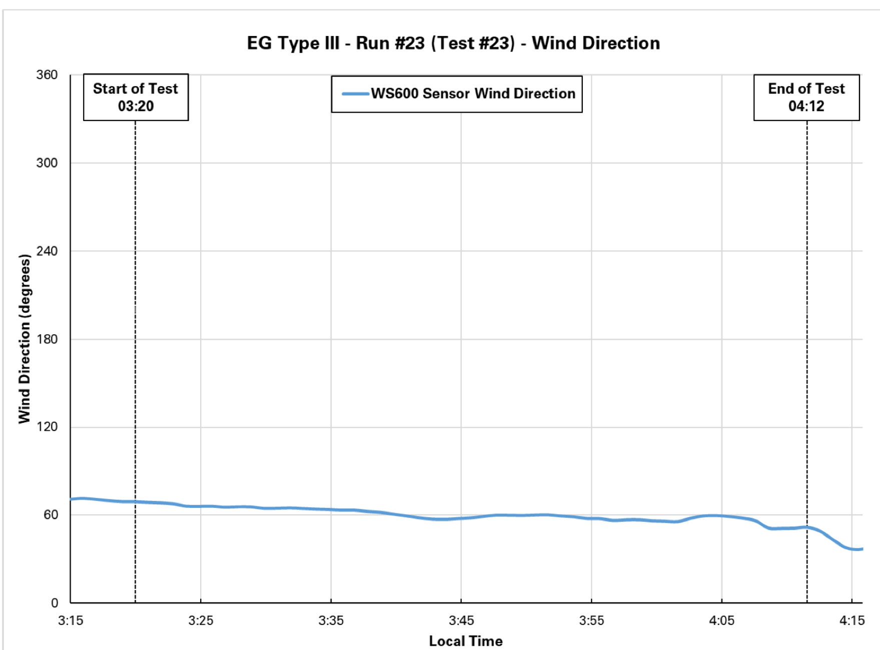
EG Type III – Run #23 (Test #23) – General Test Information

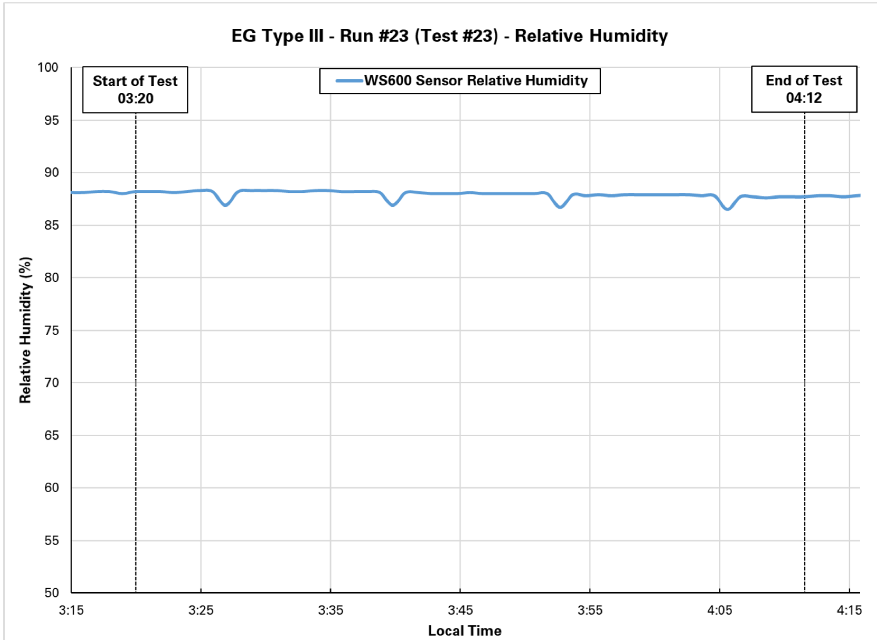
Test Number:	EG3-23
Date of Test:	February 21, 2019
Average OAT:	-7.1
Average Precipitation Rate:	8.9 g/dm²/h
Average Wind Speed:	18.8 km/h
Average Relative Humidity:	87.9%
Pour Time (Local):	03:20:00
Time of Fluid Failure (Local):	04:12:00
Fluid Brix at Failure:	8°
Endurance Time:	52 minutes
Expected Regression-Derived Endurance Time:	46.2 minutes
Difference (ET vs. Reg ET):	+6.3 minutes (+13.7%)

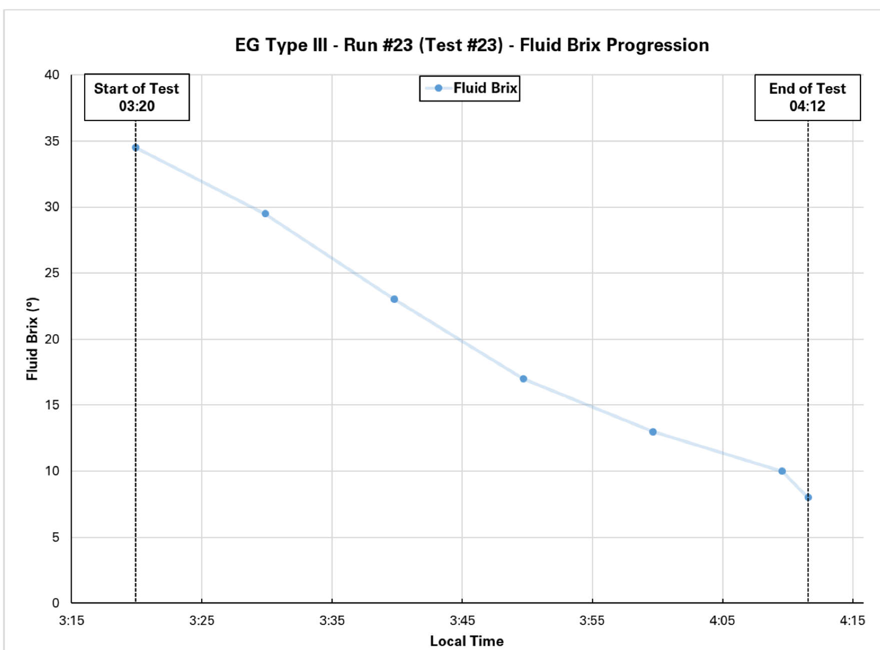

EG Type III - Run #23 (Test #23) - Precipitation Rate
Start of Test 03:20
End of Test 04:12
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

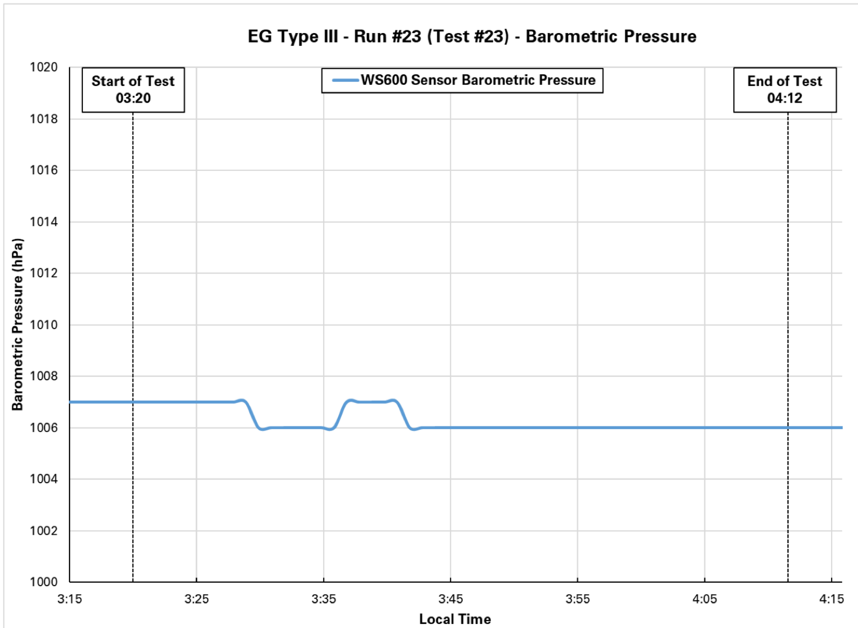

EG Type III - Run #23 (Test #23) - Temperatures
Start of Test 03:20
Initial Fluid Temp: -5.9°C
End of Test 04:12
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

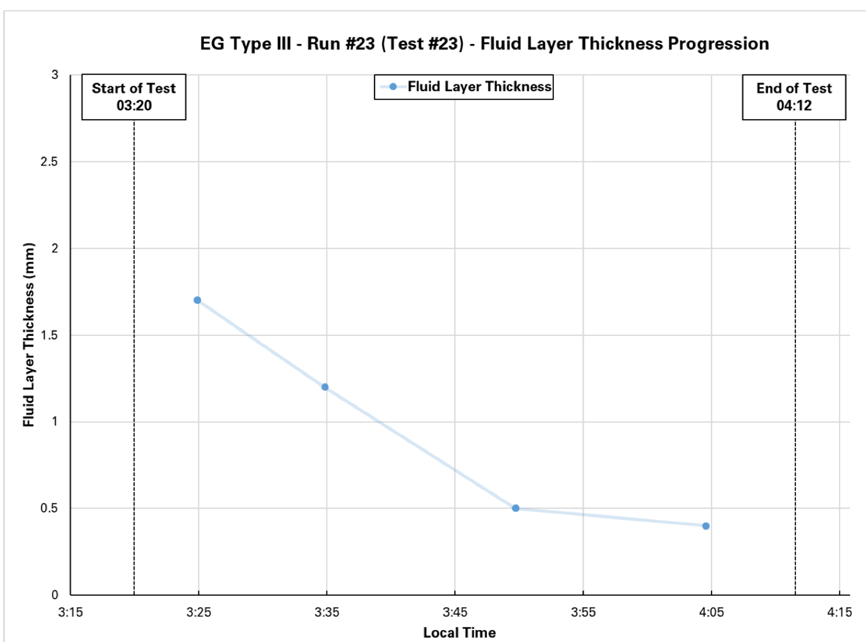
DATA PACKAGE – EG TYPE III – RUN 23 (TEST 23)

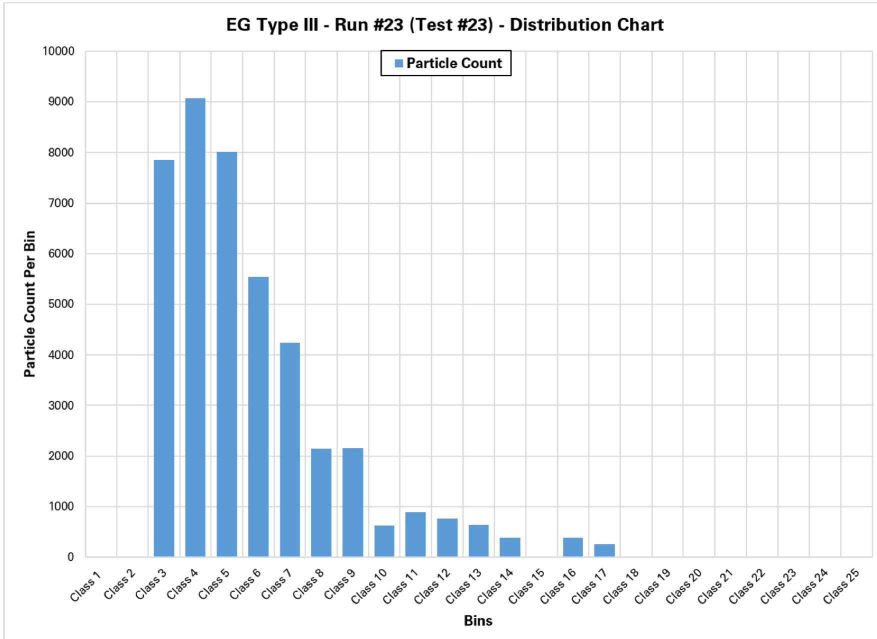


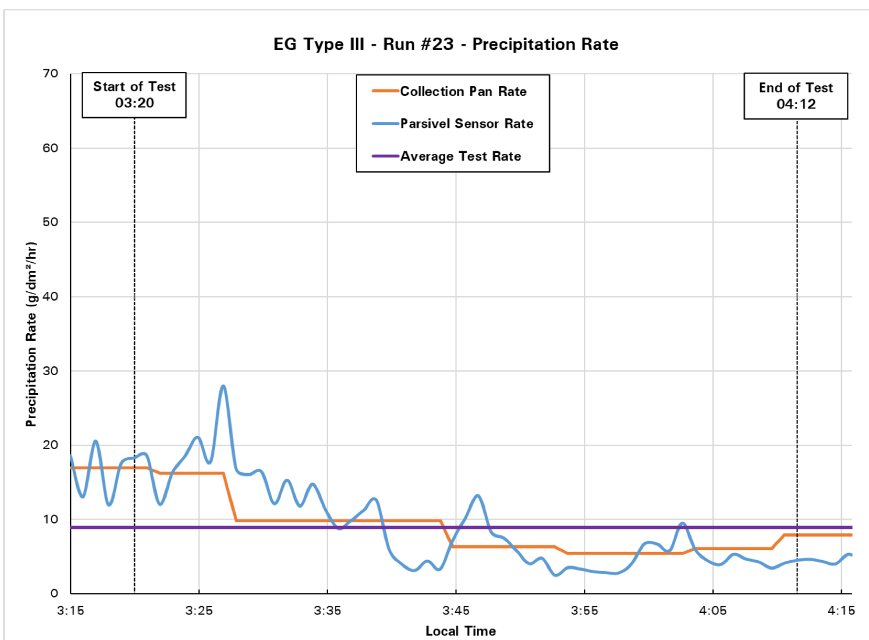

EG Type III - Run #23 (Test #23) - Relative Humidity
Start of Test 03:20
WS600 Sensor Relative Humidity
End of Test 04:12
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

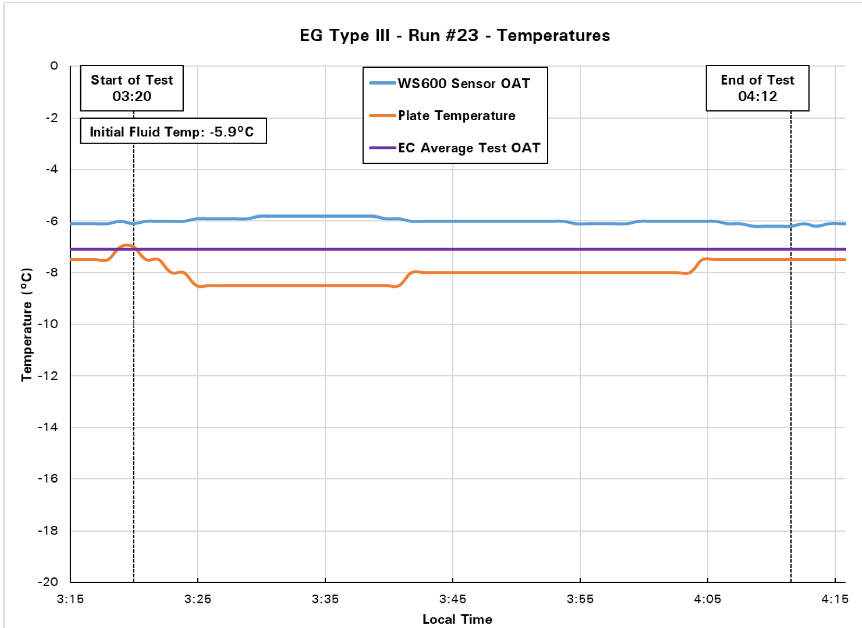

EG Type III - Run #23 (Test #23) - Fluid Brix Progression
Start of Test 03:20
Fluid Brix
End of Test 04:12
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time


EG Type III - Run #23 (Test #23) - Barometric Pressure
Start of Test 03:20
WS600 Sensor Barometric Pressure
End of Test 04:12
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

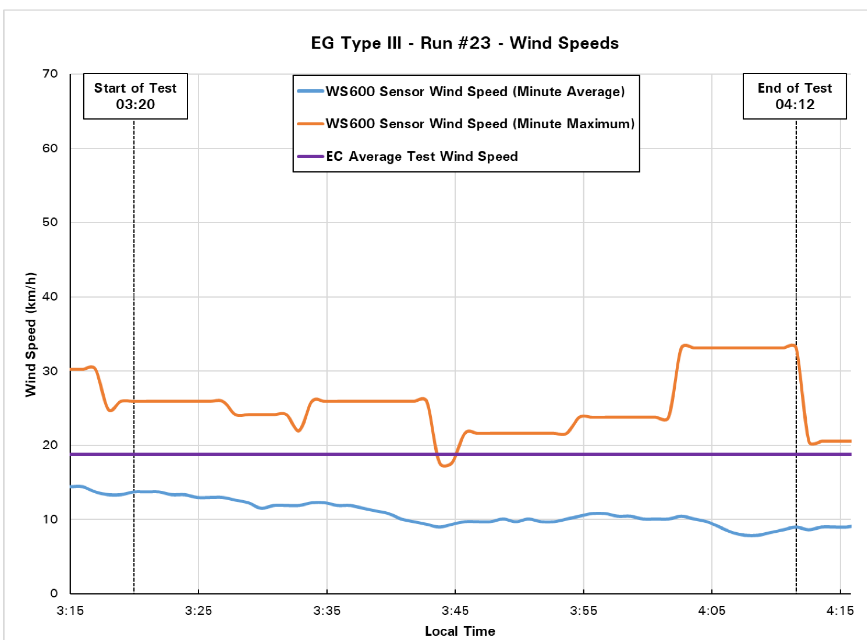

EG Type III - Run #23 (Test #23) - Fluid Layer Thickness Progression
Start of Test 03:20
Fluid Layer Thickness
End of Test 04:12
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time


EG Type III - Run #23 (Test #23) - Distribution Chart
Particle Count
Particle Count Per Bin
Bins
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
Class 9
Class 10
Class 11
Class 12
Class 13
Class 14
Class 15
Class 16
Class 17
Class 18
Class 19
Class 20
Class 21
Class 22
Class 23
Class 24
Class 25

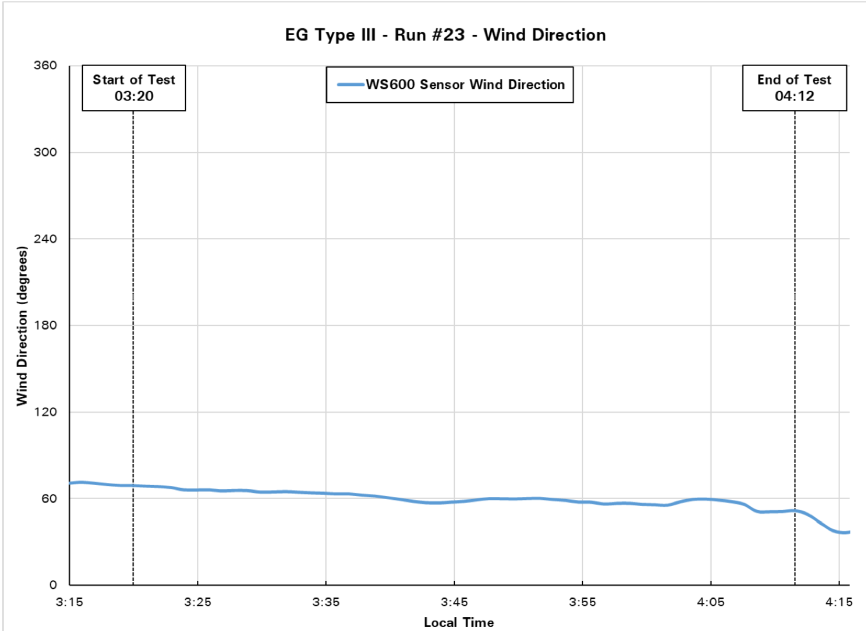

EG Type III - Run #23 - Precipitation Rate
Start of Test
03:20
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test
04:12
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

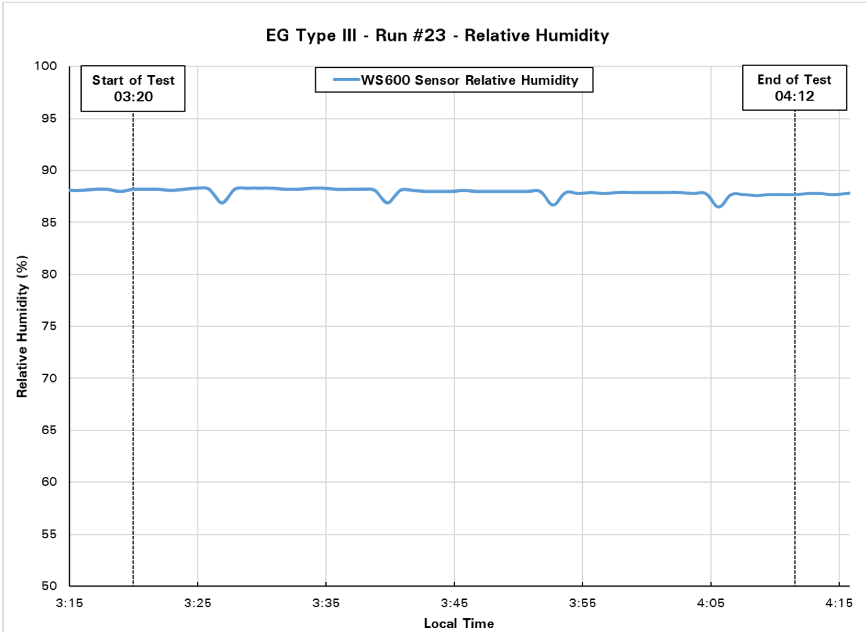


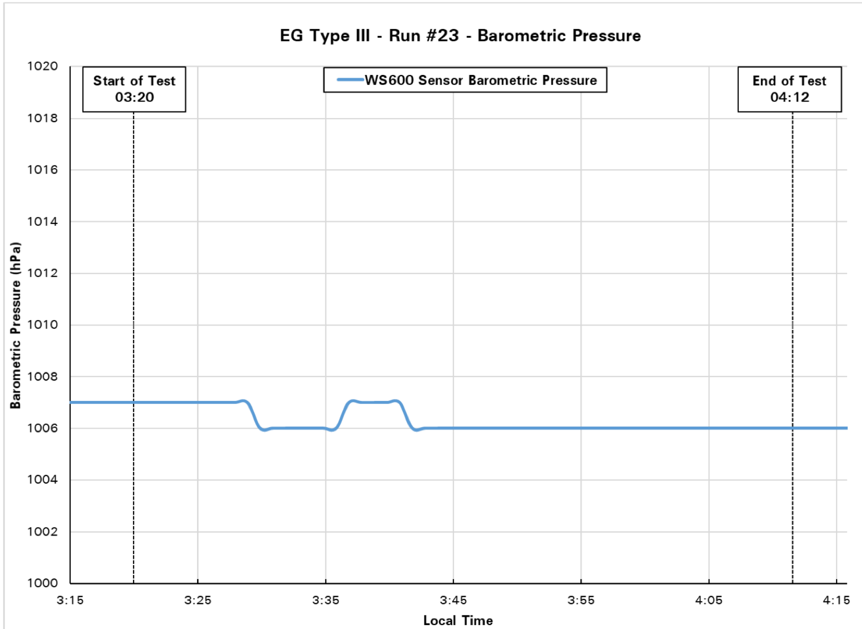
EG Type III - Run #23 - Temperatures
Start of Test 03:20
Initial Fluid Temp: -5.9°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 04:12
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time



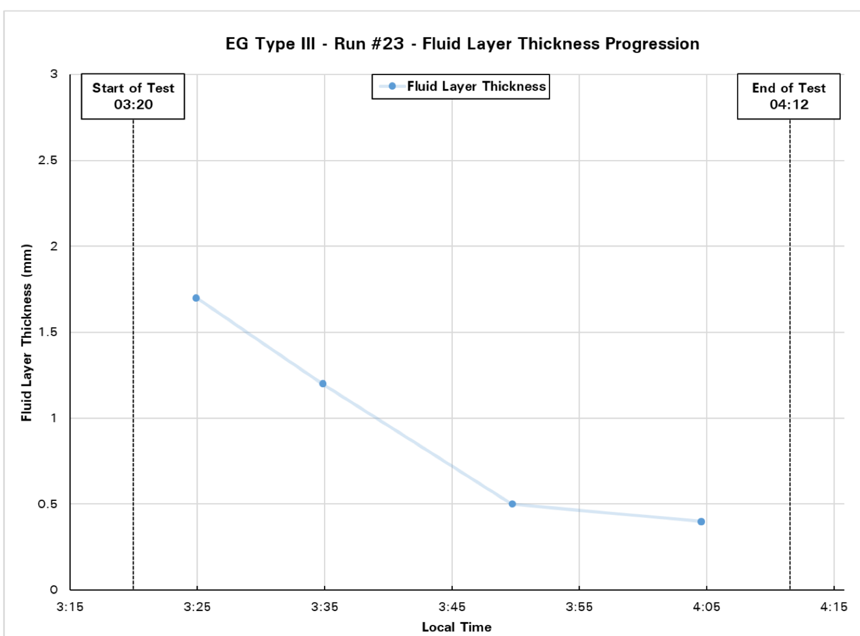
EG Type III - Run #23 - Wind Speeds
Start of Test 03:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 04:12
Wind Speed (km/h)
70
60
50
40
30
20
10
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

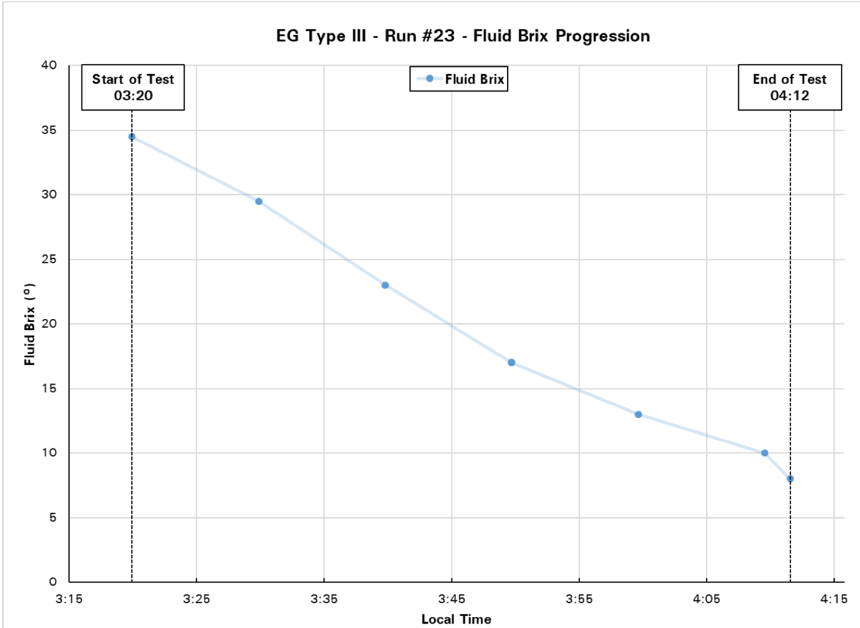

EG Type III - Run #23 - Wind Direction
Start of Test
03:20
WS600 Sensor Wind Direction
End of Test
04:12
Wind Direction (degrees)
360
300
240
180
120
60
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time

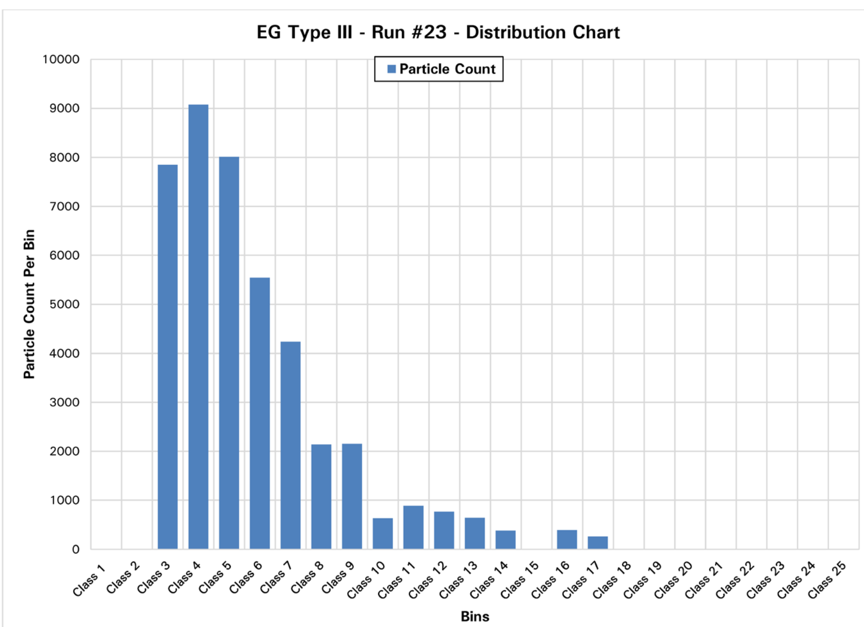

EG Type III - Run #23 - Relative Humidity
Start of Test
03:20
WS600 Sensor Relative Humidity
End of Test
04:12
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time



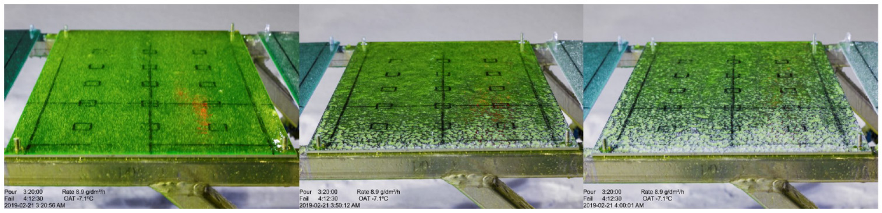
DATA PACKAGE – EG TYPE III – RUN 23 (TEST 23)



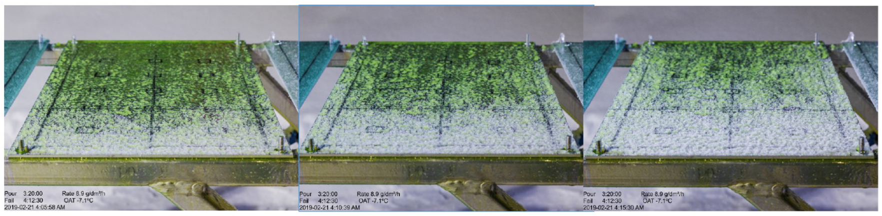

EG Type III - Run #23 - Fluid Brix Progression
Start of Test 03:20
Fluid Brix
End of Test 04:12
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
Local Time


EG Type III - Run #23 - Distribution Chart
Particle Count
Particle Count Per Bin
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
Class 9
Class 10
Class 11
Class 12
Class 13
Class 14
Class 15
Class 16
Class 17
Class 18
Class 19
Class 20
Class 21
Class 22
Class 23
Class 24
Class 25
Bins

AeroClear MAX – Run 23 (Test 23) – Failure Progression Photos

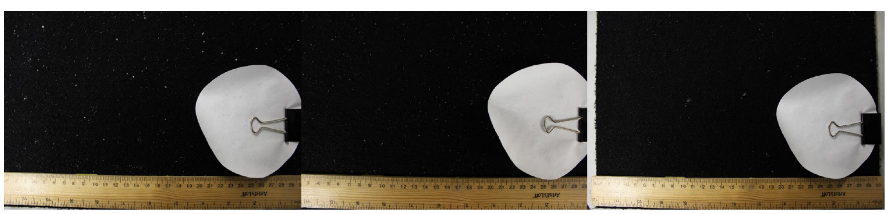


AT POUR (0/52 MIN) | PRE-FAILURE (30/52 MIN) | PRE-FAILURE (40/52 MIN)

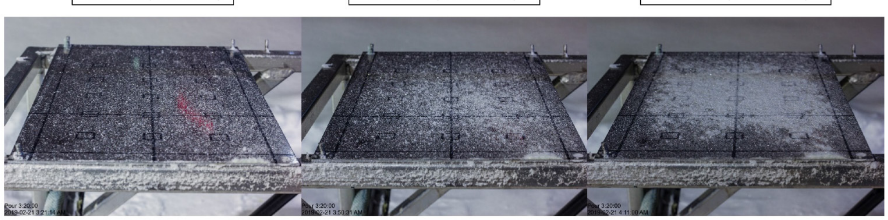


PRE-FAILURE (45/52 MIN) | PRE-FAILURE (50/52 MIN) | POST-FAILURE (55/52 MIN)

AeroClear MAX – Run 23 (Test 23) – Snow Characteristics Photos



FELT PAD (0/52 MIN) | FELT PAD (29/52 MIN) | FELT PAD (50/52 MIN)



BARE PLATE (1/52 MIN) | BARE PLATE (30/52 MIN) | BARE PLATE (51/52 MIN)

Final Bare Plate Contamination Thickness: **0.3 mm**

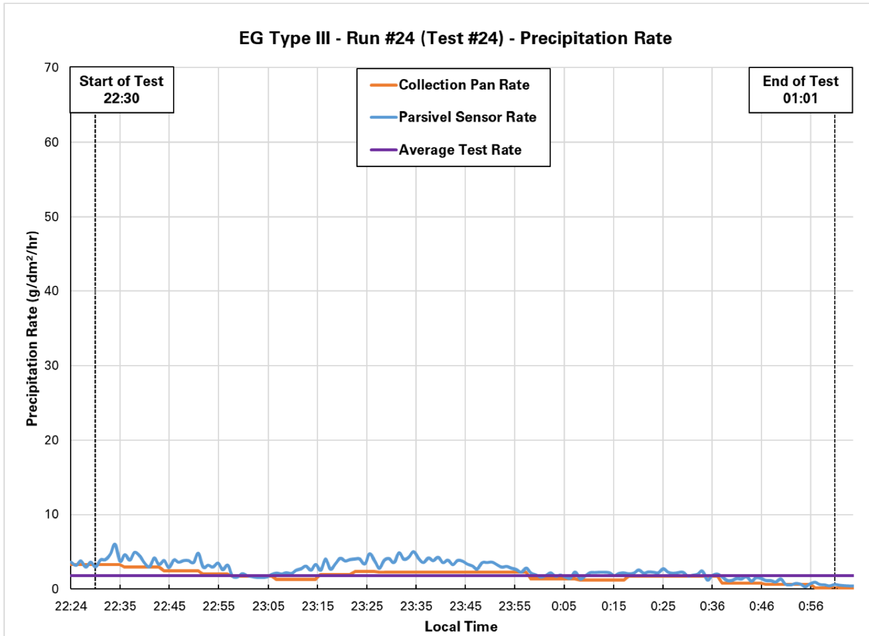
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #24 (TEST #24) – EG3-24

EG Type III – Run #24 (Test #24) – General Test Information

Test Number:	EG3-24
Date of Test:	March 3, 2019
Average OAT:	-3.7
Average Precipitation Rate:	1.8 g/dm²/h
Average Wind Speed:	10.2 km/h
Average Relative Humidity:	88.3%
Pour Time (Local):	22:30:00
Time of Fluid Failure (Local):	01:01:00
Fluid Brix at Failure:	6.5°
Endurance Time:	152 minutes
Expected Regression-Derived Endurance Time:	131.5 minutes
Difference (ET vs. Reg ET):	+20.5 minutes (+15.6%)

DATA PACKAGE – EG TYPE III – RUN 24 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 24 - Test 24/Data Package - EG Type III - Run 24 - Test 24.docx
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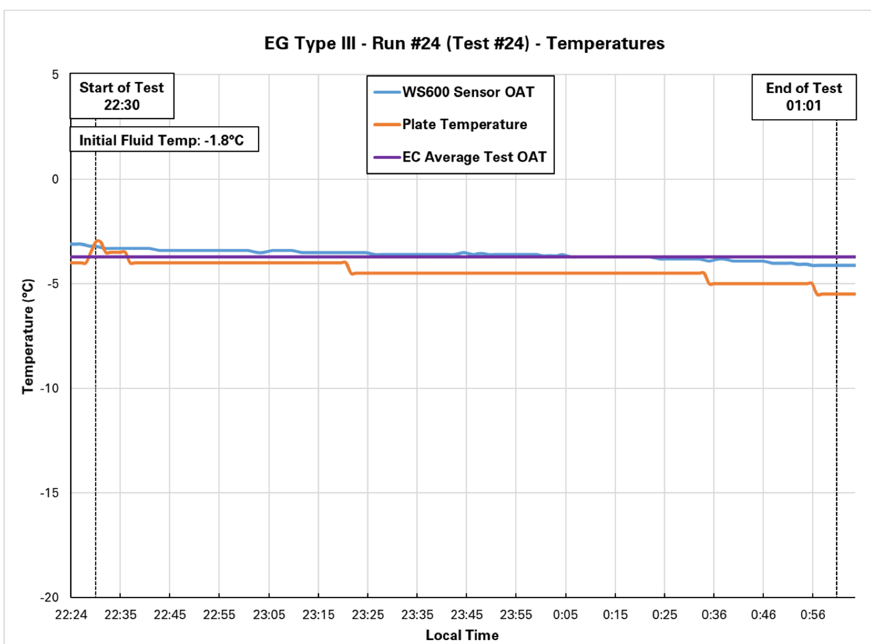
DATA PACKAGE – EG TYPE III – RUN 24 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 24 - Test 24/Data Package - EG Type III - Run 24 - Test 24.docx
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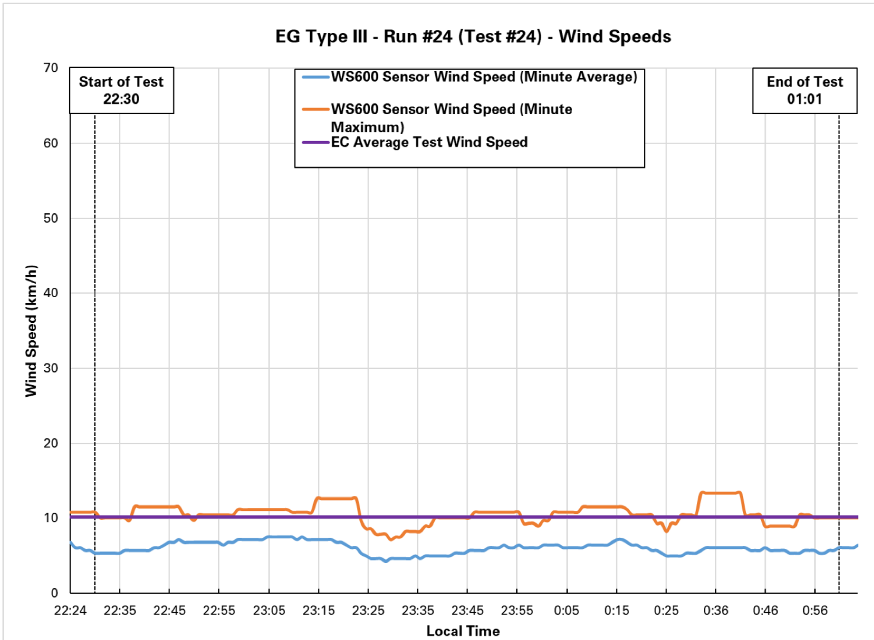
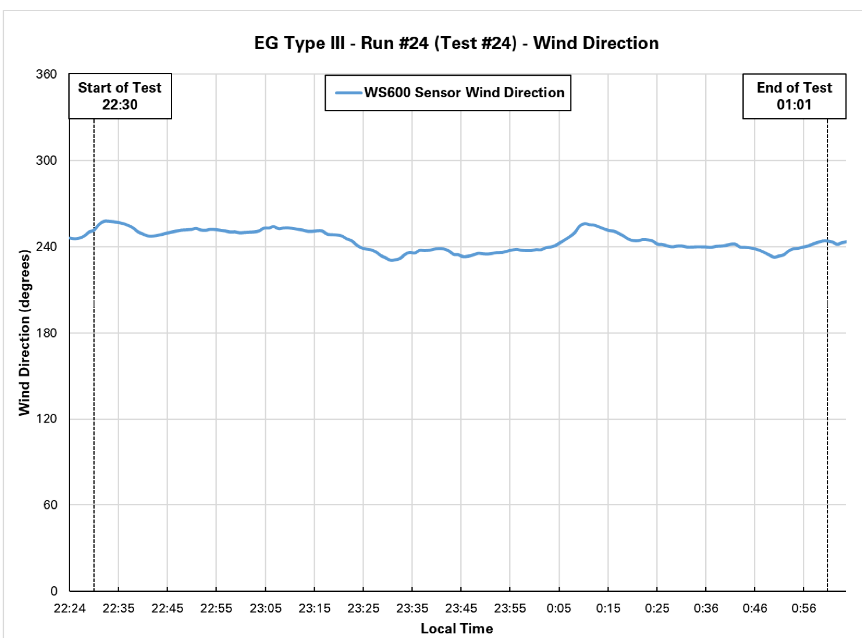
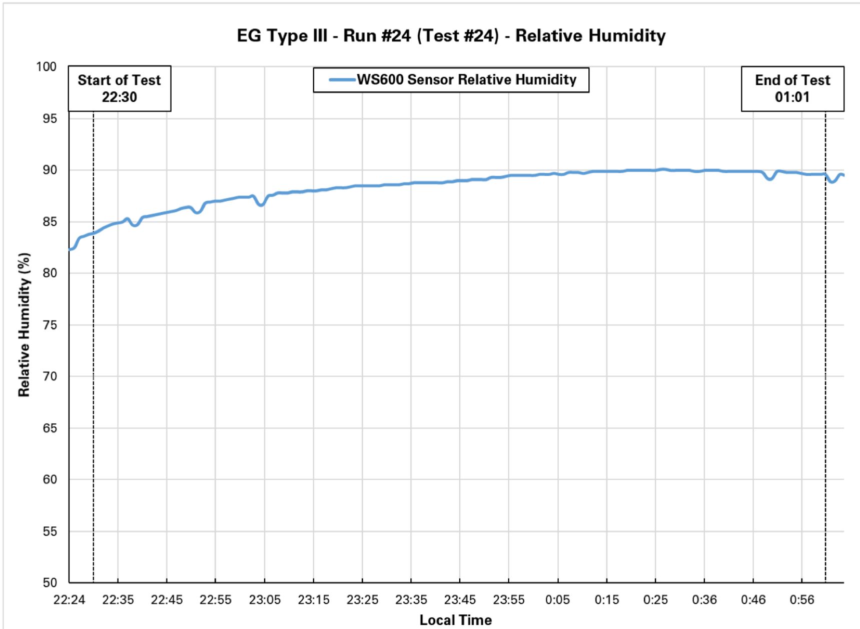
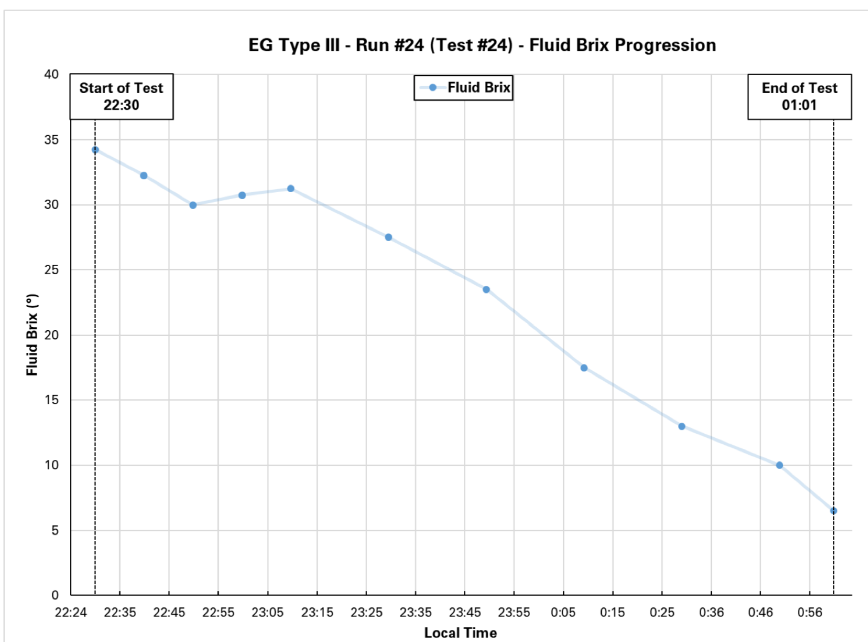
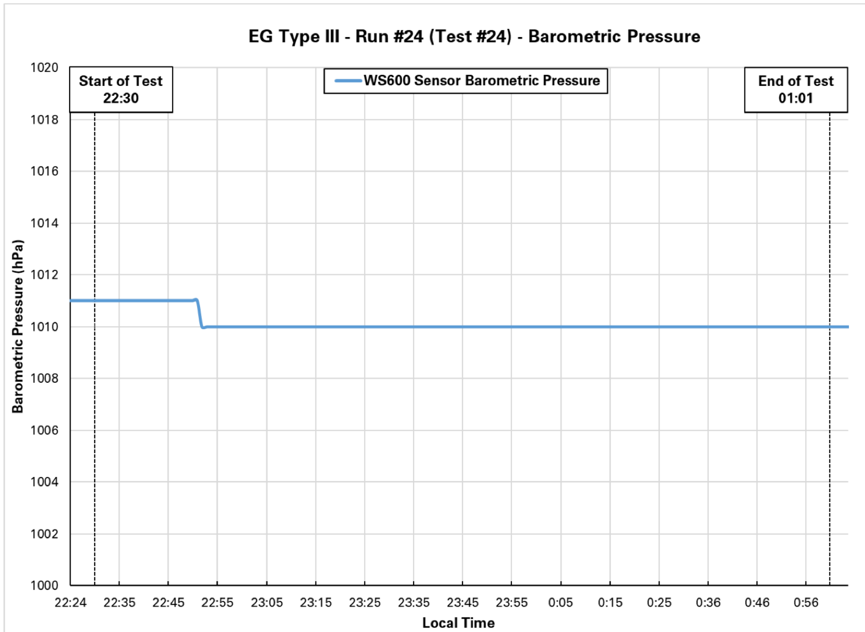

EG Type III - Run #24 (Test #24) - Wind Speeds
Start of Test 22:30
End of Test 01:01
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
22:24 22:35 22:45 22:55 23:05 23:15 23:25 23:35 23:45 23:55 0:05 0:15 0:25 0:36 0:46 0:56
Local Time

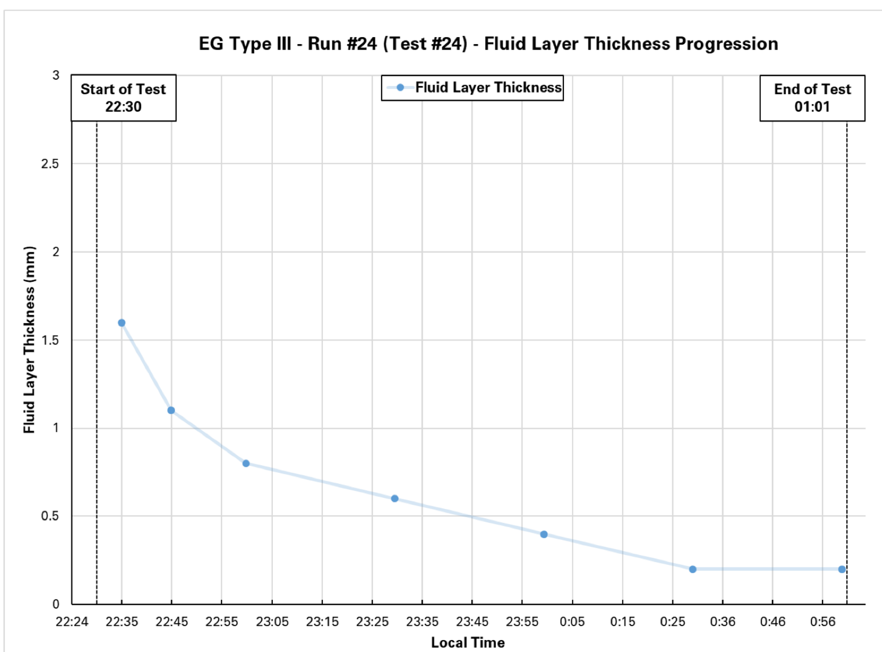

EG Type III - Run #24 (Test #24) - Wind Direction
Start of Test 22:30
End of Test 01:01
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
22:24 22:35 22:45 22:55 23:05 23:15 23:25 23:35 23:45 23:55 0:05 0:15 0:25 0:36 0:46 0:56
Local Time


EG Type III - Run #24 (Test #24) - Relative Humidity
Start of Test 22:30
WS600 Sensor Relative Humidity
End of Test 01:01
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
22:24
22:35
22:45
22:55
23:05
23:15
23:25
23:35
23:45
23:55
0:05
0:15
0:25
0:36
0:46
0:56
Local Time

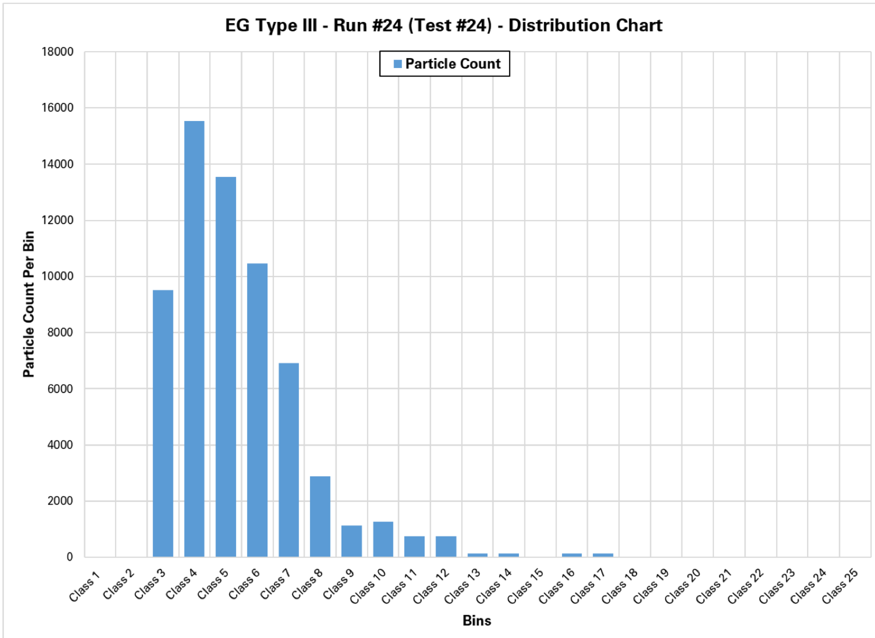

EG Type III - Run #24 (Test #24) - Fluid Brix Progression
Start of Test 22:30
Fluid Brix
End of Test 01:01
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
22:24
22:35
22:45
22:55
23:05
23:15
23:25
23:35
23:45
23:55
0:05
0:15
0:25
0:36
0:46
0:56
Local Time



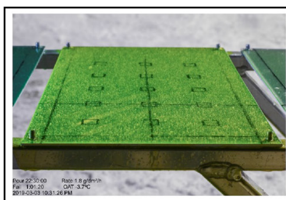
DATA PACKAGE – EG TYPE III – RUN 24 (TEST 24)

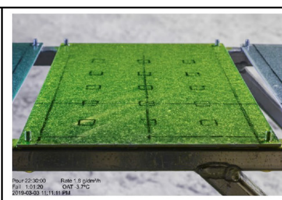


APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 24 - Test 24/Data Package - EG Type III - Run 24 - Test 24.docx
Final Version 1.0, February 2021

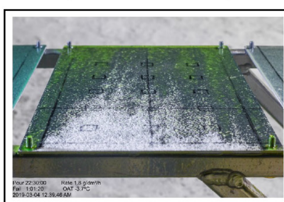


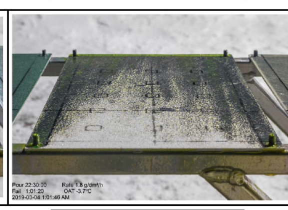
AeroClear MAX – Run 24 (Test 24) – Failure Progression Photos

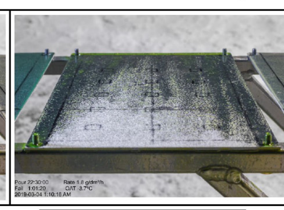

AT POUR (0/151 MIN)


PRE-FAILURE (41/151 MIN)

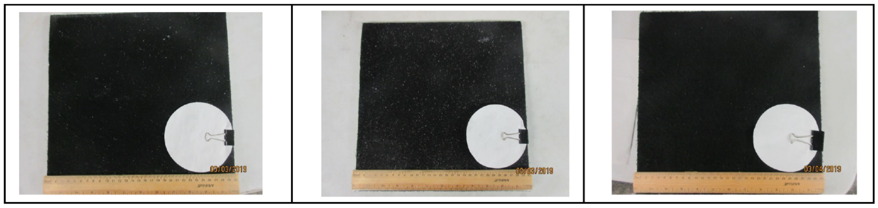

PRE-FAILURE (80/151 MIN)


PRE-FAILURE (129/151 MIN)

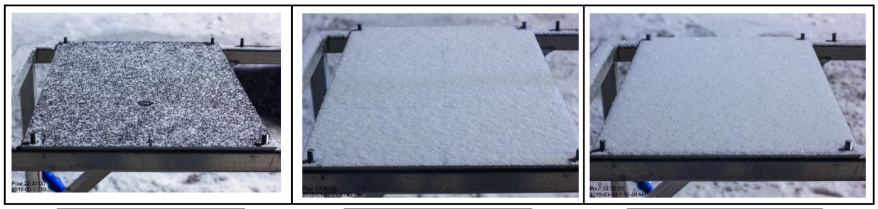

AT FAILURE (151/151 MIN)


POST-FAILURE (160/151 MIN)

AeroClear MAX – Run 24 (Test 24) – Snow Characteristics Photos



FELT PAD (32/151 MIN) | FELT PAD (81/151 MIN) | FELT PAD (161/151 MIN)



BARE PLATE (0/151 MIN) | BARE PLATE 60/151 MIN) | BARE PLATE (160/151 MIN)

Final Bare Plate Contamination Thickness: **Not taken**

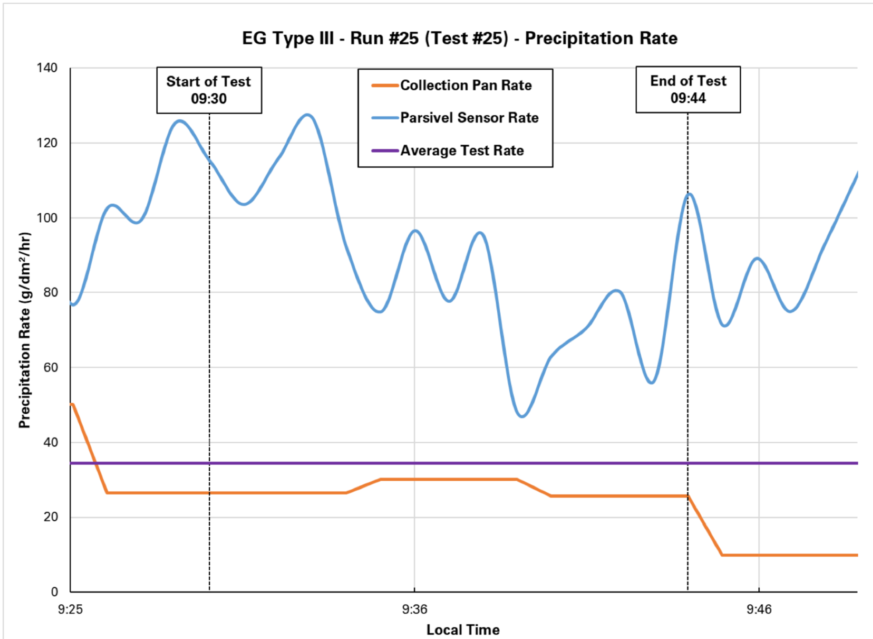
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #25 (TEST #25) – EG3-25

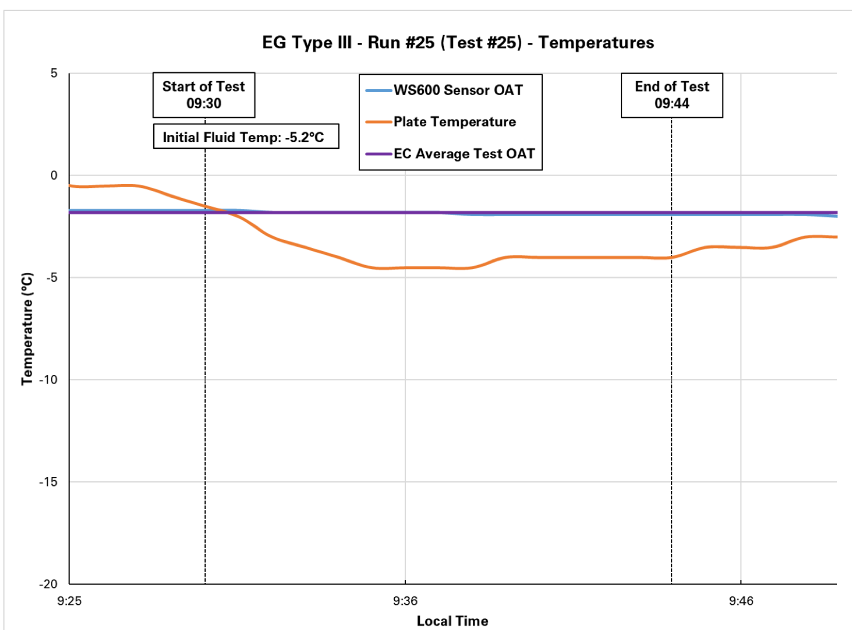
DATA PACKAGE – EG TYPE III – RUN 25 (TEST 25)

EG Type III – Run #25 (Test #25) – General Test Information

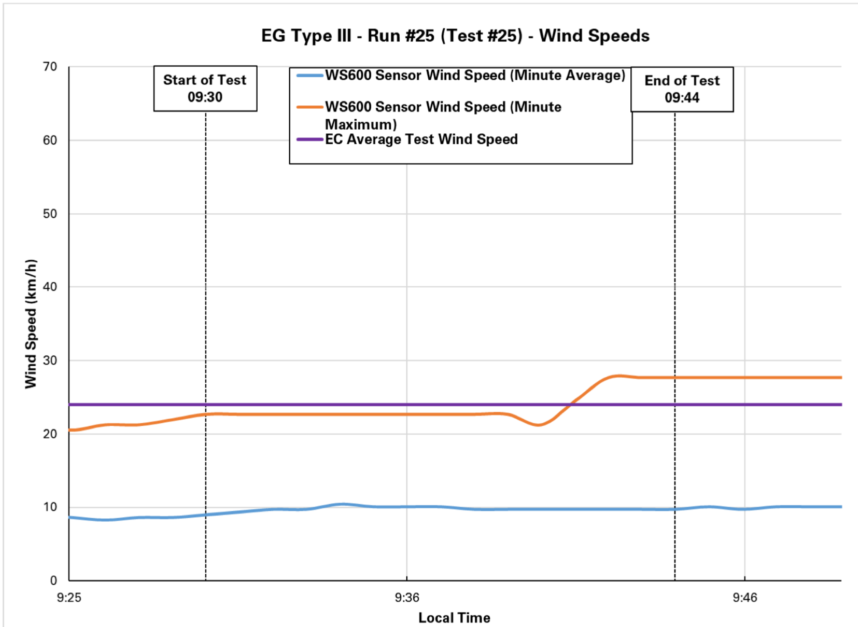
Test Number:	EG3-25
Date of Test:	March 10, 2019
Average OAT:	-1.8
Average Precipitation Rate:	34.4 g/dm²/h
Average Wind Speed:	24 km/h
Average Relative Humidity:	90.7%
Pour Time (Local):	09:30:00
Time of Fluid Failure (Local):	09:44:00
Fluid Brix at Failure:	6.5°
Endurance Time:	14 minutes
Expected Regression-Derived Endurance Time:	18.9 minutes
Difference (ET vs. Reg ET):	-4.9 minutes (-26.1%)

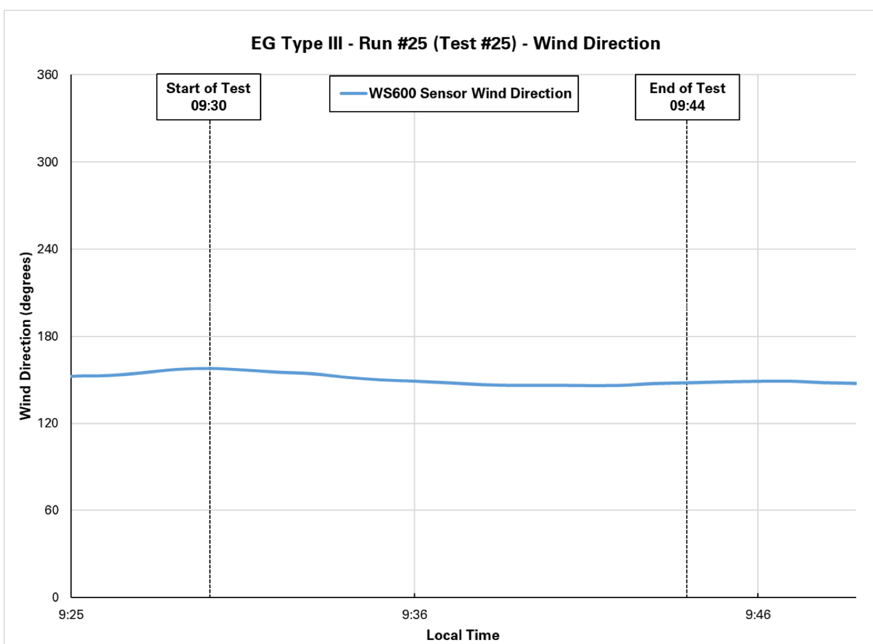


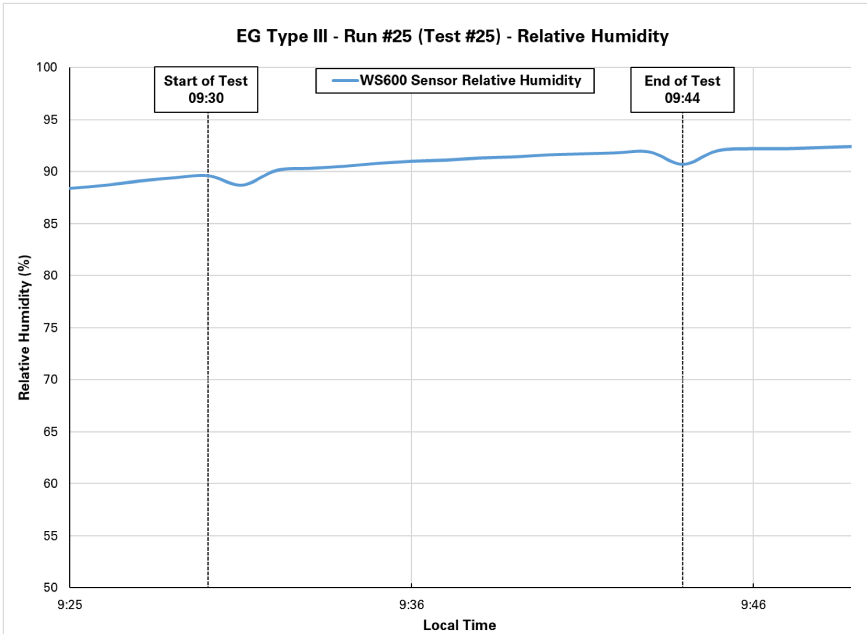
EG Type III - Run #25 (Test #25) - Precipitation Rate
Start of Test 09:30
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 09:44
Precipitation Rate (g/dm²/hr)
140
120
100
80
60
40
20
0
9:25
9:36
9:46
Local Time



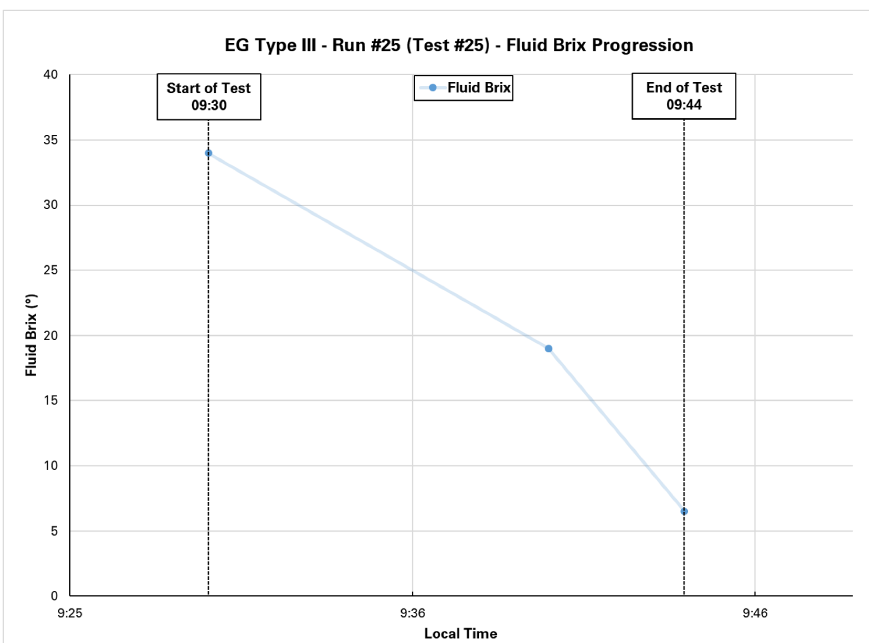
EG Type III - Run #25 (Test #25) - Temperatures
Start of Test 09:30
Initial Fluid Temp: -5.2°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 09:44
Temperature (°C)
5
0
-5
-10
-15
-20
9:25
9:36
9:46
Local Time

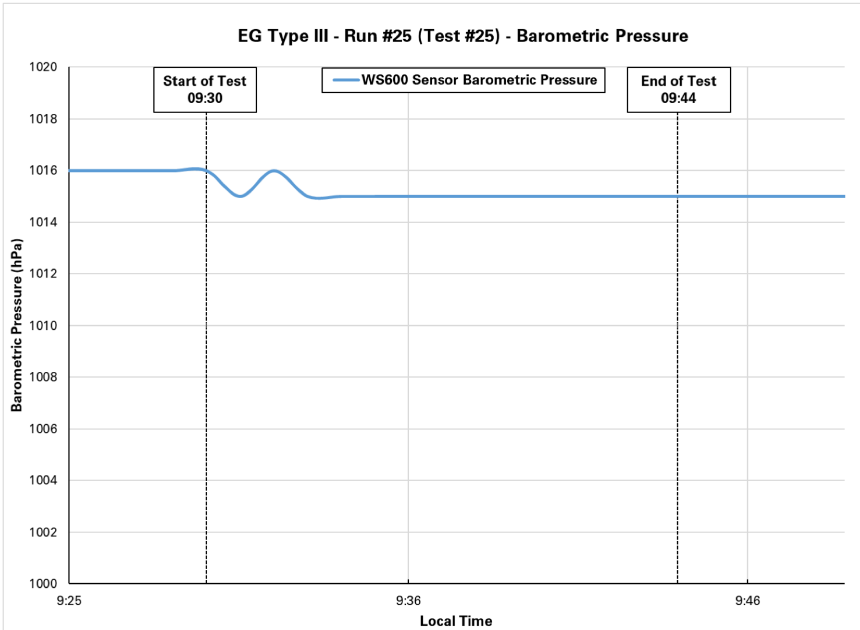

EG Type III - Run #25 (Test #25) - Wind Speeds
Start of Test 09:30
End of Test 09:44
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
9:25
9:36
9:46
Local Time

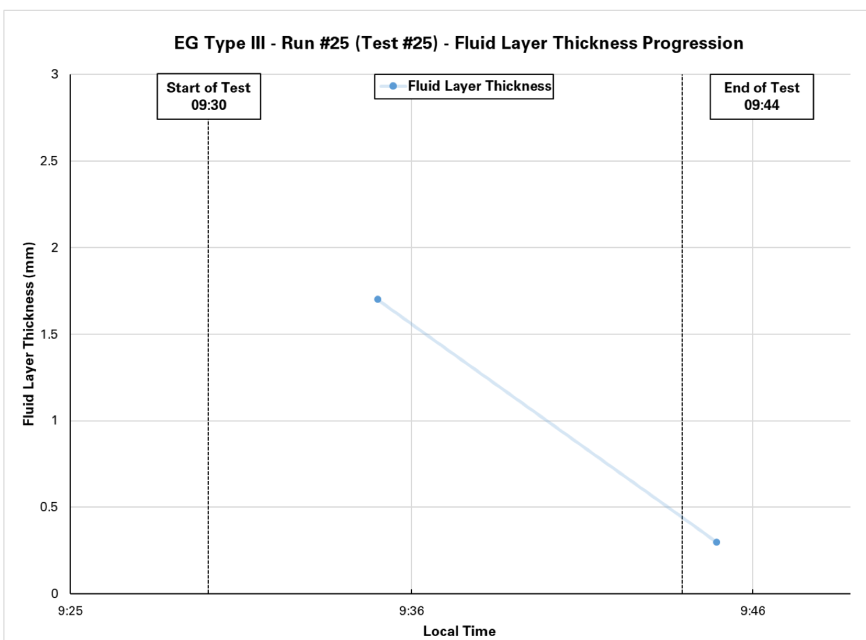

EG Type III - Run #25 (Test #25) - Wind Direction
Start of Test 09:30
WS600 Sensor Wind Direction
End of Test 09:44
Wind Direction (degrees)
0
60
120
180
240
300
360
9:25
9:36
9:46
Local Time

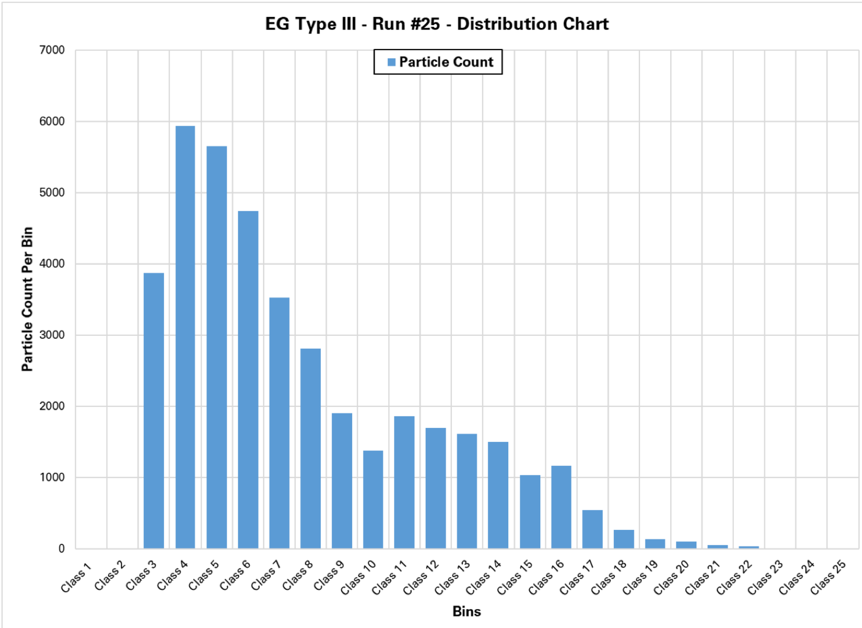


DATA PACKAGE – EG TYPE III – RUN 25 (TEST 25)

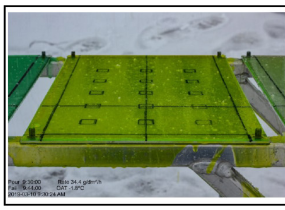



EG Type III - Run #25 (Test #25) - Barometric Pressure
Start of Test 09:30
WS600 Sensor Barometric Pressure
End of Test 09:44
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
9:25
9:36
9:46
Local Time

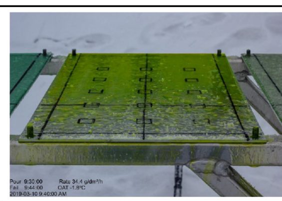

EG Type III - Run #25 (Test #25) - Fluid Layer Thickness Progression
Start of Test 09:30
Fluid Layer Thickness
End of Test 09:44
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
9:25
9:36
9:46
Local Time



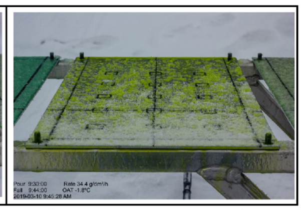
AeroClear MAX – Run 25 (Test 25) – Failure Progression Photos



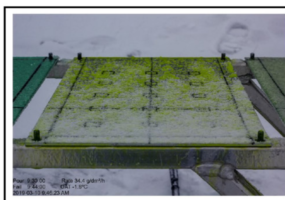
AT POUR (0/14 MIN)



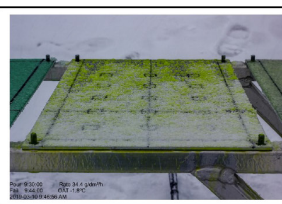
PRE-FAILURE (10/14 MIN)



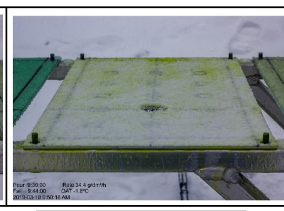
AT FAILURE (15/14 MIN)



POST-FAILURE (16/14 MIN)

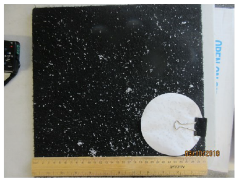


POST-FAILURE (17/14 MIN)



POST-FAILURE (20/14 MIN)

AeroClear MAX – Run 25 (Test 25) – Snow Characteristics Photos

	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (1/14 MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (1/14 MIN)	BARE PLATE 10/14 MIN)	BARE PLATE (21/14 MIN)

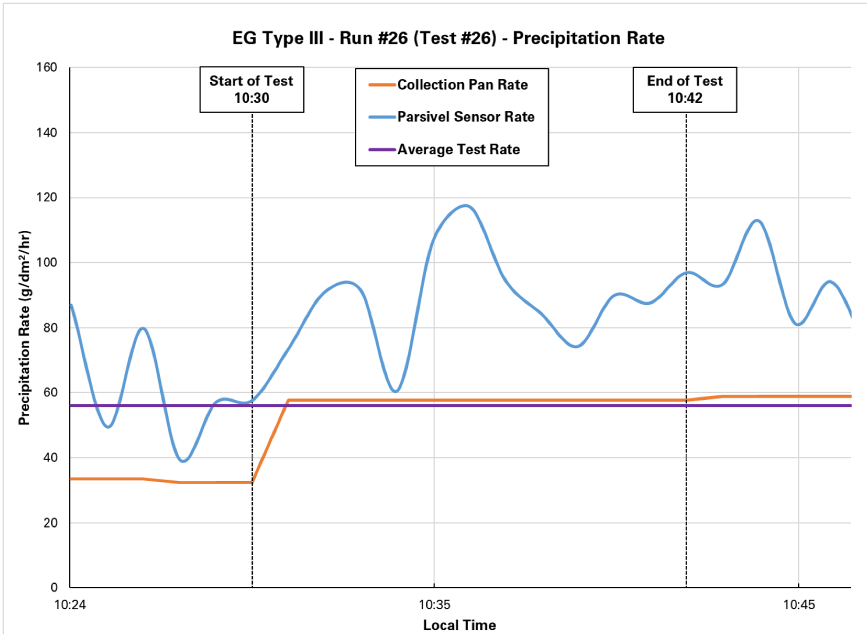
Final Bare Plate Contamination Thickness: **Not taken**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

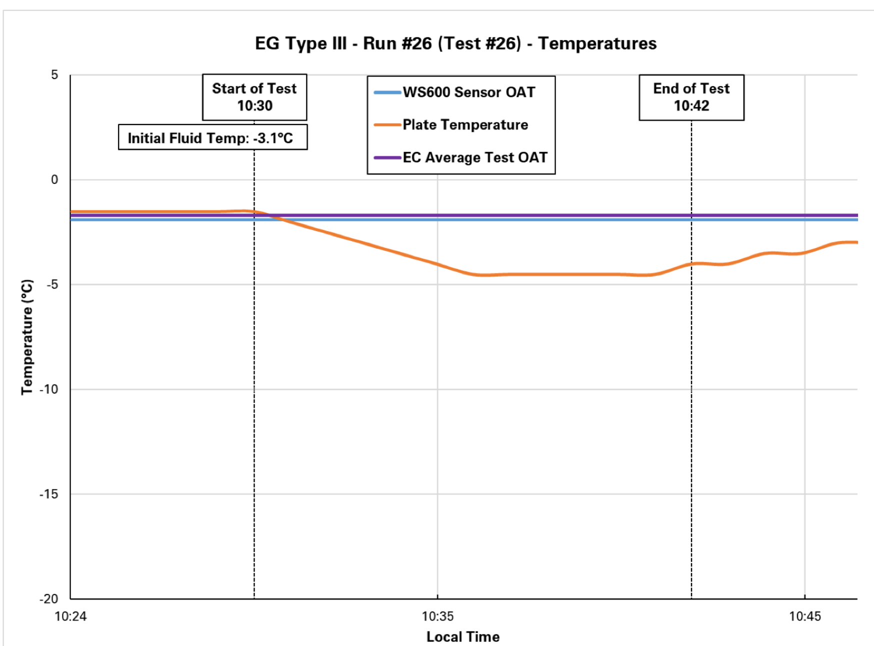
EG TYPE III
RUN #26 (TEST #26) – EG3-26

EG Type III – Run #26 (Test #26) – General Test Information

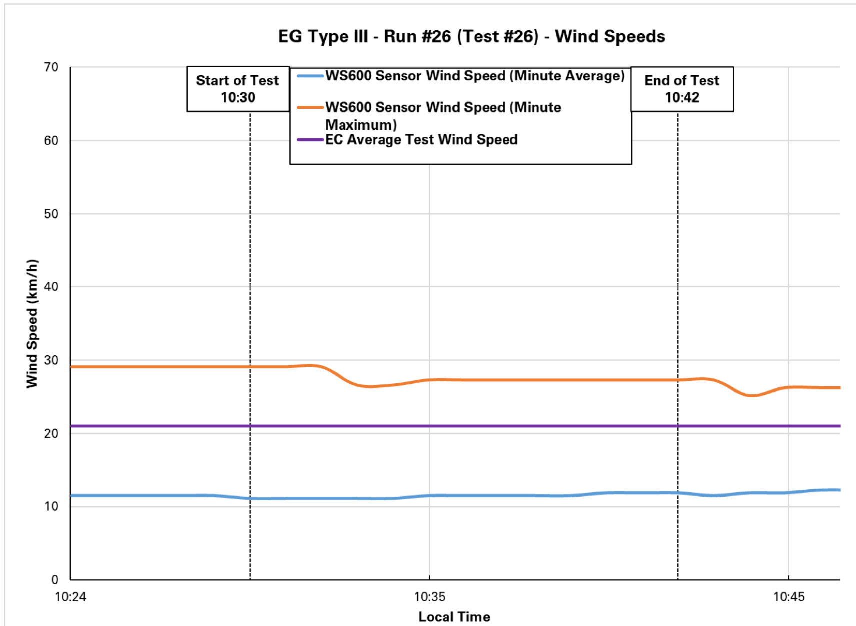
Test Number:	**EG3-26**
Date of Test:	**March 10, 2019**
Average OAT:	**-1.7**
Average Precipitation Rate:	**56 g/dm²/h**
Average Wind Speed:	**21 km/h**
Average Relative Humidity:	**94.5%**
Pour Time (Local):	**10:30:00**
Time of Fluid Failure (Local):	**10:42:00**
Fluid Brix at Failure:	**8.5°**
Endurance Time:	**12 minutes**
Expected Regression-Derived Endurance Time:	**13.7 minutes**
Difference (ET vs. Reg ET):	**-1.1 minutes (-7.9%)**



DATA PACKAGE – EG TYPE III – RUN 26 (TEST 26)



DATA PACKAGE – EG TYPE III – RUN 26 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 26 - Test 26/Data Package - EG Type III - Run 26 - Test 26.docx
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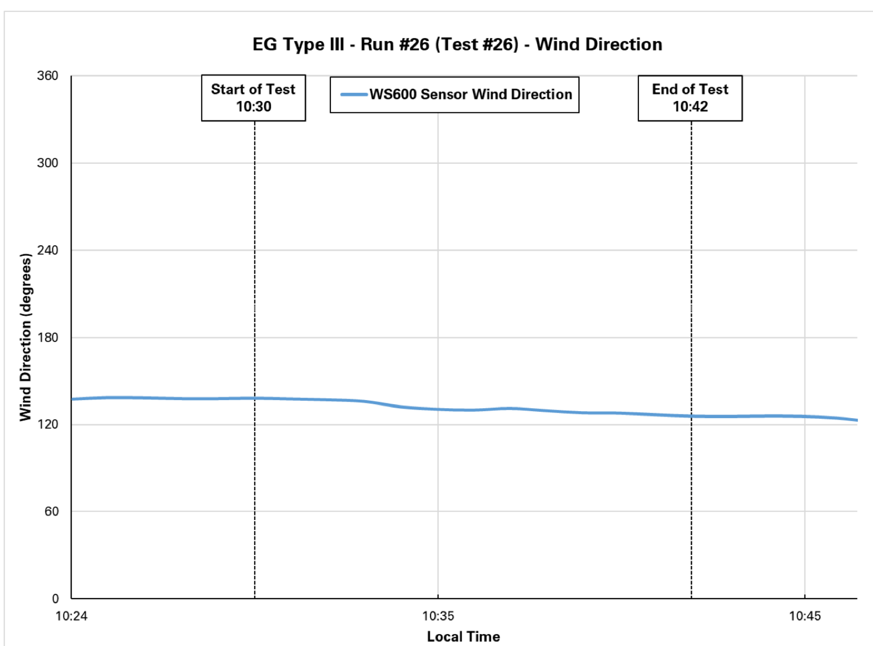
DATA PACKAGE – EG TYPE III – RUN 26 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 26 - Test 26/Data Package - EG Type III - Run 26 - Test 26.docx
Final Version 1.0, February 2021

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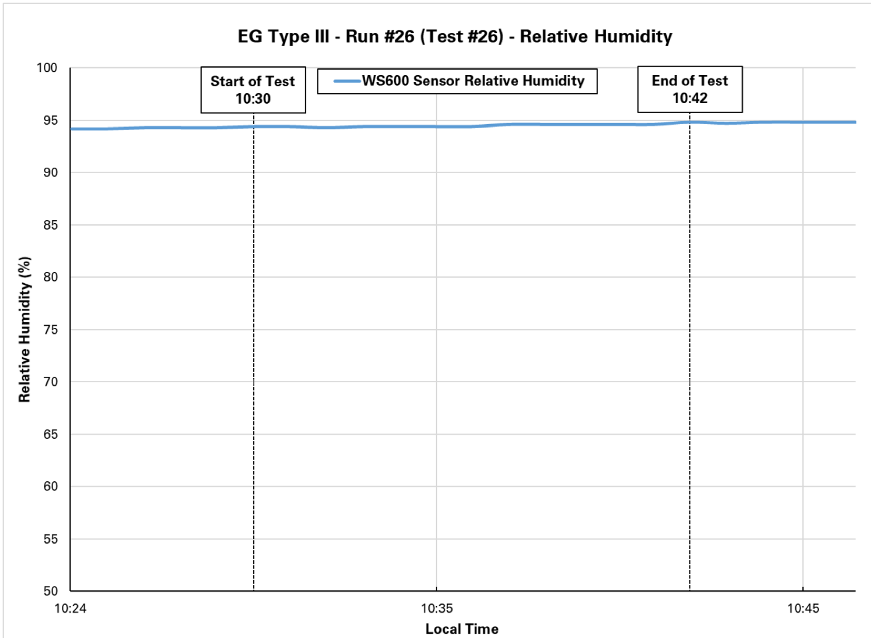
DATA PACKAGE – EG TYPE III – RUN 26 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 26 - Test 26/Data Package - EG Type III - Run 26 - Test 26.docx
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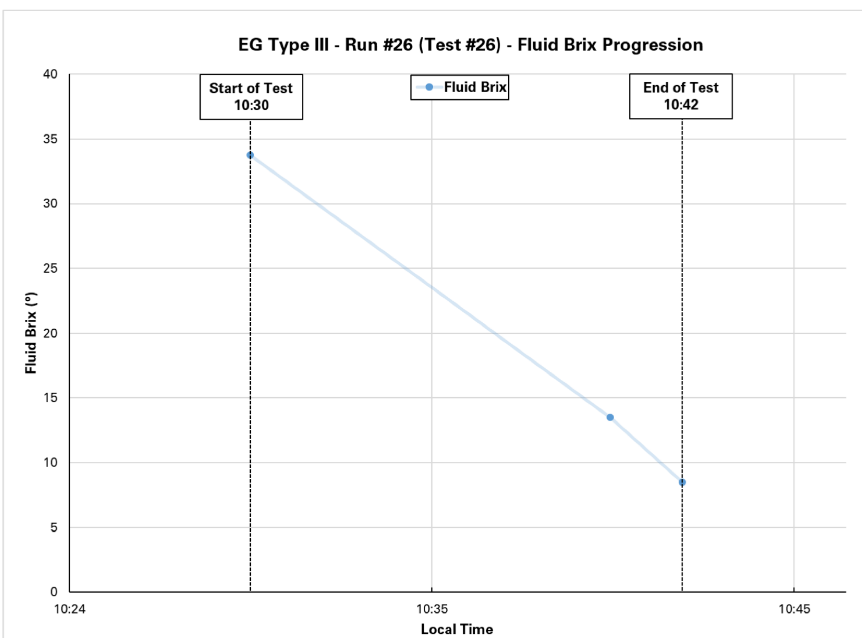
DATA PACKAGE – EG TYPE III – RUN 26 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 26 - Test 26/Data Package - EG Type III - Run 26 - Test 26.docx
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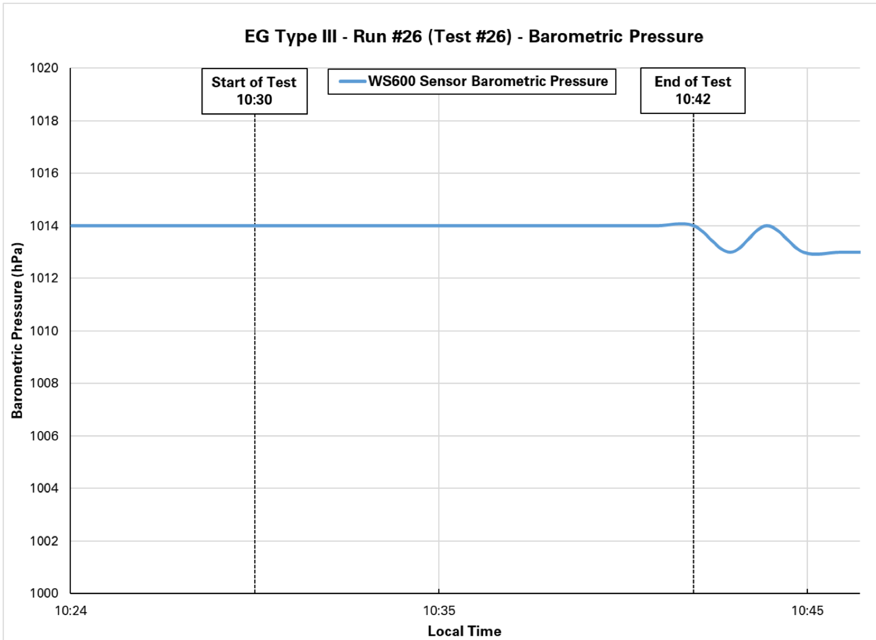
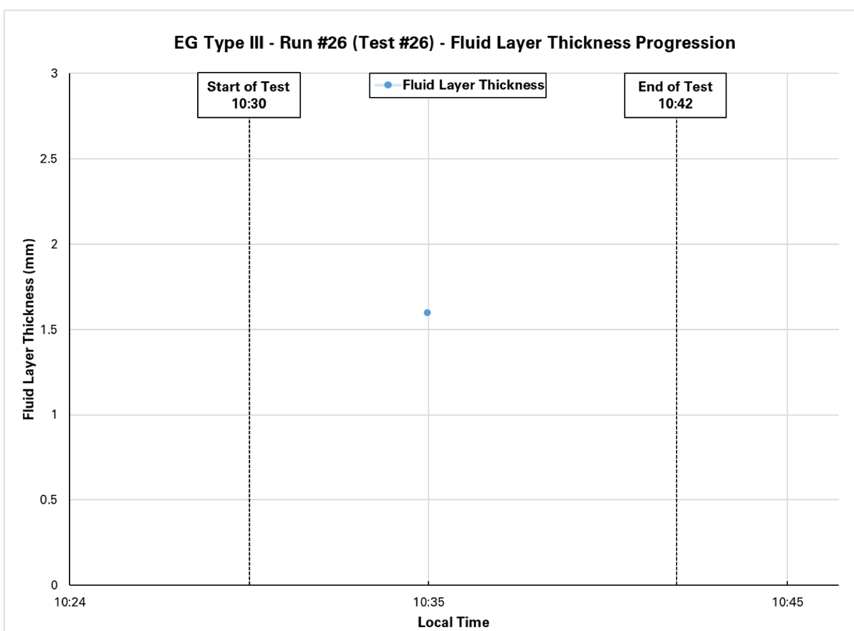
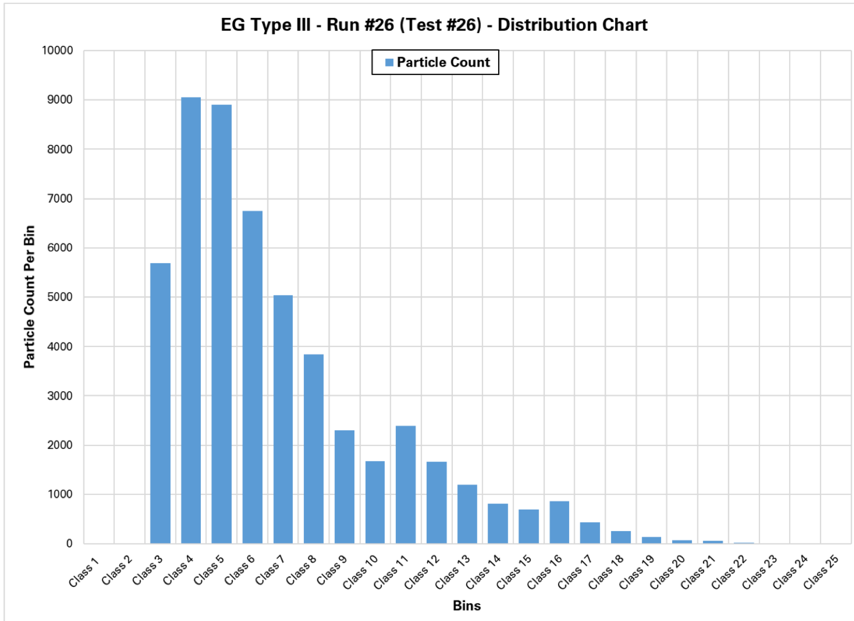
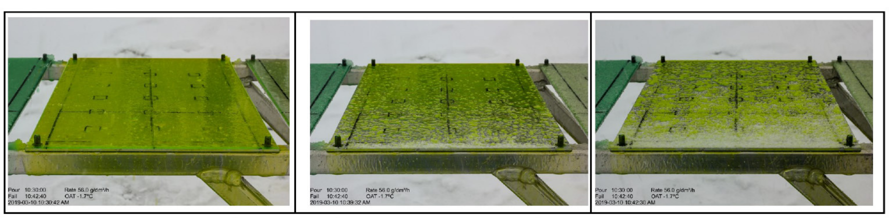

EG Type III - Run #26 (Test #26) - Barometric Pressure
Start of Test 10:30
WS600 Sensor Barometric Pressure
End of Test 10:42
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:24
10:35
10:45
Local Time

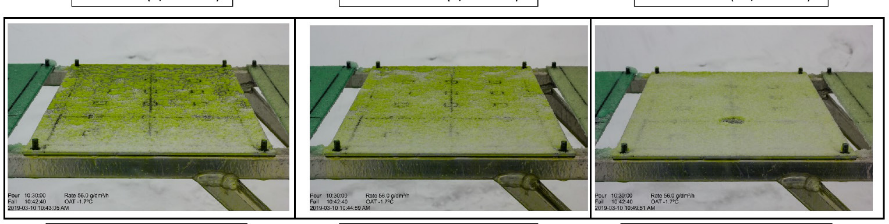

EG Type III - Run #26 (Test #26) - Fluid Layer Thickness Progression
Start of Test 10:30
Fluid Layer Thickness
End of Test 10:42
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:24
10:35
10:45
Local Time



AeroClear MAX – Run 26 (Test 26) – Failure Progression Photos

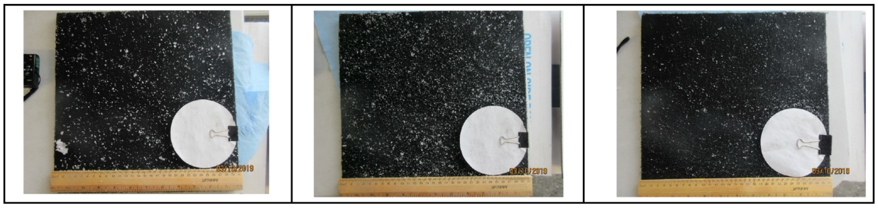


AT POUR (0/12 MIN) | PRE-FAILURE (9/12 MIN) | AT FAILURE (12/12 MIN)



POST-FAILURE (13/12 MIN) | POST-FAILURE (15/12 MIN) | POST-FAILURE (19/12 MIN)

AeroClear MAX – Run 26 (Test 26) – Snow Characteristics Photos



FELT PAD (1/12 MIN) | FELT PAD (21/12 MIN) | FELT PAD (47/12 MIN)

BARE PLATE (1/12 MIN) | BARE PLATE 9/12 MIN) | BARE PLATE (20/12 MIN)

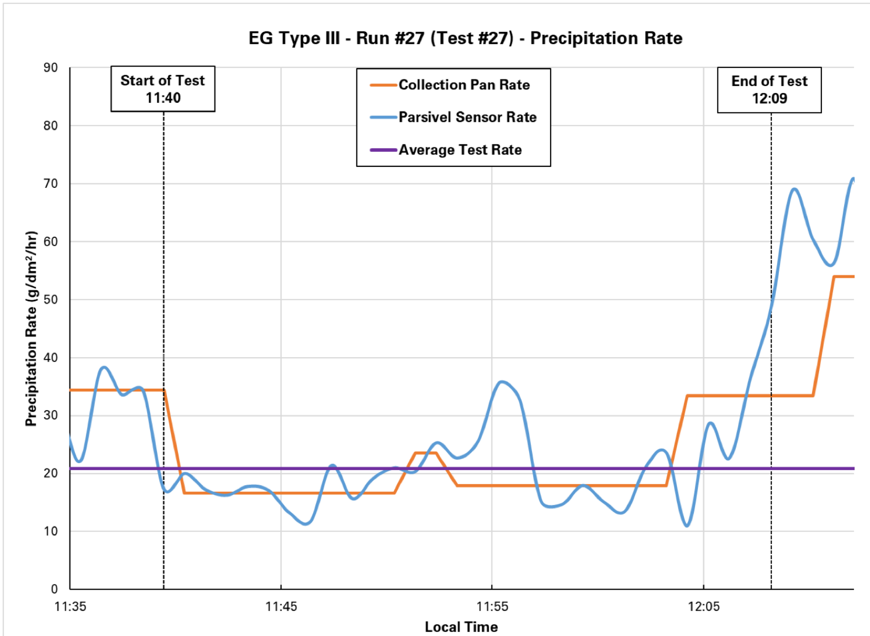
Final Bare Plate Contamination Thickness: **Not taken**

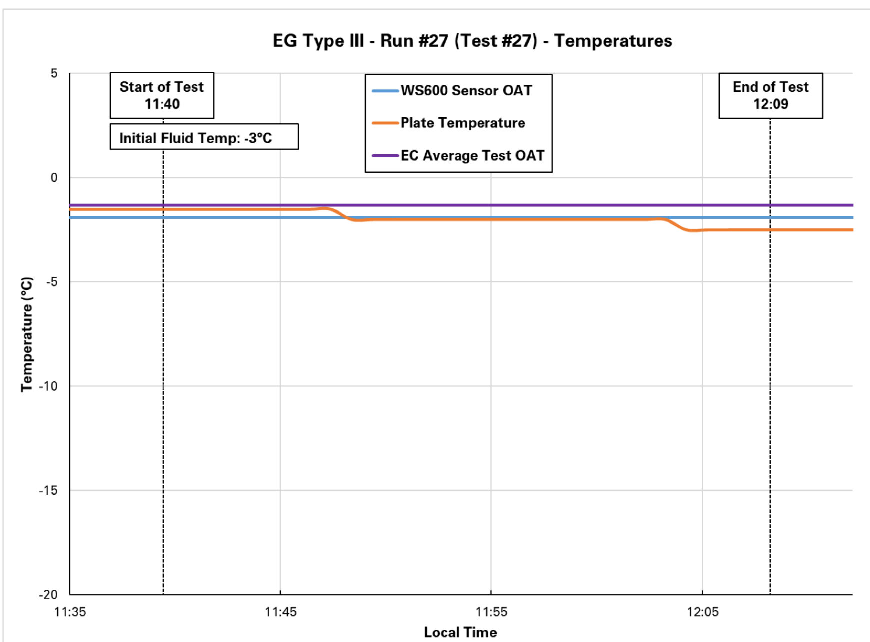
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

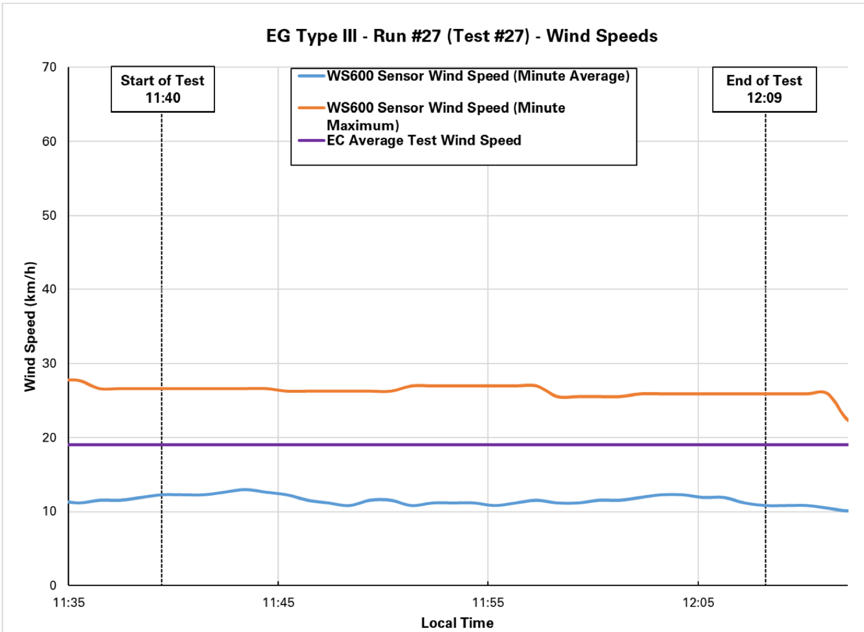
EG TYPE III
RUN #27 (TEST #27) – EG3-27

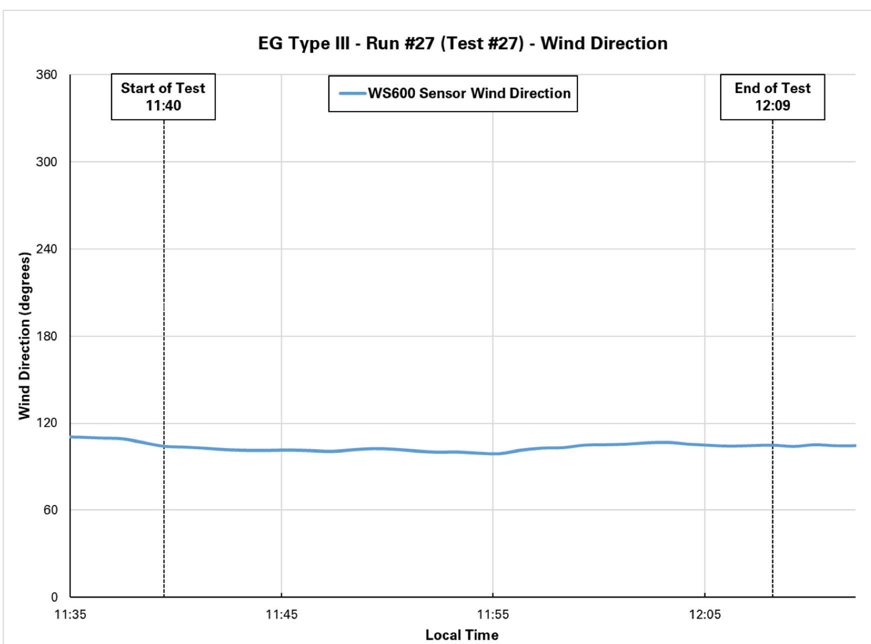
EG Type III – Run #27 (Test #27) – General Test Information

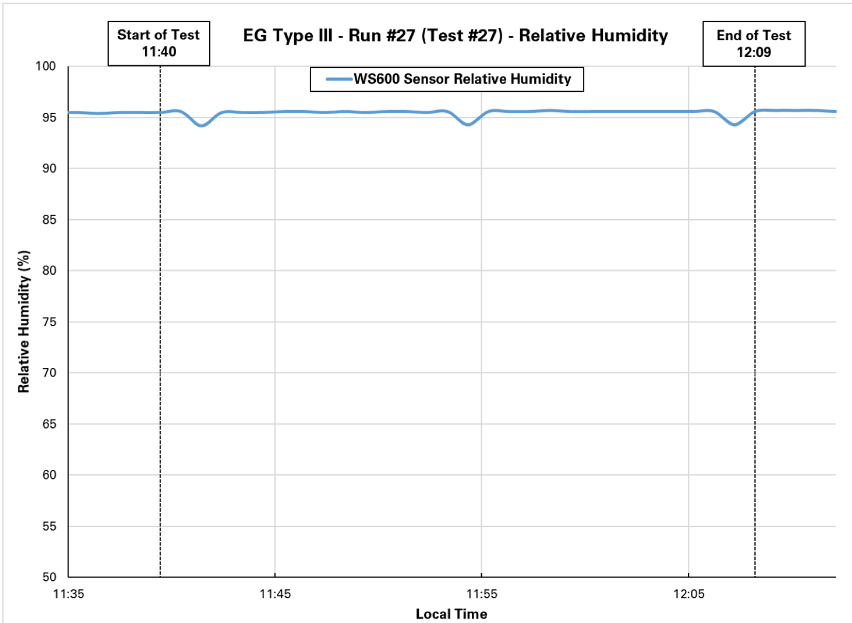
Test Number:	**EG3-27**
Date of Test:	**March 10, 2019**
Average OAT:	**-1.3**
Average Precipitation Rate:	**20.8 g/dm²/h**
Average Wind Speed:	**19 km/h**
Average Relative Humidity:	**95.5%**
Pour Time (Local):	**11:40:00**
Time of Fluid Failure (Local):	**12:09:00**
Fluid Brix at Failure:	**12°**
Endurance Time:	**29 minutes**
Expected Regression-Derived Endurance Time:	**26.7 minutes**
Difference (ET vs. Reg ET):	**+3.4 minutes (+13.1%)**


EG Type III - Run #27 (Test #27) - Precipitation Rate
Start of Test 11:40
End of Test 12:09
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
80
90
11:35
11:45
11:55
12:05
Local Time

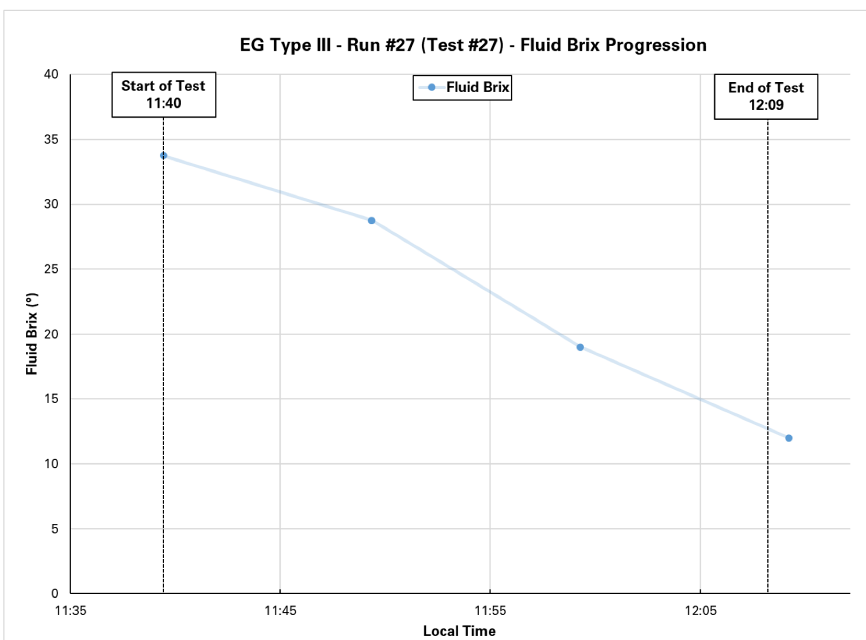

EG Type III - Run #27 (Test #27) - Temperatures
Start of Test 11:40
Initial Fluid Temp: -3°C
End of Test 12:09
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
0
-5
-10
-15
-20
11:35
11:45
11:55
12:05
Local Time


EG Type III - Run #27 (Test #27) - Wind Speeds
Start of Test 11:40
End of Test 12:09
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
11:35
11:45
11:55
12:05
Local Time

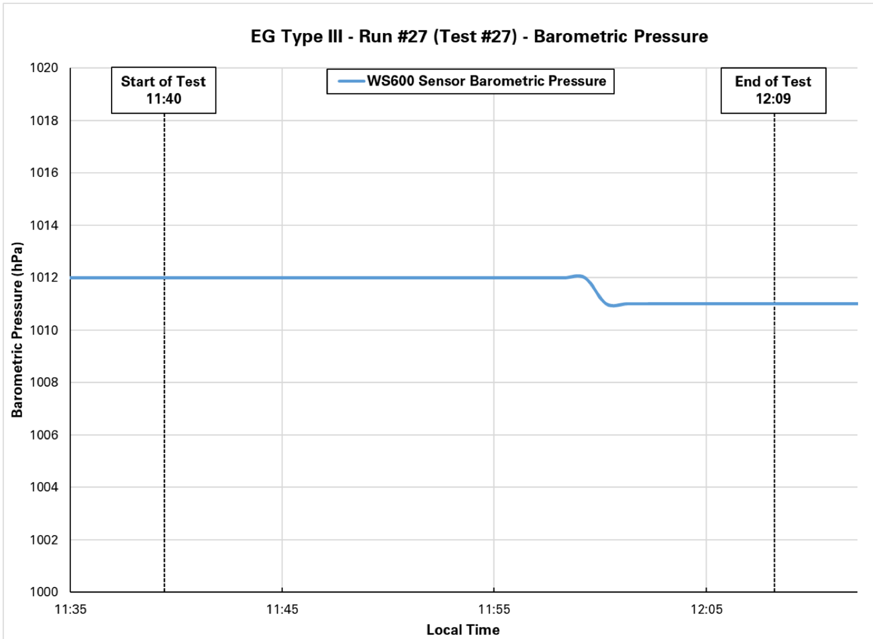

EG Type III - Run #27 (Test #27) - Wind Direction
Start of Test 11:40
End of Test 12:09
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
11:35
11:45
11:55
12:05
Local Time

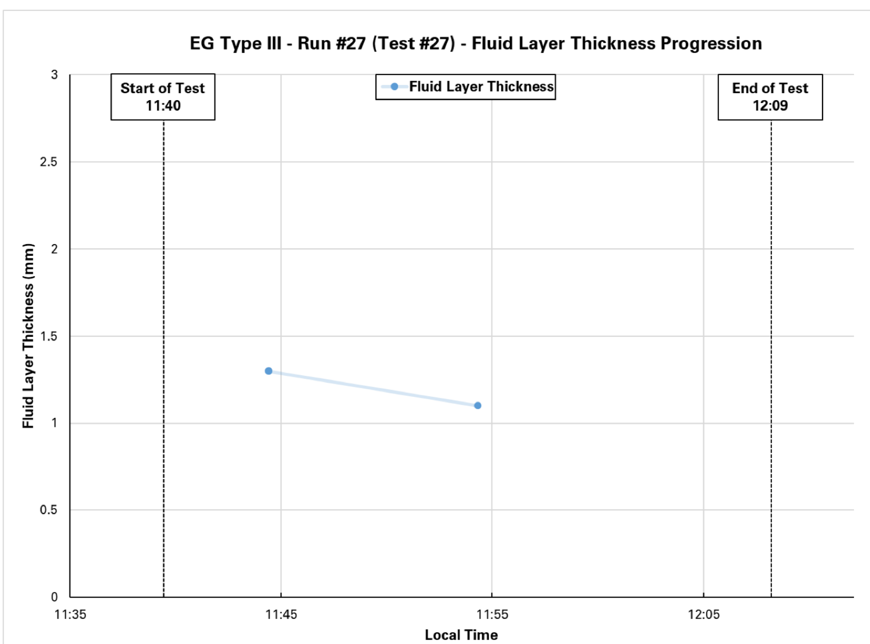


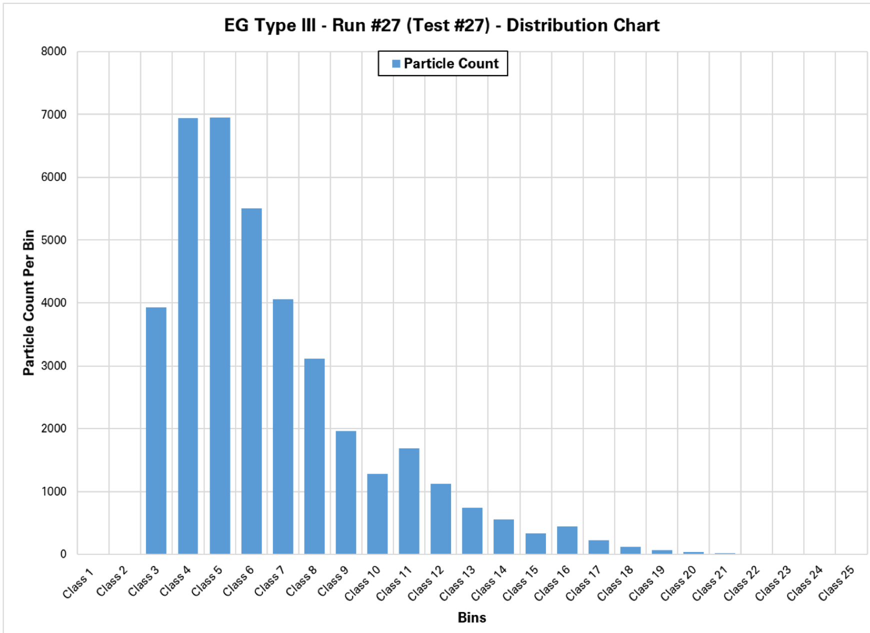
EG Type III - Run #27 (Test #27) - Relative Humidity
Start of Test
11:40
End of Test
12:09
WS600 Sensor Relative Humidity
100
95
90
85
80
75
70
65
60
55
50
Relative Humidity (%)
11:35
11:45
11:55
12:05
Local Time



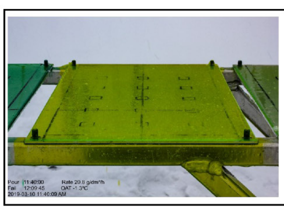
EG Type III - Run #27 (Test #27) - Fluid Brix Progression
Start of Test
11:40
Fluid Brix
End of Test
12:09
40
35
30
25
20
15
10
5
0
Fluid Brix (°)
11:35
11:45
11:55
12:05
Local Time

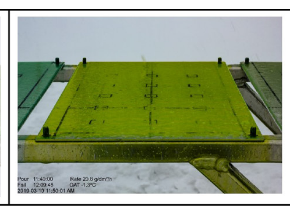

EG Type III - Run #27 (Test #27) - Barometric Pressure
Start of Test 11:40
WS600 Sensor Barometric Pressure
End of Test 12:09
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
11:35
11:45
11:55
12:05
Local Time

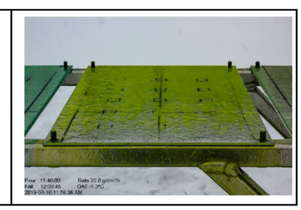

EG Type III - Run #27 (Test #27) - Fluid Layer Thickness Progression
Start of Test 11:40
Fluid Layer Thickness
End of Test 12:09
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
11:35
11:45
11:55
12:05
Local Time

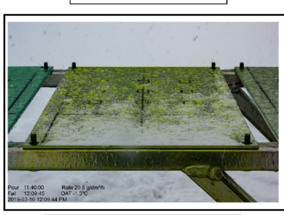


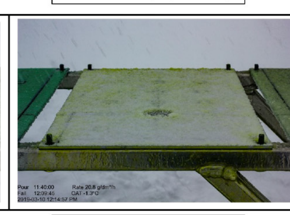
AeroClear MAX – Run 27 (Test 27) – Failure Progression Photos

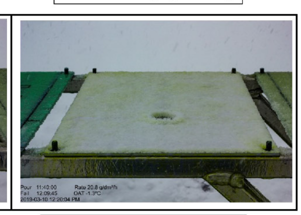

AT POUR (0/29 MIN)


PRE-FAILURE (10/29 MIN)

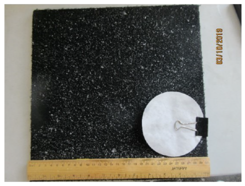

PRE-FAILURE (19/29 MIN)


AT FAILURE (29/29 MIN)

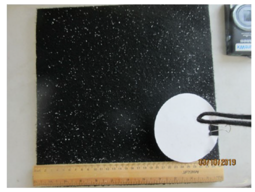

POST-FAILURE (34/29 MIN)


POST-FAILURE (40/29 MIN)

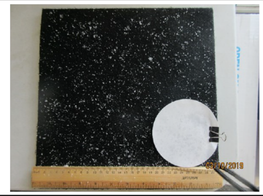
AeroClear MAX – Run 27 (Test 27) – Snow Characteristics Photos



FELT PAD (1/29 MIN)



FELT PAD (21/29 MIN)



FELT PAD (41/29 MIN)

BARE PLATE (0/29 MIN)

BARE PLATE 10/29 MIN)

BARE PLATE (30/29 MIN)

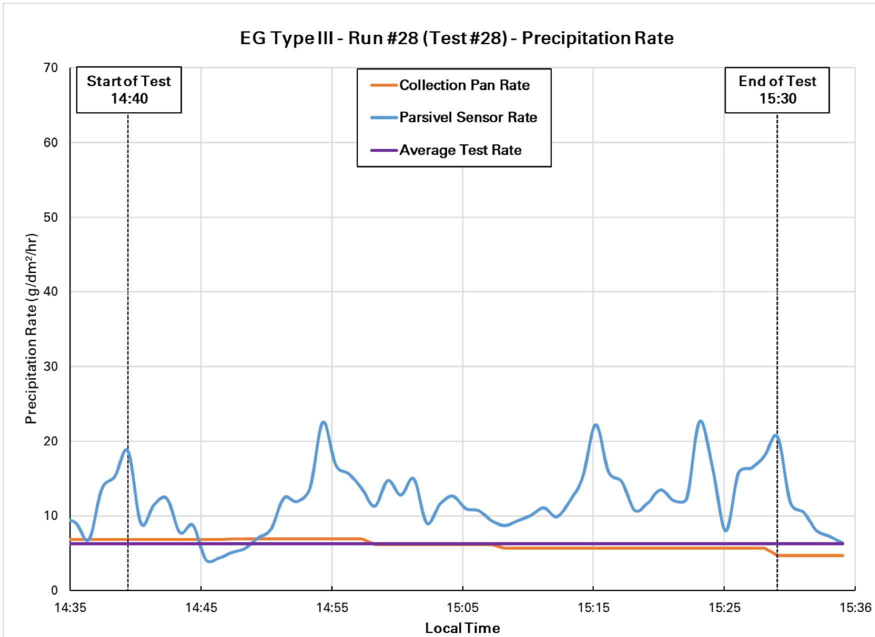
Final Bare Plate Contamination Thickness: **Not taken**

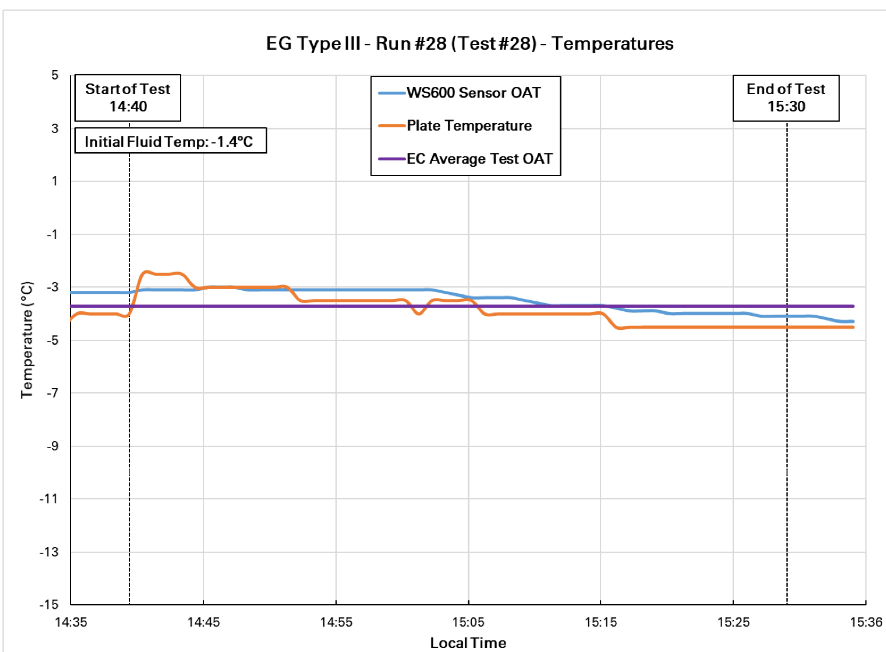
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

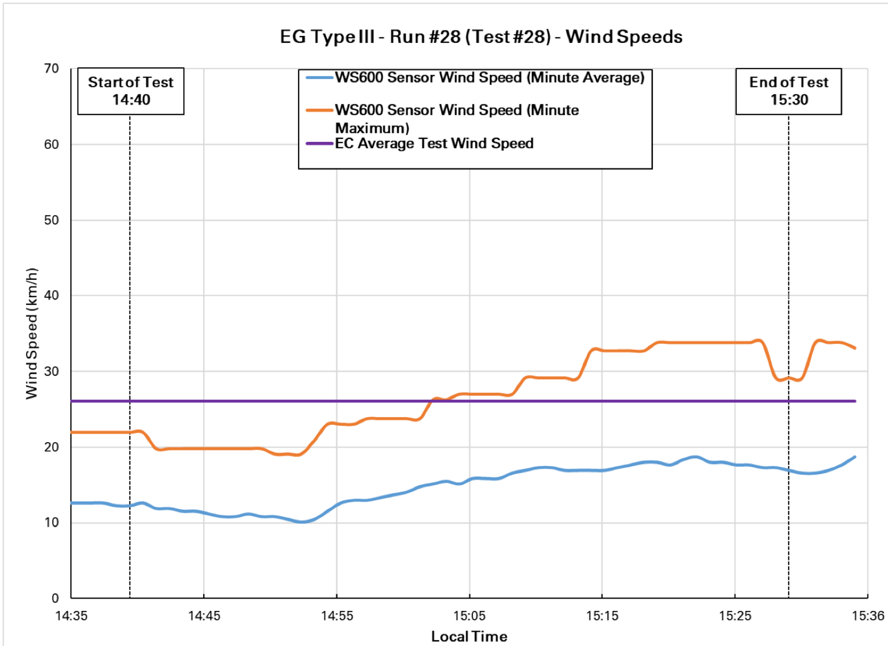
EG TYPE III
RUN #28 (TEST #28) – EG3-28

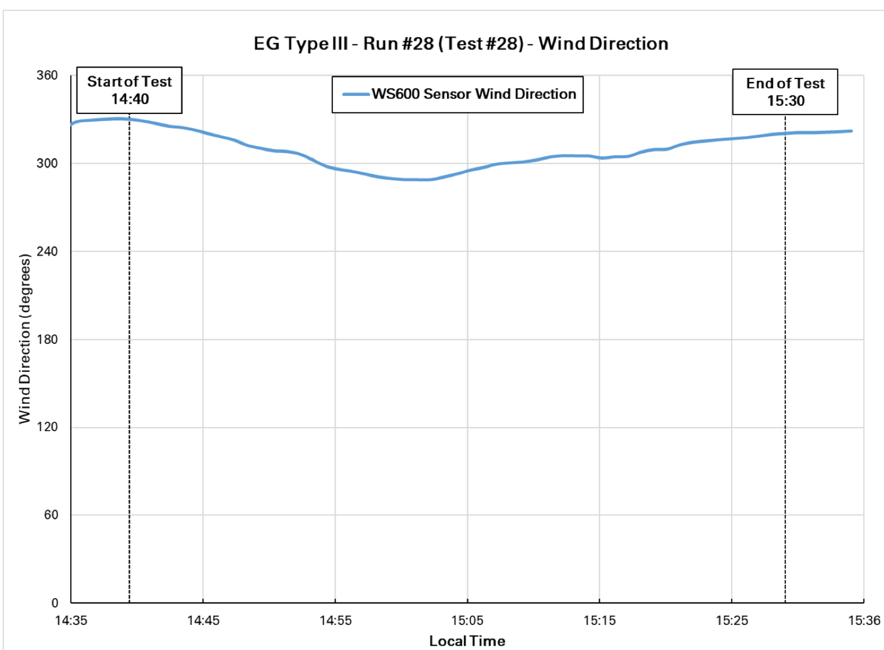
EG Type III – Run #28 (Test #28) – General Test Information

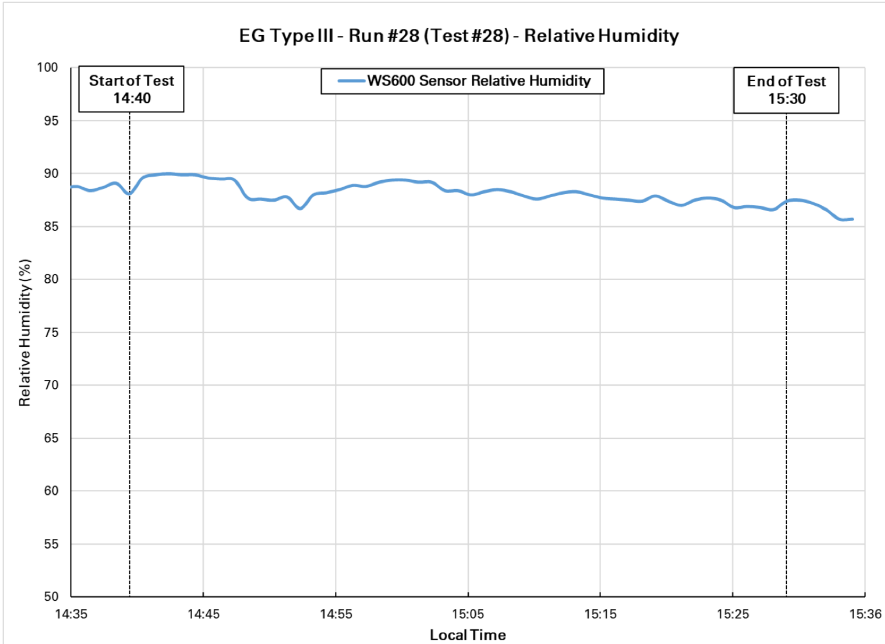
Test Number:	**EG3-28**
Date of Test:	**December 18, 2019**
Average OAT:	**-3.7**
Average Precipitation Rate:	**6.2 g/dm²/h**
Average Wind Speed:	**26.1 km/h**
Average Relative Humidity:	**88.1%**
Pour Time (Local):	**14:40:00**
Time of Fluid Failure (Local):	**15:30:00**
Fluid Brix at Failure:	**8°**
Endurance Time:	**50 minutes**
Expected Regression-Derived Endurance Time:	**58 minutes**
Difference (ET vs. Reg ET):	**- 7.5 minutes (- 12.9%)**


EG Type III - Run #28 (Test #28) - Precipitation Rate
Start of Test
14:40
End of Test
15:30
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
14:35
14:45
14:55
15:05
15:15
15:25
15:36
Local Time

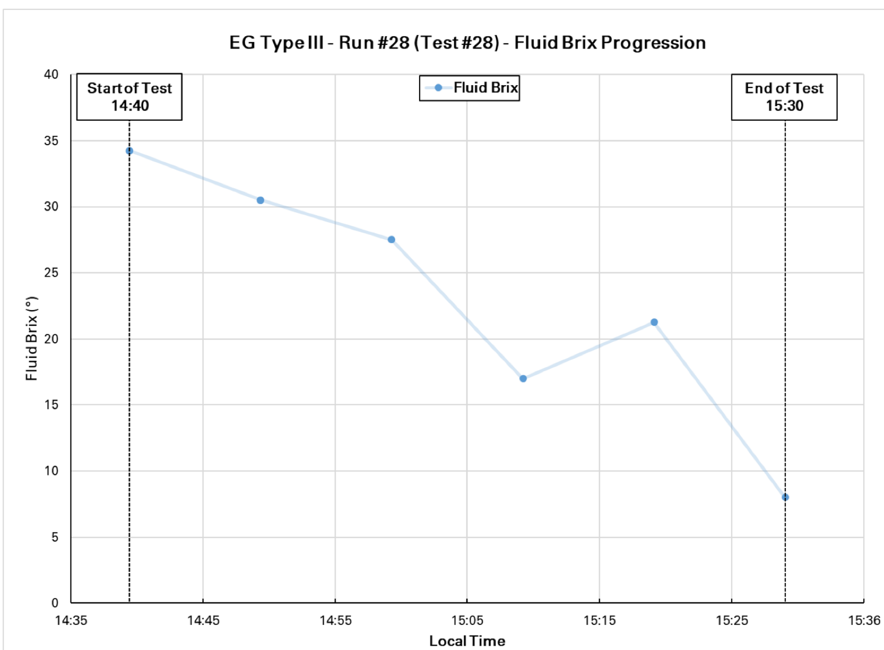

EG Type III - Run #28 (Test #28) - Temperatures
Start of Test
14:40
Initial Fluid Temp: -1.4°C
End of Test
15:30
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
14:35
14:45
14:55
15:05
15:15
15:25
15:36
Local Time

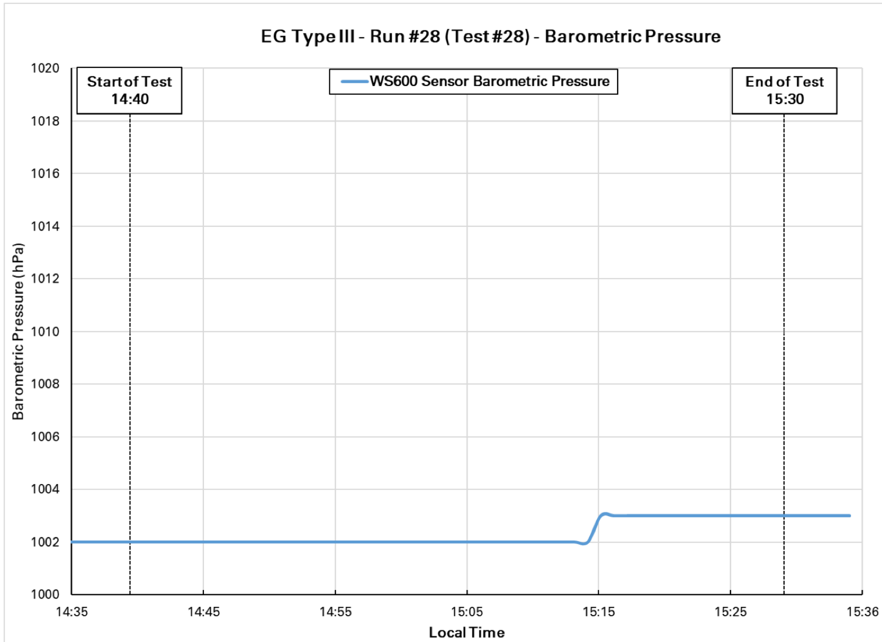

EG Type III - Run #28 (Test #28) - Wind Speeds
Start of Test 14:40
End of Test 15:30
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
14:35
14:45
14:55
15:05
15:15
15:25
15:36
Local Time


EG Type III - Run #28 (Test #28) - Wind Direction
Start of Test 14:40
End of Test 15:30
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
14:35
14:45
14:55
15:05
15:15
15:25
15:36
Local Time

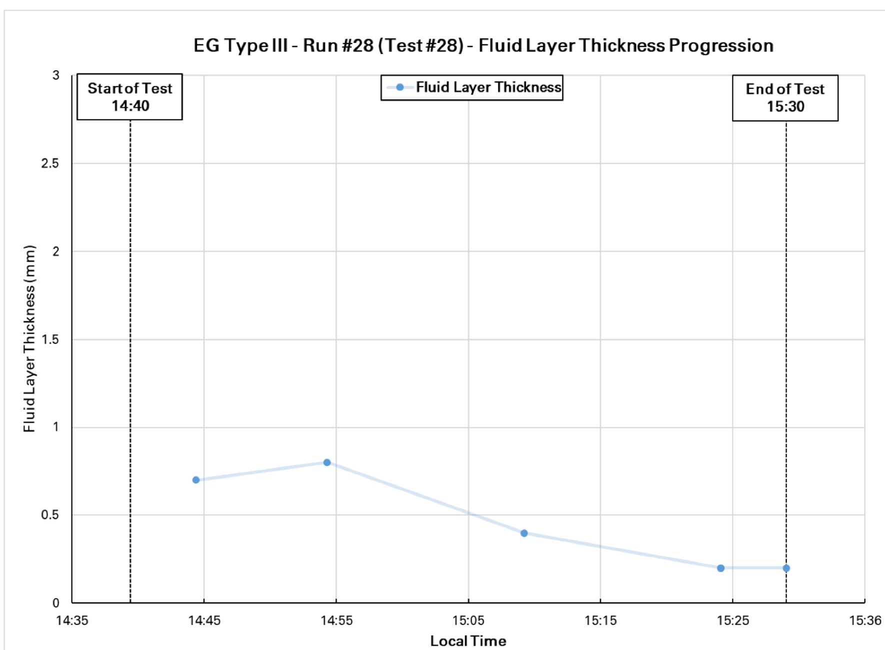


DATA PACKAGE – EG TYPE III – RUN 28 (TEST 28)

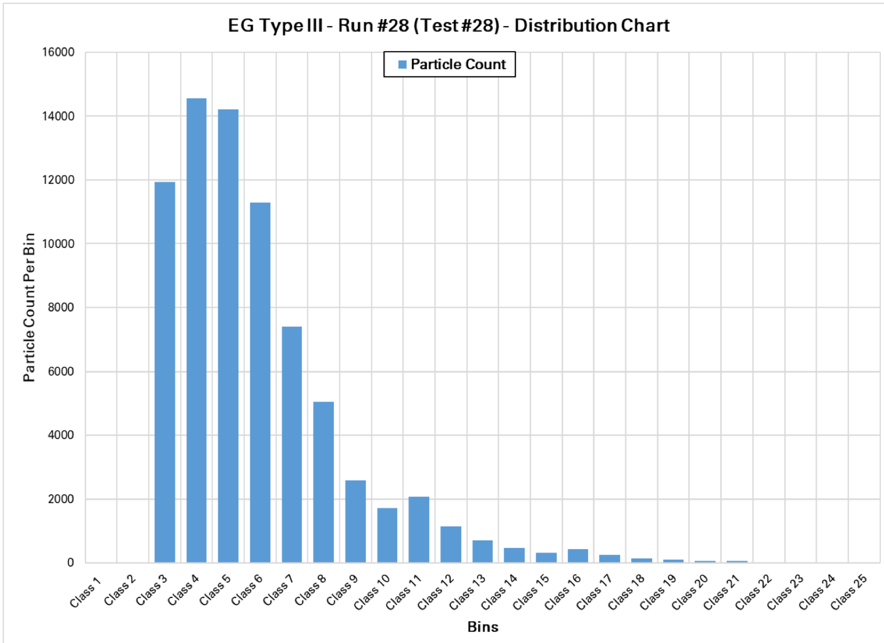




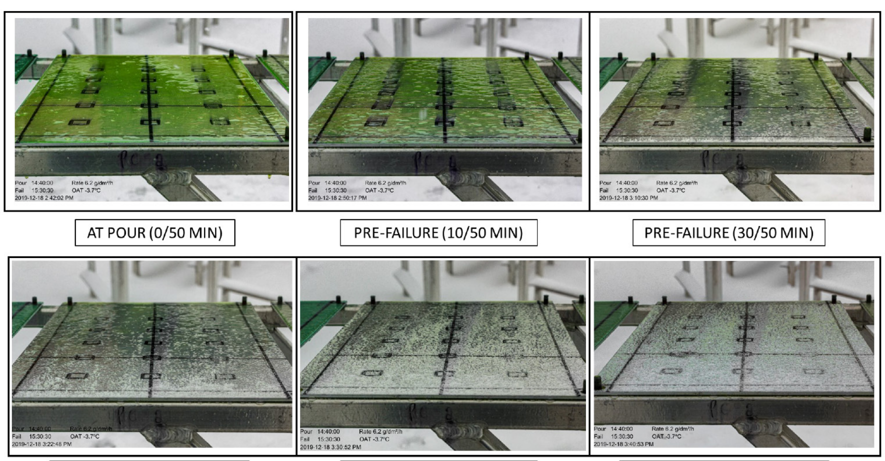
EG Type III - Run #28 (Test #28) - Barometric Pressure
Start of Test 14:40
WS600 Sensor Barometric Pressure
End of Test 15:30
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
14:35
14:45
14:55
15:05
15:15
15:25
15:36
Local Time



EG Type III - Run #28 (Test #28) - Fluid Layer Thickness Progression
Start of Test 14:40
Fluid Layer Thickness
End of Test 15:30
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
14:35
14:45
14:55
15:05
15:15
15:25
15:36
Local Time



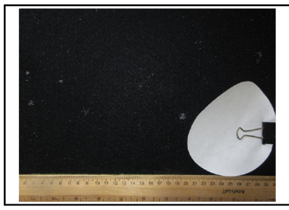
AeroClear MAX – Run 28 (Test 28) – Failure Progression Photos



AT POUR (0/50 MIN) | PRE-FAILURE (10/50 MIN) | PRE-FAILURE (30/50 MIN)

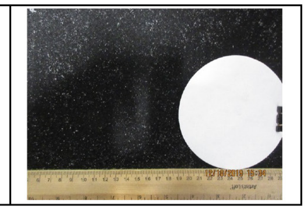
PRE-FAILURE (42/50 MIN) | AT FAILURE (51/50 MIN) | POST-FAILURE (60/50 MIN)

AeroClear MAX – Run 28 (Test 28) – Snow Characteristics Photos

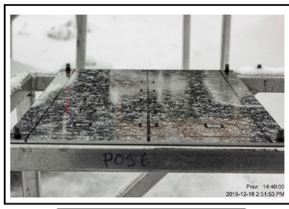


FELT PAD (6/50 MIN)

FELT PAD (23/50 MIN)



FELT PAD (54/50 MIN)



BARE PLATE (11/50 MIN)

BARE PLATE (33/50 MIN)

BARE PLATE (53/50 MIN)

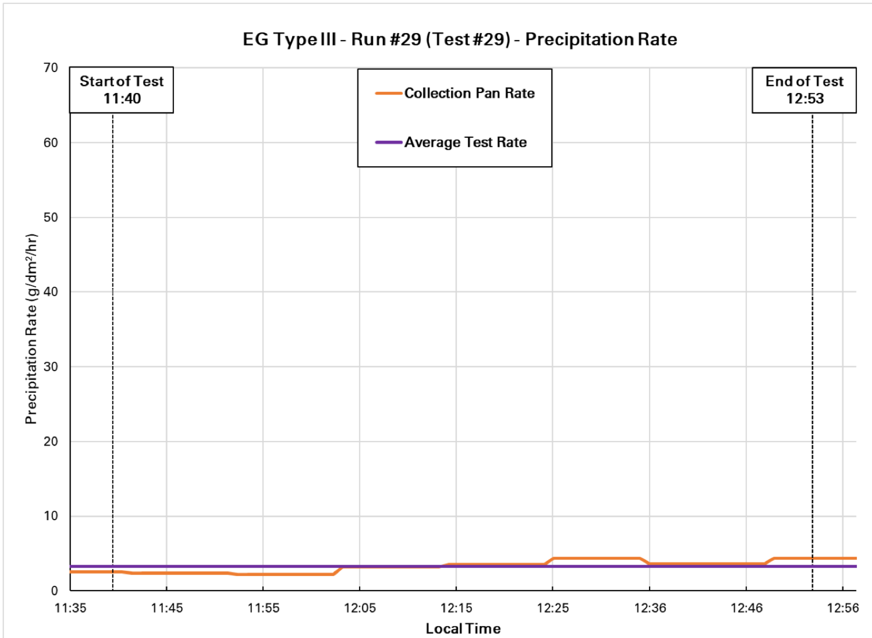
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

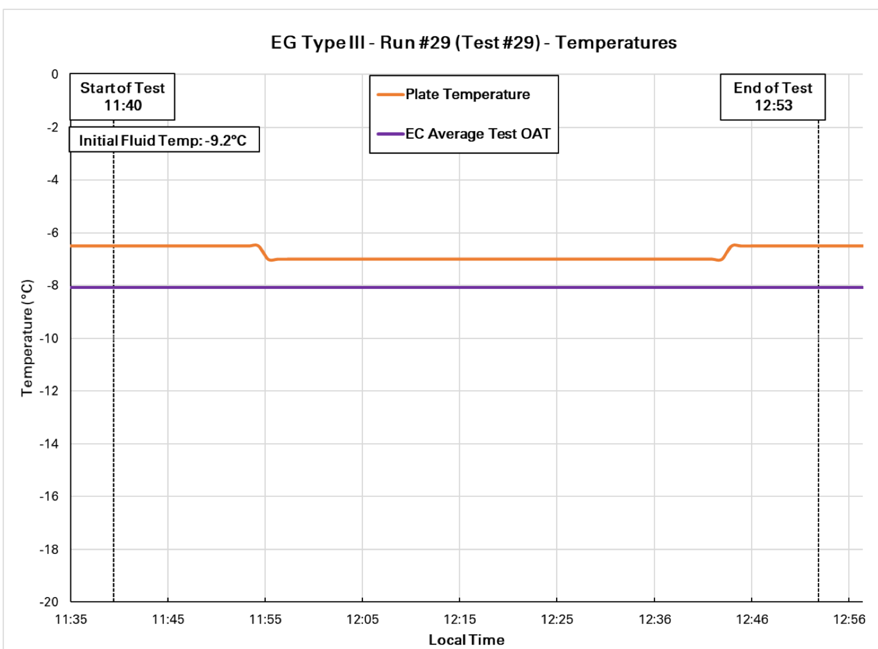
EG TYPE III
RUN #29 (TEST #29) – EG3-29

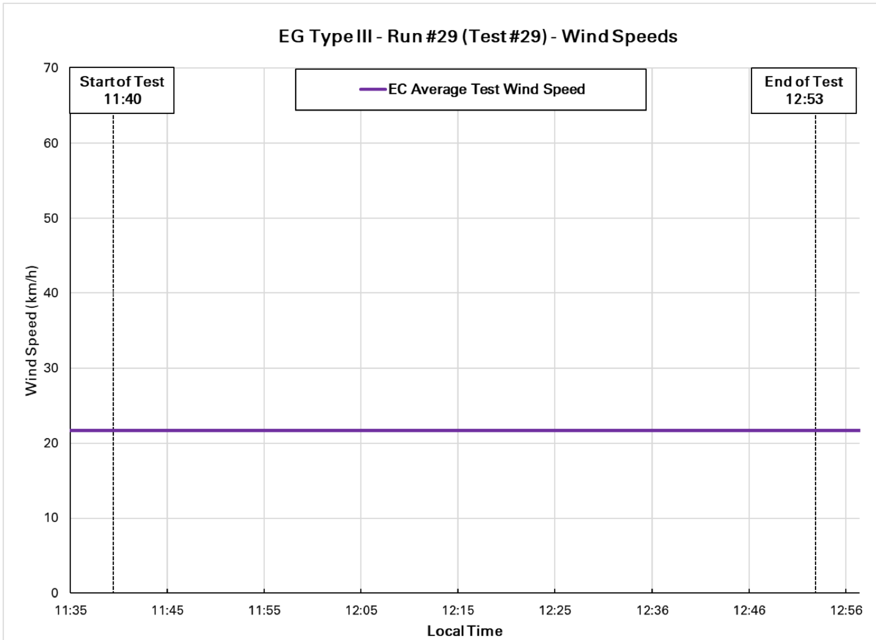
EG Type III – Run #29 (Test #29) – General Test Information

Test Number:	EG3-29
Date of Test:	January 6, 2020
Average OAT:	-8.1
Average Precipitation Rate:	3.3 g/dm²/h
Average Wind Speed:	21.7 km/h
Average Relative Humidity:	Not Available
Pour Time (Local):	11:40:00
Time of Fluid Failure (Local):	12:53:00
Fluid Brix at Failure:	10°
Endurance Time:	73 minutes
Expected Regression-Derived Endurance Time:	88.8 minutes
Difference (ET vs. Reg ET):	- 15.8 minutes (- 17.8%)

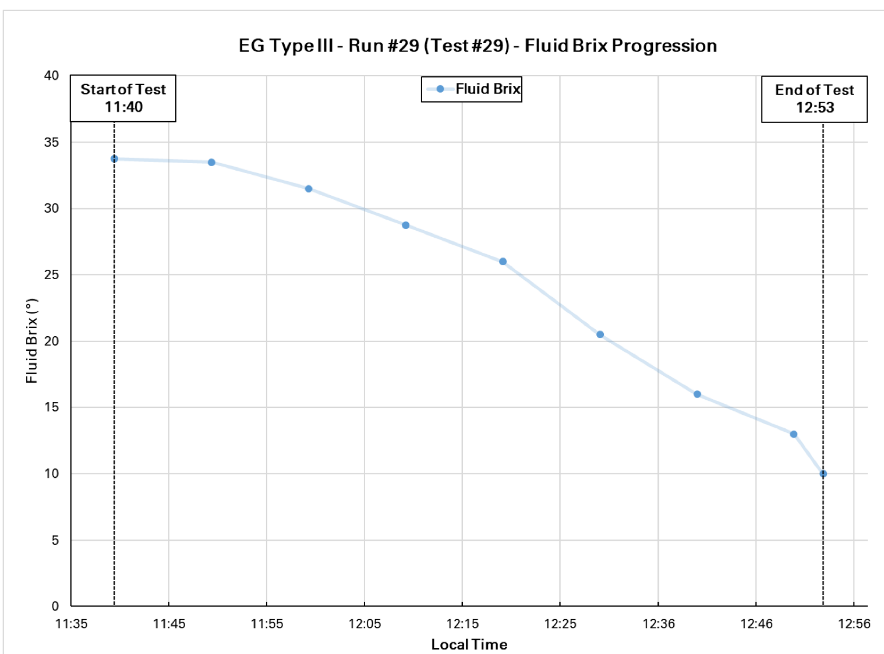


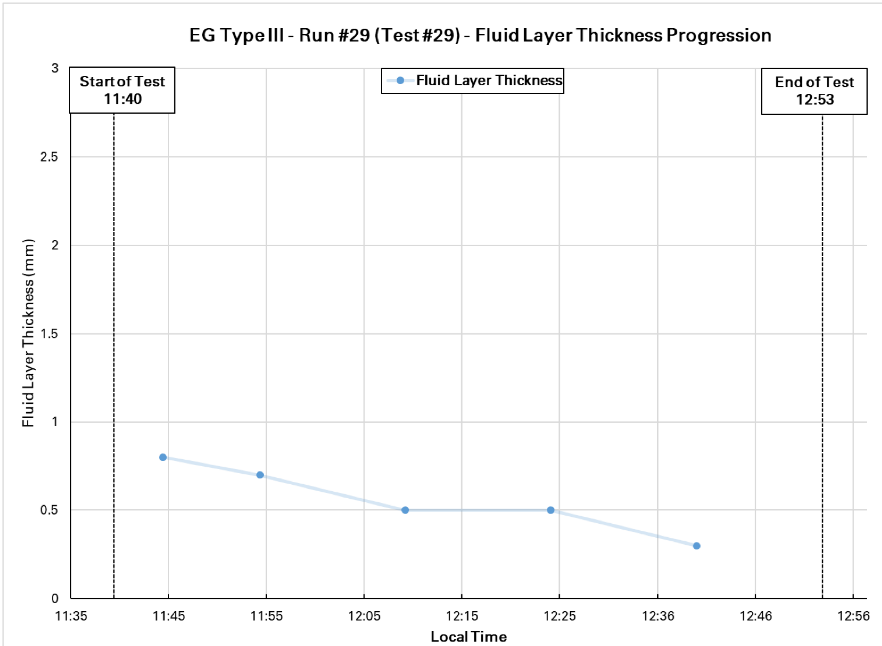
DATA PACKAGE – EG TYPE III – RUN 29 (TEST 29)



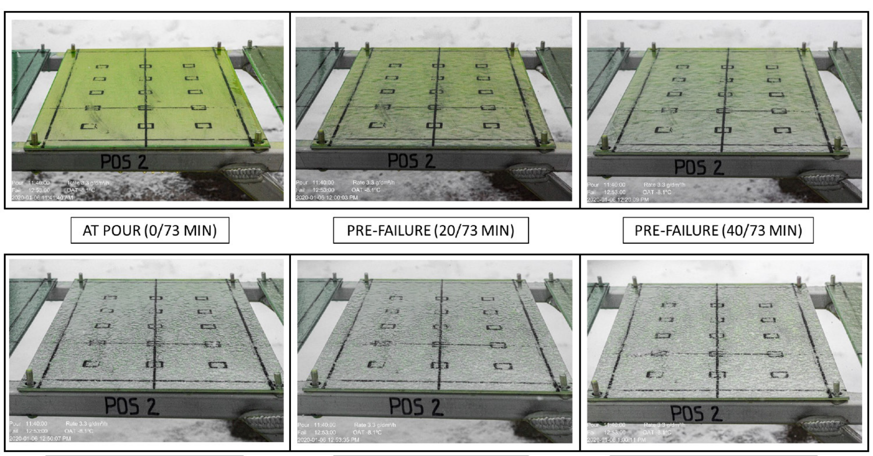


DATA PACKAGE – EG TYPE III – RUN 29 (TEST 29)





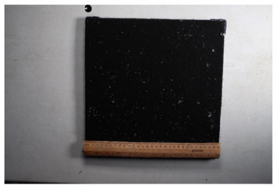
AeroClear MAX – Run 29 (Test 29) – Failure Progression Photos



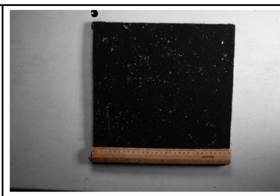
AT POUR (0/73 MIN) | PRE-FAILURE (20/73 MIN) | PRE-FAILURE (40/73 MIN)

PRE-FAILURE (70/73 MIN) | AT FAILURE (73/73 MIN) | POST-FAILURE (80/73 MIN)

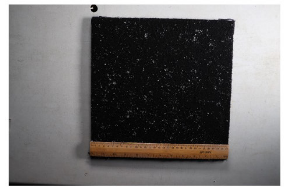
AeroClear MAX – Run 29 (Test 29) – Snow Characteristics Photos



FELT PAD (10/73 MIN)

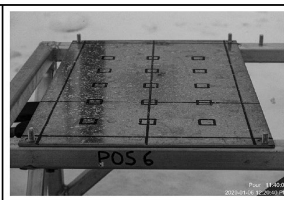


FELT PAD (40/73 MIN)

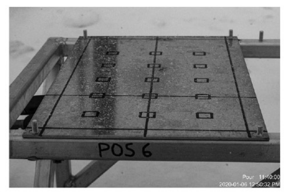


FELT PAD (70/73 MIN)

BARE PLATE (2/73 MIN)



BARE PLATE (40/73 MIN)



BARE PLATE (70/73 MIN)

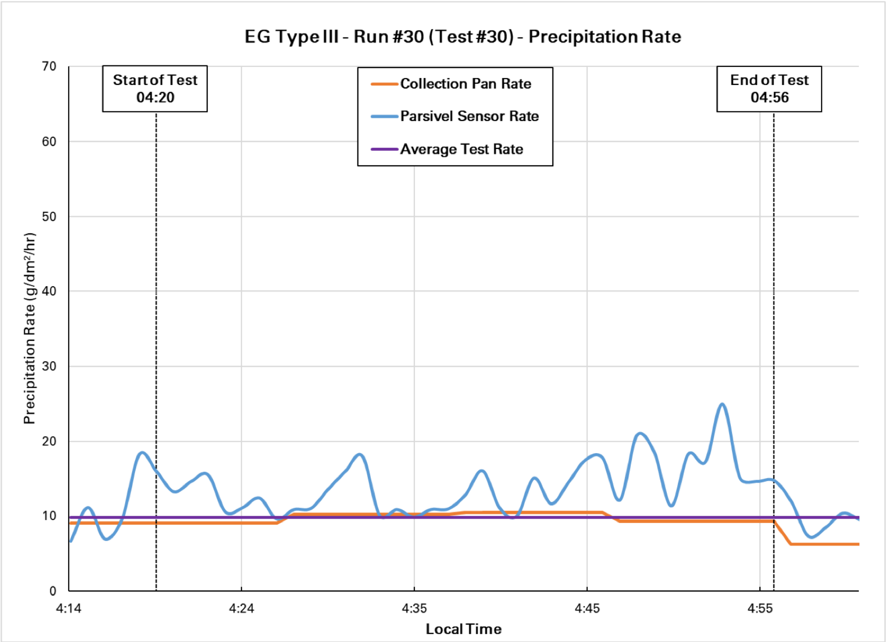
Final Bare Plate Contamination Thickness: **Nil (0mm)**

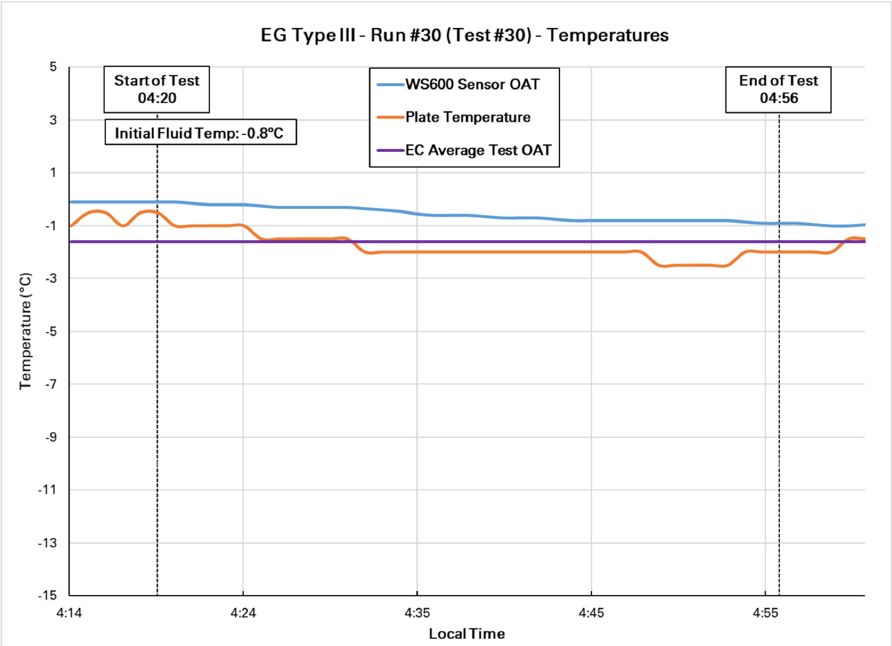
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

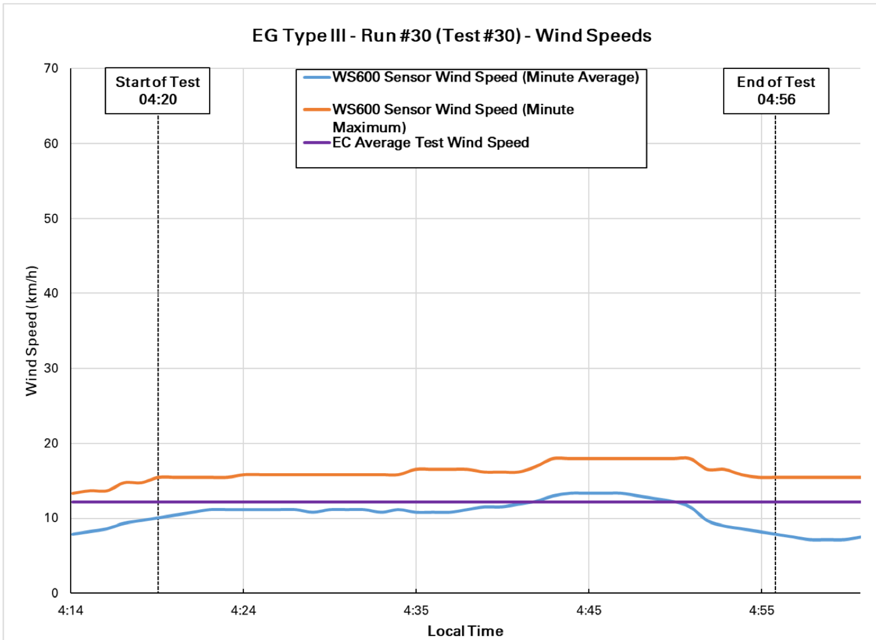
EG TYPE III
RUN #30 (TEST #30) – EG3-30

EG Type III – Run #30 (Test #30) – General Test Information

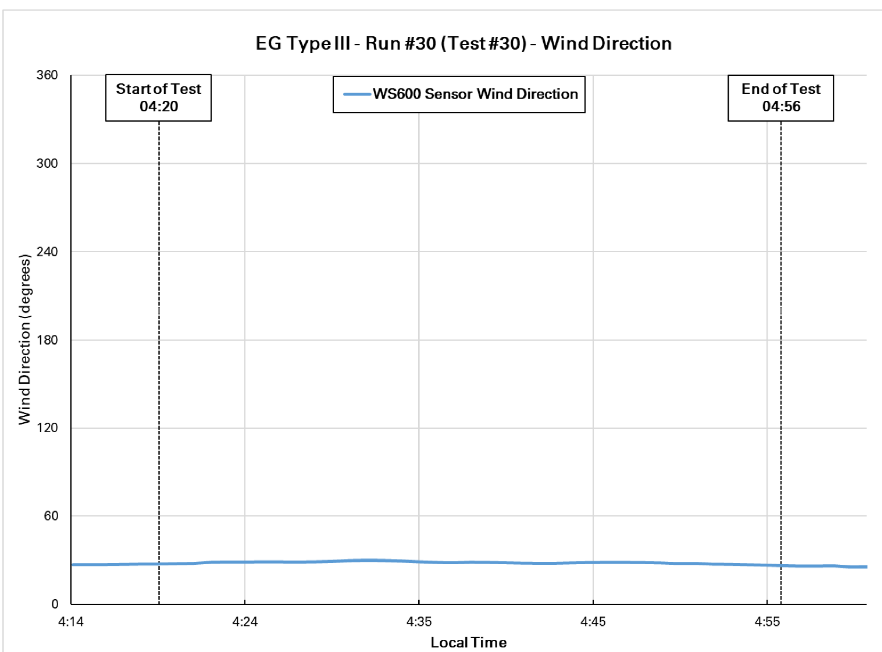
Test Number:	EG3-30
Date of Test:	January 16, 2020
Average OAT:	-1.6
Average Precipitation Rate:	9.8 g/dm²/h
Average Wind Speed:	12.2 km/h
Average Relative Humidity:	90.3%
Pour Time (Local):	04:20:00
Time of Fluid Failure (Local):	04:56:00
Fluid Brix at Failure:	5.25°
Endurance Time:	36 minutes
Expected Regression-Derived Endurance Time:	43.1 minutes
Difference (ET vs. Reg ET):	-6.8 minutes (-15.9%)


EG Type III - Run #30 (Test #30) - Precipitation Rate
Start of Test 04:20
End of Test 04:56
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
4:14
4:24
4:35
4:45
4:55
Local Time

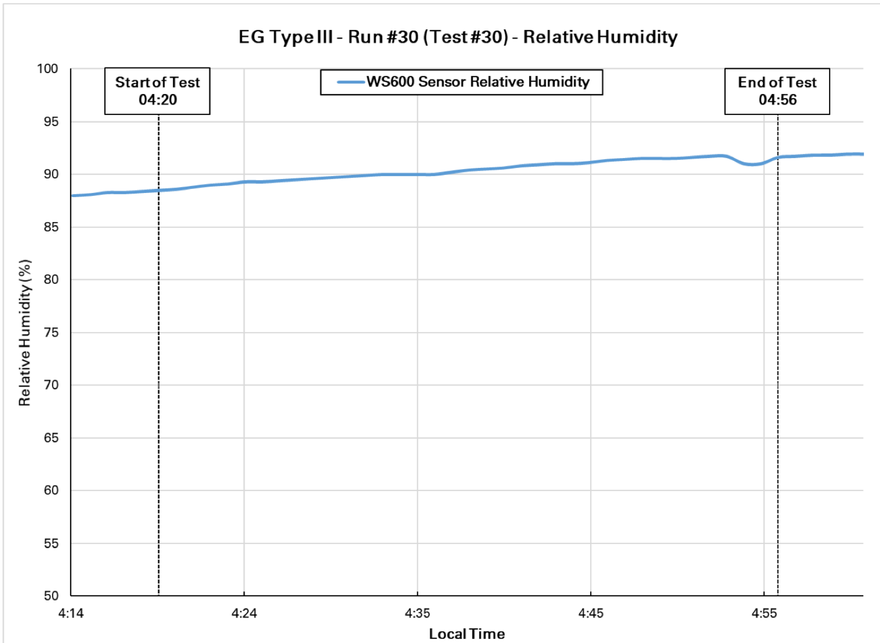

EG Type III - Run #30 (Test #30) - Temperatures
Start of Test 04:20
Initial Fluid Temp: -0.8°C
End of Test 04:56
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
4:14
4:24
4:35
4:45
4:55
Local Time



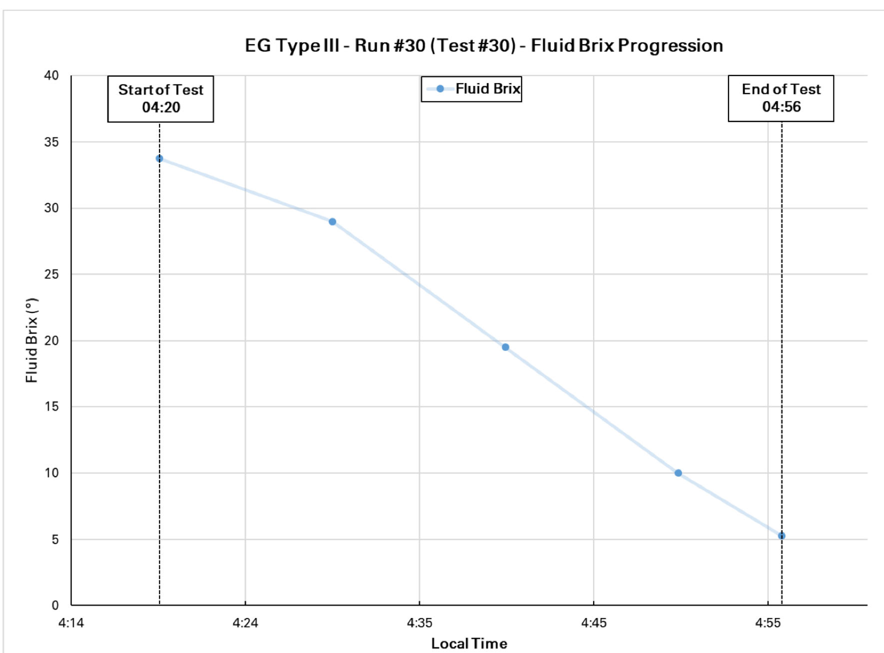
EG Type III - Run #30 (Test #30) - Wind Speeds
Start of Test 04:20
End of Test 04:56
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
4:14
4:24
4:35
4:45
4:55
Local Time



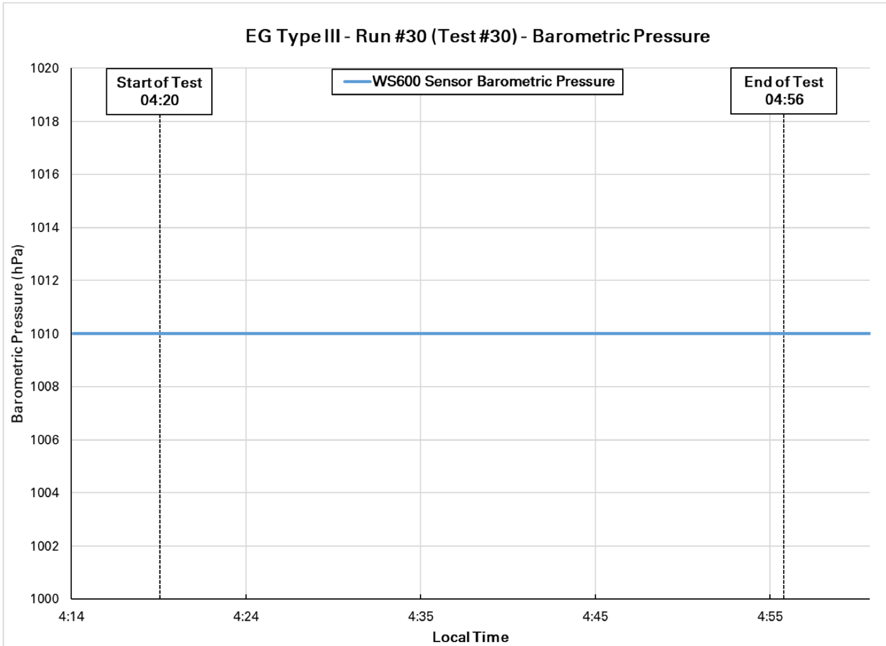
EG Type III - Run #30 (Test #30) - Wind Direction
Start of Test 04:20
End of Test 04:56
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
4:14
4:24
4:35
4:45
4:55
Local Time

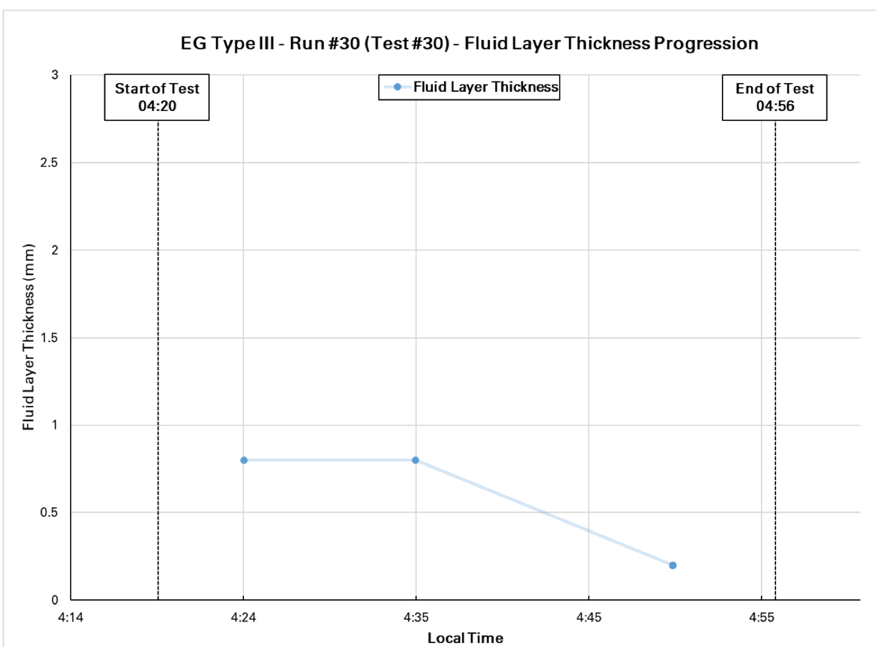


EG Type III - Run #30 (Test #30) - Relative Humidity
Start of Test 04:20
WS600 Sensor Relative Humidity
End of Test 04:56
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
4:14
4:24
4:35
4:45
4:55
Local Time

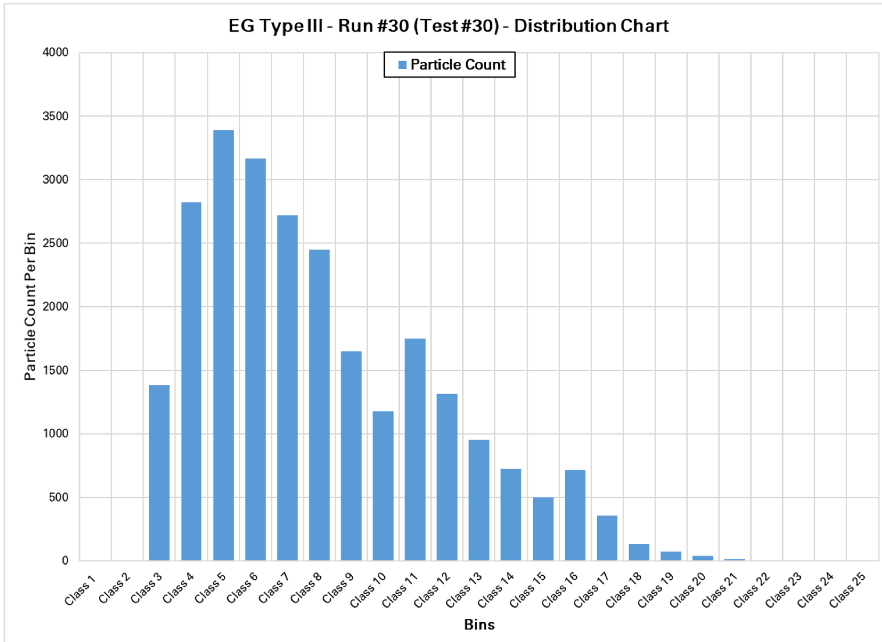


EG Type III - Run #30 (Test #30) - Fluid Brix Progression
Start of Test 04:20
Fluid Brix
End of Test 04:56
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
4:14
4:24
4:35
4:45
4:55
Local Time


EG Type III - Run #30 (Test #30) - Barometric Pressure
Start of Test 04:20
WS600 Sensor Barometric Pressure
End of Test 04:56
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
4:14
4:24
4:35
4:45
4:55
Local Time


EG Type III - Run #30 (Test #30) - Fluid Layer Thickness Progression
Start of Test 04:20
Fluid Layer Thickness
End of Test 04:56
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
4:14
4:24
4:35
4:45
4:55
Local Time

DATA PACKAGE – EG TYPE III – RUN 30 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 30 - Test 30/Data Package - EG Type III - Run 30 - Test 30.docx
Final Version 1.0, March 2021

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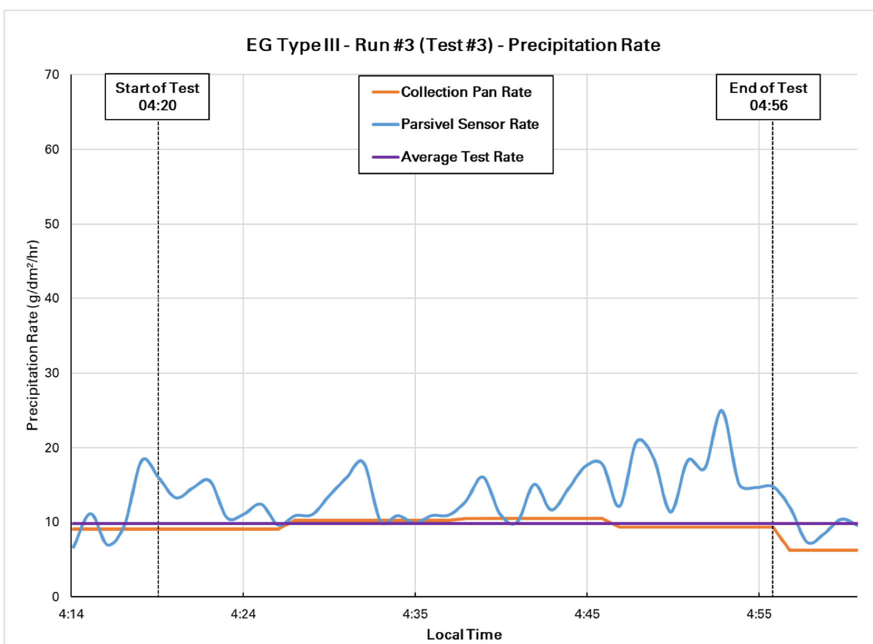
DATA PACKAGE – EG TYPE III – RUN 30 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 30 - Test 30/Data Package - EG Type III - Run 30 - Test 30.docx
Final Version 1.0, March 2021

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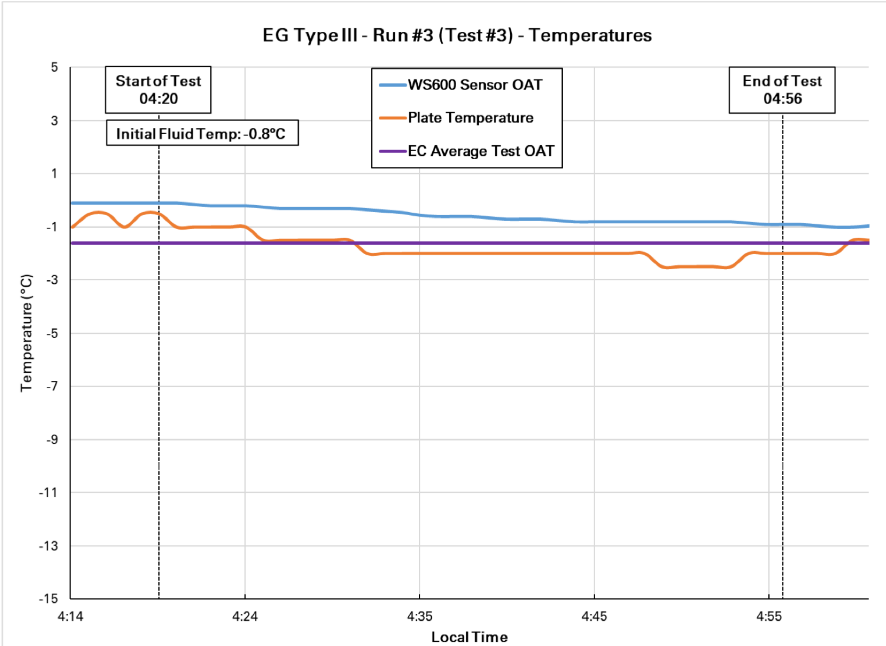
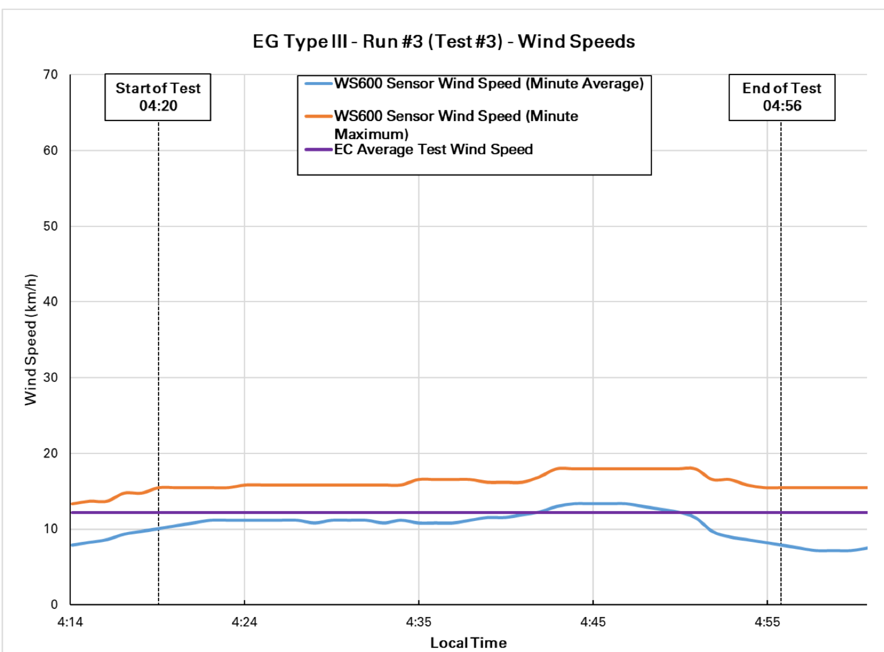
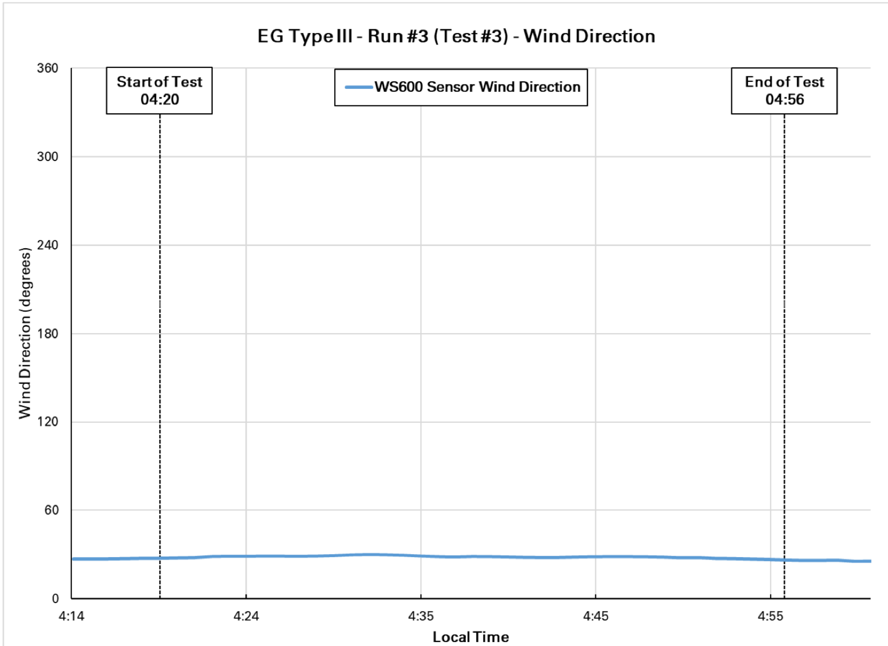

EG Type III - Run #3 (Test #3) - Temperatures
Start of Test 04:20
Initial Fluid Temp: -0.8°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 04:56
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
4:14
4:24
4:35
4:45
4:55
Local Time


EG Type III - Run #3 (Test #3) - Wind Speeds
Start of Test 04:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 04:56
Wind Speed (km/h)
70
60
50
40
30
20
10
0
4:14
4:24
4:35
4:45
4:55
Local Time

DATA PACKAGE – EG TYPE III – RUN 30 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 30 - Test 30/Data Package - EG Type III - Run 30 - Test 30.docx
Final Version 1.0, March 2021

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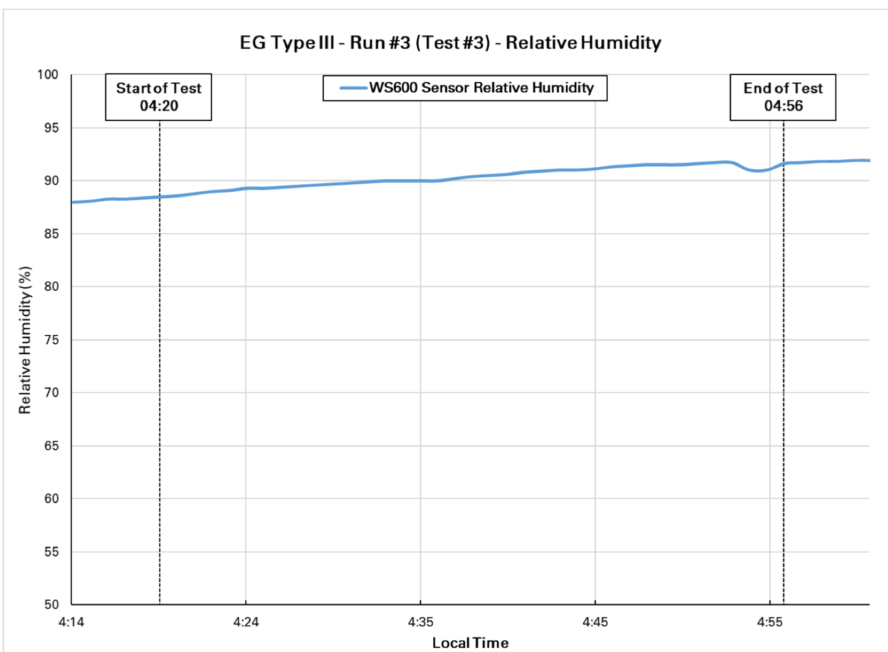
DATA PACKAGE – EG TYPE III – RUN 30 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 30 - Test 30/Data Package - EG Type III - Run 30 - Test 30.docx
Final Version 1.0, March 2021

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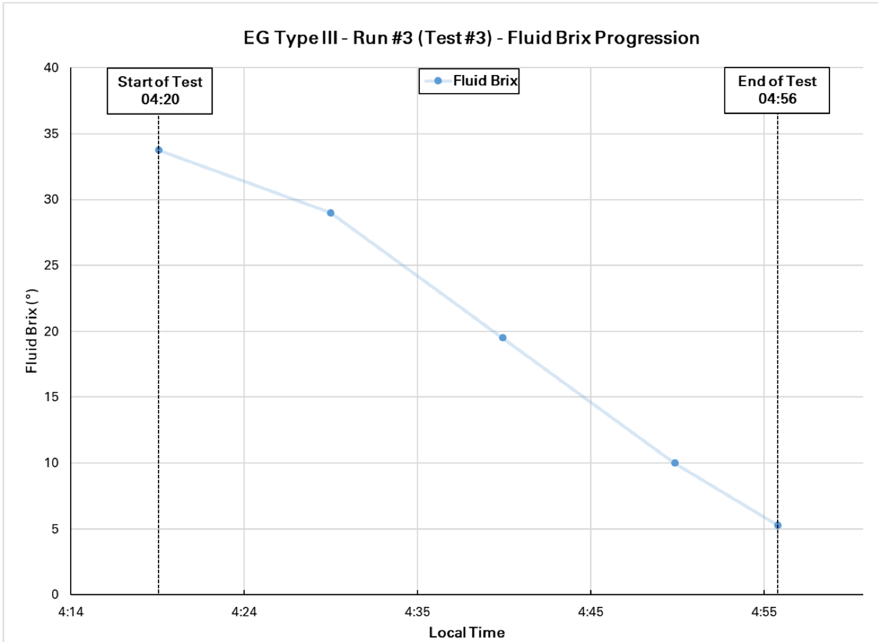
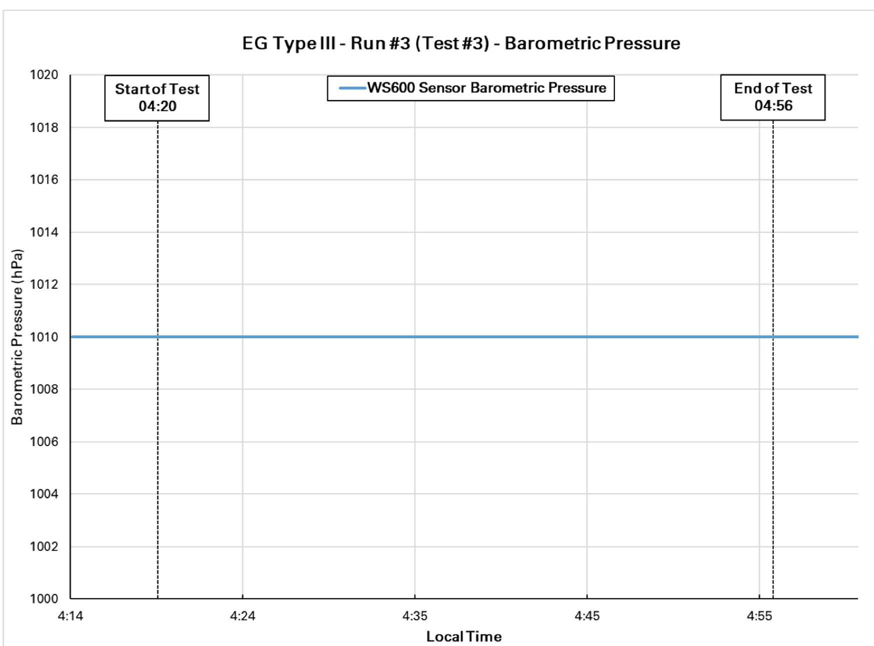
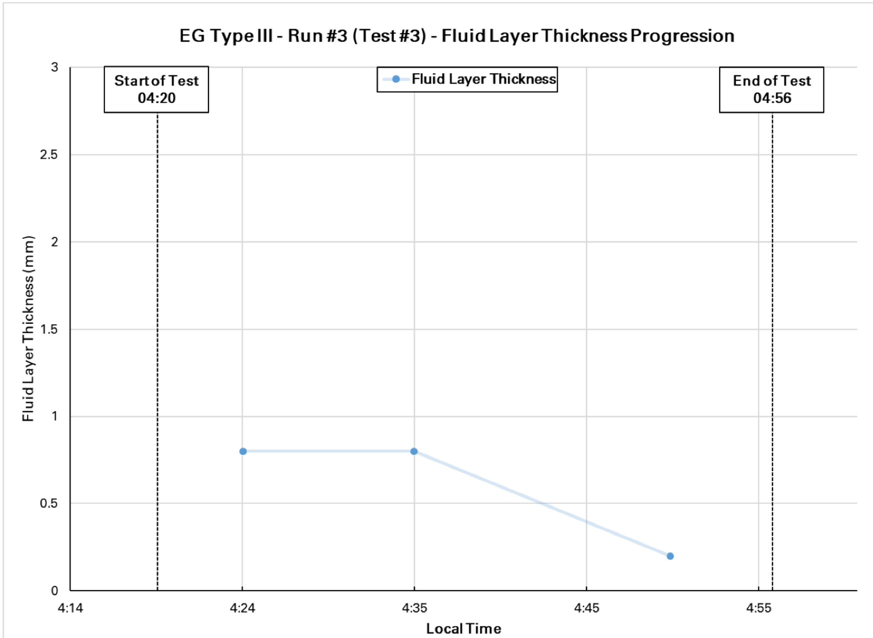
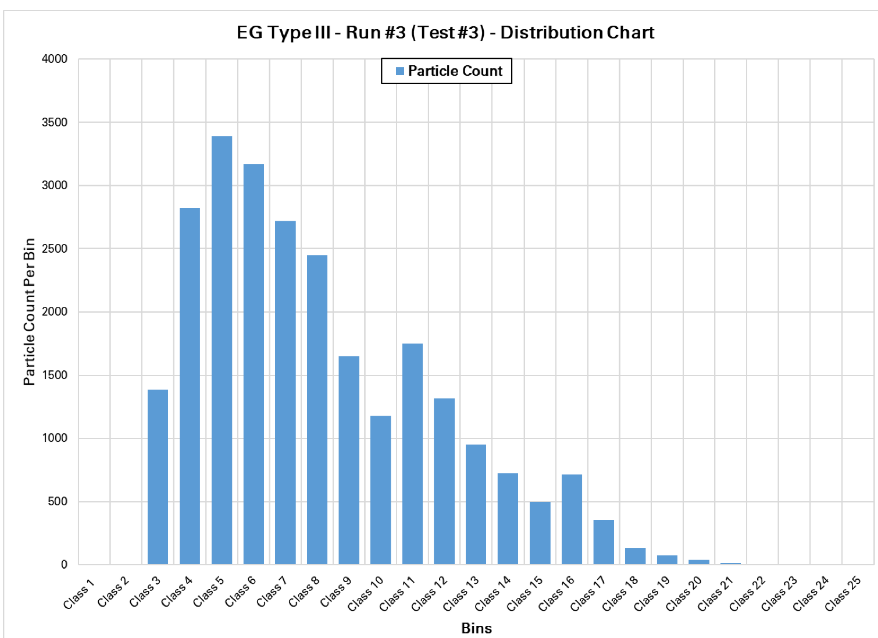

EG Type III - Run #3 (Test #3) - Fluid Brix Progression
Start of Test 04:20
Fluid Brix
End of Test 04:56
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
4:14
4:24
4:35
4:45
4:55
Local Time


EG Type III - Run #3 (Test #3) - Barometric Pressure
Start of Test 04:20
WS600 Sensor Barometric Pressure
End of Test 04:56
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
4:14
4:24
4:35
4:45
4:55
Local Time

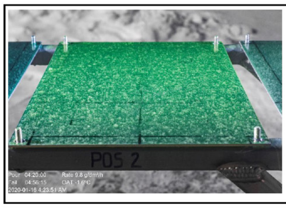


EG Type III - Run #3 (Test #3) - Fluid Layer Thickness Progression
Start of Test 04:20
Fluid Layer Thickness
End of Test 04:56
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
4:14
4:24
4:35
4:45
4:55
Local Time

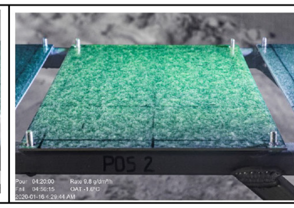


EG Type III - Run #3 (Test #3) - Distribution Chart
Particle Count
Particle Count Per Bin
4000
3500
3000
2500
2000
1500
1000
500
0
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
Class 9
Class 10
Class 11
Class 12
Class 13
Class 14
Class 15
Class 16
Class 17
Class 18
Class 19
Class 20
Class 21
Class 22
Class 23
Class 24
Class 25
Bins

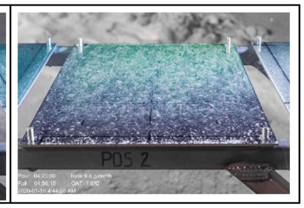
AeroClear MAX – Run 3 (Test 3) – Failure Progression Photos



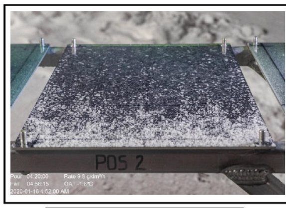
AT POUR (3/36 MIN)



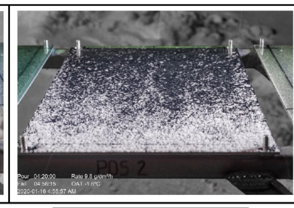
PRE-FAILURE (9/36 MIN)



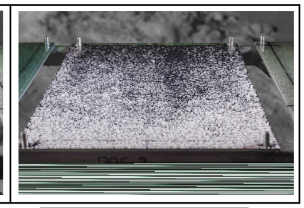
PRE-FAILURE (24/36 MIN)



PRE-FAILURE (32/36 MIN)



AT FAILURE (36/36 MIN)



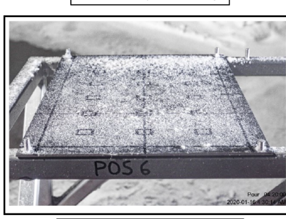
POST-FAILURE (39/36 MIN)

AeroClear MAX – Run 3 (Test 3) – Snow Characteristics Photos

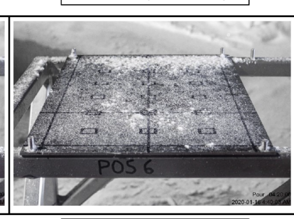
FELT PAD (5/36 MIN)

FELT PAD (20/36 MIN)

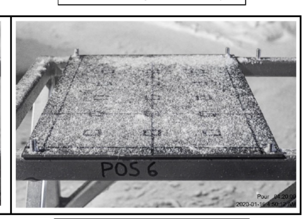
FELT PAD (31/36 MIN)



BARE PLATE (10/36 MIN)



BARE PLATE (20/36 MIN)



BARE PLATE (30/36 MIN)

Final Bare Plate Contamination Thickness: **1.25mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

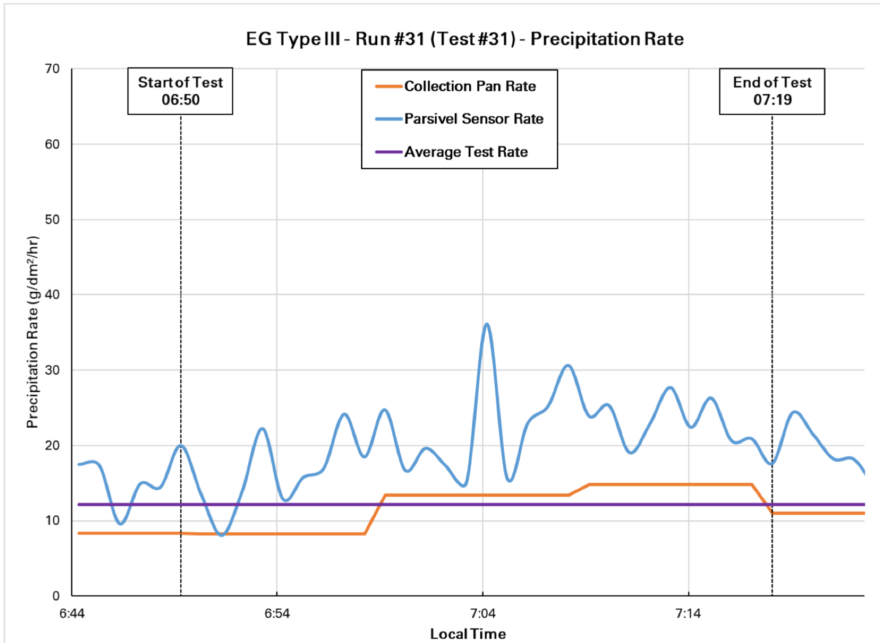
EG TYPE III
RUN #31 (TEST #31) – EG3-31

DATA PACKAGE – EG TYPE III – RUN 31 (TEST 31)

EG Type III – Run #31 (Test #31) – General Test Information

Test Number:	**EG3-31**
Date of Test:	**January 16, 2020**
Average OAT:	**-1.8**
Average Precipitation Rate:	**12.2 g/dm²/h**
Average Wind Speed:	**11.0 km/h**
Average Relative Humidity:	**92.9%**
Pour Time (Local):	**06:50:00**
Time of Fluid Failure (Local):	**07:19:00**
Fluid Brix at Failure:	**6°**
Endurance Time:	**29 minutes**
Expected Regression-Derived Endurance Time:	**37.5 minutes**
Difference (ET vs. Reg ET):	**- 8.5 minutes (- 22.6%)**

DATA PACKAGE – EG TYPE III – RUN 31 (TEST 31)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 31 - Test 31/Data Package - EG Type III - Run 31 - Test 31.docx
Final Version 1.0, March 2021

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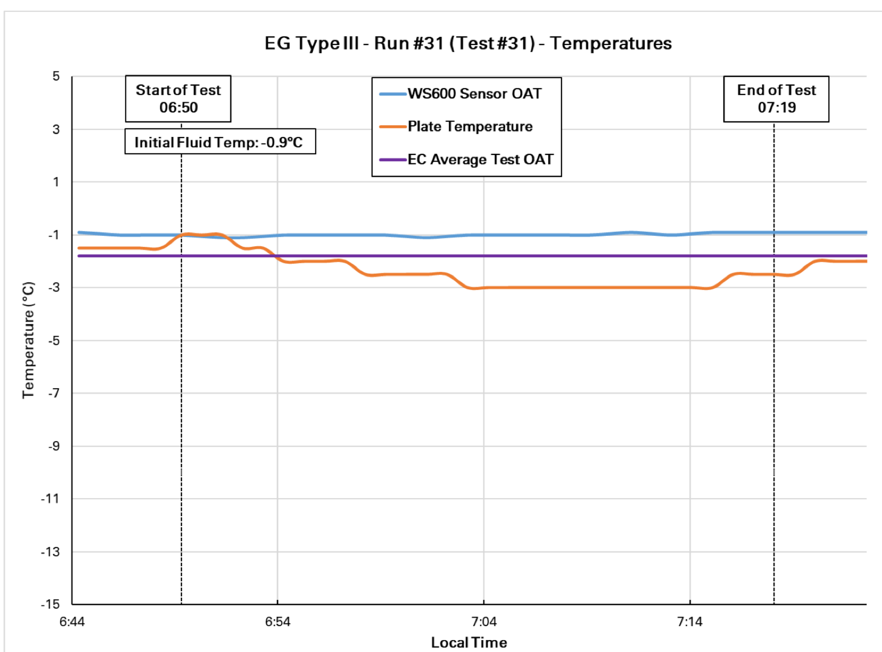
DATA PACKAGE – EG TYPE III – RUN 31 (TEST 31)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 31 - Test 31/Data Package - EG Type III - Run 31 - Test 31.docx
Final Version 1.0, March 2021

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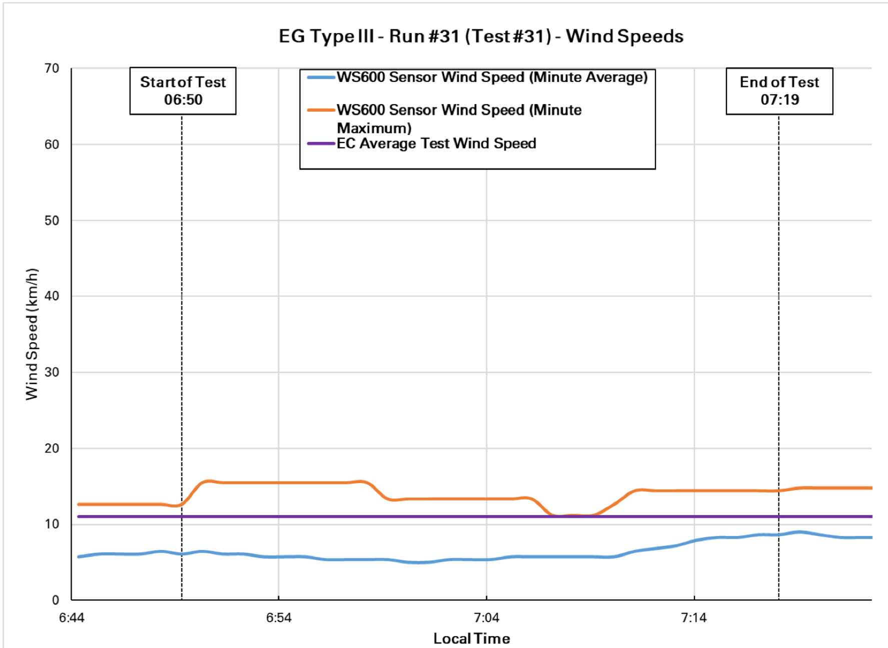
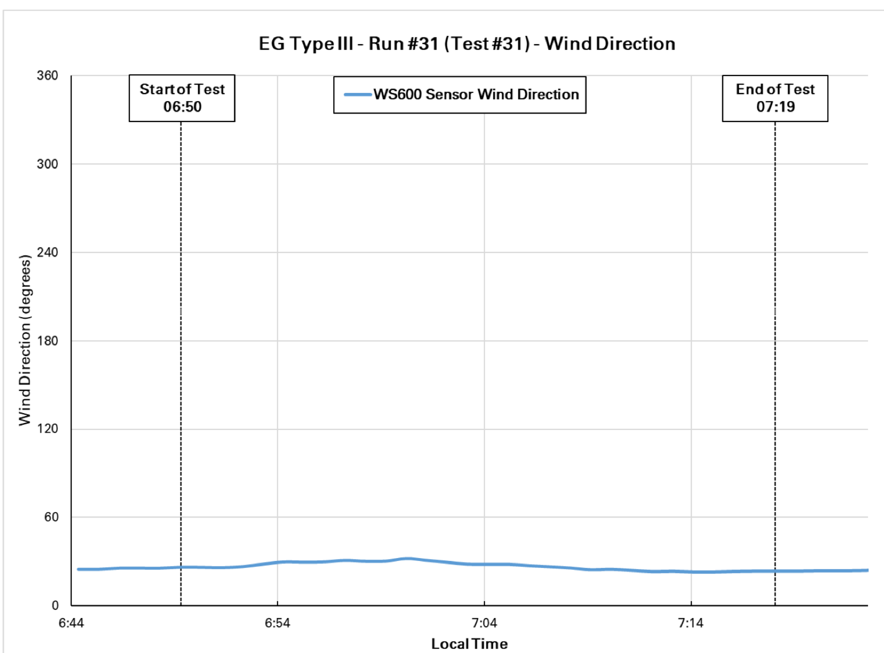
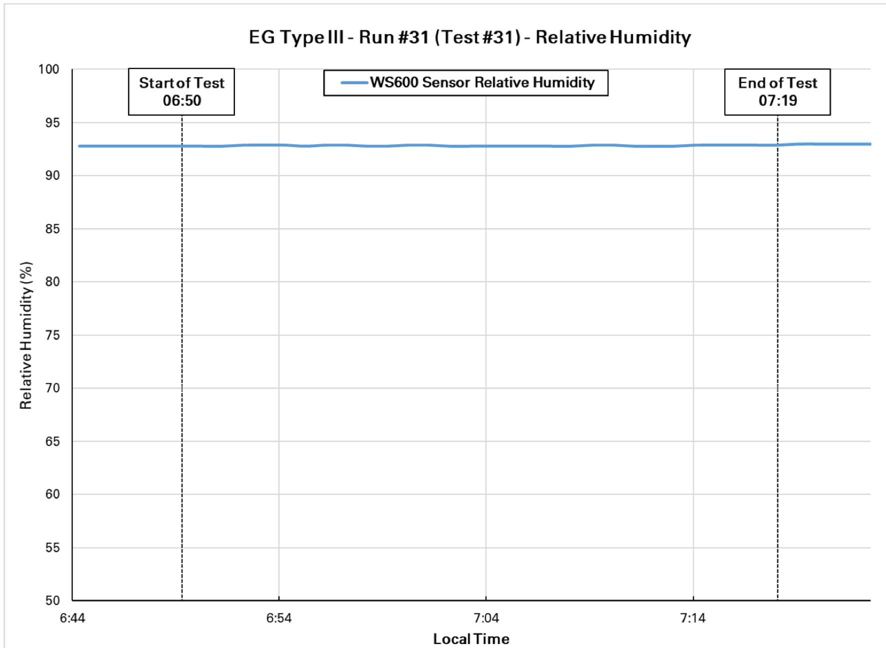
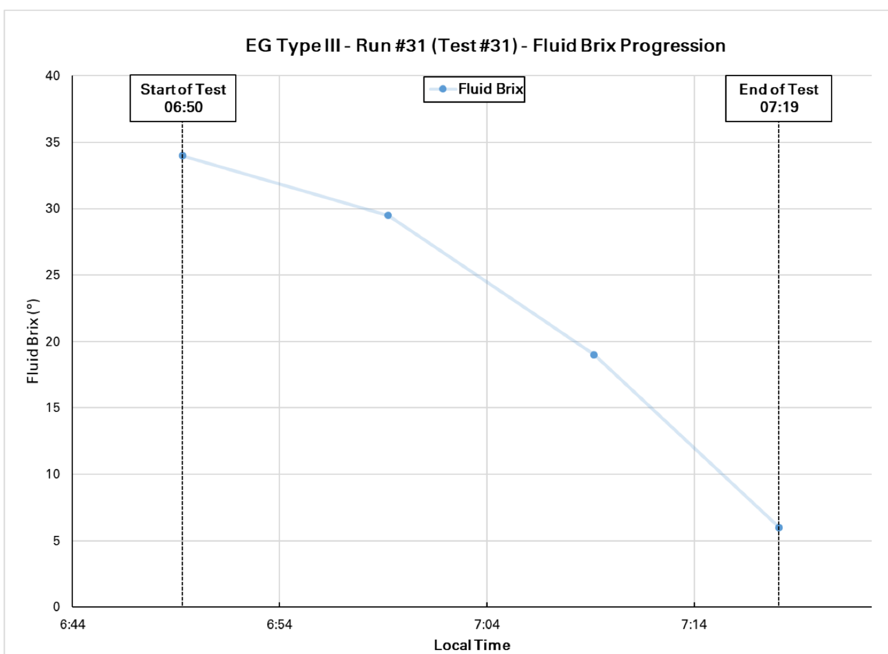

EG Type III - Run #31 (Test #31) - Wind Speeds
Start of Test 06:50
End of Test 07:19
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
6:44
6:54
7:04
7:14
Local Time

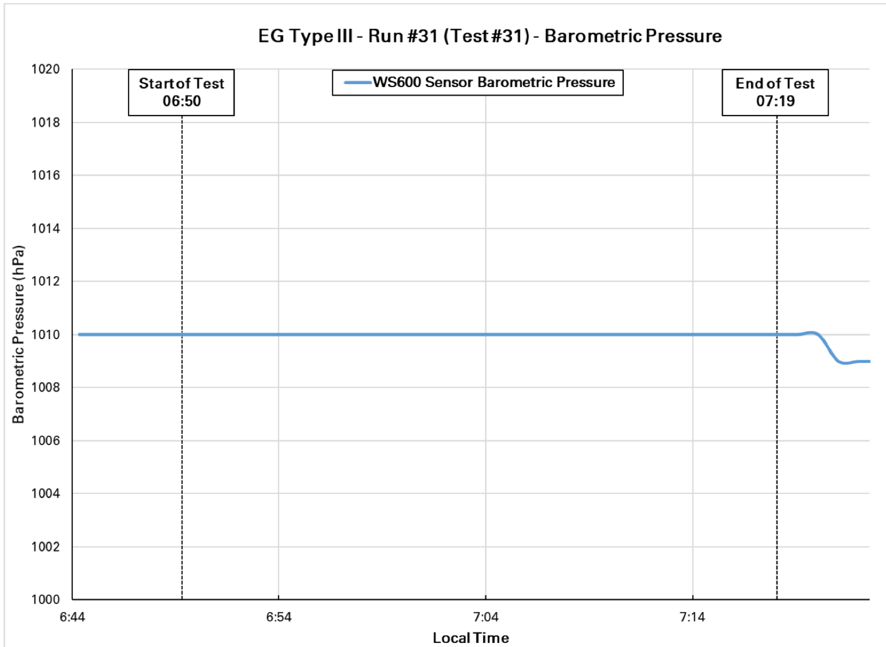

EG Type III - Run #31 (Test #31) - Wind Direction
Start of Test 06:50
End of Test 07:19
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
6:44
6:54
7:04
7:14
Local Time

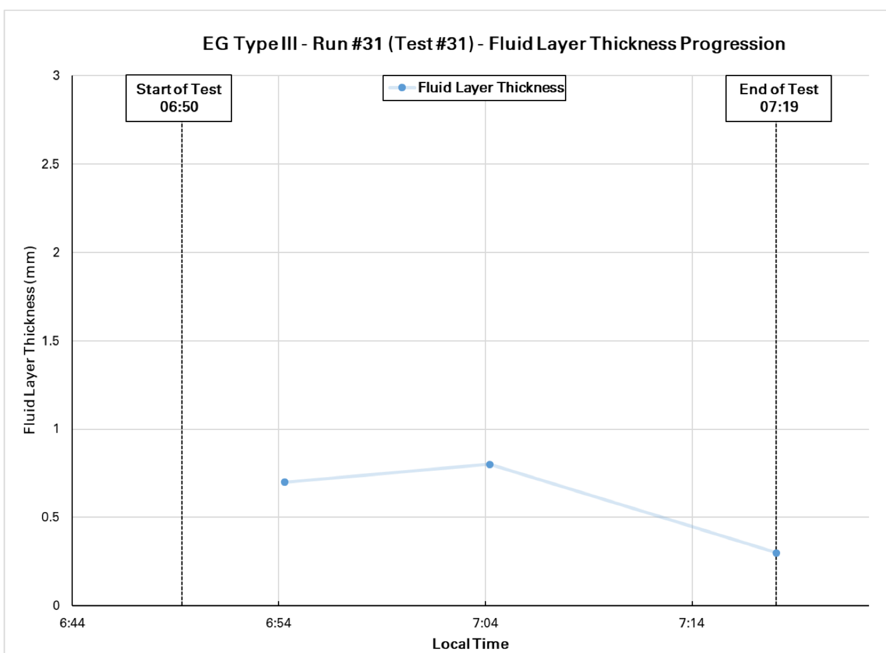


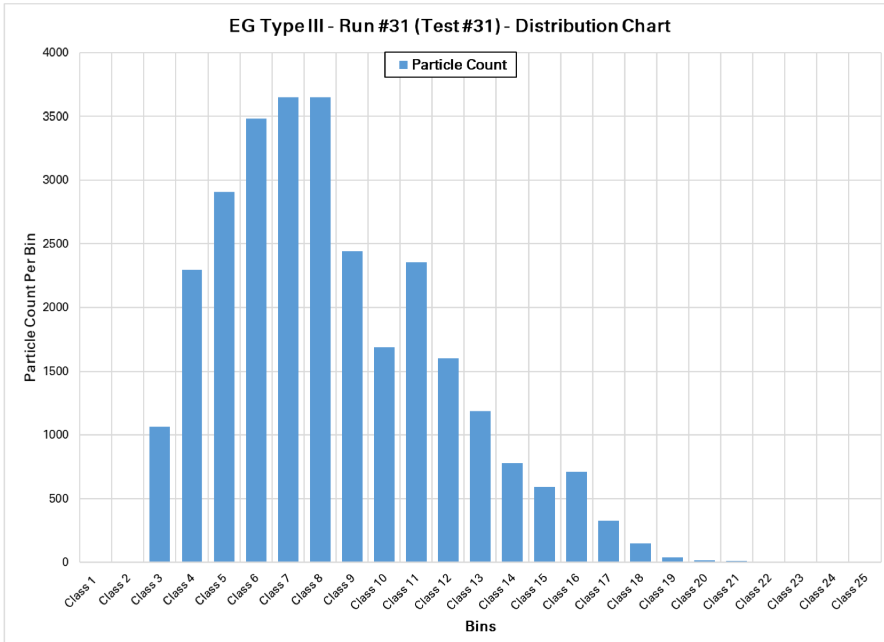
EG Type III - Run #31 (Test #31) - Relative Humidity
Start of Test 06:50
WS600 Sensor Relative Humidity
End of Test 07:19
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
6:44
6:54
7:04
7:14
Local Time



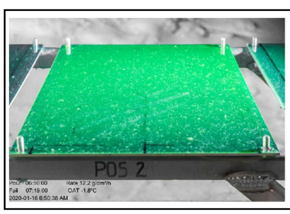
EG Type III - Run #31 (Test #31) - Fluid Brix Progression
Start of Test 06:50
Fluid Brix
End of Test 07:19
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
6:44
6:54
7:04
7:14
Local Time


EG Type III - Run #31 (Test #31) - Barometric Pressure
Start of Test 06:50
WS600 Sensor Barometric Pressure
End of Test 07:19
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
6:44
6:54
7:04
7:14
Local Time

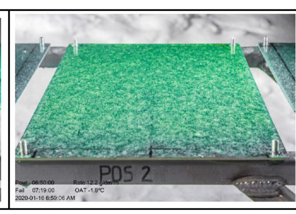

EG Type III - Run #31 (Test #31) - Fluid Layer Thickness Progression
Start of Test 06:50
Fluid Layer Thickness
End of Test 07:19
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:44
6:54
7:04
7:14
Local Time



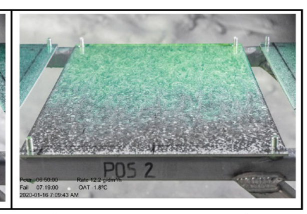
AeroClear MAX – Run 31 (Test 31) – Failure Progression Photos



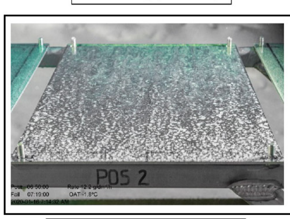
AT POUR (0/29 MIN)



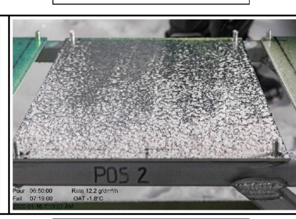
PRE-FAILURE (9/29 MIN)



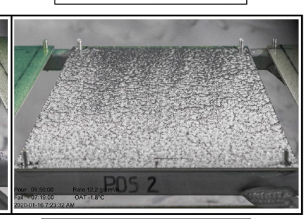
PRE-FAILURE (19/29 MIN)



PRE-FAILURE (24/29 MIN)

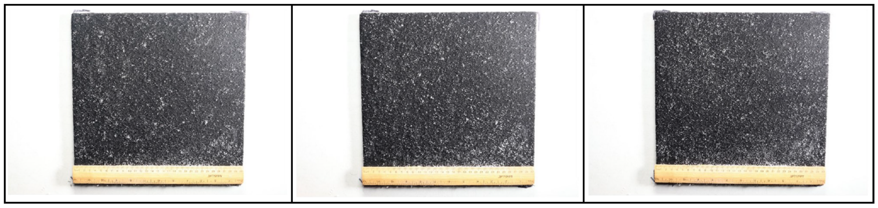


AT FAILURE (29/29 MIN)

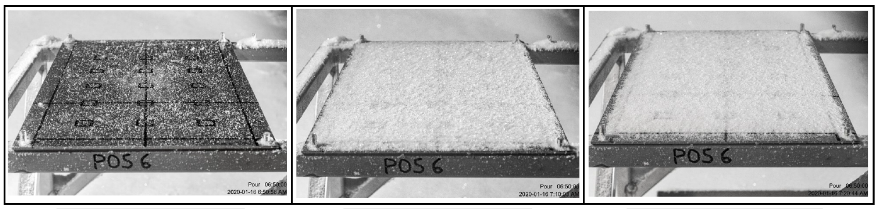


POST-FAILURE (33/29 MIN)

AeroClear MAX – Run 31 (Test 31) – Snow Characteristics Photos



FELT PAD (2/29 MIN) | FELT PAD (10/29 MIN) | FELT PAD (21/29 MIN)



BARE PLATE (0/29 MIN) | BARE PLATE (20/29 MIN) | BARE PLATE (30/29 MIN)

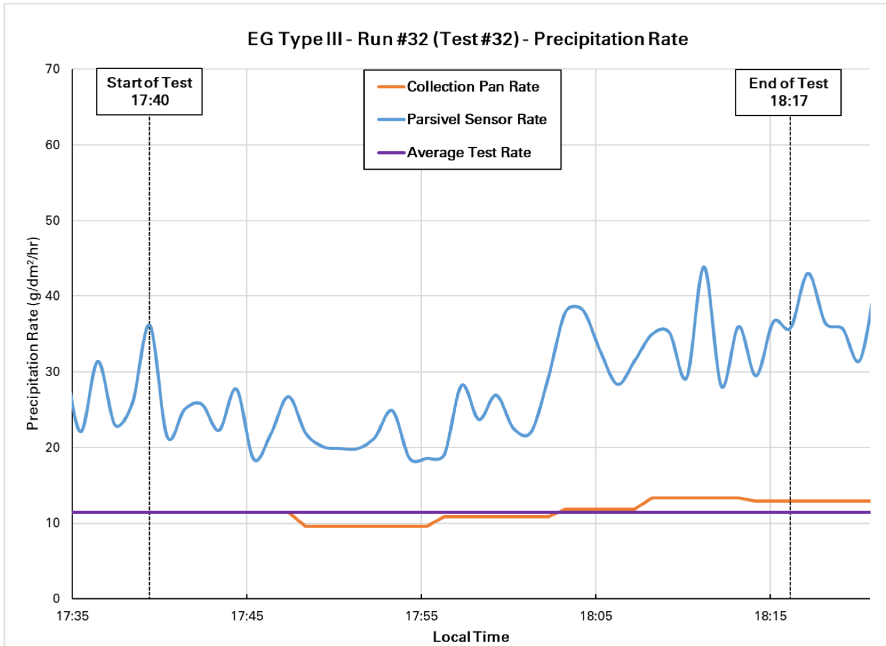
Final Bare Plate Contamination Thickness: **0.3mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

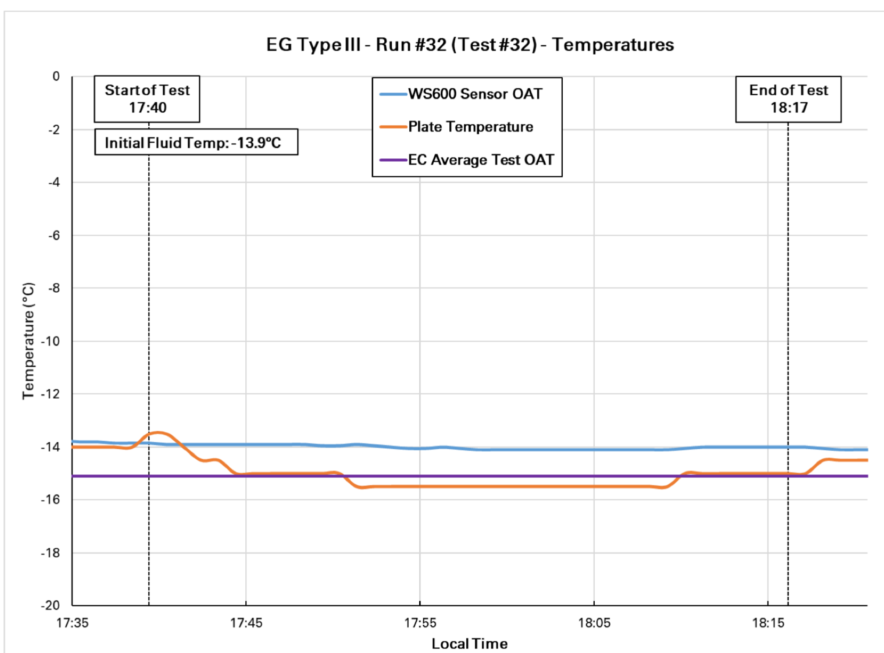
EG TYPE III
RUN #32 (TEST #32) – EG3-32

EG Type III – Run #32 (Test #32) – General Test Information

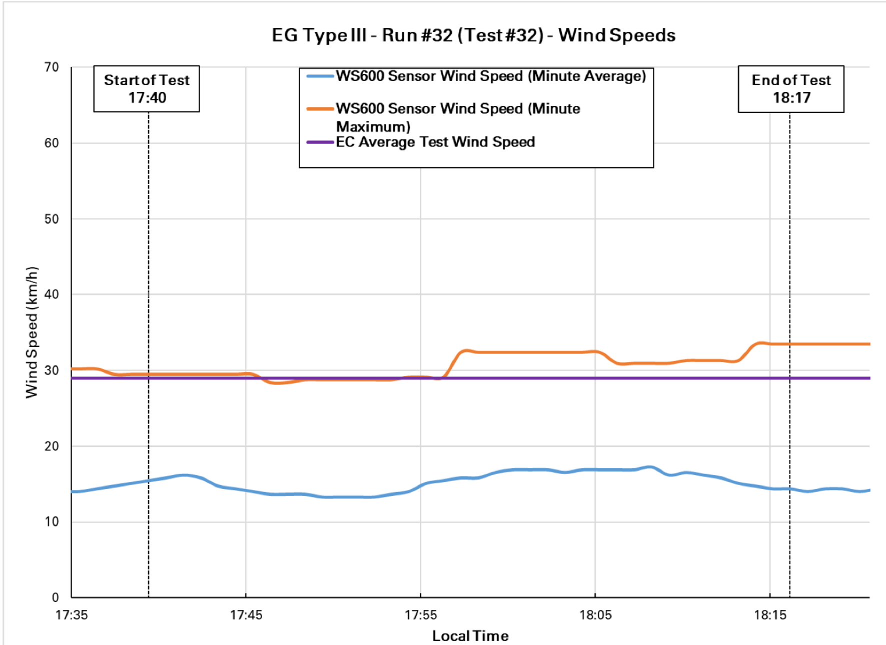
Test Number:	**EG3-32**
Date of Test:	**January 18, 2020**
Average OAT:	**-15.1**
Average Precipitation Rate:	**11.4 g/dm²/h**
Average Wind Speed:	**29.0 km/h**
Average Relative Humidity:	**75.2%**
Pour Time (Local):	**17:40:00**
Time of Fluid Failure (Local):	**18:17:00**
Fluid Brix at Failure:	**19.75°**
Endurance Time:	**37 minutes**
Expected Regression-Derived Endurance Time:	**39.1 minutes**
Difference (ET vs. Reg ET):	**-2.1 minutes (-5.4%)**

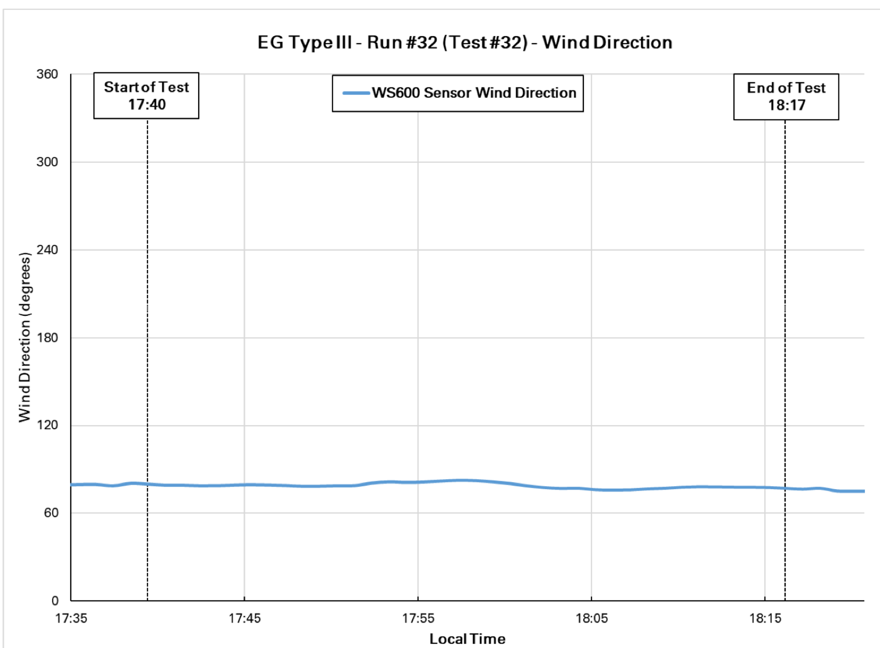


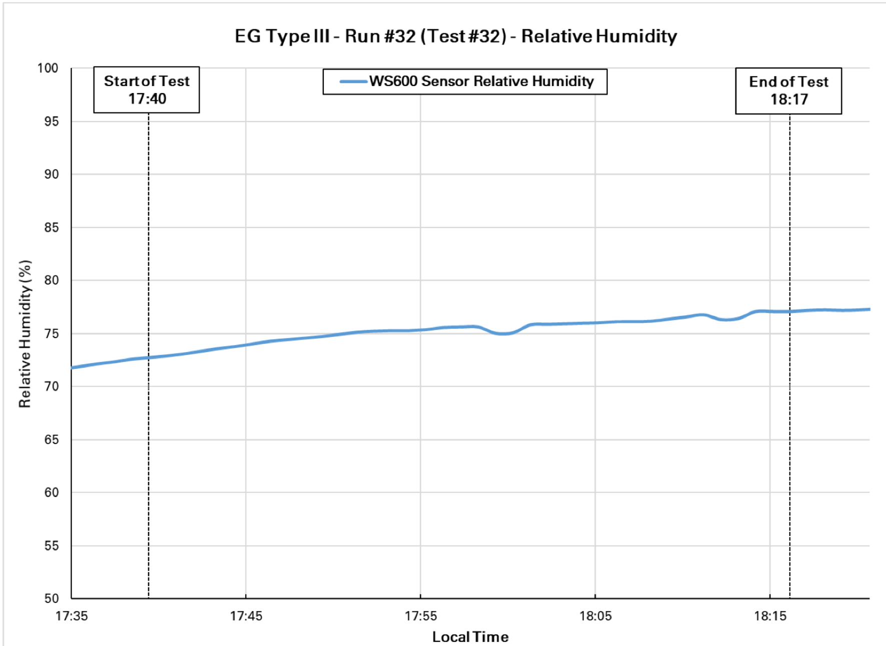
EG Type III - Run #32 (Test #32) - Precipitation Rate
Start of Test
17:40
End of Test
18:17
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
17:35
17:45
17:55
18:05
18:15
Local Time

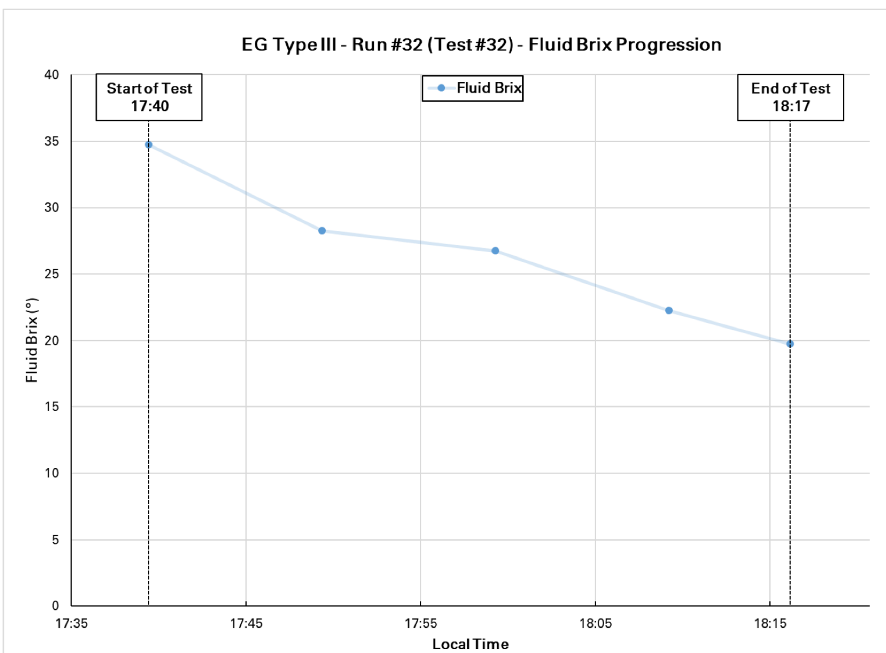


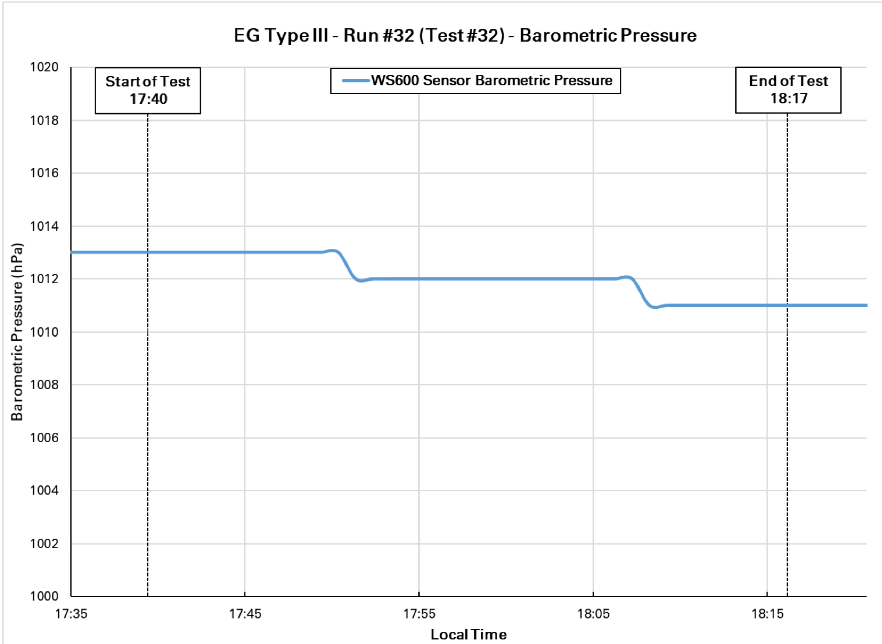
EG Type III - Run #32 (Test #32) - Temperatures
Start of Test
17:40
Initial Fluid Temp: -13.9°C
End of Test
18:17
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
17:35
17:45
17:55
18:05
18:15
Local Time

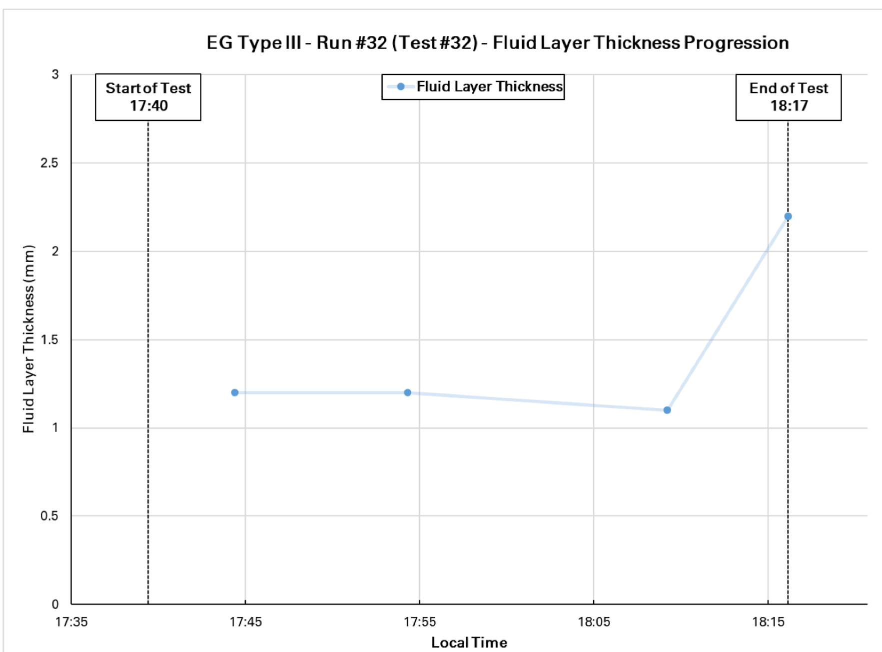

EG Type III - Run #32 (Test #32) - Wind Speeds
Start of Test 17:40
End of Test 18:17
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
17:35
17:45
17:55
18:05
18:15
Local Time

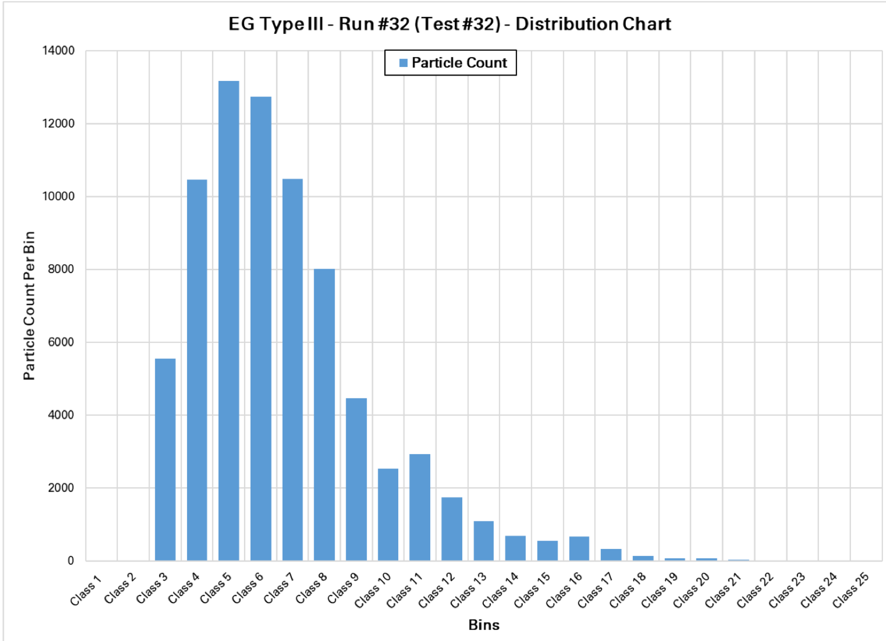

EG Type III - Run #32 (Test #32) - Wind Direction
Start of Test 17:40
End of Test 18:17
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
17:35
17:45
17:55
18:05
18:15
Local Time


EG Type III - Run #32 (Test #32) - Relative Humidity
Start of Test 17:40
WS600 Sensor Relative Humidity
End of Test 18:17
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
17:35
17:45
17:55
18:05
18:15
Local Time

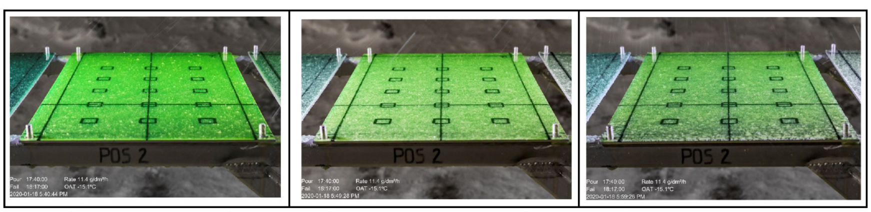

EG Type III - Run #32 (Test #32) - Fluid Brix Progression
Start of Test 17:40
Fluid Brix
End of Test 18:17
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
17:35
17:45
17:55
18:05
18:15
Local Time


EG Type III - Run #32 (Test #32) - Barometric Pressure
WS600 Sensor Barometric Pressure
Start of Test 17:40
End of Test 18:17
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
17:35
17:45
17:55
18:05
18:15
Local Time

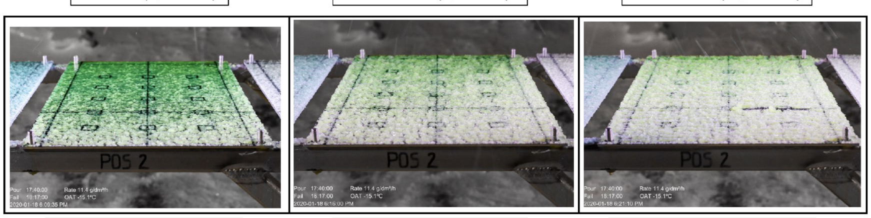

EG Type III - Run #32 (Test #32) - Fluid Layer Thickness Progression
Fluid Layer Thickness
Start of Test 17:40
End of Test 18:17
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
17:35
17:45
17:55
18:05
18:15
Local Time



AeroClear MAX – Run 32 (Test 32) – Failure Progression Photos

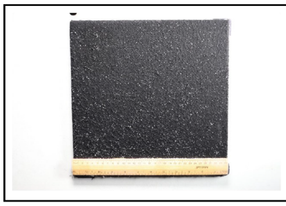


AT POUR (0/37 MIN) | PRE-FAILURE (9/37 MIN) | PRE-FAILURE (19/37 MIN)

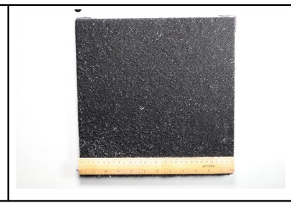


PRE-FAILURE (29/37 MIN) | AT FAILURE (37/37 MIN) | POST-FAILURE (41/37 MIN)

AeroClear MAX – Run 32 (Test 32) – Snow Characteristics Photos

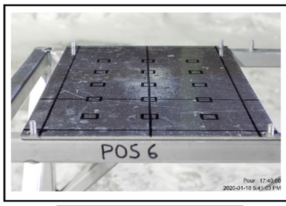


FELT PAD (2/37 MIN)

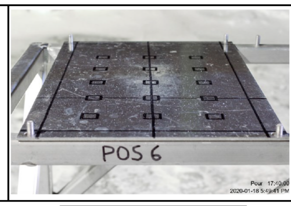


FELT PAD (21/37 MIN)

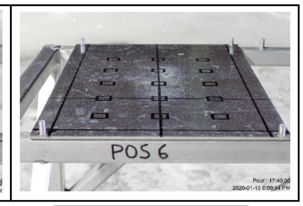
FELT PAD (30/37 MIN)



BARE PLATE (1/37 MIN)



BARE PLATE (19/37 MIN)



BARE PLATE (29/37 MIN)

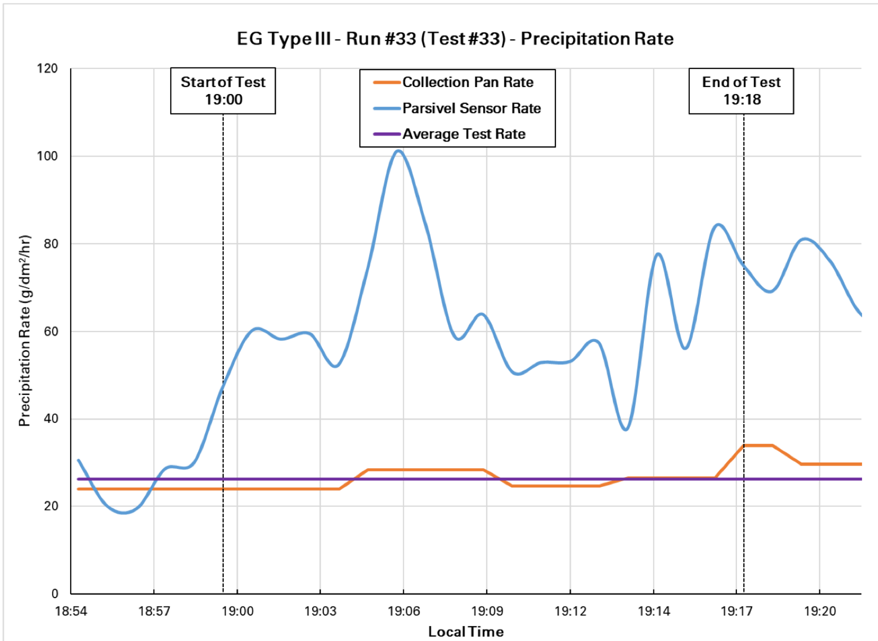
Final Bare Plate Contamination Thickness: **Nil (0mm)**

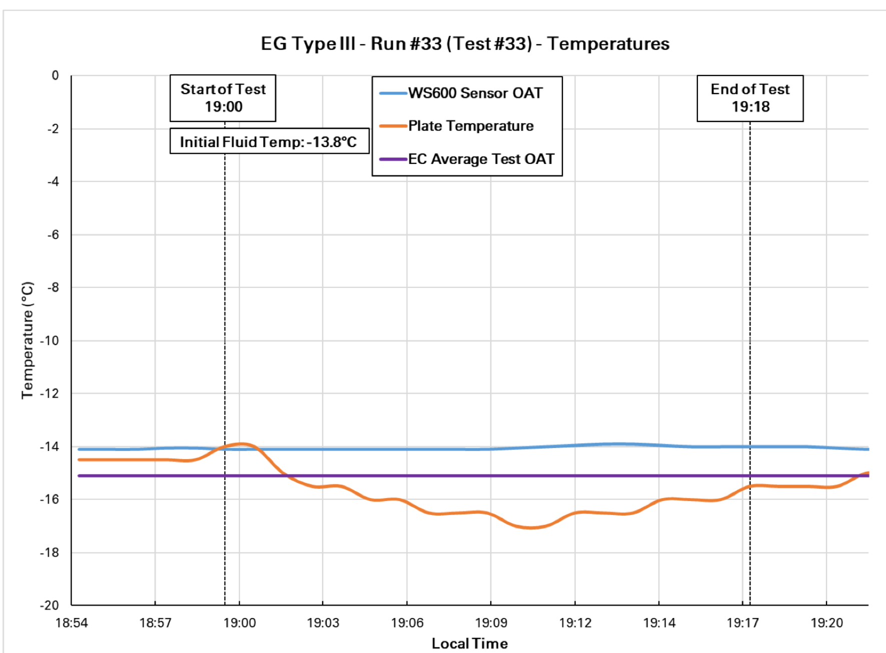
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

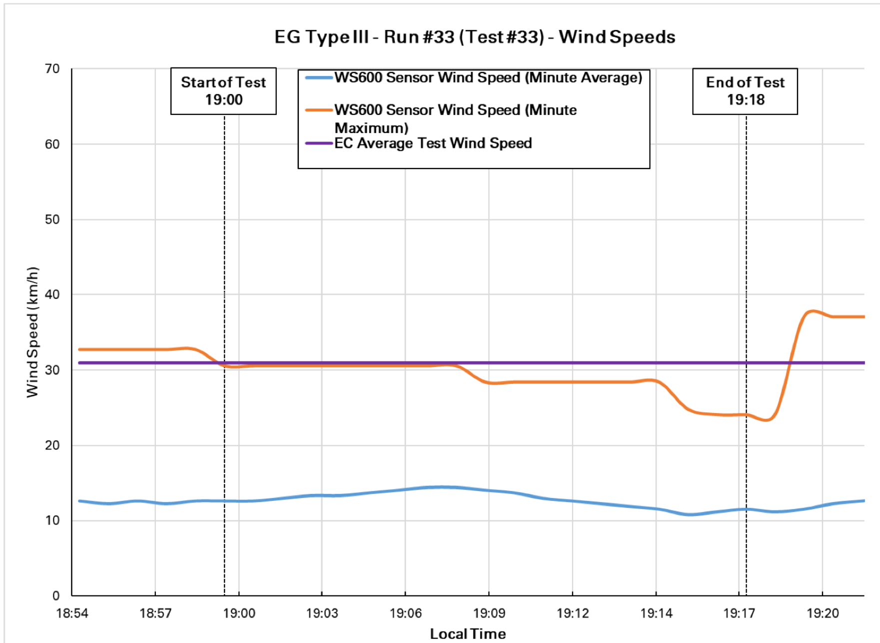
EG TYPE III
RUN #33 (TEST #33) – EG3-33

EG Type III – Run #33 (Test #33) – General Test Information

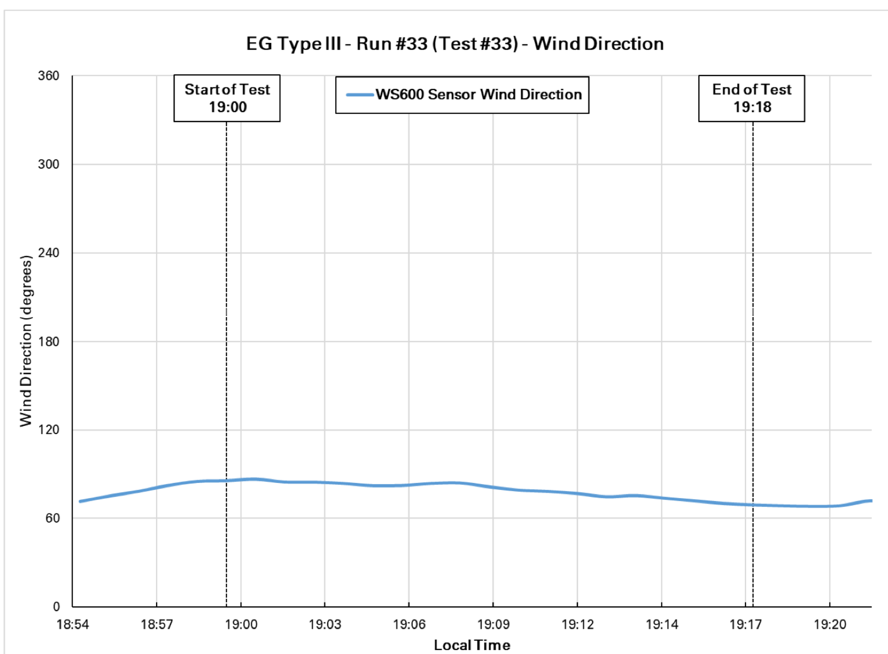
Test Number:	**EG3-33**
Date of Test:	**January 18, 2020**
Average OAT:	**-15.1**
Average Precipitation Rate:	**26.2 g/dm²/h**
Average Wind Speed:	**31.0 km/h**
Average Relative Humidity:	**78.3%**
Pour Time (Local):	**19:00:00**
Time of Fluid Failure (Local):	**19:18:00**
Fluid Brix at Failure:	**21°**
Endurance Time:	**18 minutes**
Expected Regression-Derived Endurance Time:	**22.6 minutes**
Difference (ET vs. Reg ET):	**-4.1 minutes (-18.0%)**


EG Type III - Run #33 (Test #33) - Precipitation Rate
Start of Test 19:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 19:18
Precipitation Rate (g/dm²/hr)
120
100
80
60
40
20
0
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time


EG Type III - Run #33 (Test #33) - Temperatures
Start of Test 19:00
Initial Fluid Temp: -13.8°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 19:18
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

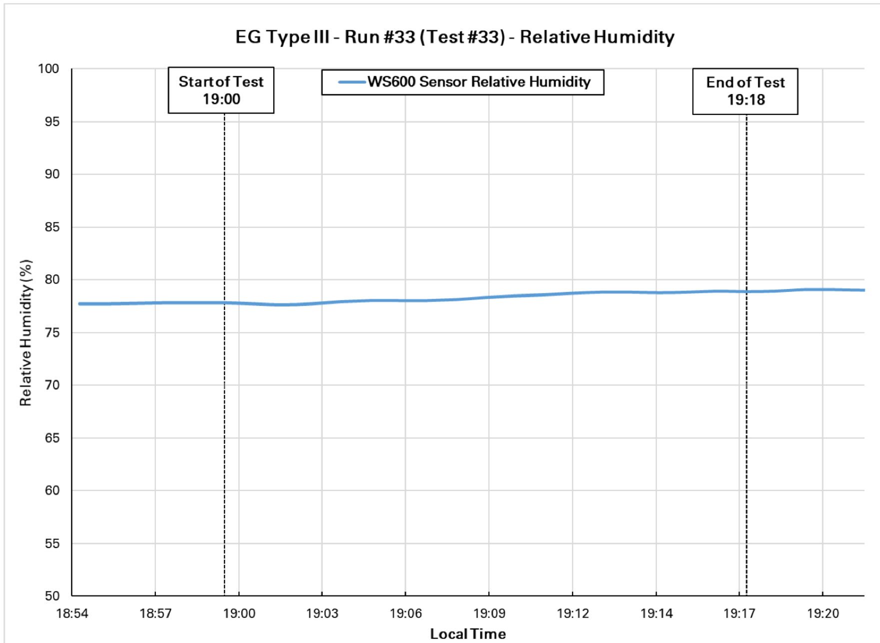


EG Type III - Run #33 (Test #33) - Wind Speeds
Start of Test 19:00
End of Test 19:18
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time



EG Type III - Run #33 (Test #33) - Wind Direction
Start of Test 19:00
WS600 Sensor Wind Direction
End of Test 19:18
Wind Direction (degrees)
360
300
240
180
120
60
0
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

DATA PACKAGE – EG TYPE III – RUN 33 (TEST 33)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 33 - Test 33/Data Package - EG Type III - Run 33 - Test 33.docx
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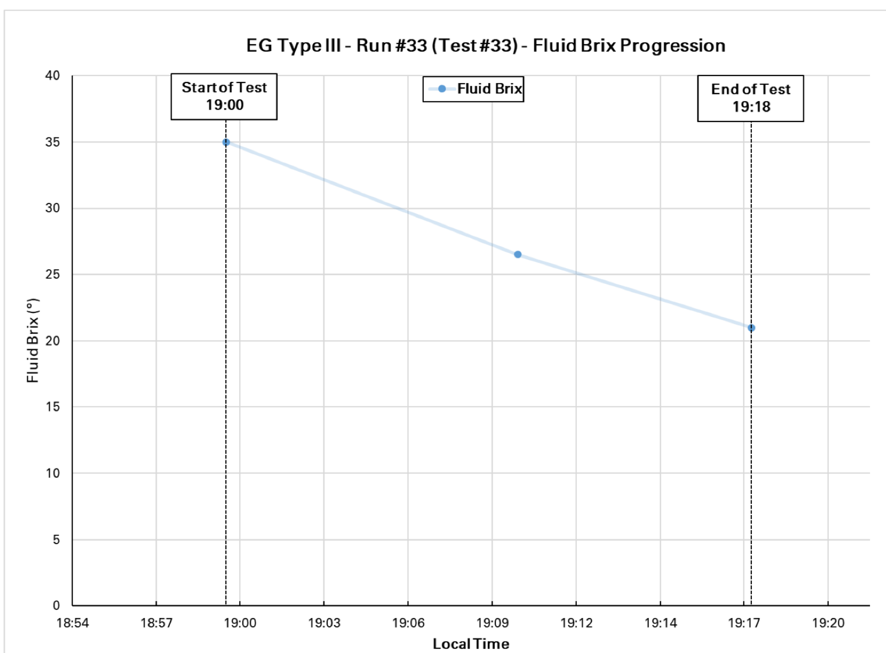
DATA PACKAGE – EG TYPE III – RUN 33 (TEST 33)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 33 - Test 33/Data Package - EG Type III - Run 33 - Test 33.docx
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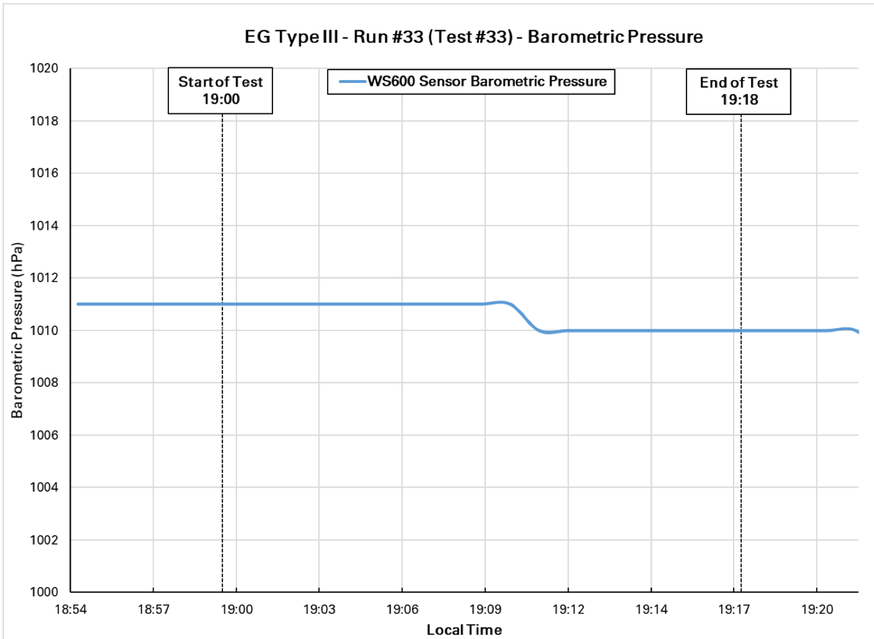
DATA PACKAGE – EG TYPE III – RUN 33 (TEST 33)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 33 - Test 33/Data Package - EG Type III - Run 33 - Test 33.docx
Final Version 1.0, March 2021

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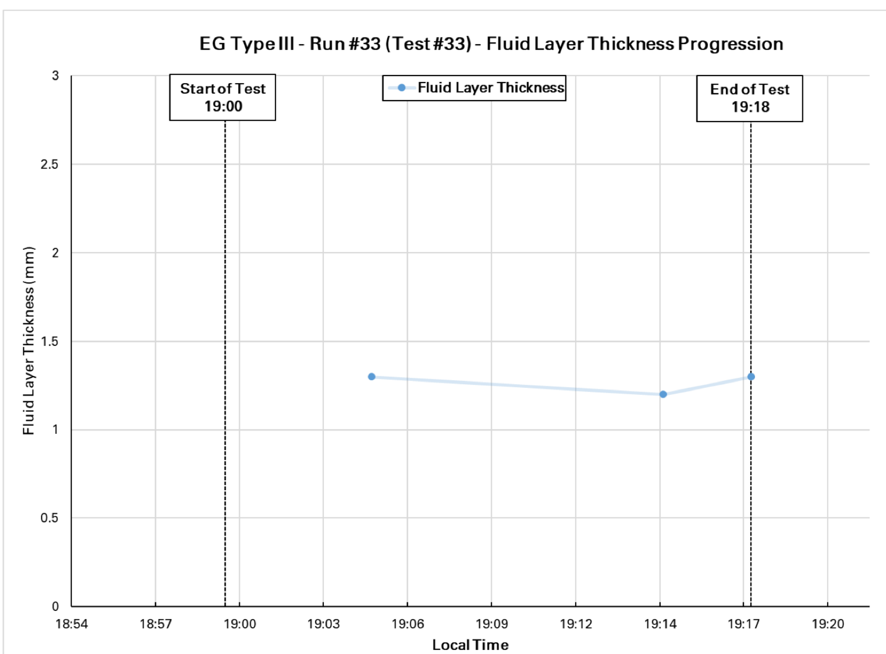
DATA PACKAGE – EG TYPE III – RUN 33 (TEST 33)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 33 - Test 33/Data Package - EG Type III - Run 33 - Test 33.docx
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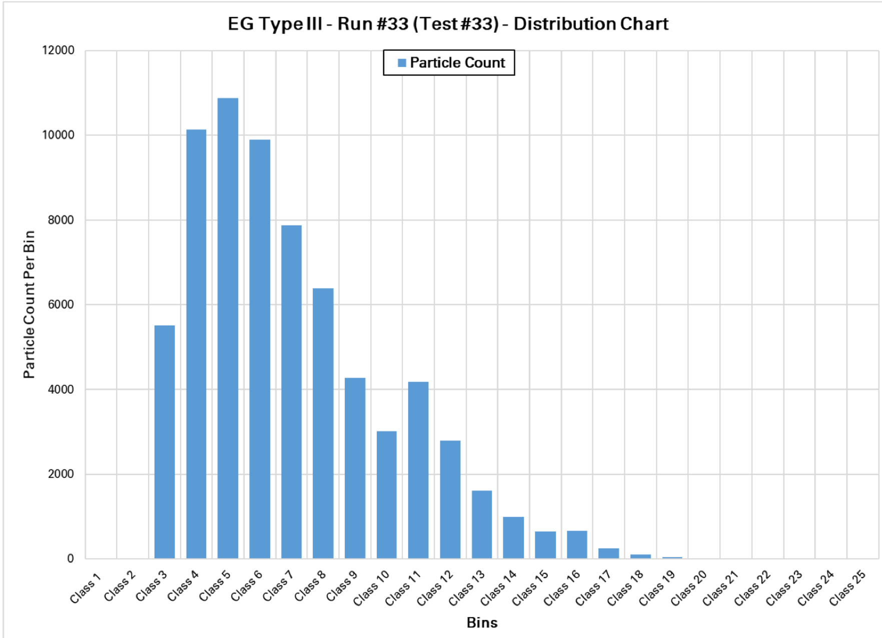
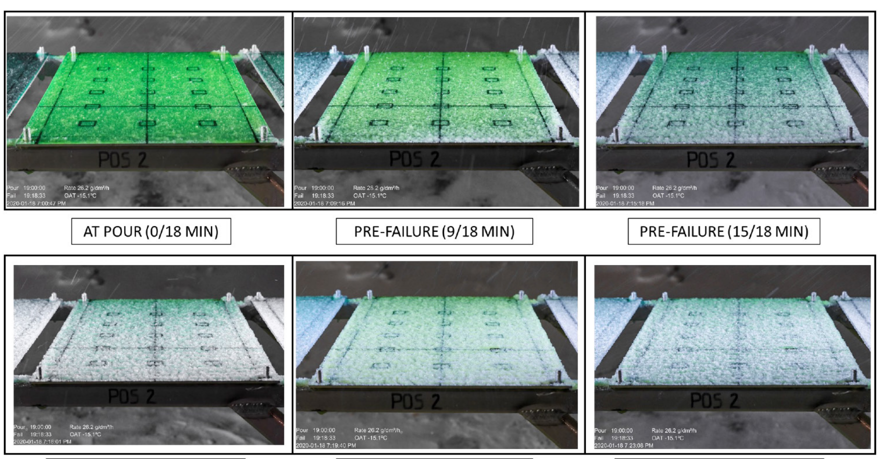


AeroClear MAX – Run 33 (Test 33) – Failure Progression Photos



AT POUR (0/18 MIN) | PRE-FAILURE (9/18 MIN) | PRE-FAILURE (15/18 MIN)

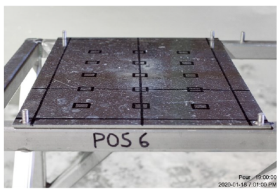
AT FAILURE (18/18 MIN) | POST-FAILURE (19/18 MIN) | POST-FAILURE (23/18 MIN)

AeroClear MAX – Run 33 (Test 33) – Snow Characteristics Photos

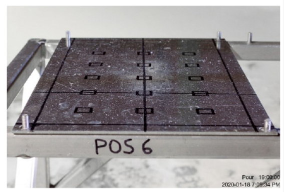

FELT PAD (1/18 MIN)


FELT PAD (10/18 MIN)

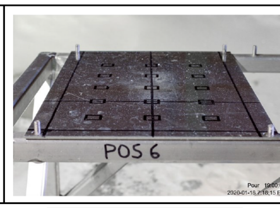

FELT PAD (18/18 MIN)



BARE PLATE (1/18 MIN)



BARE PLATE (9/18 MIN)



BARE PLATE (18/18 MIN)

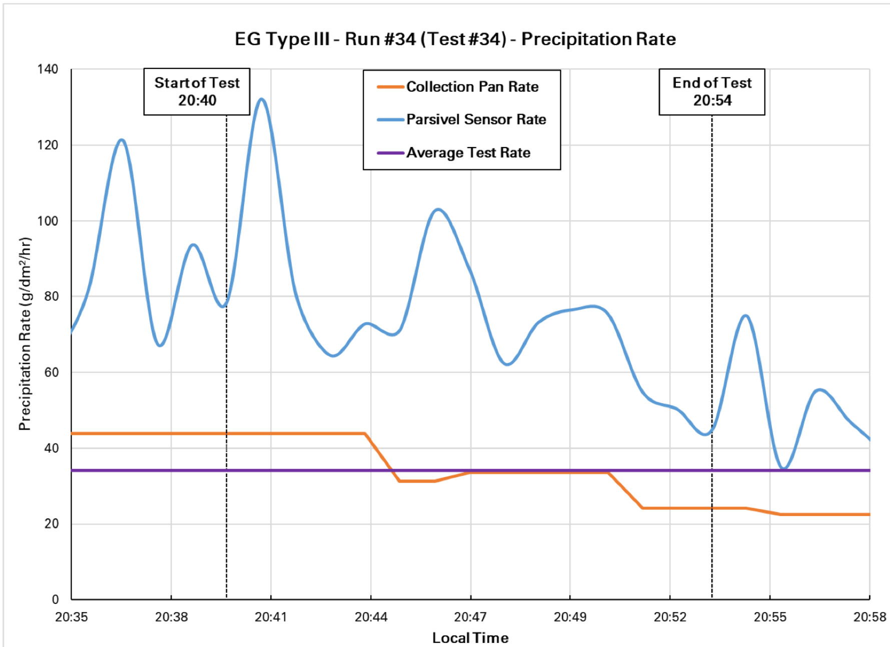
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

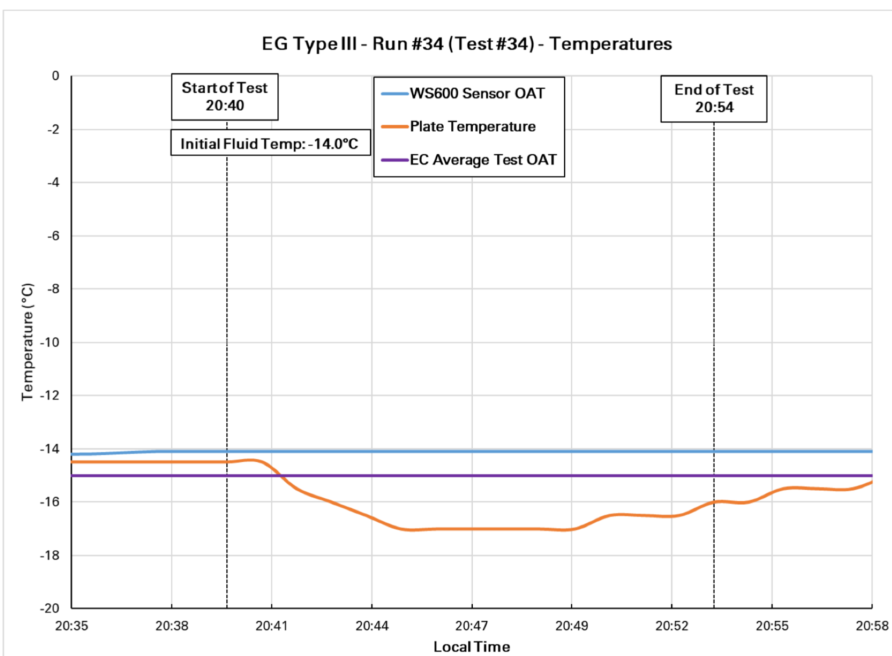
EG TYPE III
RUN #34 (TEST #34) – EG3-34

EG Type III – Run #34 (Test #34) – General Test Information

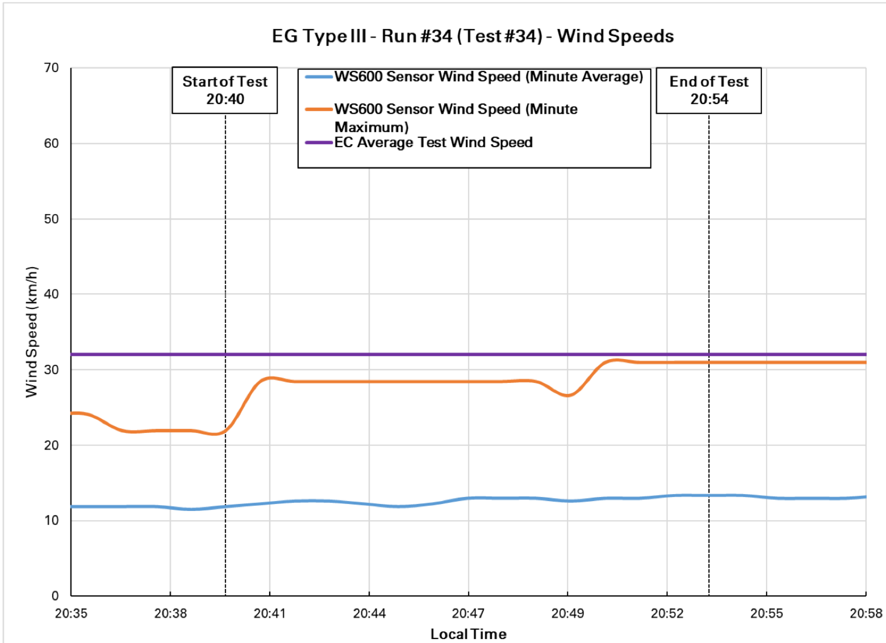
Test Number:	EG3-34
Date of Test:	January 18, 2020
Average OAT:	-15.0
Average Precipitation Rate:	34.2 g/dm²/h
Average Wind Speed:	32.0 km/h
Average Relative Humidity:	80.9%
Pour Time (Local):	20:40:00
Time of Fluid Failure (Local):	20:54:00
Fluid Brix at Failure:	21.25°
Endurance Time:	14 minutes
Expected Regression-Derived Endurance Time:	19 minutes
Difference (ET vs. Reg ET):	-4.1 minutes (-22.5%)

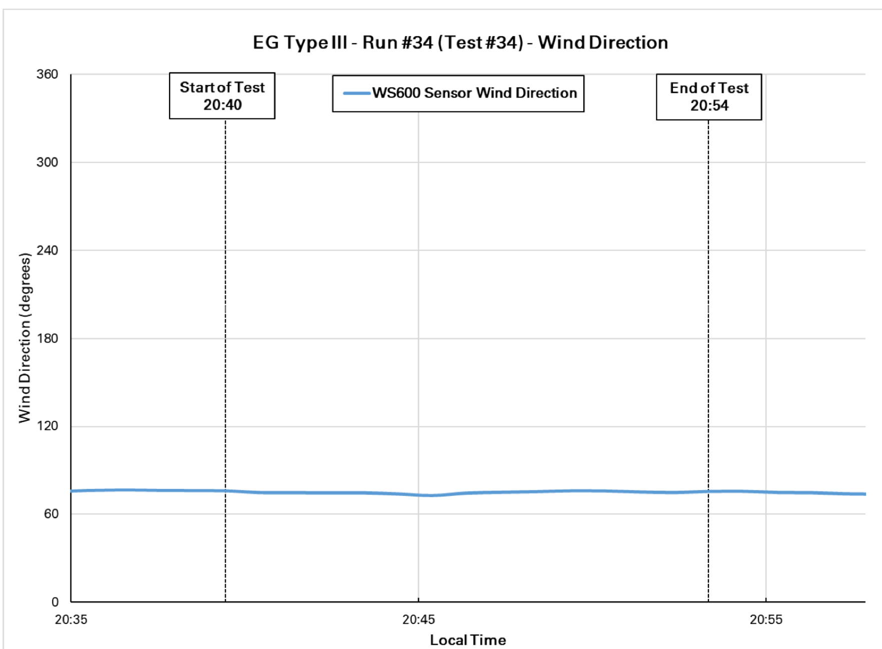


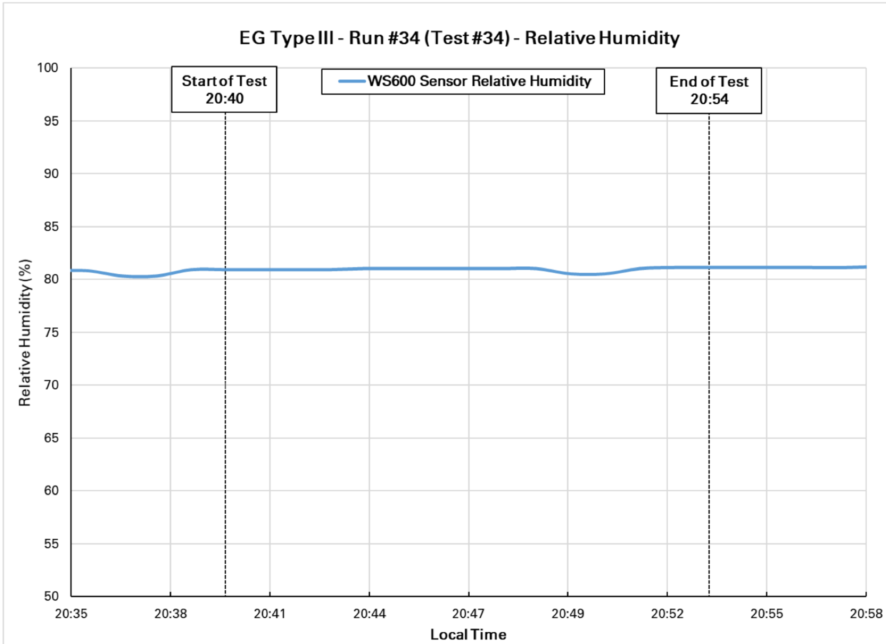
EG Type III - Run #34 (Test #34) - Precipitation Rate
Start of Test 20:40
End of Test 20:54
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
120
140
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time

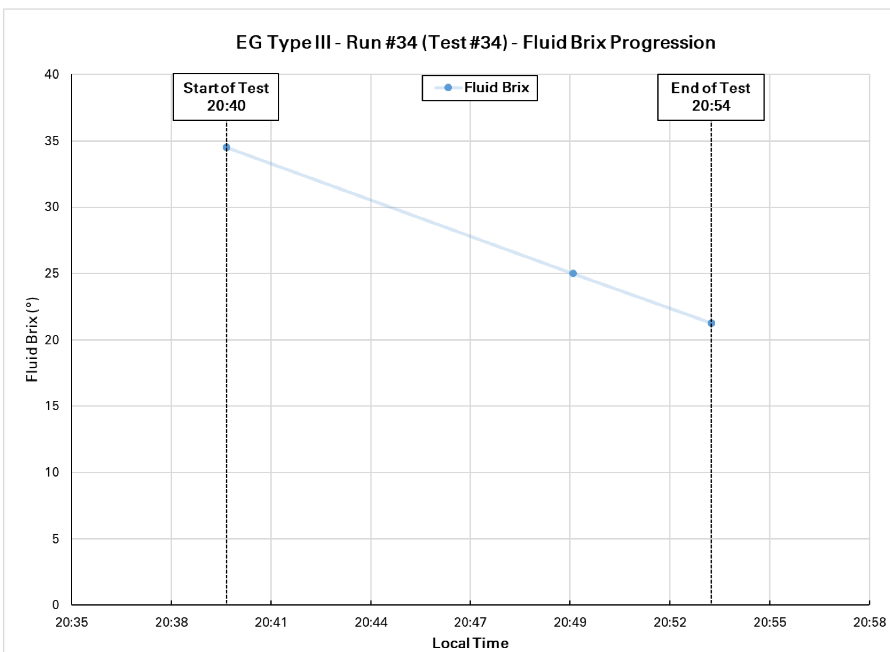


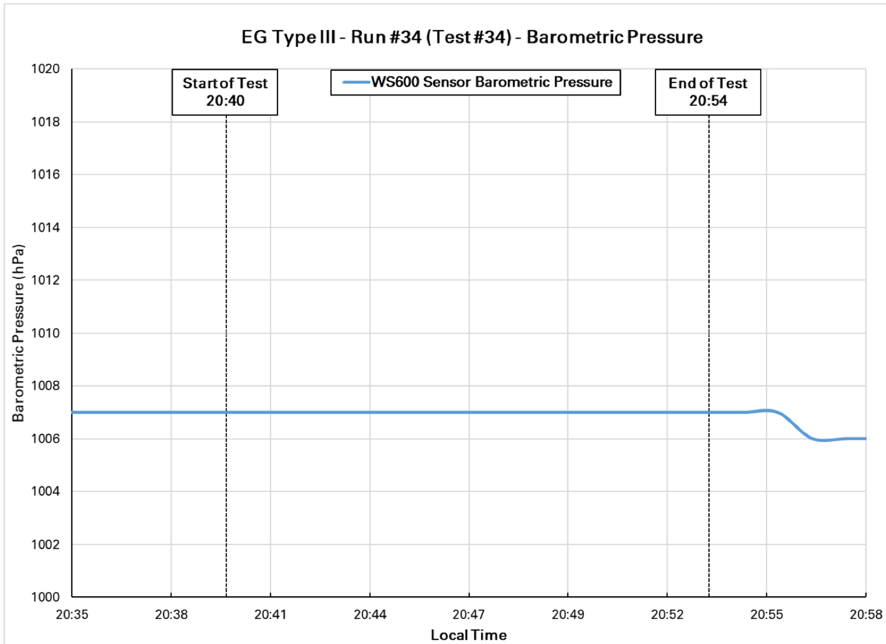
EG Type III - Run #34 (Test #34) - Temperatures
Start of Test 20:40
Initial Fluid Temp: -14.0°C
End of Test 20:54
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time

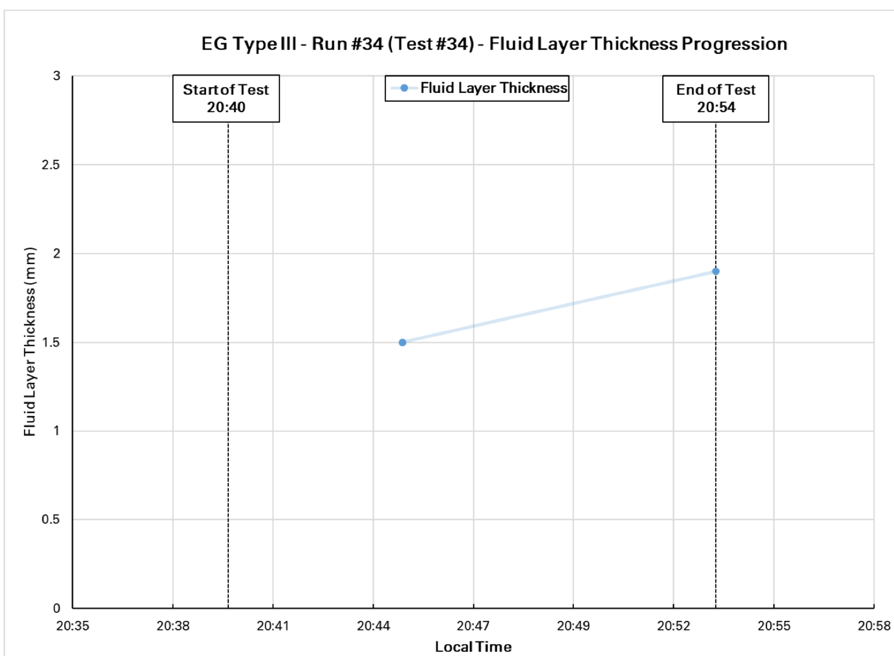

EG Type III - Run #34 (Test #34) - Wind Speeds
Start of Test 20:40
End of Test 20:54
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time

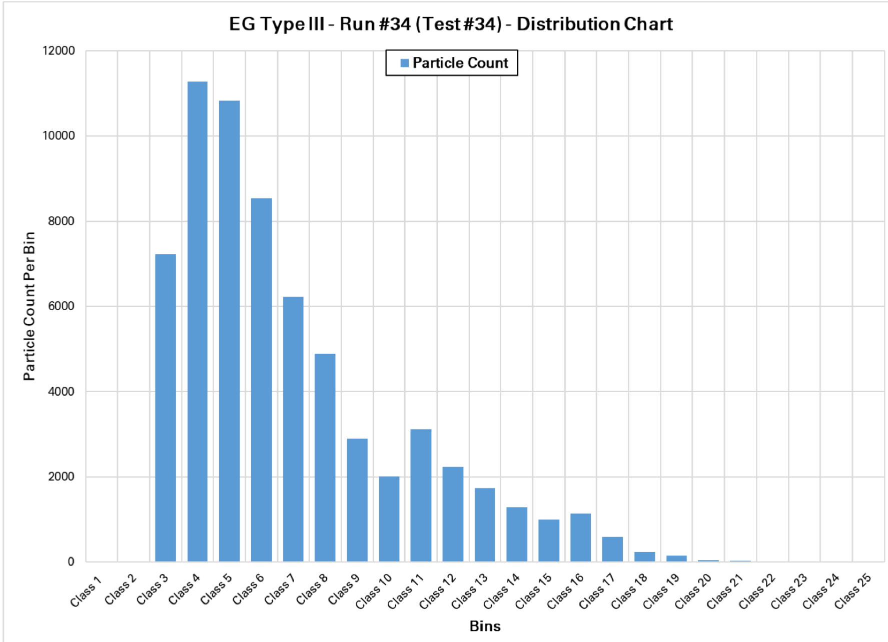

EG Type III - Run #34 (Test #34) - Wind Direction
Start of Test 20:40
WS600 Sensor Wind Direction
End of Test 20:54
Wind Direction (degrees)
0
60
120
180
240
300
360
20:35
20:45
20:55
Local Time


EG Type III - Run #34 (Test #34) - Relative Humidity
Start of Test 20:40
WS600 Sensor Relative Humidity
End of Test 20:54
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time

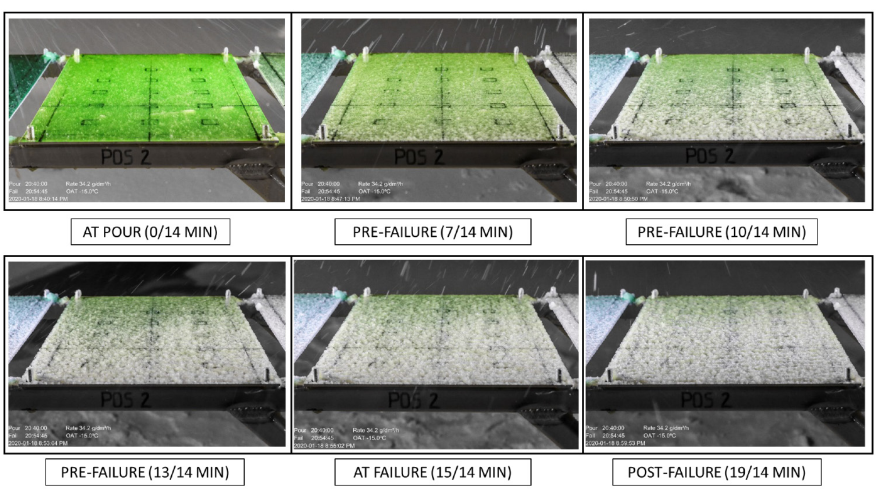

EG Type III - Run #34 (Test #34) - Fluid Brix Progression
Start of Test 20:40
Fluid Brix
End of Test 20:54
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time


EG Type III - Run #34 (Test #34) - Barometric Pressure
Start of Test 20:40
WS600 Sensor Barometric Pressure
End of Test 20:54
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time


EG Type III - Run #34 (Test #34) - Fluid Layer Thickness Progression
Start of Test 20:40
Fluid Layer Thickness
End of Test 20:54
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
20:35
20:38
20:41
20:44
20:47
20:49
20:52
20:55
20:58
Local Time



AeroClear MAX – Run 34 (Test 34) – Failure Progression Photos

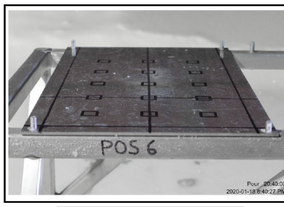


AeroClear MAX – Run 34 (Test 34) – Snow Characteristics Photos

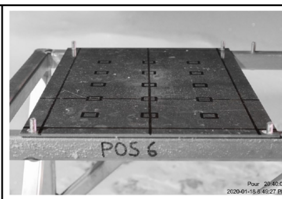
FELT PAD (1/14 MIN)

FELT PAD (10/14 MIN)

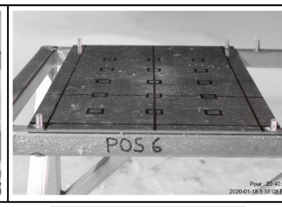
FELT PAD (20/14 MIN)



BARE PLATE (0/14 MIN)



BARE PLATE (9/14 MIN)



BARE PLATE (16/14 MIN)

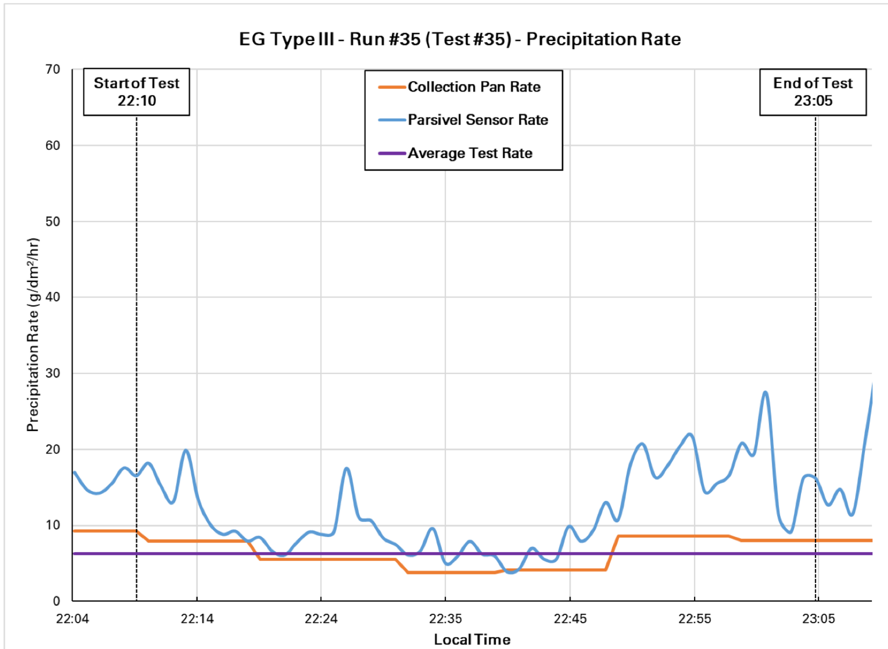
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

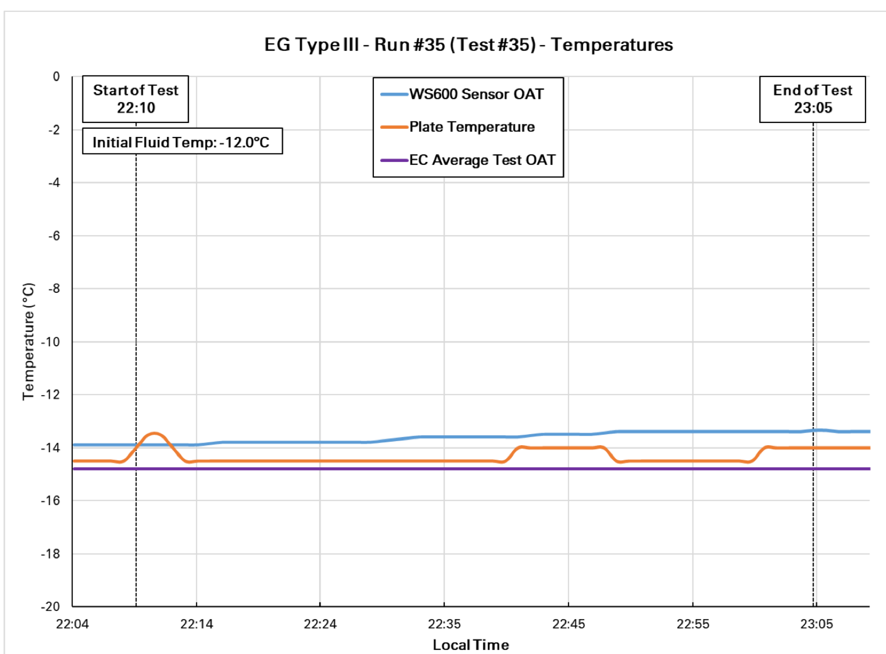
EG TYPE III
RUN #35 (TEST #35) – EG3-35

EG Type III – Run #35 (Test #35) – General Test Information

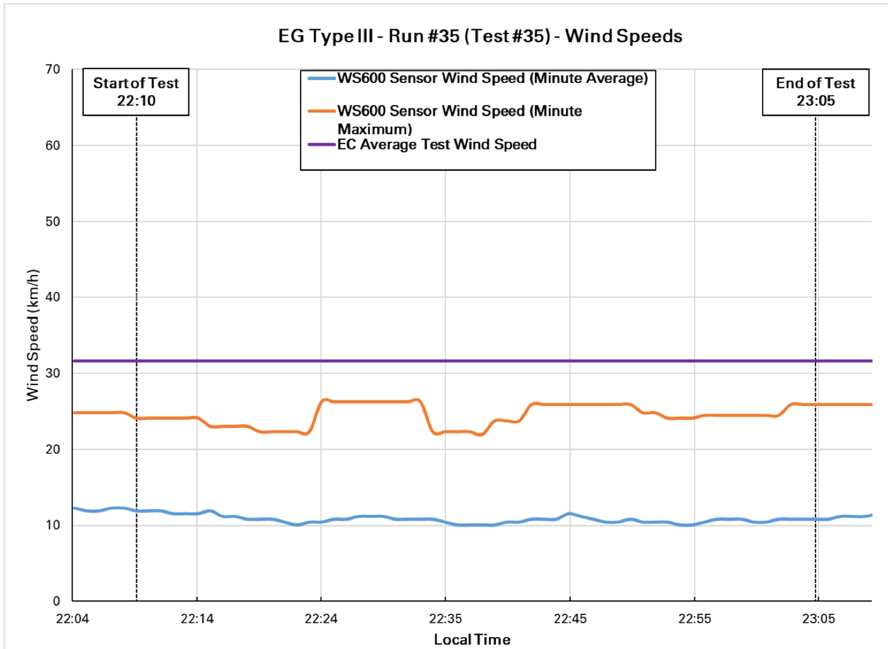
Test Number:	**EG3-35**
Date of Test:	**January 18, 2020**
Average OAT:	**-14.8**
Average Precipitation Rate:	**6.3 g/dm²/h**
Average Wind Speed:	**31.6 km/h**
Average Relative Humidity:	**81.1%**
Pour Time (Local):	**22:10:00**
Time of Fluid Failure (Local):	**23:05:00**
Fluid Brix at Failure:	**20.5°**
Endurance Time:	**55 minutes**
Expected Regression-Derived Endurance Time:	**57.9 minutes**
Difference (ET vs. Reg ET):	**-2.2 minutes (-3.9%)**



DATA PACKAGE – EG TYPE III – RUN 35 (TEST 35)



DATA PACKAGE – EG TYPE III – RUN 35 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 35 - Test 35/Data Package - EG Type III - Run 35 - Test 35.docx
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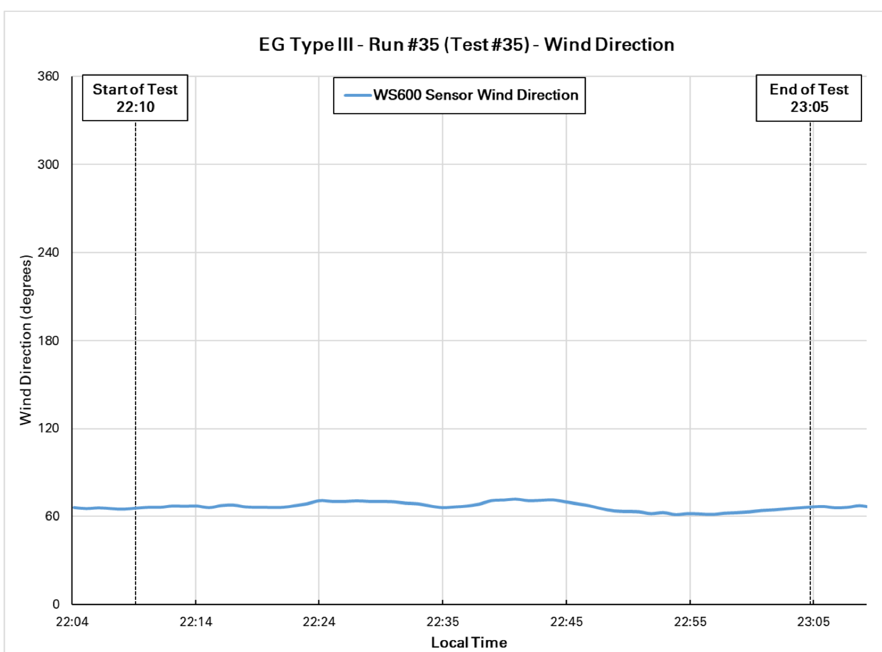
DATA PACKAGE – EG TYPE III – RUN 35 (TEST 35)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 35 - Test 35/Data Package - EG Type III - Run 35 - Test 35.docx
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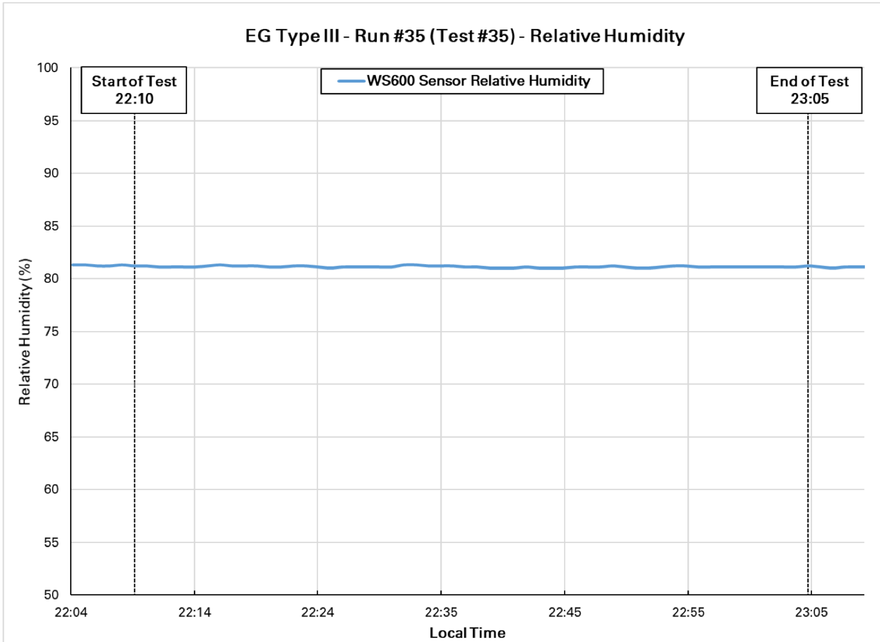
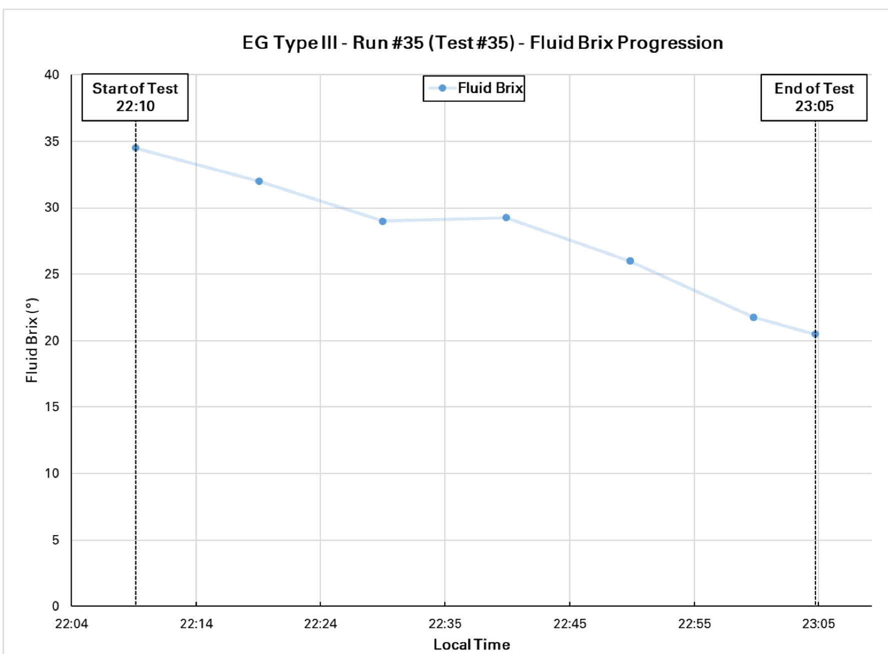
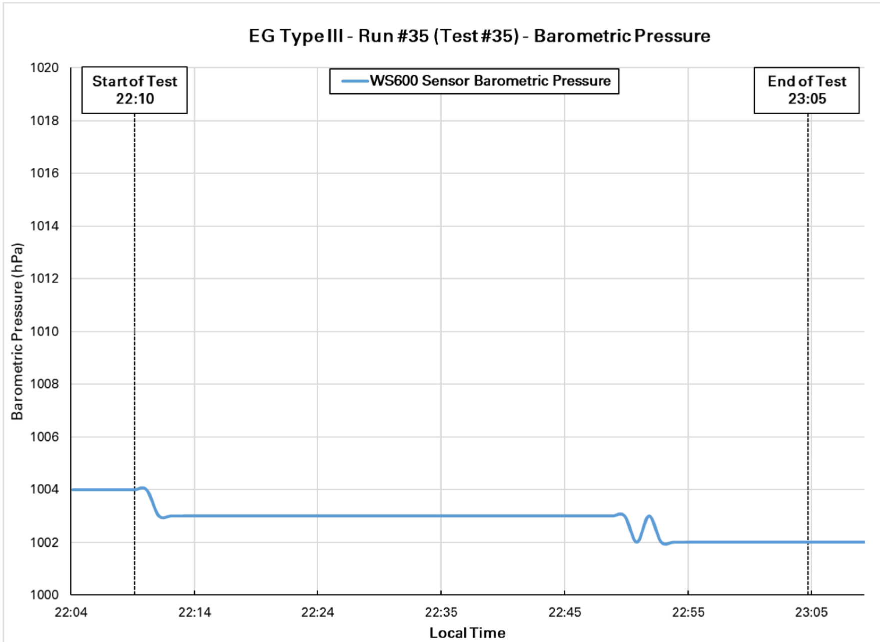
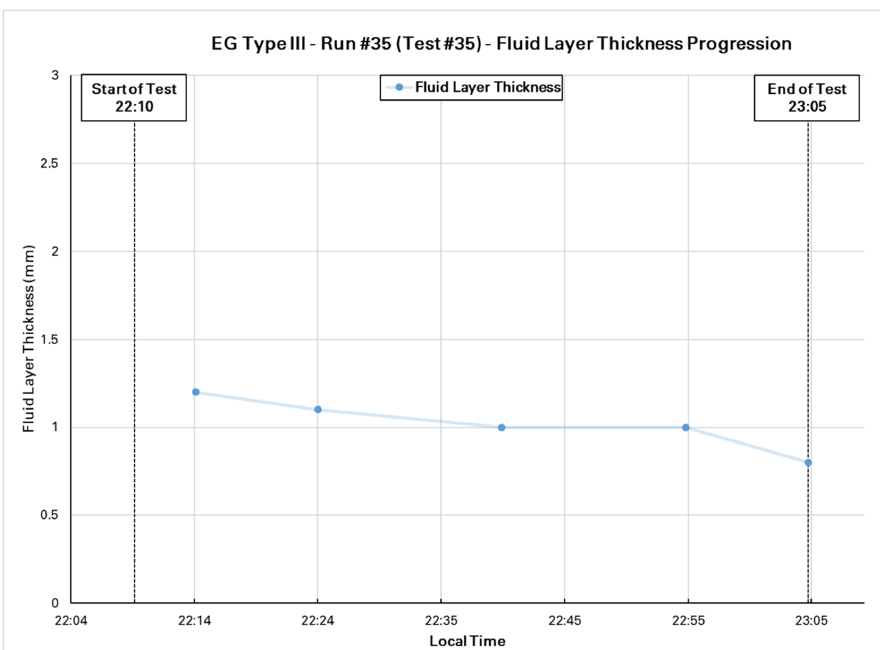


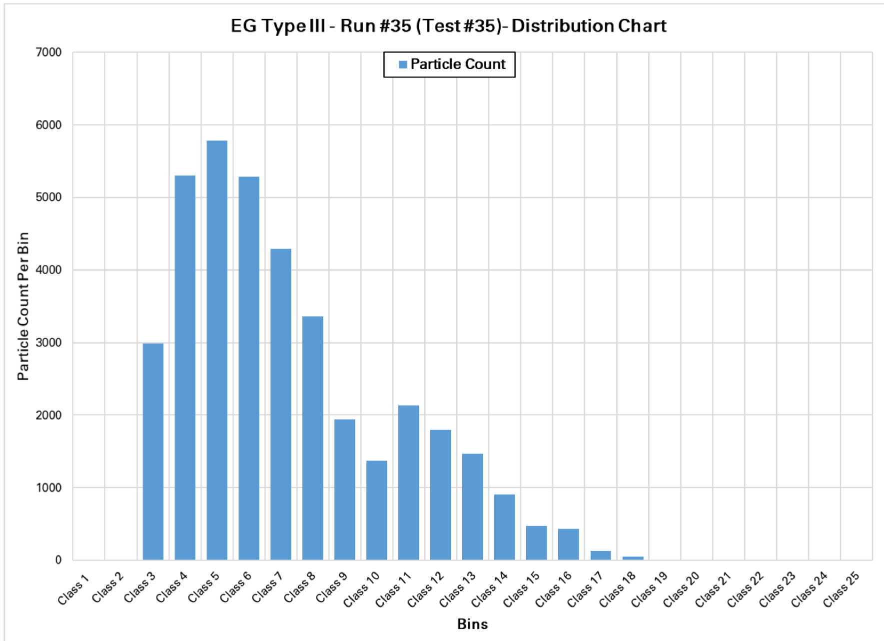
EG Type III - Run #35 (Test #35) - Relative Humidity
Start of Test 22:10
WS600 Sensor Relative Humidity
End of Test 23:05
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time



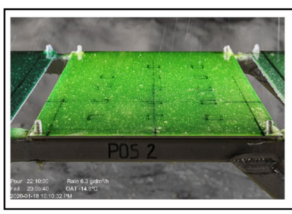
EG Type III - Run #35 (Test #35) - Fluid Brix Progression
Start of Test 22:10
Fluid Brix
End of Test 23:05
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time


EG Type III - Run #35 (Test #35) - Barometric Pressure
Start of Test 22:10
WS600 Sensor Barometric Pressure
End of Test 23:05
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

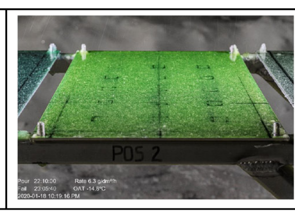

EG Type III - Run #35 (Test #35) - Fluid Layer Thickness Progression
Start of Test 22:10
Fluid Layer Thickness
End of Test 23:05
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time



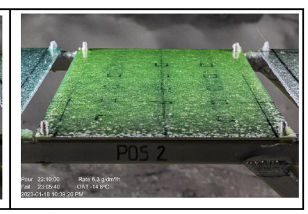
AeroClear MAX – Run 35 (Test 35) – Failure Progression Photos



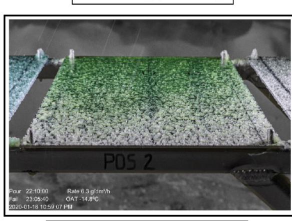
AT POUR (0/55 MIN)



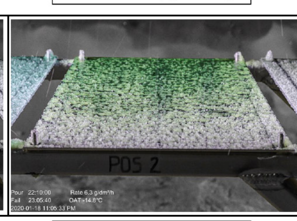
PRE-FAILURE (9/55 MIN)



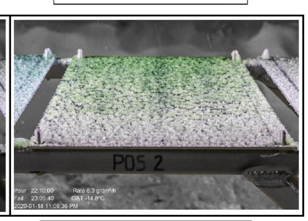
PRE-FAILURE (29/55 MIN)



PRE-FAILURE (49/55 MIN)

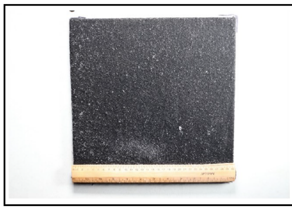


AT FAILURE (56/55 MIN)

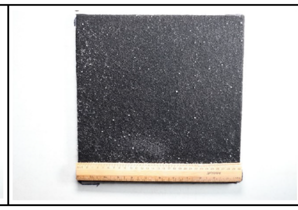


POST-FAILURE (59/55 MIN)

AeroClear MAX – Run 35 (Test 35) – Snow Characteristics Photos

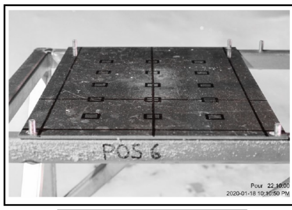


FELT PAD (10/55 MIN)

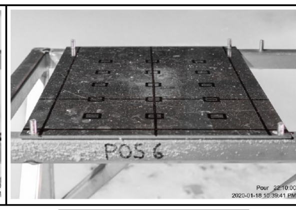


FELT PAD (30/55 MIN)

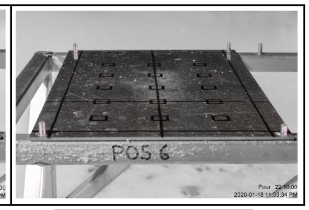
FELT PAD (50/55 MIN)



BARE PLATE (0/55 MIN)



BARE PLATE (29/55 MIN)



BARE PLATE (53/55 MIN)

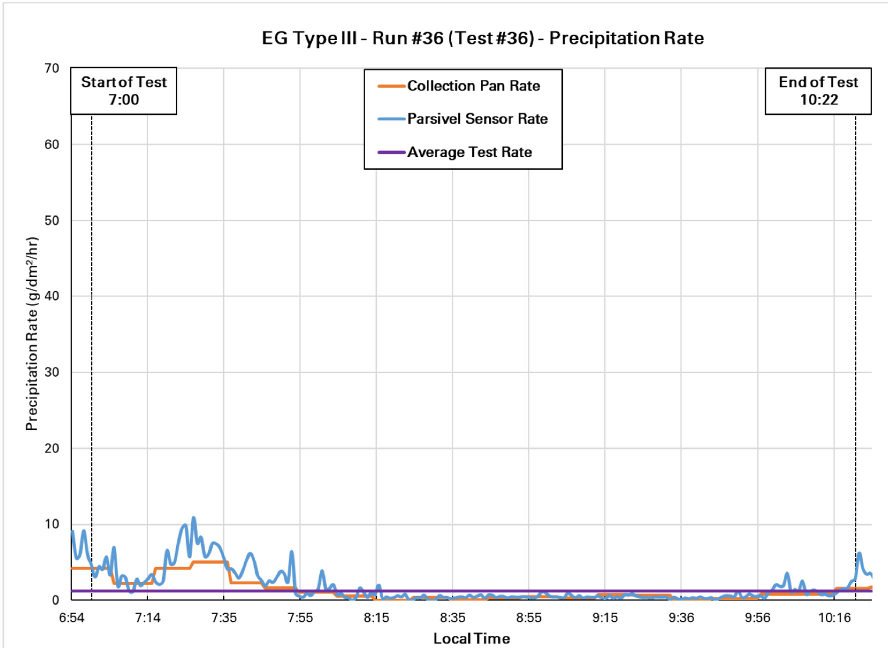
Final Bare Plate Contamination Thickness: **Nil (0mm)**

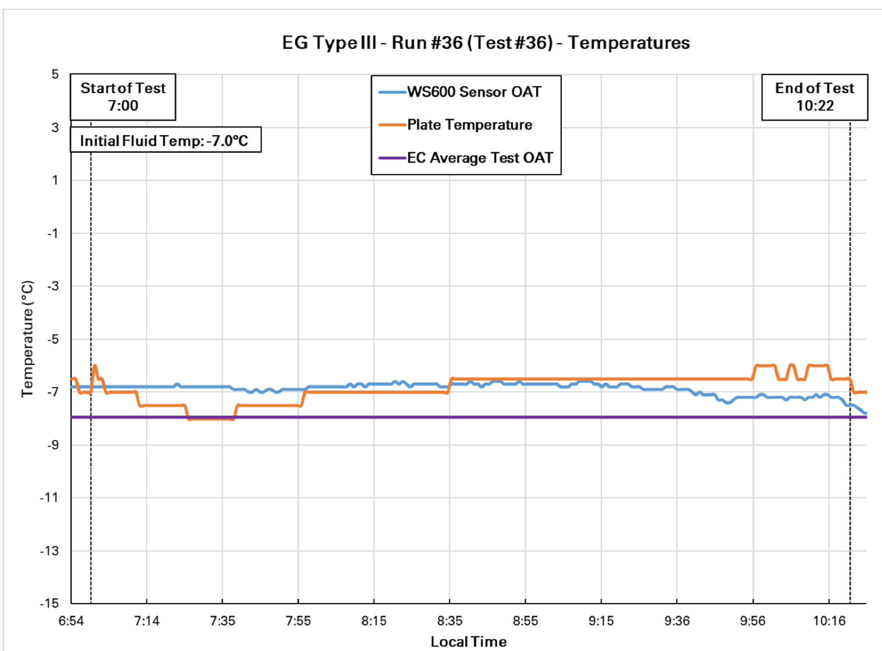
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

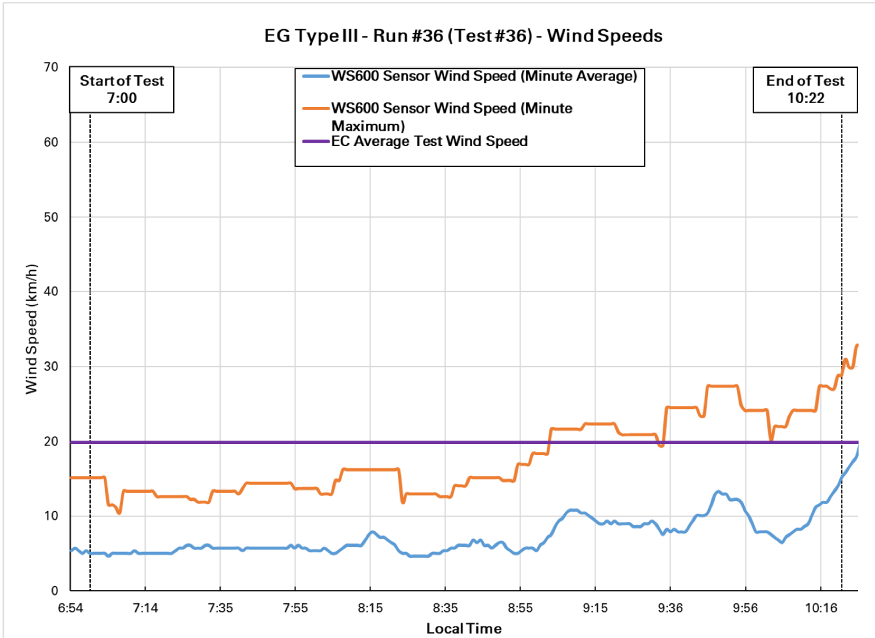
EG TYPE III
RUN #36 (TEST #36) – EG3-36

EG Type III – Run #36 (Test #36) – General Test Information

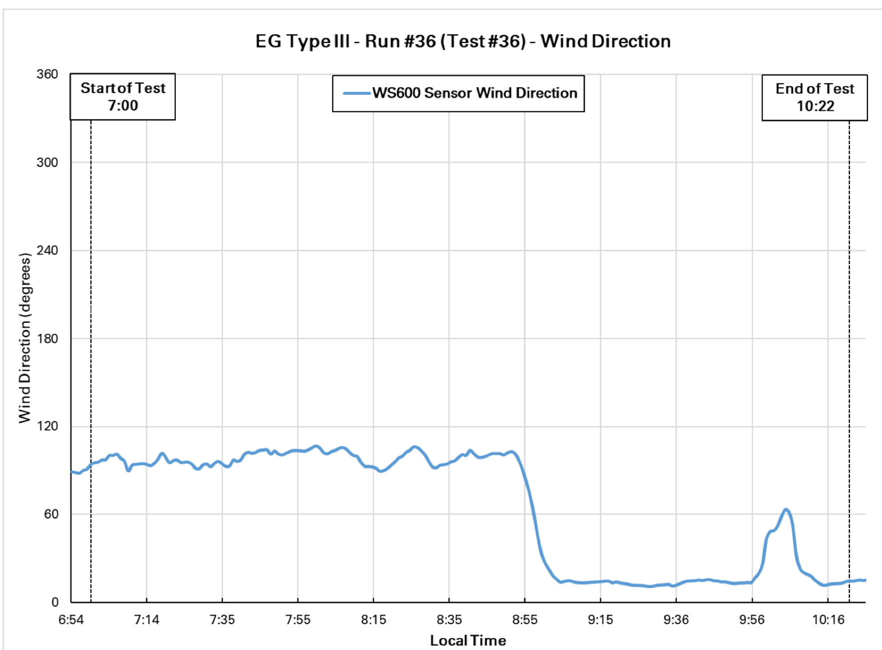
Test Number:	EG3-36
Date of Test:	February 6, 2020
Average OAT:	-8.0
Average Precipitation Rate:	1.2 g/dm²/h
Average Wind Speed:	19.9 km/h
Average Relative Humidity:	79.9%
Pour Time (Local):	07:00:00
Time of Fluid Failure (Local):	10:22:00
Fluid Brix at Failure:	12.75°
Endurance Time:	202 minutes
Expected Regression-Derived Endurance Time:	167.5 minutes
Difference (ET vs. Reg ET):	+35 minutes (+20.9%)

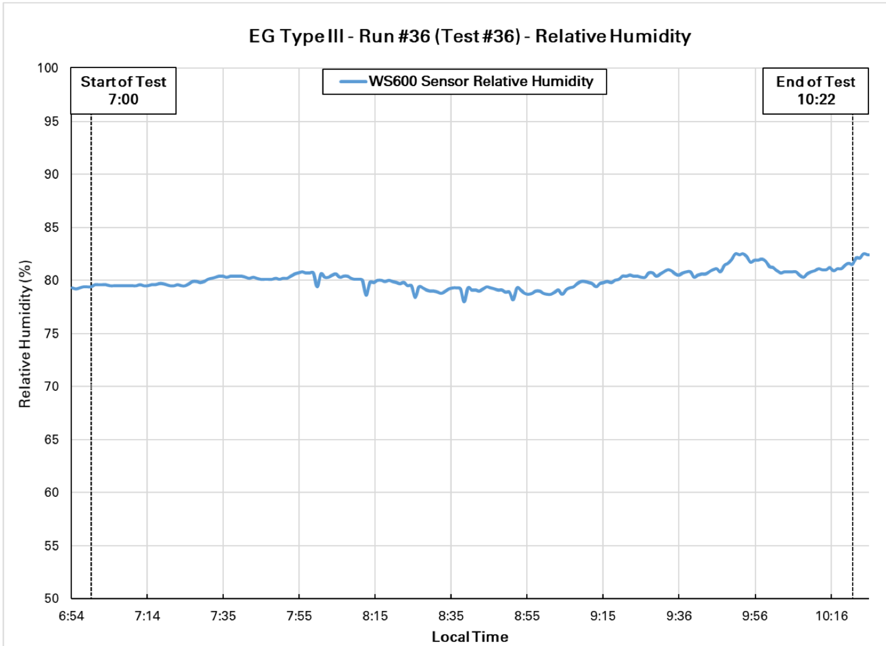

EG Type III - Run #36 (Test #36) - Precipitation Rate
Start of Test 7:00
End of Test 10:22
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
Local Time

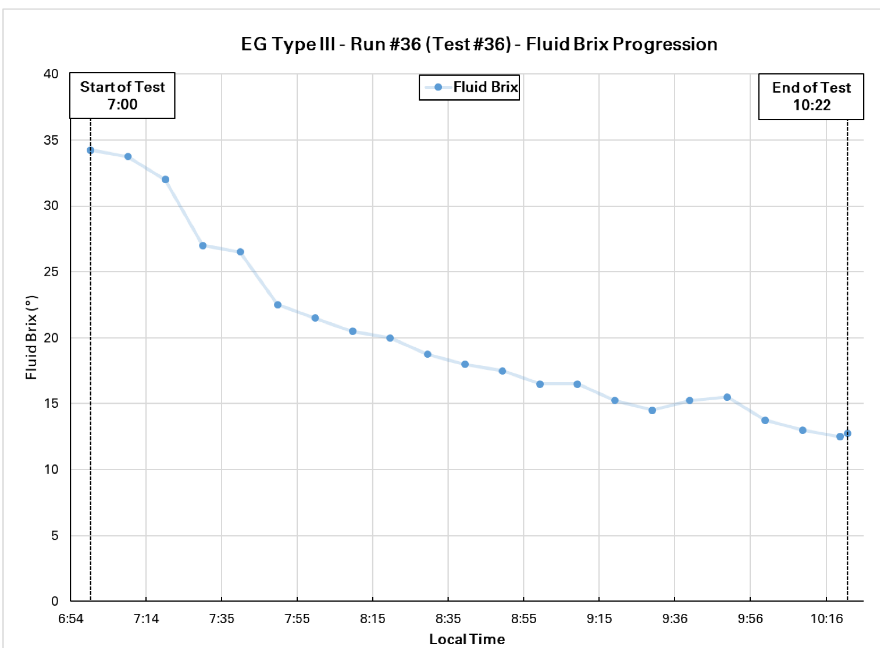

EG Type III - Run #36 (Test #36) - Temperatures
Start of Test 7:00
Initial Fluid Temp: -7.0°C
End of Test 10:22
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
Local Time

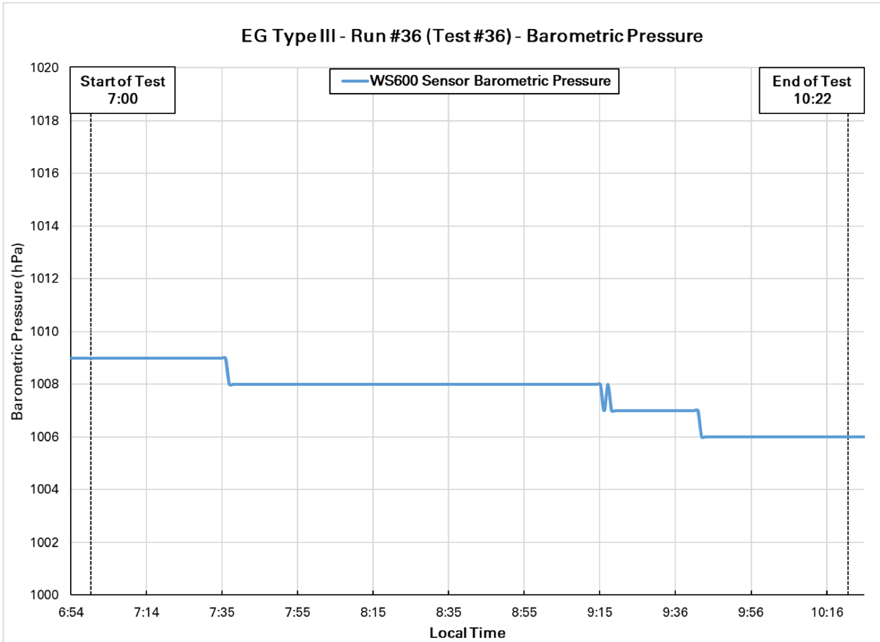


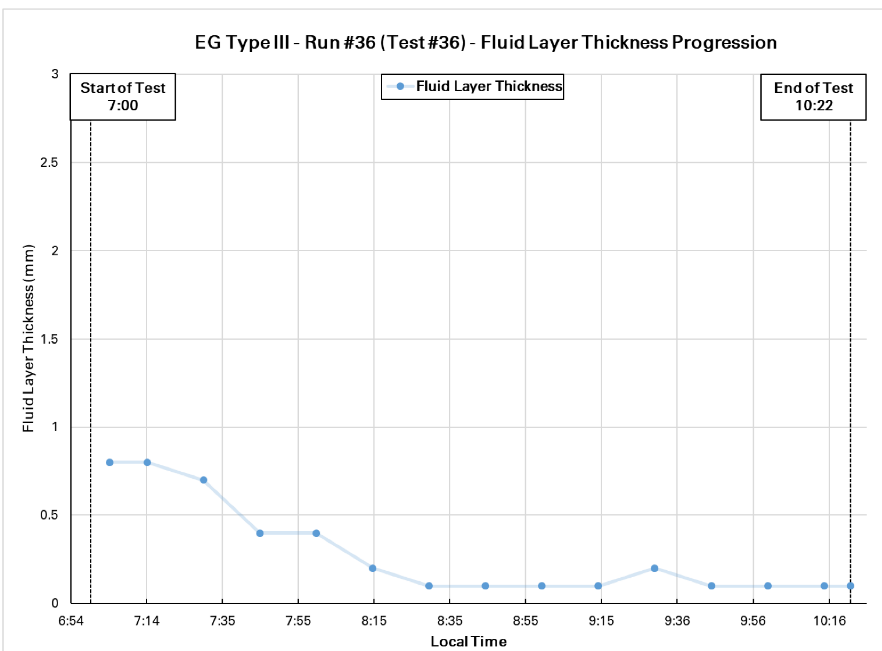
DATA PACKAGE – EG TYPE III – RUN 36 (TEST 36)

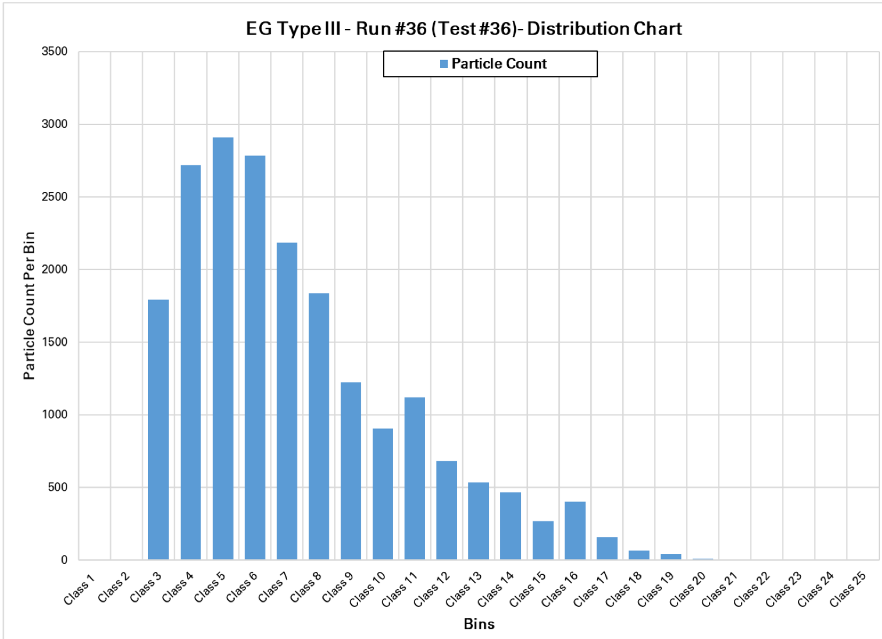



EG Type III - Run #36 (Test #36) - Relative Humidity
Start of Test 7:00
WS600 Sensor Relative Humidity
End of Test 10:22
Relative Humidity (%)
Local Time
100
95
90
85
80
75
70
65
60
55
50
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16

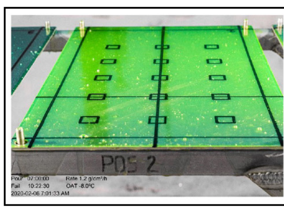

EG Type III - Run #36 (Test #36) - Fluid Brix Progression
Start of Test 7:00
Fluid Brix
End of Test 10:22
Fluid Brix (°)
Local Time
40
35
30
25
20
15
10
5
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16

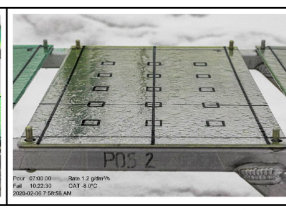

EG Type III - Run #36 (Test #36) - Barometric Pressure
Start of Test 7:00
WS600 Sensor Barometric Pressure
End of Test 10:22
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
Local Time

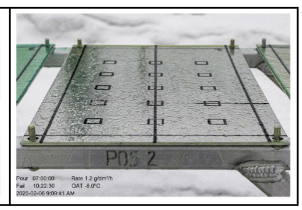

EG Type III - Run #36 (Test #36) - Fluid Layer Thickness Progression
Start of Test 7:00
Fluid Layer Thickness
End of Test 10:22
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
Local Time

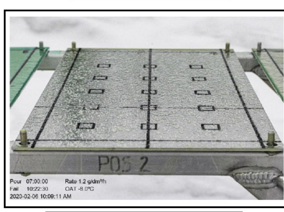


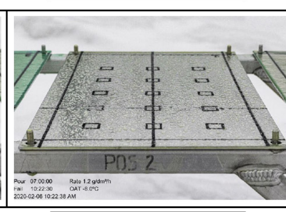
AeroClear MAX – Run 36 (Test #36) – Failure Progression Photos

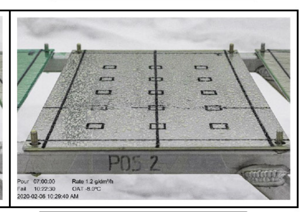

AT POUR (0/202 MIN)


PRE-FAILURE (58/202 MIN)


PRE-FAILURE (129/202 MIN)

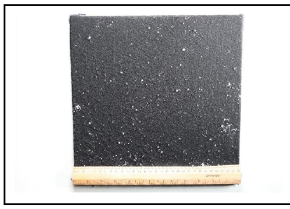

PRE-FAILURE (189/202 MIN)


AT FAILURE (202/202 MIN)


POST-FAILURE (209/202 MIN)

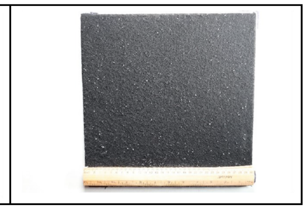
DATA PACKAGE – EG TYPE III – RUN 36 (TEST 36)

AeroClear MAX – Run 36 (Test #36) – Snow Characteristics Photos

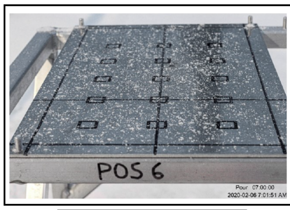


FELT PAD (10/202 MIN)

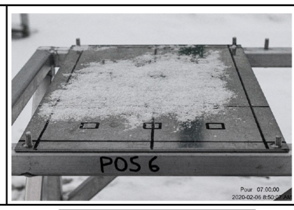
FELT PAD (119/202 MIN)



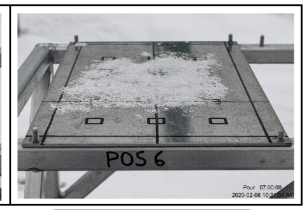
FELT PAD (190/202 MIN)



BARE PLATE (1/202 MIN)



BARE PLATE (110/202 MIN)



BARE PLATE (201/202 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 36 - Test 36/Data Package - EG Type III - Run 36 - Test 36.docx
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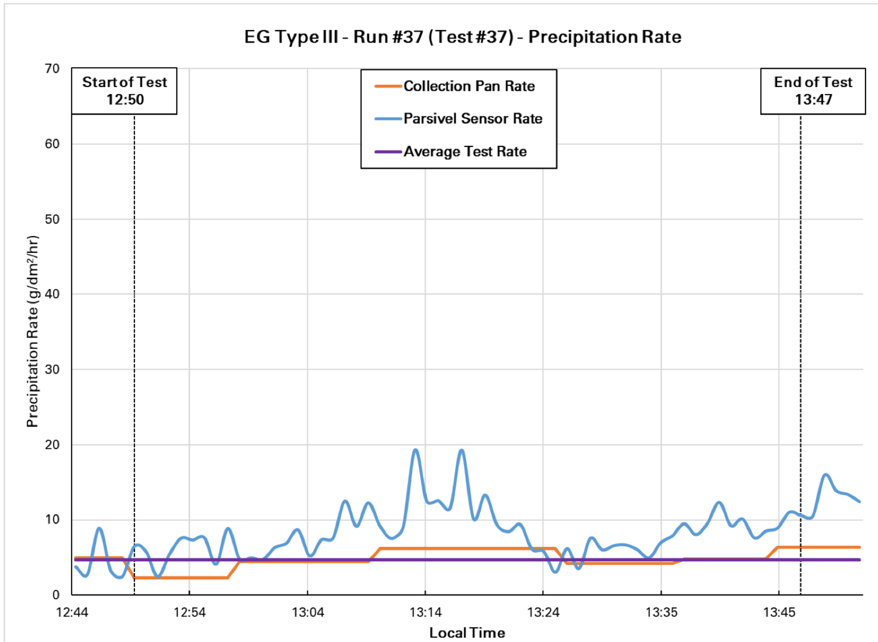
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

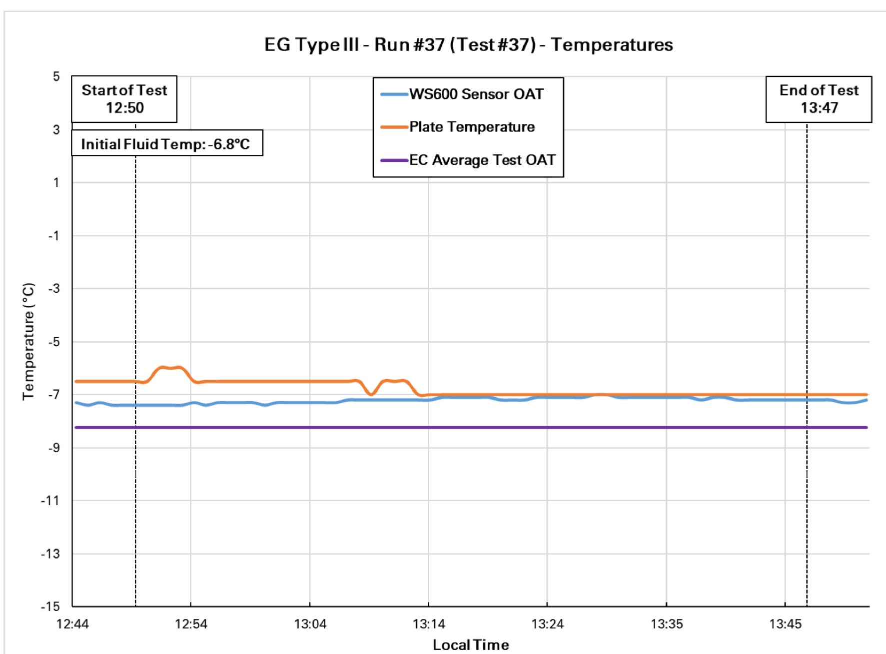
EG TYPE III
RUN #37 (TEST #37) – EG3-37

EG Type III – Run #37 (Test #37) – General Test Information

Test Number:	EG3-37
Date of Test:	February 6, 2020
Average OAT:	-8.2
Average Precipitation Rate:	4.7 g/dm²/h
Average Wind Speed:	27.3 km/h
Average Relative Humidity:	82.4%
Pour Time (Local):	12:50:00
Time of Fluid Failure (Local):	13:47:00
Fluid Brix at Failure:	10°
Endurance Time:	57 minutes
Expected Regression-Derived Endurance Time:	69.5 minutes
Difference (ET vs. Reg ET):	-12.5 minutes (-18%)

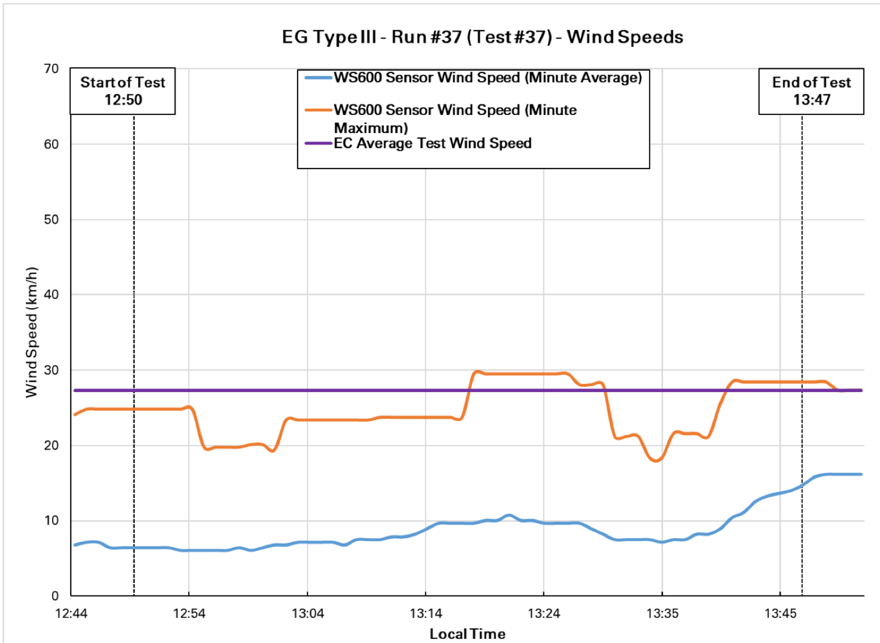


EG Type III - Run #37 (Test #37) - Precipitation Rate
Start of Test 12:50
End of Test 13:47
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
12:44
12:54
13:04
13:14
13:24
13:35
13:45
Local Time



EG Type III - Run #37 (Test #37) - Temperatures
Start of Test 12:50
Initial Fluid Temp: -6.8°C
End of Test 13:47
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
12:44
12:54
13:04
13:14
13:24
13:35
13:45
Local Time

DATA PACKAGE – EG TYPE III – RUN 37 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 37 - Test 37/Data Package - EG Type III - Run 37 - Test 37.docx
Final Version 1.0, March 2021

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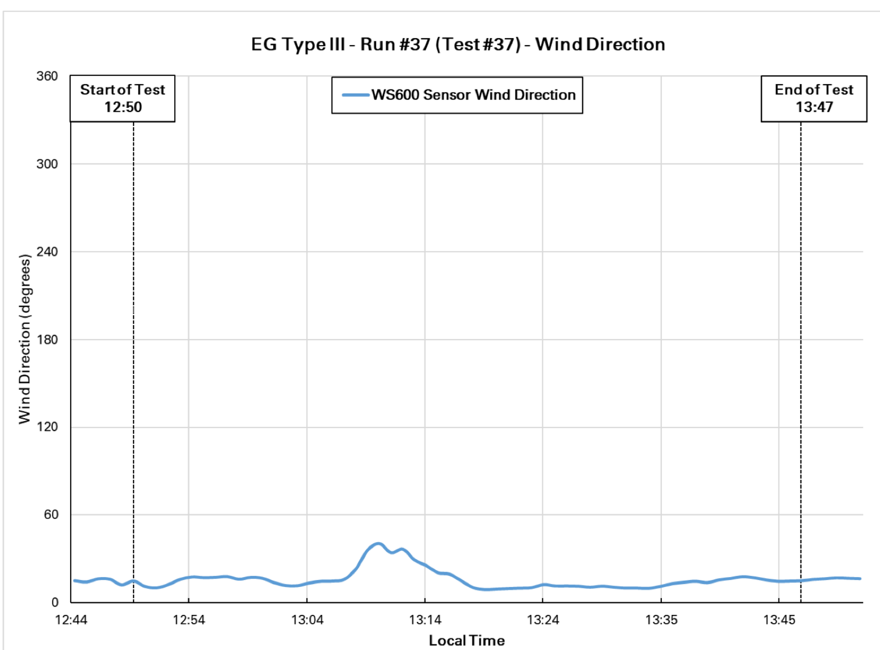
DATA PACKAGE – EG TYPE III – RUN 37 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 37 - Test 37/Data Package - EG Type III - Run 37 - Test 37.docx
Final Version 1.0, March 2021

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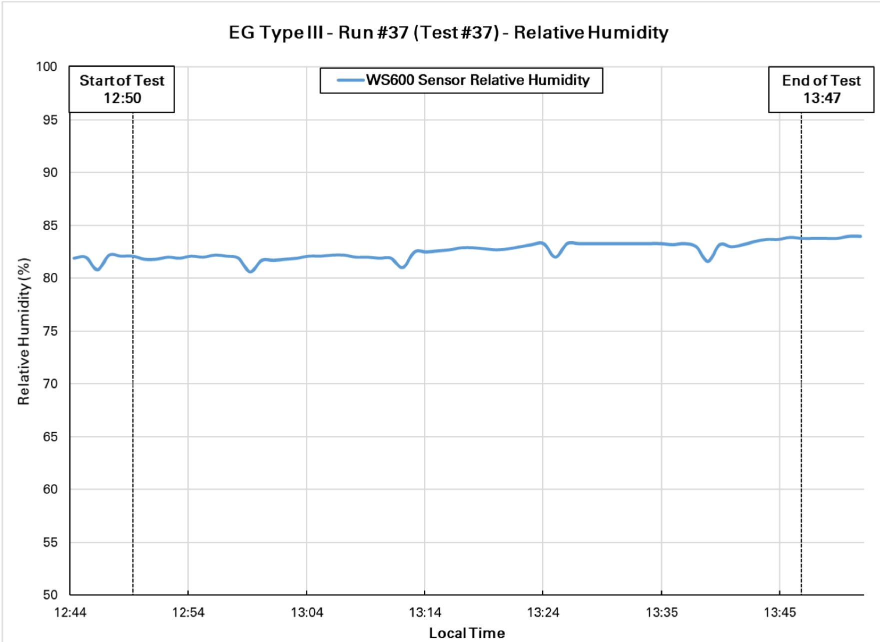
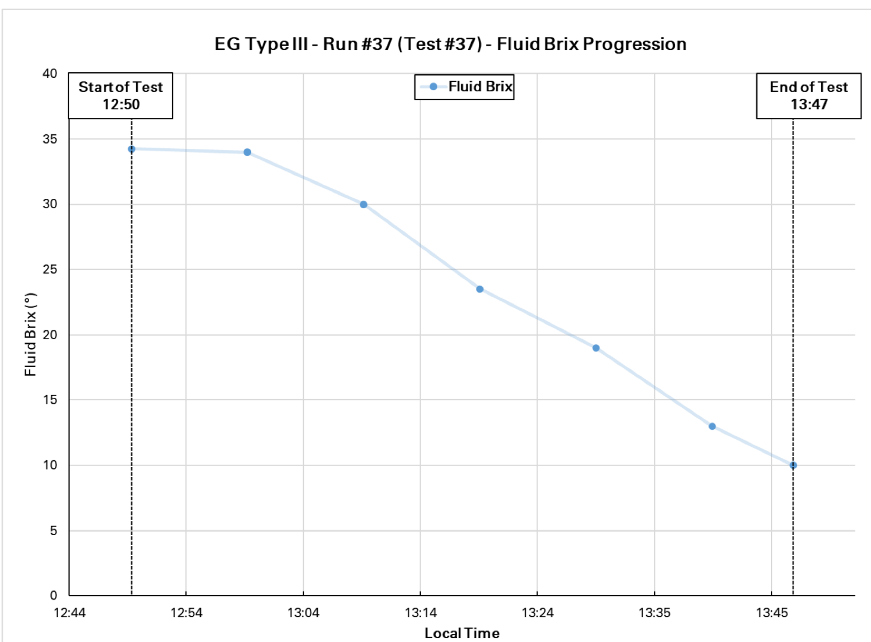
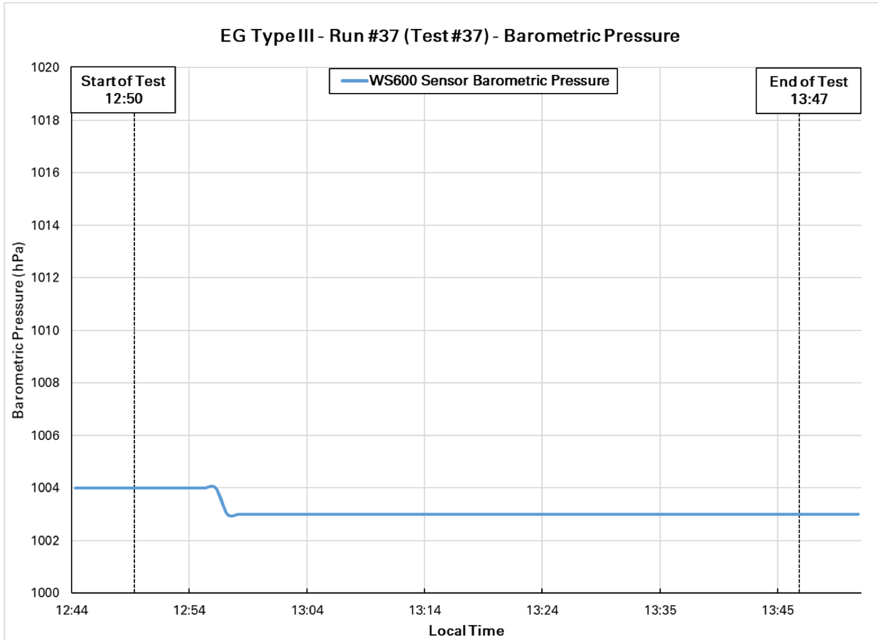


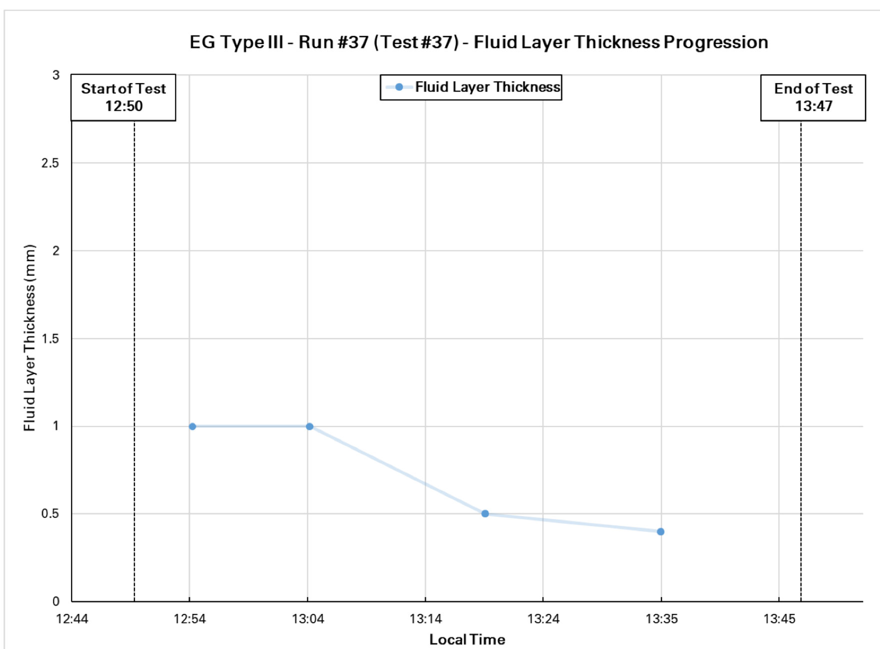
EG Type III - Run #37 (Test #37) - Relative Humidity
Start of Test 12:50
WS600 Sensor Relative Humidity
End of Test 13:47
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
12:44
12:54
13:04
13:14
13:24
13:35
13:45
Local Time



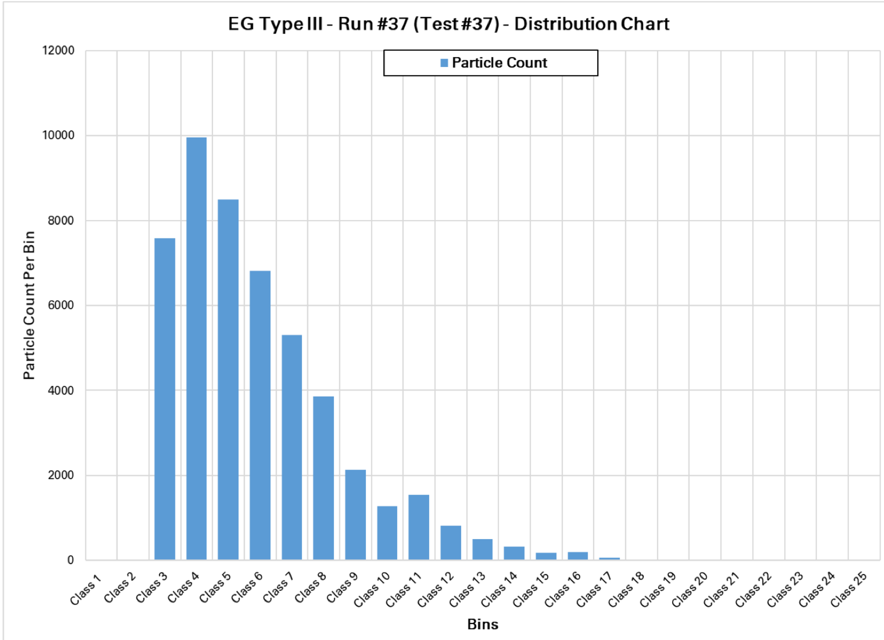
EG Type III - Run #37 (Test #37) - Fluid Brix Progression
Start of Test 12:50
Fluid Brix
End of Test 13:47
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
12:44
12:54
13:04
13:14
13:24
13:35
13:45
Local Time



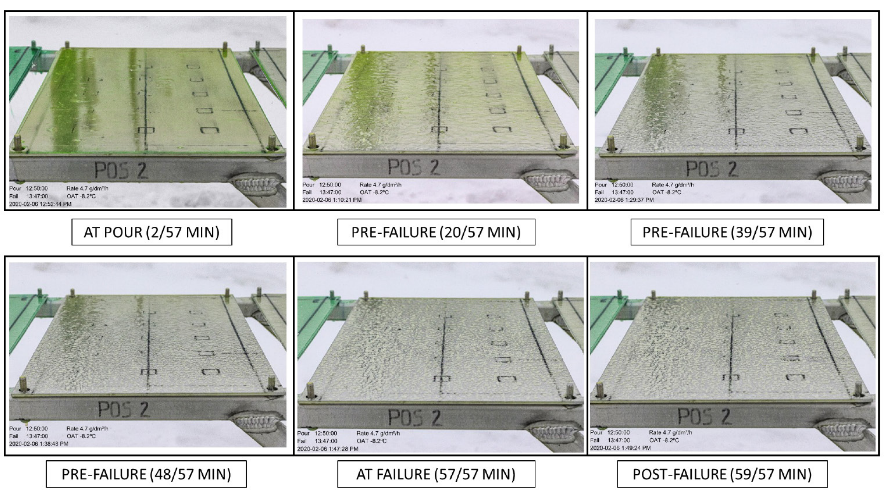
EG Type III - Run #37 (Test #37) - Barometric Pressure
Start of Test 12:50
WS600 Sensor Barometric Pressure
End of Test 13:47
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
12:44
12:54
13:04
13:14
13:24
13:35
13:45
Local Time



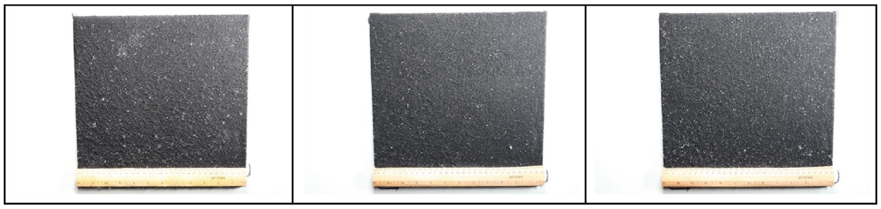
EG Type III - Run #37 (Test #37) - Fluid Layer Thickness Progression
Start of Test 12:50
Fluid Layer Thickness
End of Test 13:47
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
12:44
12:54
13:04
13:14
13:24
13:35
13:45
Local Time



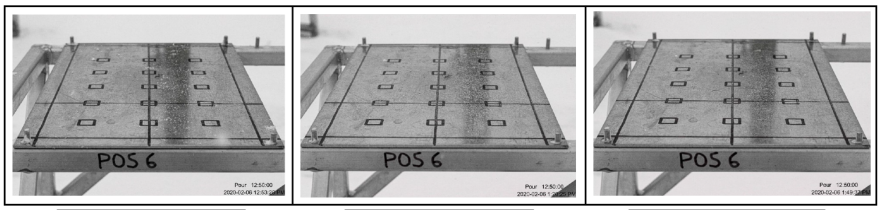
AeroClear MAX – Run 37 (Test 37) – Failure Progression Photos



AeroClear MAX – Run 37 (Test 37) – Snow Characteristics Photos



FELT PAD (9/57 MIN) FELT PAD (30/57 MIN) FELT PAD (60/57 MIN)



BARE PLATE (3/57 MIN) BARE PLATE (30/57 MIN) BARE PLATE (59/57 MIN)

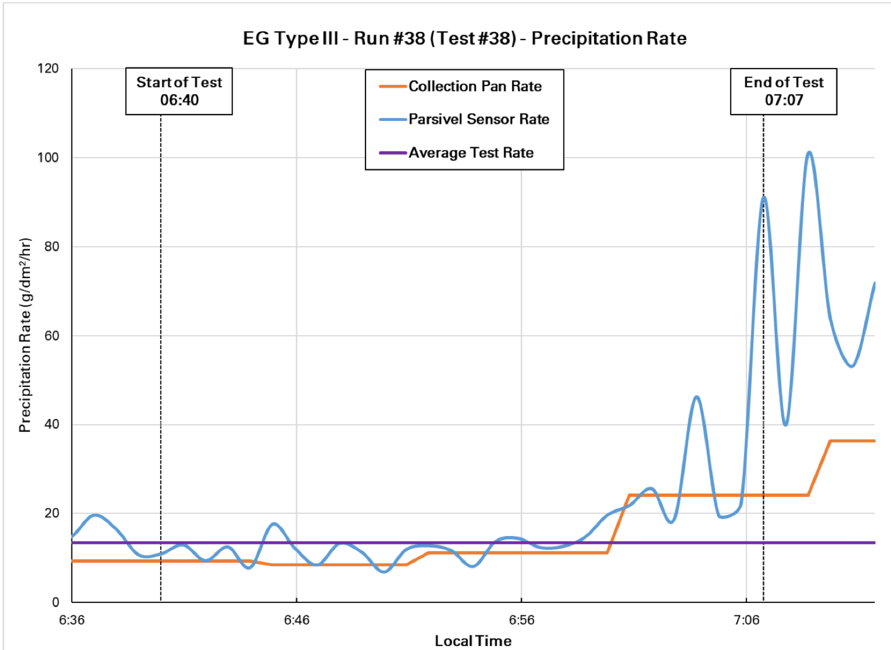
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

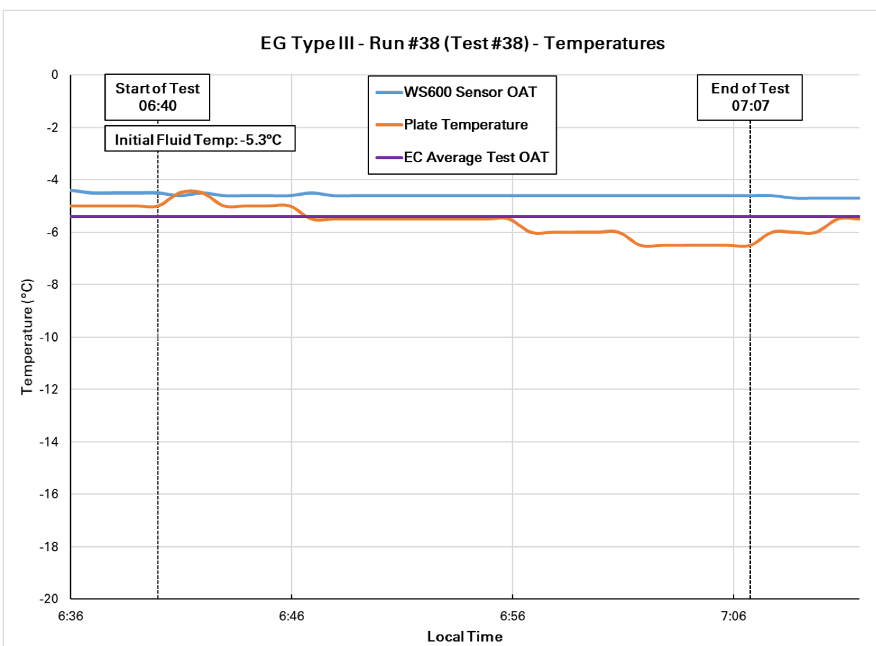
EG TYPE III
RUN #38 (TEST #38) – EG3-38

EG Type III – Run #38 (Test #38) – General Test Information

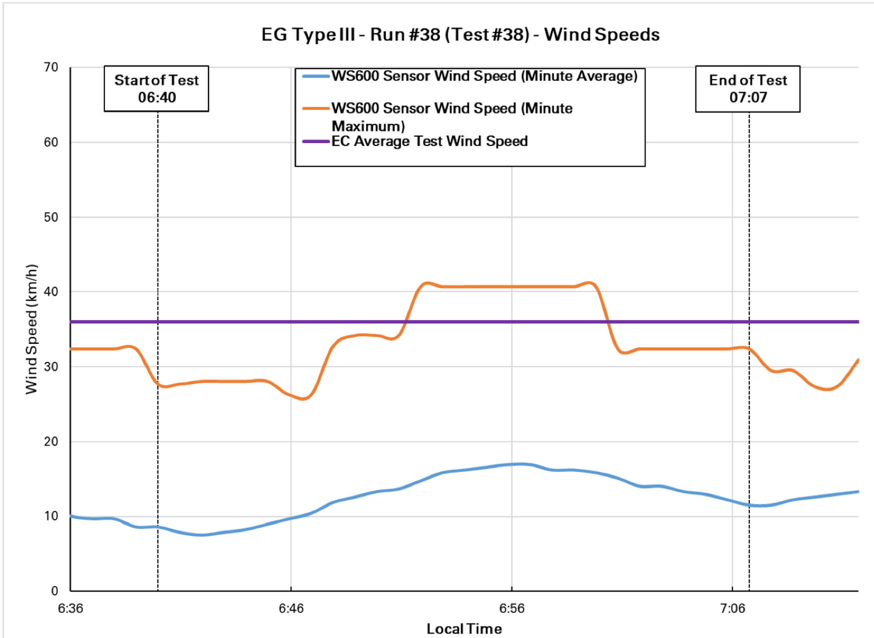
Test Number:	**EG3-38**
Date of Test:	**February 7, 2020**
Average OAT:	**-5.4**
Average Precipitation Rate:	**13.4 g/dm²/h**
Average Wind Speed:	**36 km/h**
Average Relative Humidity:	**88.8%**
Pour Time (Local):	**06:40:00**
Time of Fluid Failure (Local):	**07:07:00**
Fluid Brix at Failure:	**8.5°**
Endurance Time:	**27 minutes**
Expected Regression-Derived Endurance Time:	**35.1 minutes**
Difference (ET vs. Reg ET):	**-8.1 minutes (-23.1%)**

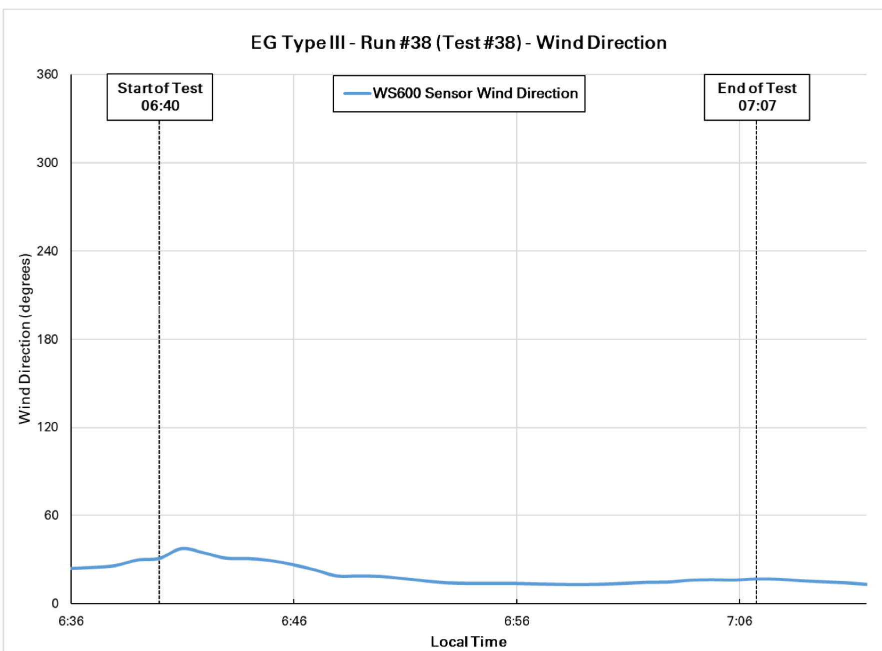


EG Type III - Run #38 (Test #38) - Precipitation Rate
Start of Test 06:40
End of Test 07:07
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
Local Time
0
20
40
60
80
100
120
6:36
6:46
6:56
7:06

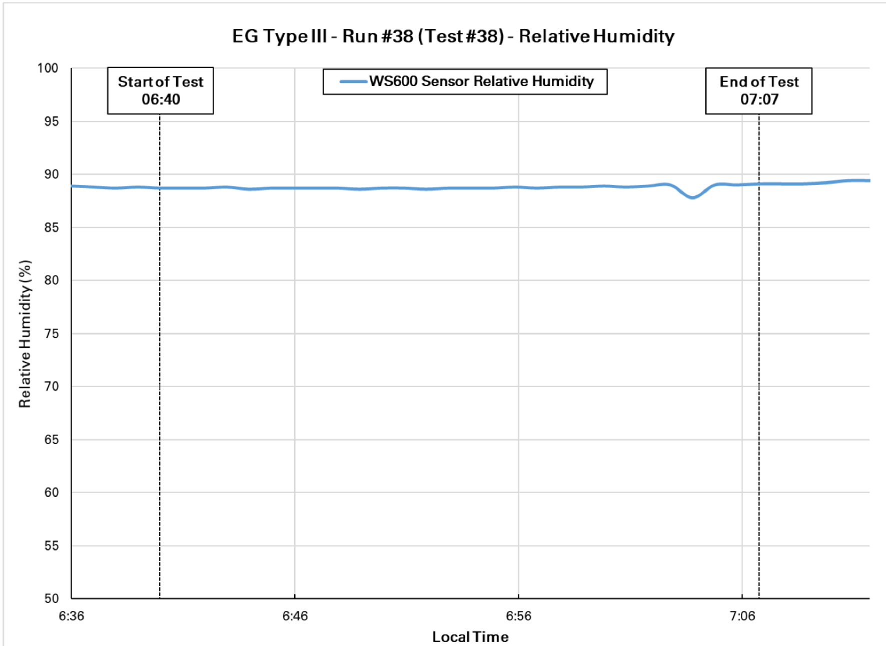


EG Type III - Run #38 (Test #38) - Temperatures
Start of Test 06:40
Initial Fluid Temp: -5.3°C
End of Test 07:07
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
Local Time
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
6:36
6:46
6:56
7:06


EG Type III - Run #38 (Test #38) - Wind Speeds
Start of Test 06:40
End of Test 07:07
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
6:36
6:46
6:56
7:06
Local Time


EG Type III - Run #38 (Test #38) - Wind Direction
Start of Test 06:40
WS600 Sensor Wind Direction
End of Test 07:07
Wind Direction (degrees)
360
300
240
180
120
60
0
6:36
6:46
6:56
7:06
Local Time

DATA PACKAGE – EG TYPE III – RUN 38 (TEST 38)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 38 - Test 38/Data Package - EG Type III - Run 38 - Test 38.docx
Final Version 1.0, March 2021

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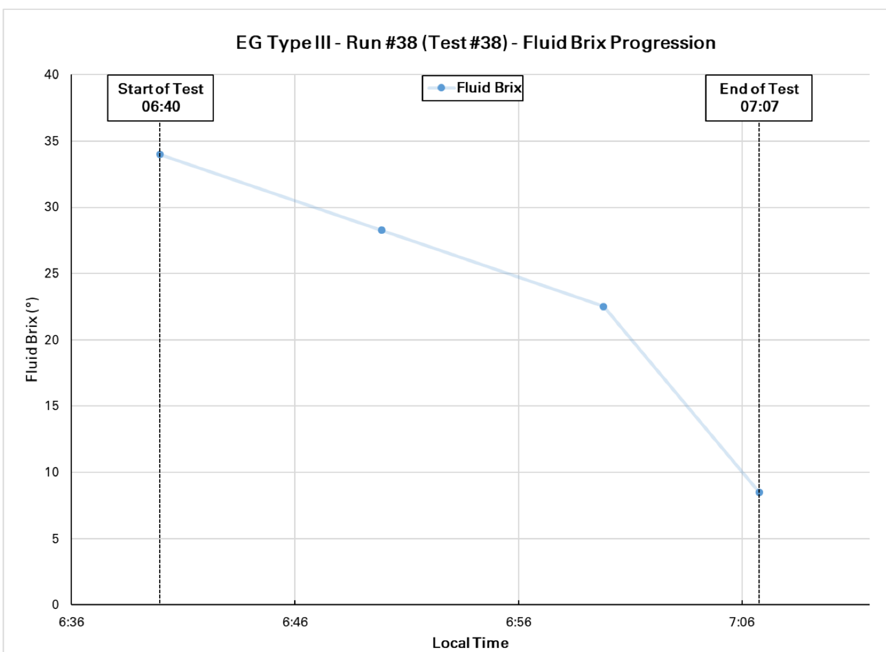
DATA PACKAGE – EG TYPE III – RUN 38 (TEST 38)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 38 - Test 38/Data Package - EG Type III - Run 38 - Test 38.docx
Final Version 1.0, March 2021

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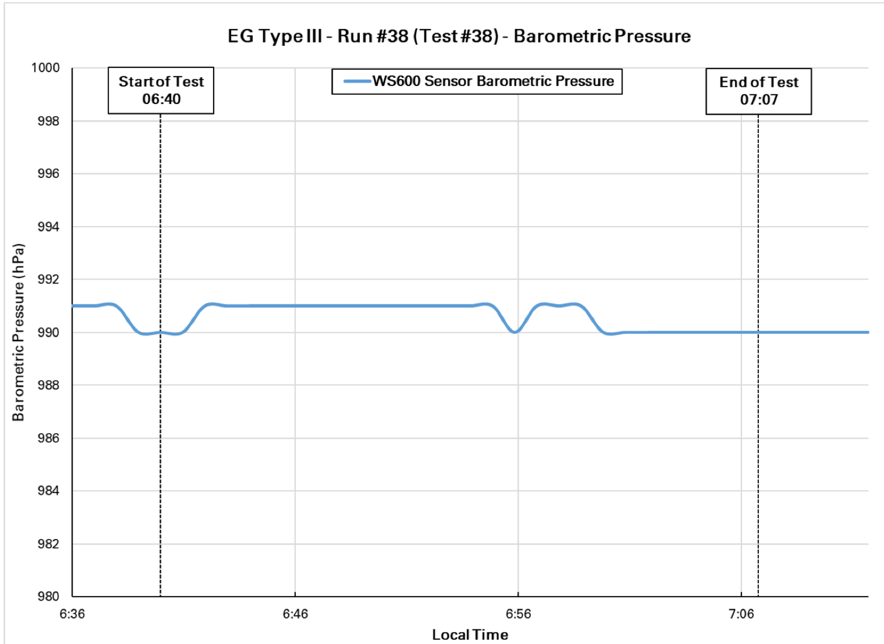
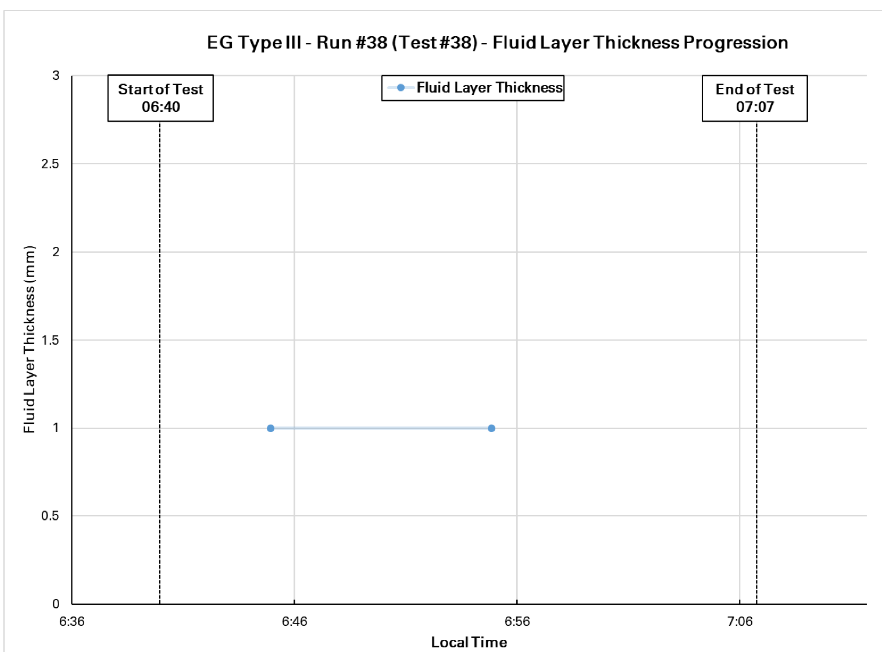
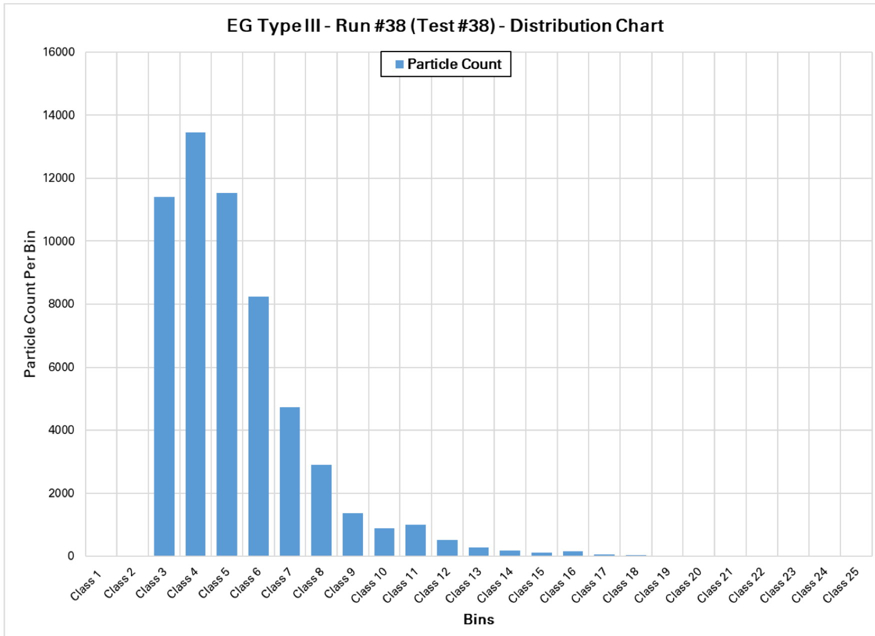


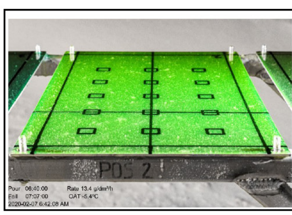
EG Type III - Run #38 (Test #38) - Barometric Pressure
Start of Test 06:40
WS600 Sensor Barometric Pressure
End of Test 07:07
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
6:36
6:46
6:56
7:06
Local Time



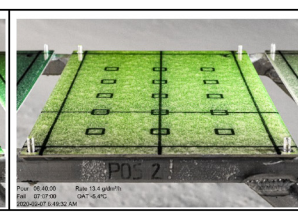
EG Type III - Run #38 (Test #38) - Fluid Layer Thickness Progression
Start of Test 06:40
Fluid Layer Thickness
End of Test 07:07
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:36
6:46
6:56
7:06
Local Time



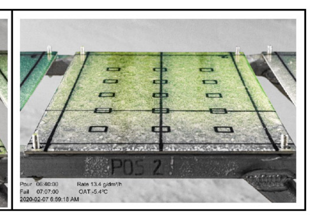
AeroClear MAX – Run 38 (Test 38) – Failure Progression Photos



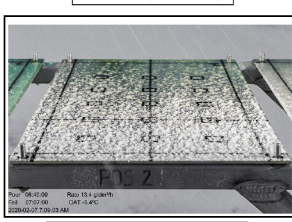
AT POUR (2/27 MIN)



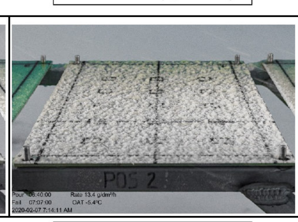
PRE-FAILURE (9/27 MIN)



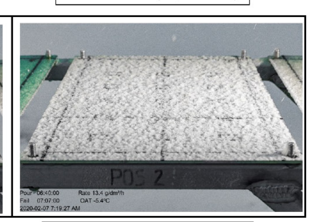
PRE-FAILURE (19/27 MIN)



AT FAILURE (29/27 MIN)



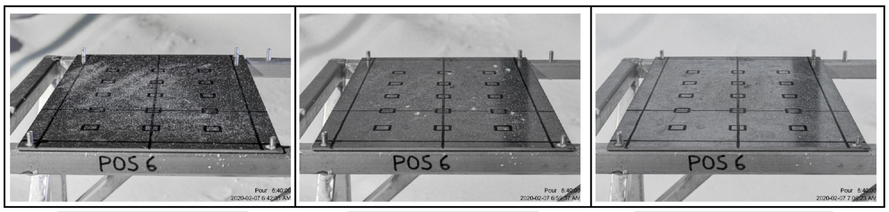
POST-FAILURE (34/27 MIN)



POST-FAILURE (39/27 MIN)

AeroClear MAX – Run 38 (Test 38) – Snow Characteristics Photos

FELT PAD (10/27 MIN) | FELT PAD (20/27 MIN) | FELT PAD (30/27 MIN)



BARE PLATE (2/27 MIN) | BARE PLATE (19/27 MIN) | BARE PLATE (29/27 MIN)

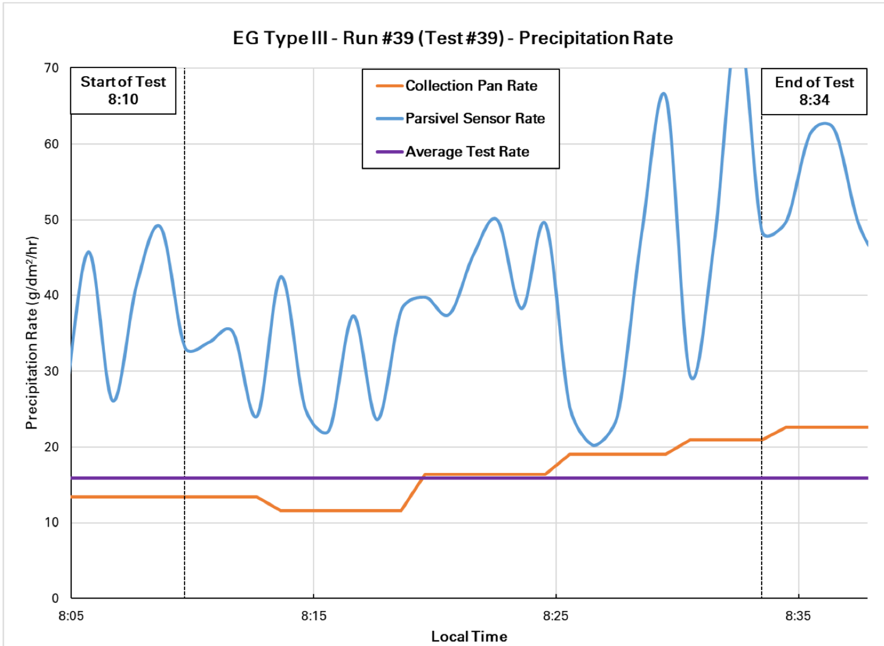
Final Bare Plate Contamination Thickness: **Nil (0 mm)**

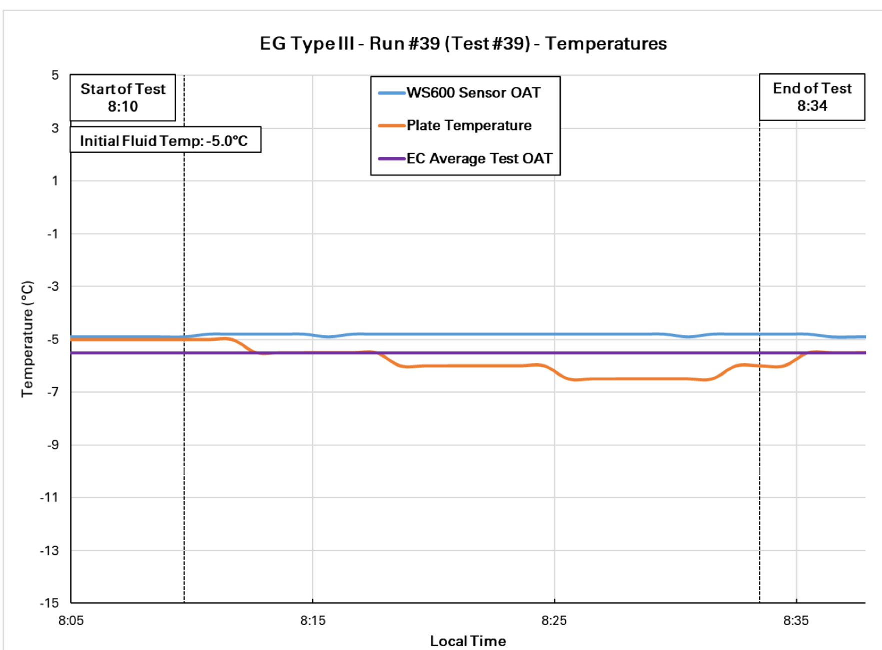
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

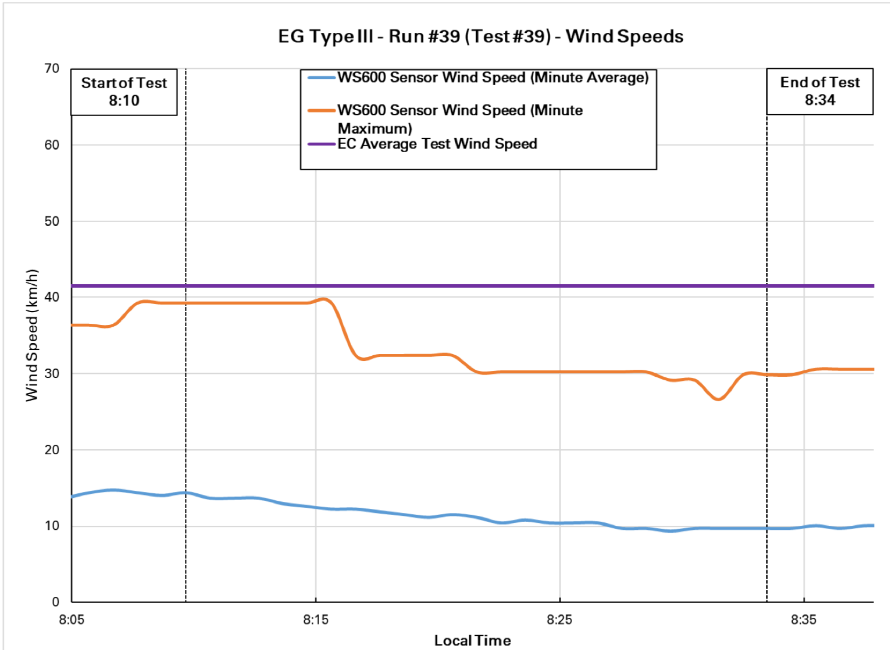
EG TYPE III
RUN #39 (TEST #39) – EG3-39

EG Type III – Run #39 (Test #39)– General Test Information

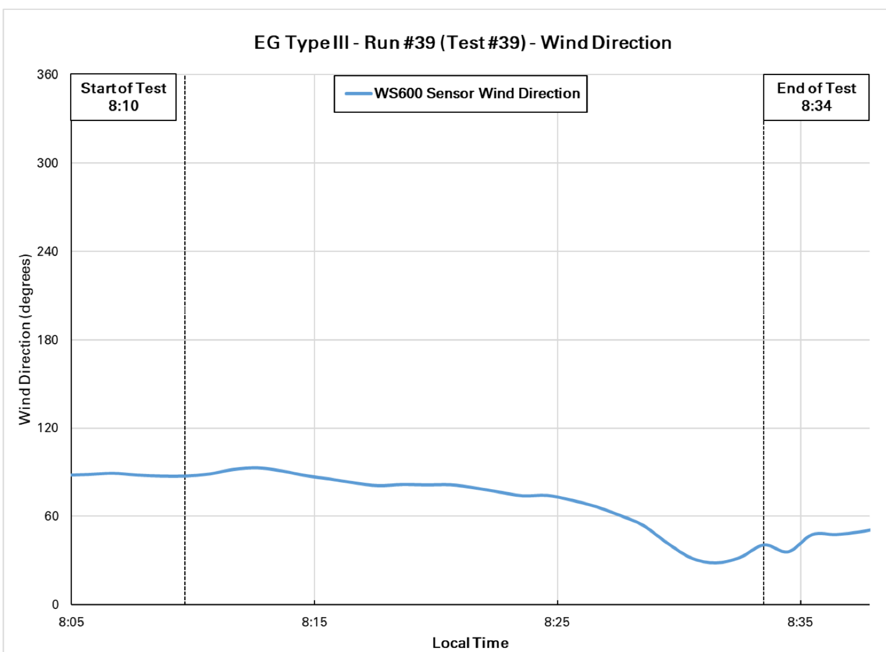
Test Number:	**EG3-39**
Date of Test:	**February 7, 2020**
Average OAT:	**-5.5**
Average Precipitation Rate:	**15.9 g/dm²/h**
Average Wind Speed:	**41.4 km/h**
Average Relative Humidity:	**89.3%**
Pour Time (Local):	**08:10:00**
Time of Fluid Failure (Local):	**08:34:00**
Fluid Brix at Failure:	**9.75°**
Endurance Time:	**24 minutes**
Expected Regression-Derived Endurance Time:	**31.5 minutes**
Difference (ET vs. Reg ET):	**-7.3 minutes (-23.2%)**

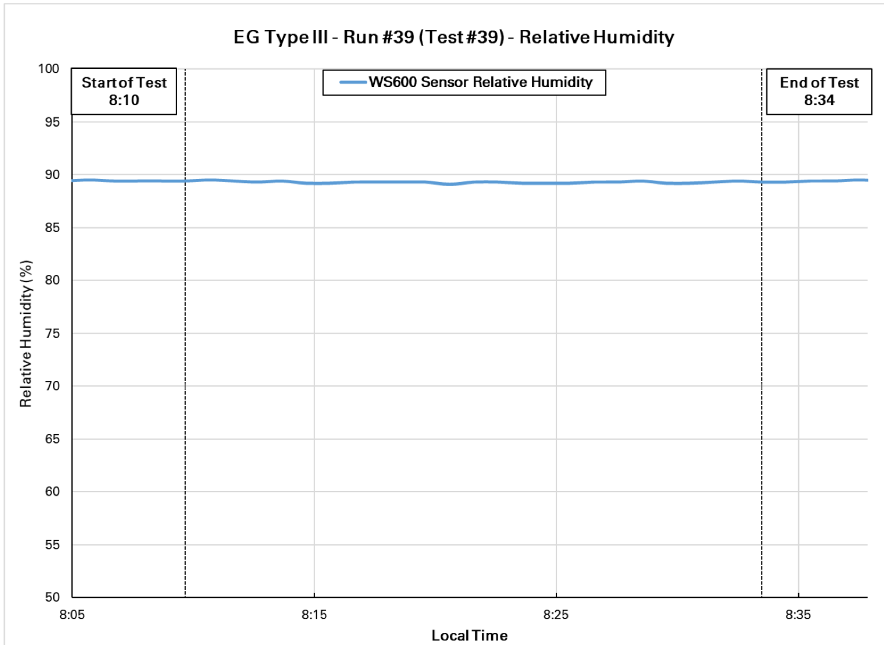

EG Type III - Run #39 (Test #39) - Precipitation Rate
Start of Test 8:10
End of Test 8:34
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
8:05
8:15
8:25
8:35
Local Time


EG Type III - Run #39 (Test #39) - Temperatures
Start of Test 8:10
Initial Fluid Temp: -5.0°C
End of Test 8:34
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
8:05
8:15
8:25
8:35
Local Time

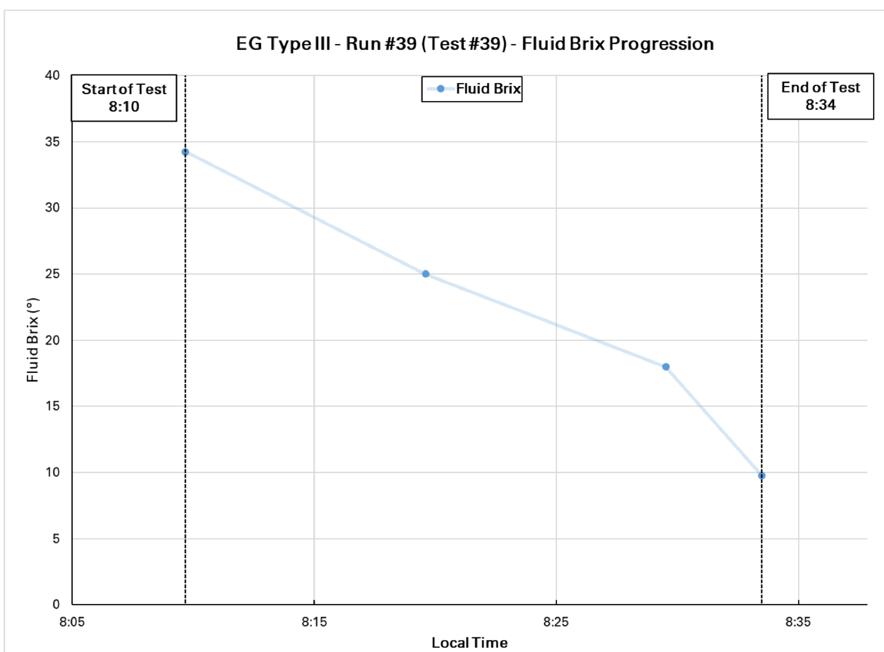


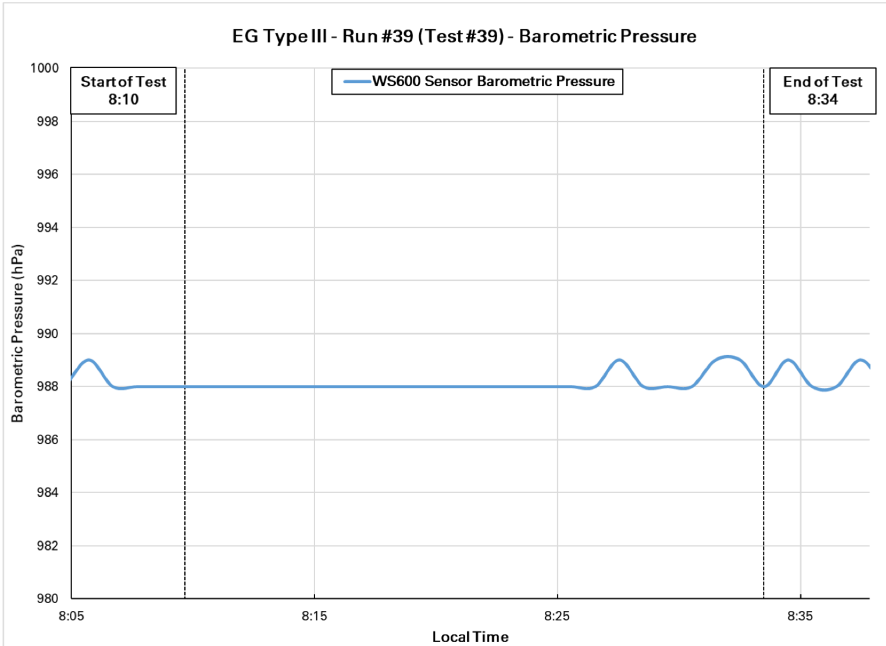
DATA PACKAGE – EG TYPE III – RUN 39 (TEST 39)

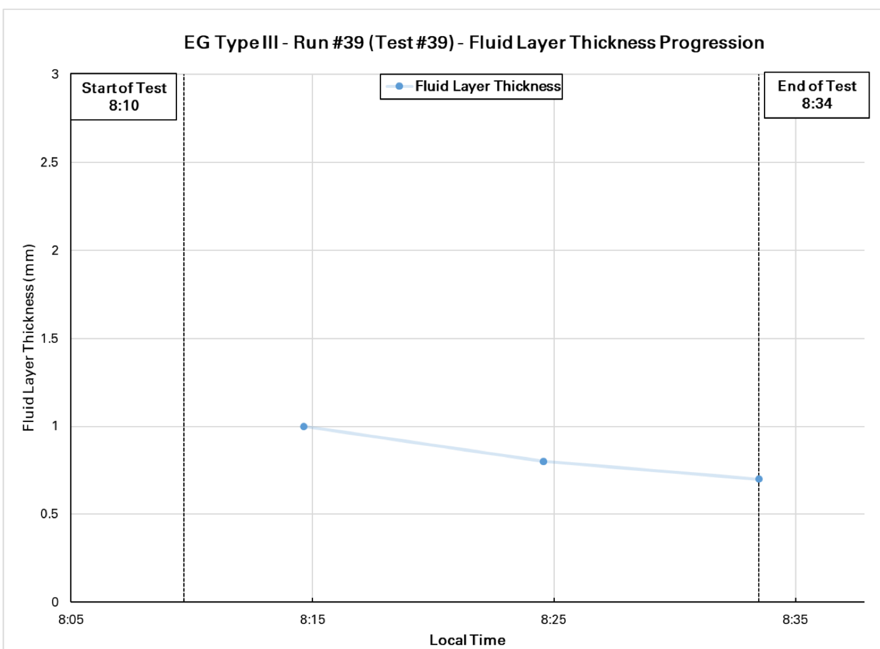


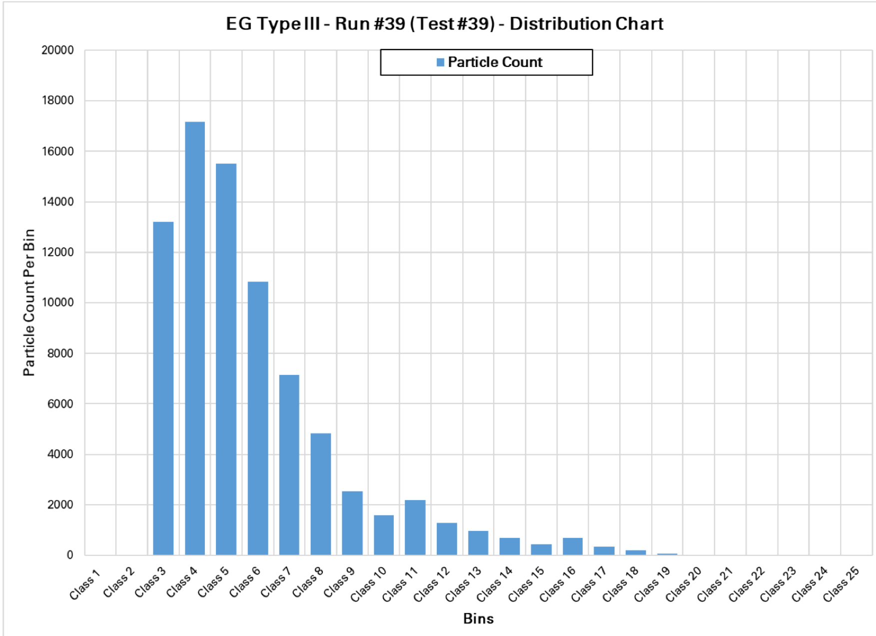


DATA PACKAGE – EG TYPE III – RUN 39 (TEST 39)

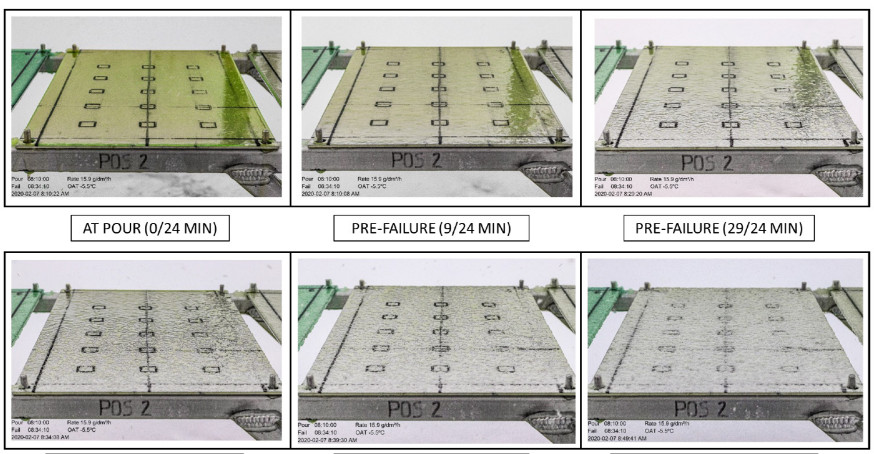



EG Type III - Run #39 (Test #39) - Barometric Pressure
Start of Test 8:10
WS600 Sensor Barometric Pressure
End of Test 8:34
1000
998
996
994
992
990
988
986
984
982
980
Barometric Pressure (hPa)
8:05
8:15
8:25
8:35
Local Time


EG Type III - Run #39 (Test #39) - Fluid Layer Thickness Progression
Start of Test 8:10
Fluid Layer Thickness
End of Test 8:34
3
2.5
2
1.5
1
0.5
0
Fluid Layer Thickness (mm)
8:05
8:15
8:25
8:35
Local Time



AeroClear MAX – Run 39 (Test 39) – Failure Progression Photos



AT POUR (0/24 MIN) | PRE-FAILURE (9/24 MIN) | PRE-FAILURE (29/24 MIN)

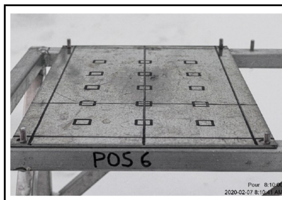
AT FAILURE (24/24 MIN) | POST-FAILURE (29/24 MIN) | POST-FAILURE (39/24 MIN)

AeroClear MAX – Run 39 (Test 39) – Snow Characteristics Photos

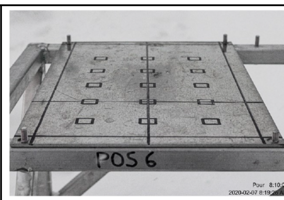
FELT PAD (3/24 MIN)

FELT PAD (19/24 MIN)

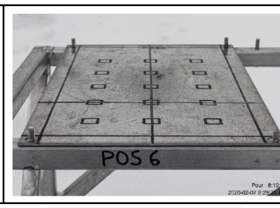
FELT PAD (25/24 MIN)



BARE PLATE (0/24 MIN)



BARE PLATE (9/24 MIN)



BARE PLATE (19/24 MIN)

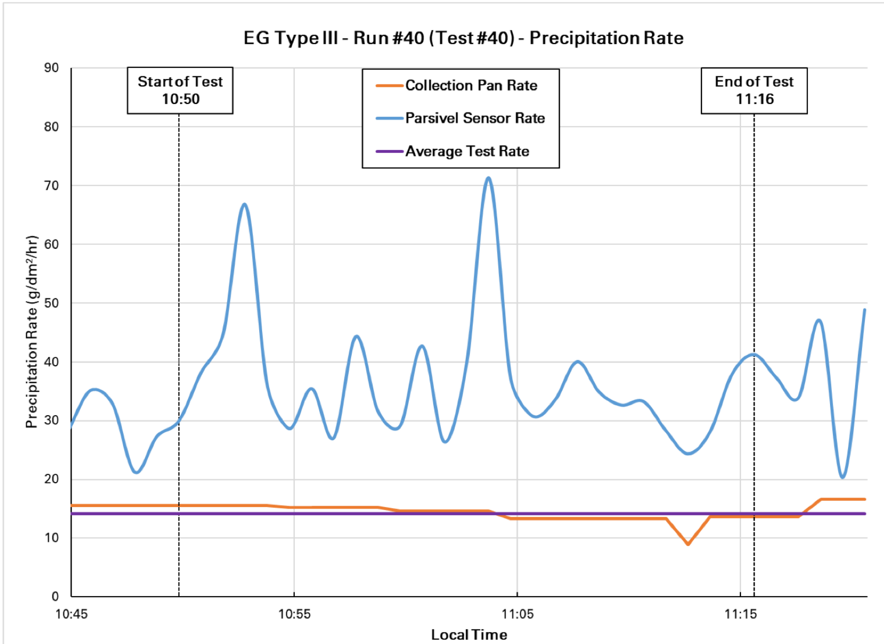
Final Bare Plate Contamination Thickness: **Nil (0mm)**

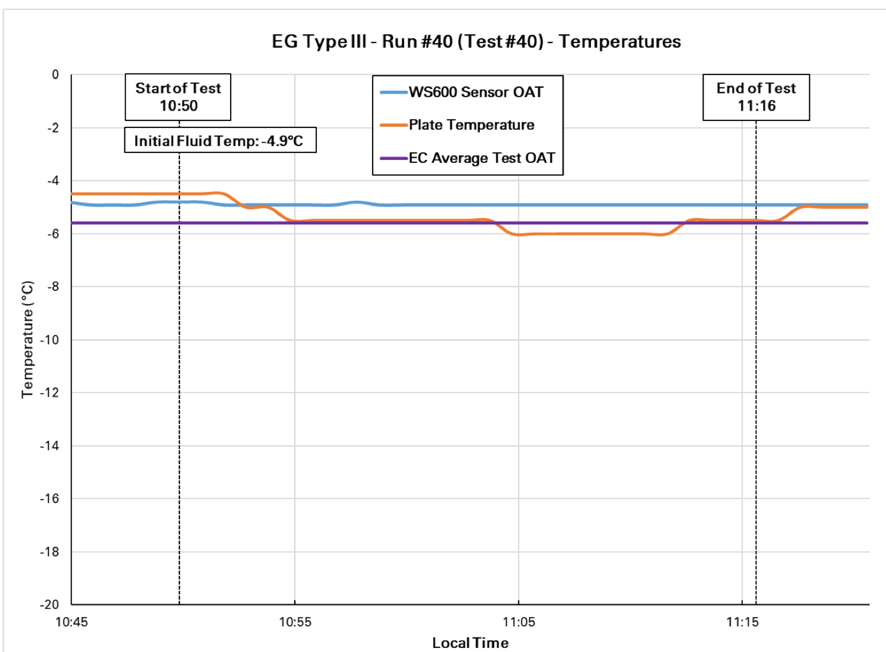
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

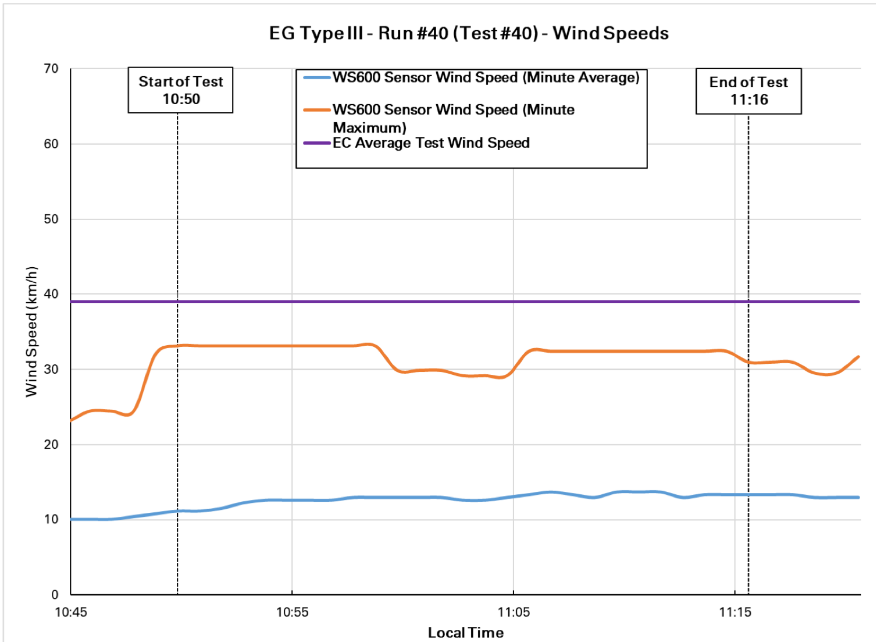
EG TYPE III
RUN #40 (TEST #40) – EG3-40

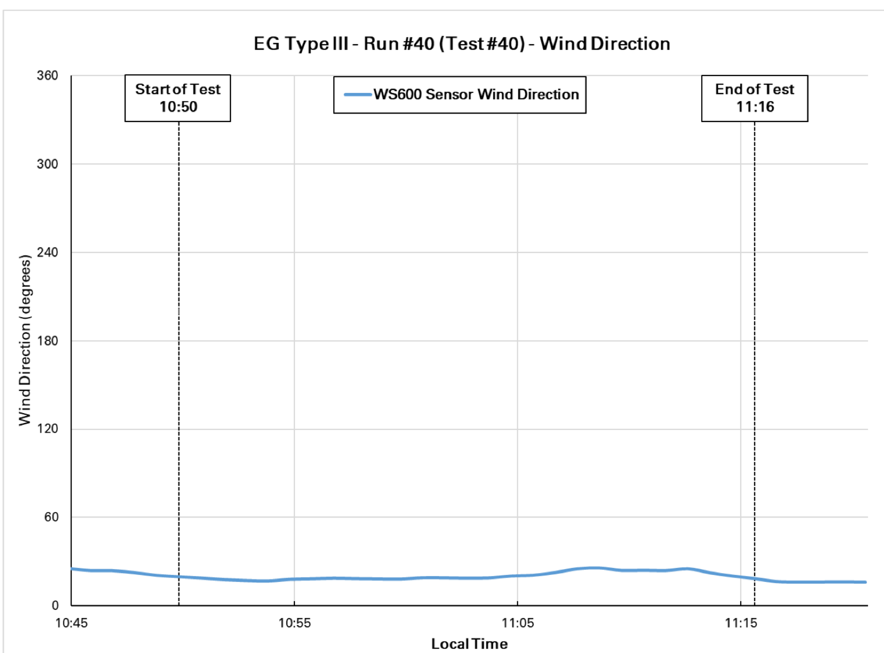
EG Type III – Run 40 (Test #40) – General Test Information

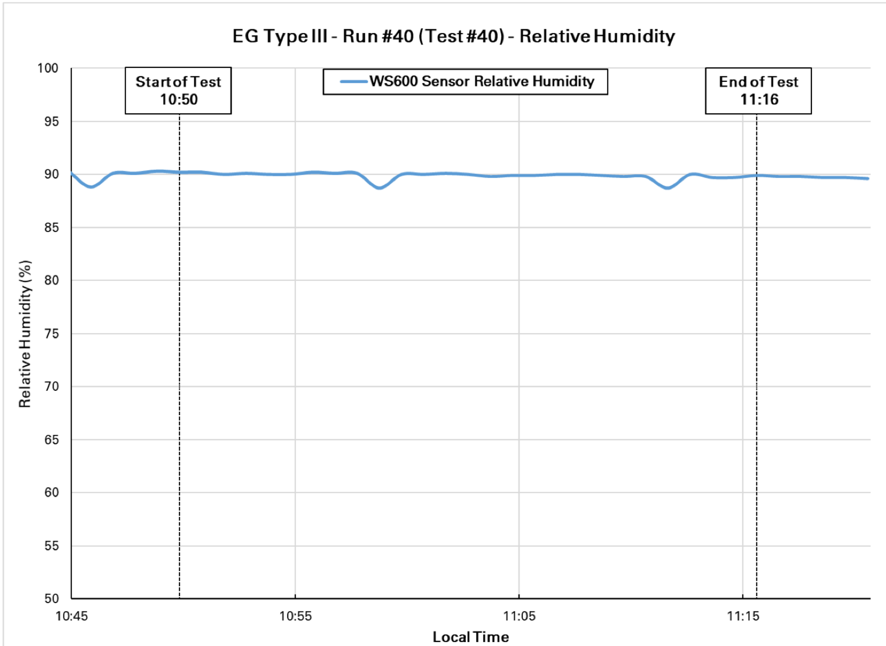
Test Number:	EG3-40
Date of Test:	February 7, 2020
Average OAT:	-5.6
Average Precipitation Rate:	14.2 g/dm²/h
Average Wind Speed:	39 km/h
Average Relative Humidity:	89.9%
Pour Time (Local):	10:50:00
Time of Fluid Failure (Local):	11:16:00
Fluid Brix at Failure:	9°
Endurance Time:	26 minutes
Expected Regression-Derived Endurance Time:	33.9 minutes
Difference (ET vs. Reg ET):	-7.6 minutes (-22.3%)


EG Type III - Run #40 (Test #40) - Precipitation Rate
Start of Test 10:50
End of Test 11:16
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
80
90
10:45
10:55
11:05
11:15
Local Time

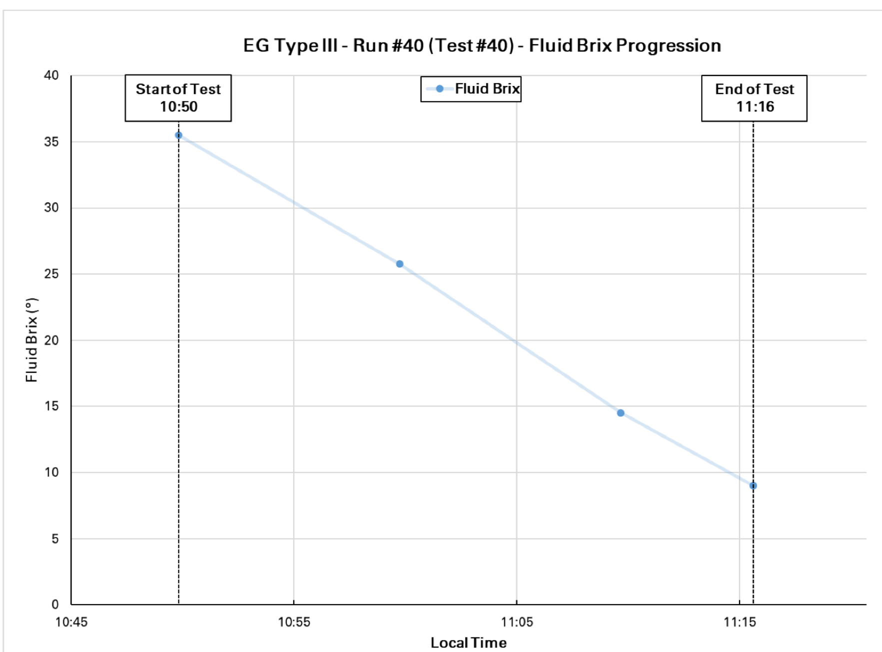

EG Type III - Run #40 (Test #40) - Temperatures
Start of Test 10:50
Initial Fluid Temp: -4.9°C
End of Test 11:16
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
10:45
10:55
11:05
11:15
Local Time


EG Type III - Run #40 (Test #40) - Wind Speeds
Start of Test 10:50
End of Test 11:16
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
10:45
10:55
11:05
11:15
Local Time

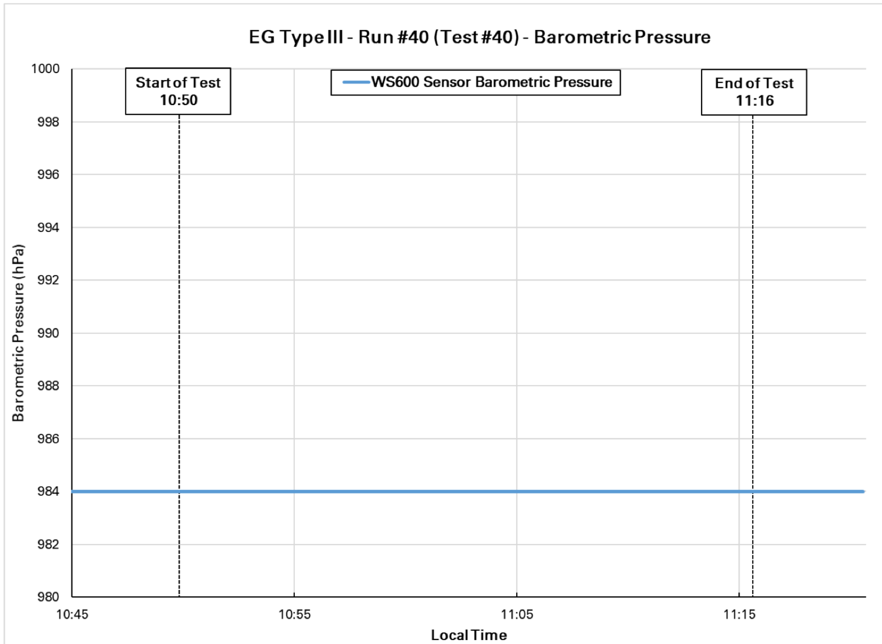

EG Type III - Run #40 (Test #40) - Wind Direction
Start of Test 10:50
End of Test 11:16
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
10:45
10:55
11:05
11:15
Local Time

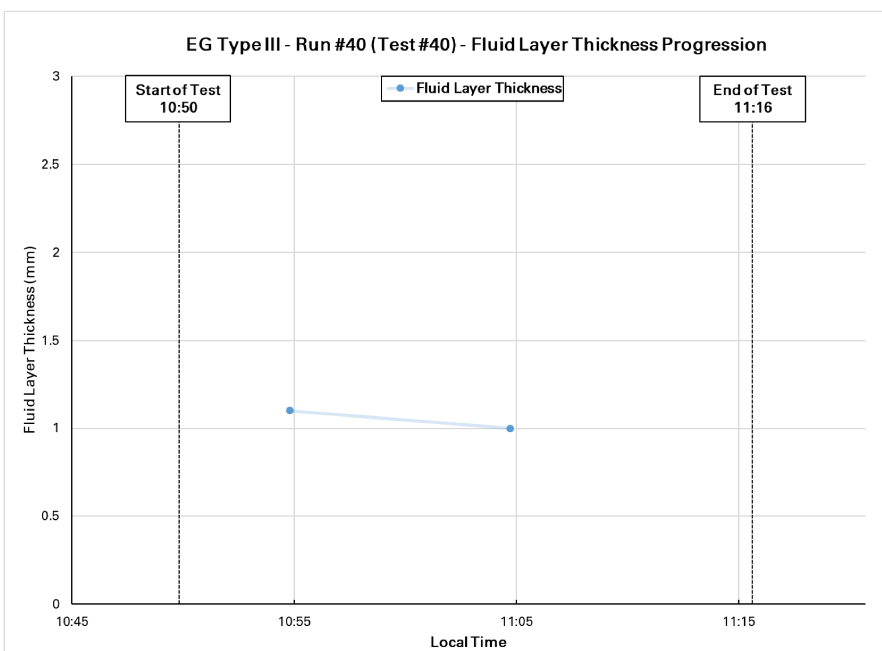


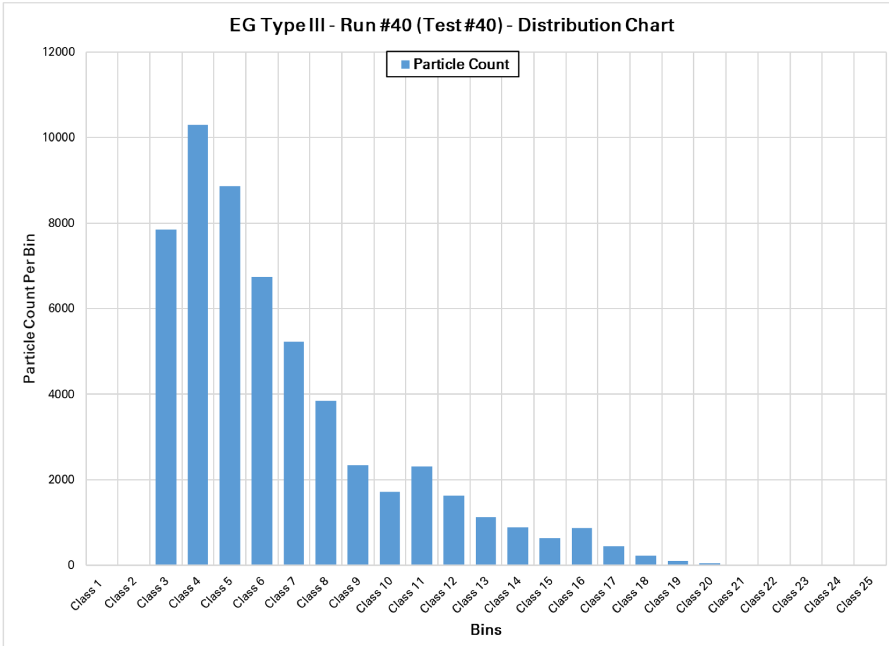
EG Type III - Run #40 (Test #40) - Relative Humidity
Start of Test 10:50
WS600 Sensor Relative Humidity
End of Test 11:16
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:45
10:55
11:05
11:15
Local Time



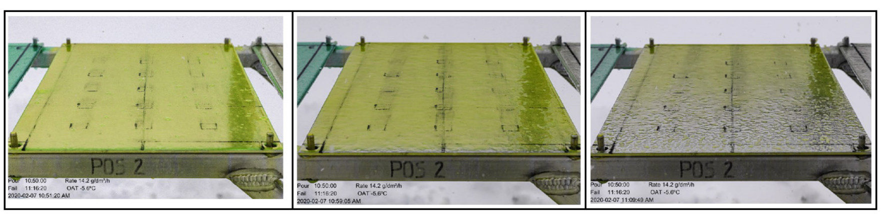
EG Type III - Run #40 (Test #40) - Fluid Brix Progression
Start of Test 10:50
Fluid Brix
End of Test 11:16
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:45
10:55
11:05
11:15
Local Time


EG Type III - Run #40 (Test #40) - Barometric Pressure
Start of Test 10:50
WS600 Sensor Barometric Pressure
End of Test 11:16
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
10:45
10:55
11:05
11:15
Local Time

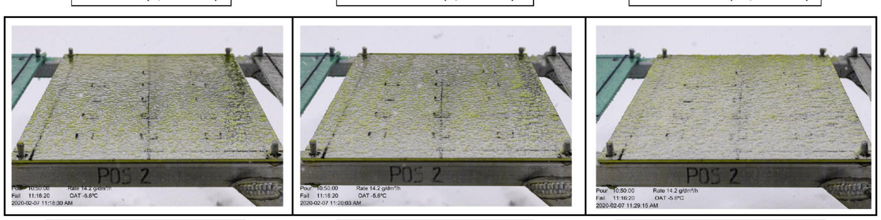

EG Type III - Run #40 (Test #40) - Fluid Layer Thickness Progression
Start of Test 10:50
Fluid Layer Thickness
End of Test 11:16
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:45
10:55
11:05
11:15
Local Time



AeroClear MAX – Run 40 (Test 40) – Failure Progression Photos



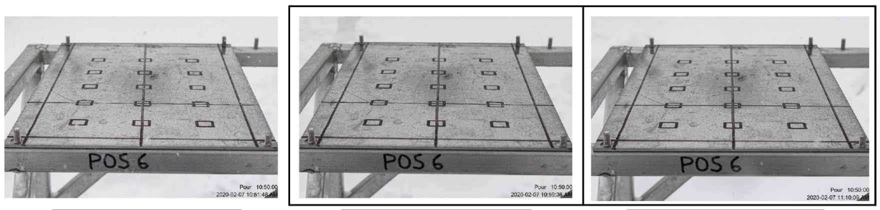
AT POUR (1/26 MIN) PRE-FAILURE (9/26 MIN) PRE-FAILURE (19/26 MIN)



AT FAILURE (26/26 MIN) POST-FAILURE (30/26 MIN) POST-FAILURE (39/26 MIN)

AeroClear MAX – Run 40 (Test 40) – Snow Characteristics Photos

FELT PAD (1/26 MIN) | FELT PAD (9/26 MIN) | FELT PAD (20/26 MIN)



BARE PLATE (1/26 MIN) | BARE PLATE (9/26 MIN) | BARE PLATE (20/26 MIN)

Final Bare Plate Contamination Thickness: **Nil (0 mm)**

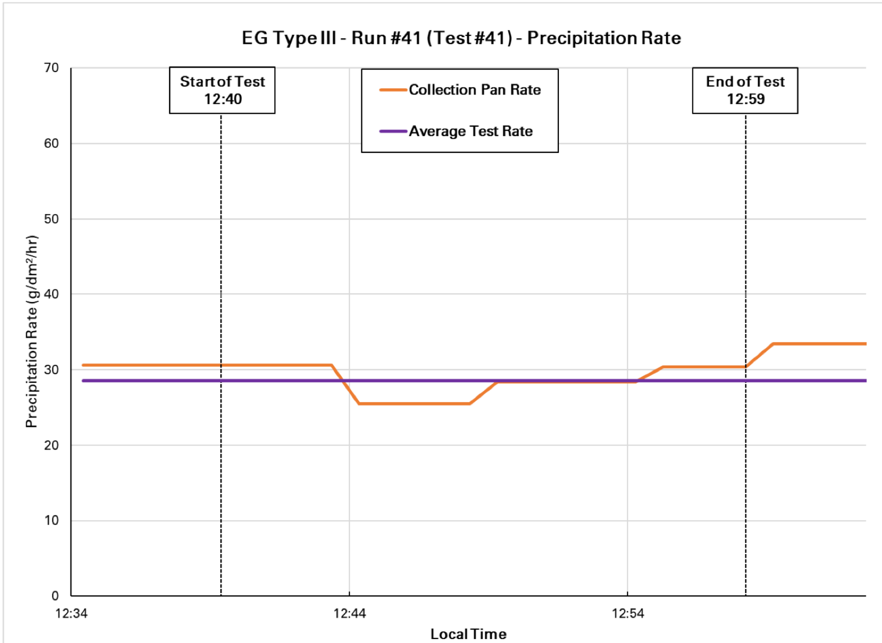
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #41 (TEST #41) – EG3-41

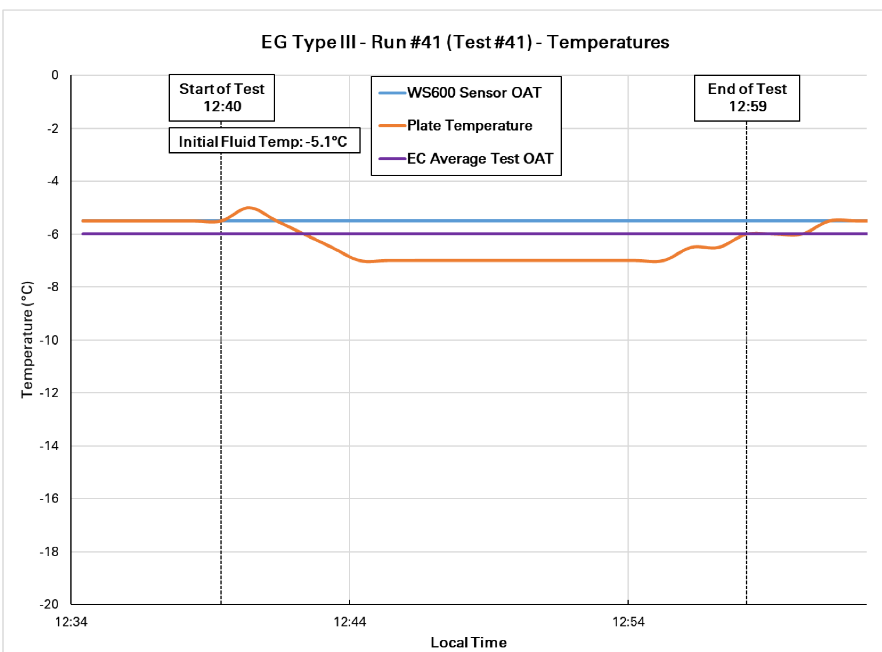
DATA PACKAGE – EG TYPE III – RUN 41 (TEST 41)

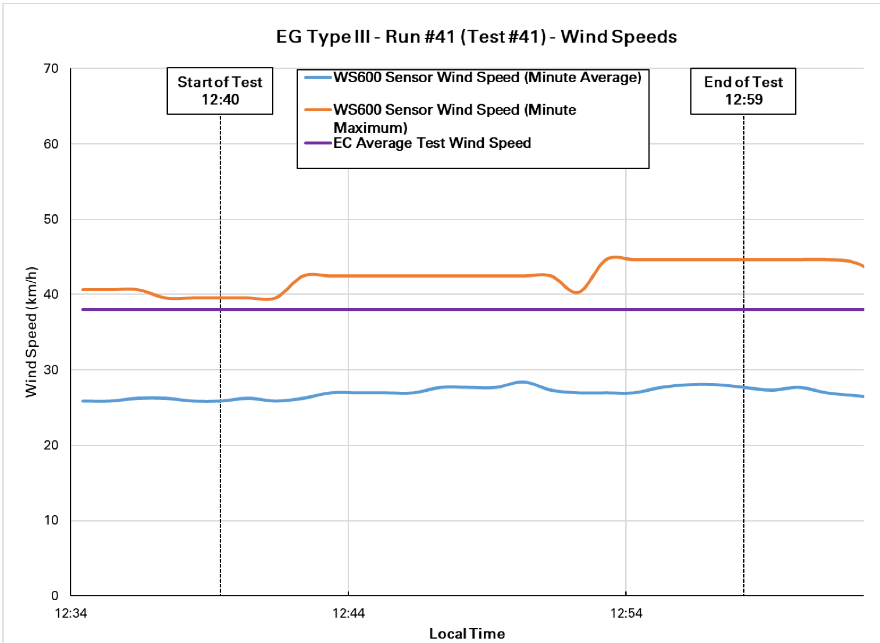
EG Type III – Run #41 (Test #41) – General Test Information

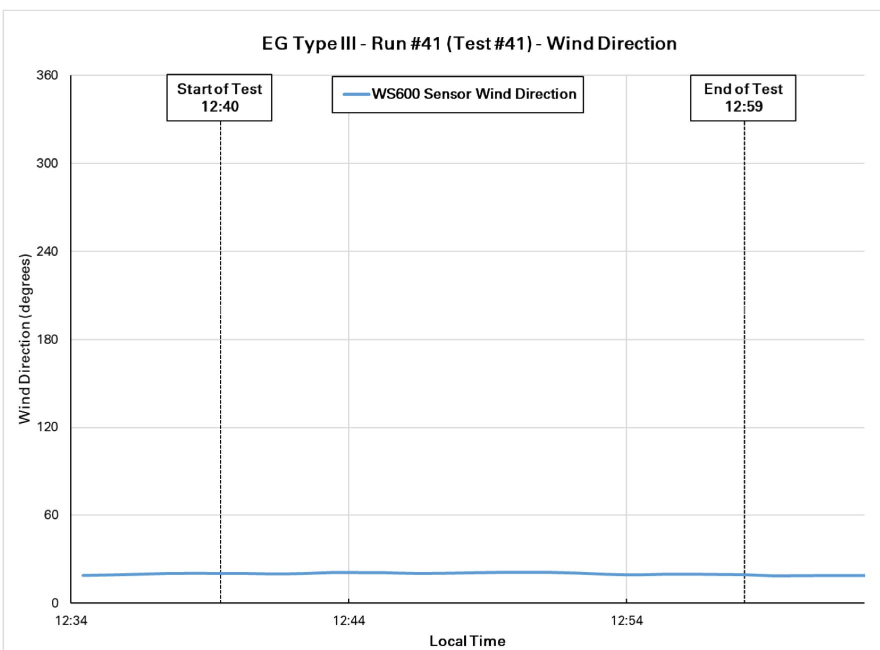
Test Number:	**EG3-41**
Date of Test:	**February 7, 2020**
Average OAT:	**-6.0**
Average Precipitation Rate:	**28.5 g/dm²/h**
Average Wind Speed:	**38.0 km/h**
Average Relative Humidity:	**89.49%**
Pour Time (Local):	**12:40:00**
Time of Fluid Failure (Local):	**12:59:00**
Fluid Brix at Failure:	**8.5°**
Endurance Time:	**19 minutes**
Expected Regression-Derived Endurance Time:	**21.4 minutes**
Difference (ET vs. Reg ET):	**-2 minutes (-9.3%)**

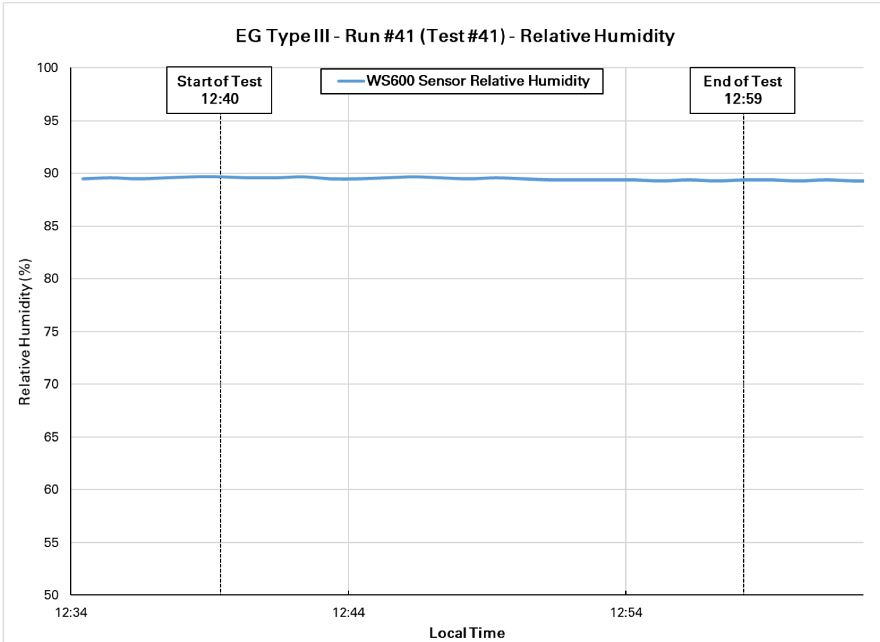


DATA PACKAGE – EG TYPE III – RUN 41 (TEST 41)

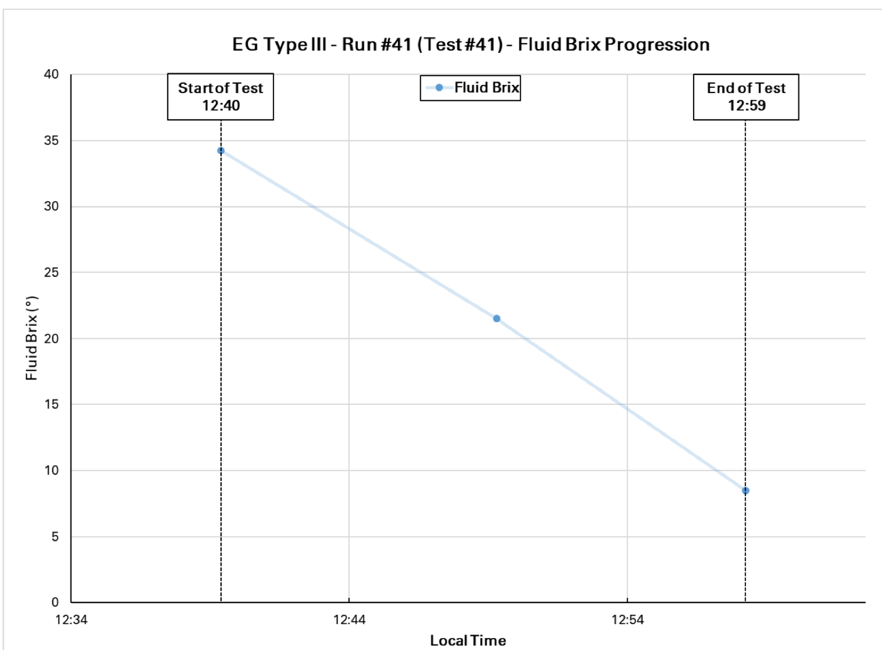



EG Type III - Run #41 (Test #41) - Wind Speeds
Start of Test 12:40
End of Test 12:59
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
12:34
12:44
12:54
Local Time

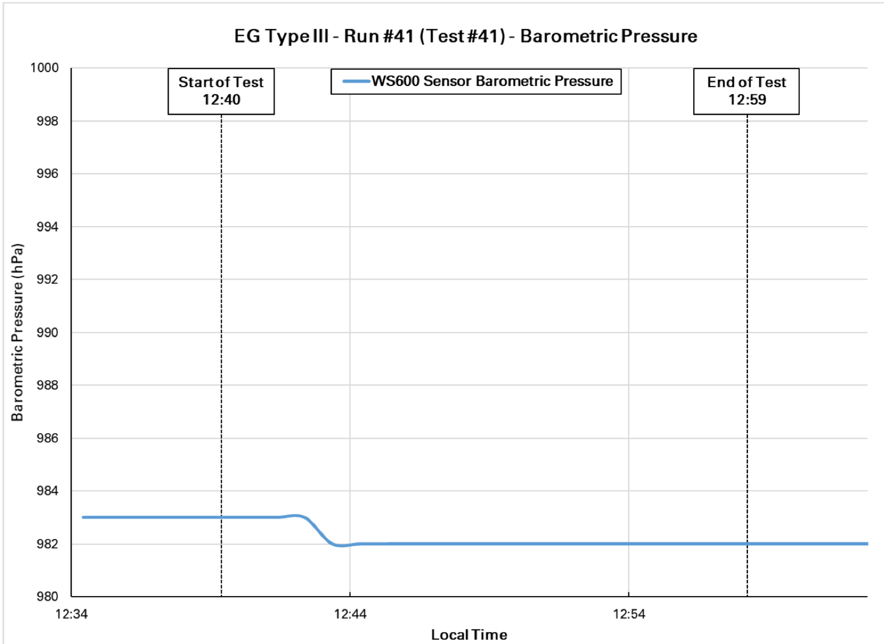

EG Type III - Run #41 (Test #41) - Wind Direction
Start of Test 12:40
End of Test 12:59
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
12:34
12:44
12:54
Local Time

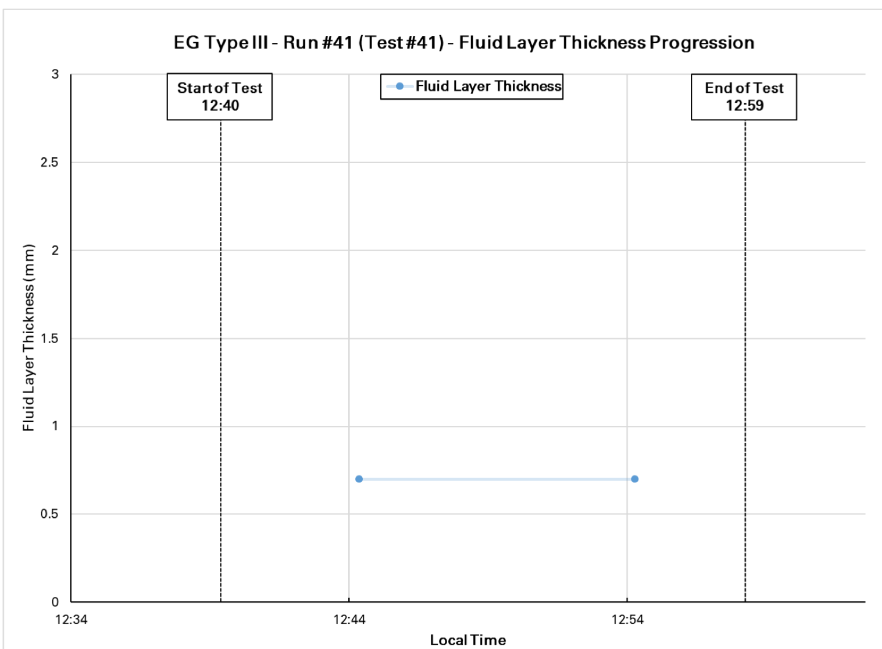


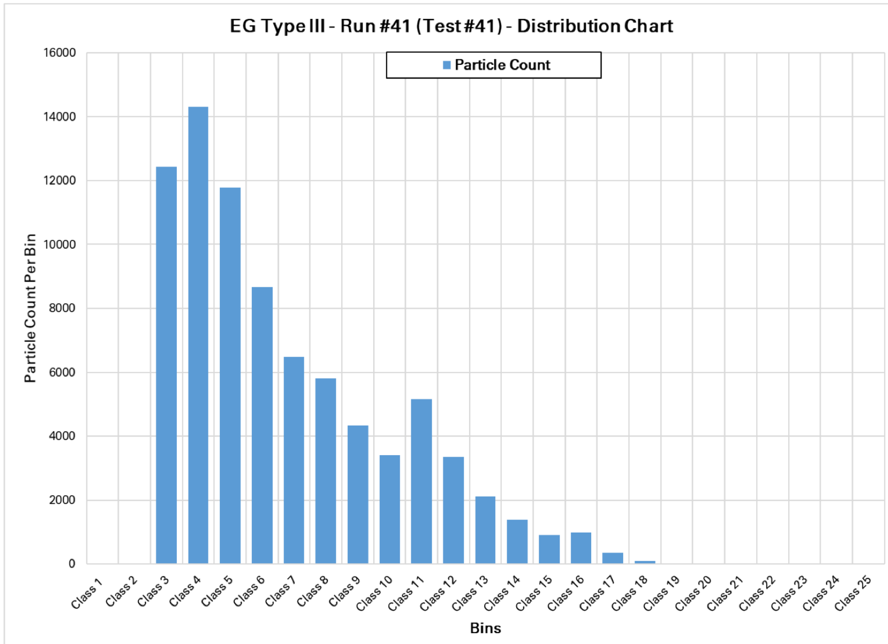
EG Type III - Run #41 (Test #41) - Relative Humidity
Start of Test 12:40
WS600 Sensor Relative Humidity
End of Test 12:59
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
12:34
12:44
12:54
Local Time



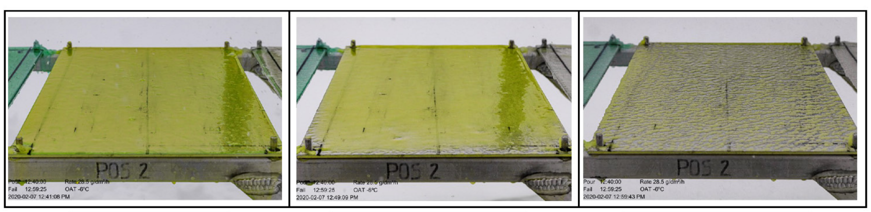
EG Type III - Run #41 (Test #41) - Fluid Brix Progression
Start of Test 12:40
Fluid Brix
End of Test 12:59
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
12:34
12:44
12:54
Local Time


EG Type III - Run #41 (Test #41) - Barometric Pressure
Start of Test 12:40
WS600 Sensor Barometric Pressure
End of Test 12:59
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
12:34
12:44
12:54
Local Time


EG Type III - Run #41 (Test #41) - Fluid Layer Thickness Progression
Start of Test 12:40
Fluid Layer Thickness
End of Test 12:59
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
12:34
12:44
12:54
Local Time



AeroClear MAX – Run 41 (Test 41) – Failure Progression Photos

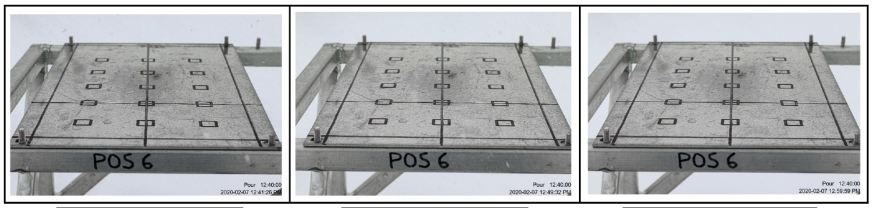


AT POUR (0/19 MIN) | PRE-FAILURE (9/19 MIN) | AT FAILURE (19/19 MIN)

POST-FAILURE (29/19 MIN) | POST-FAILURE (39/19 MIN) | POST-FAILURE (45/19 MIN)

AeroClear MAX – Run 41 (Test 41) – Snow Characteristics Photos

FELT PAD (1/19 MIN) | FELT PAD (10/19 MIN) | FELT PAD (20/19 MIN)



BARE PLATE (1/19 MIN) | BARE PLATE (9/19 MIN) | BARE PLATE (19/19 MIN)

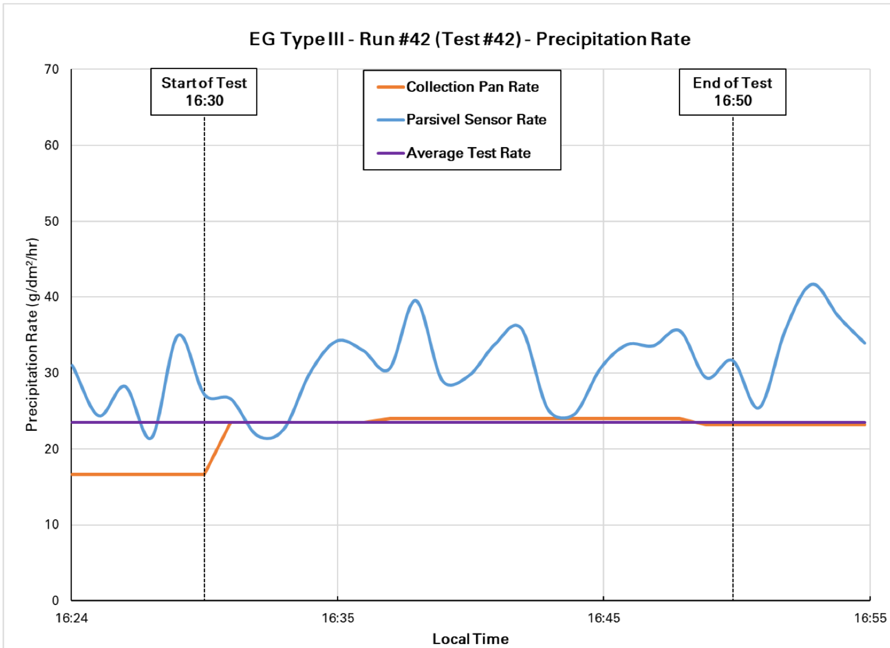
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

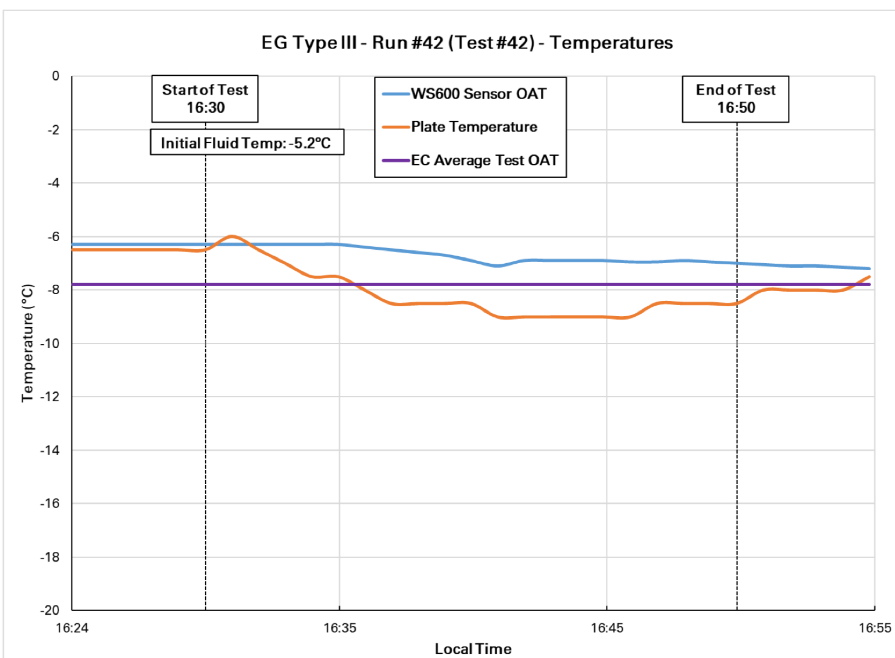
EG TYPE III
RUN #42 (TEST #42) – EG3-42

EG Type III – Run #42 (Test #42) – General Test Information

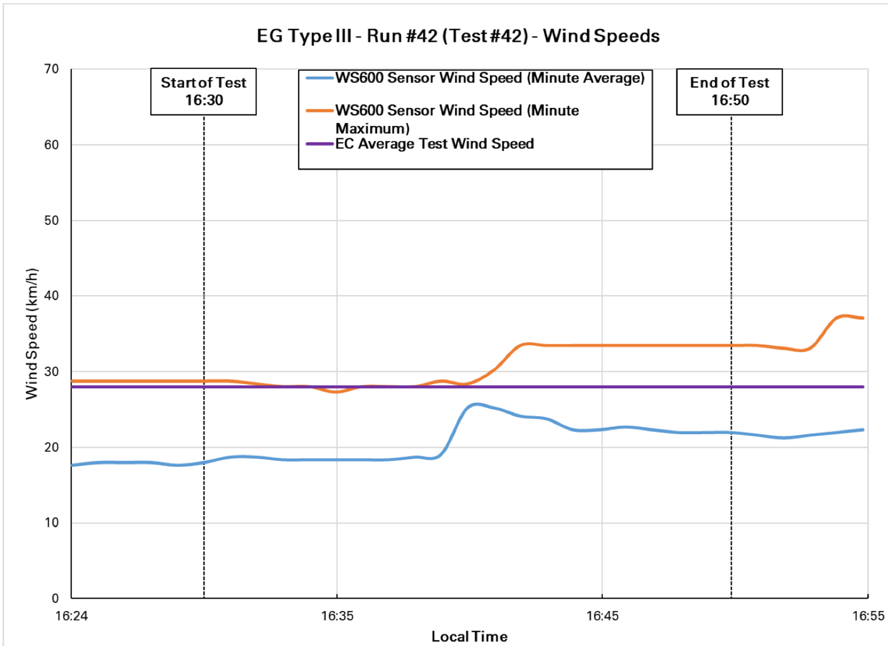
Test Number:	EG3-42
Date of Test:	February 7, 2020
Average OAT:	-7.8
Average Precipitation Rate:	23.5 g/dm²/h
Average Wind Speed:	28.0 km/h
Average Relative Humidity:	87.7%
Pour Time (Local):	16:30:00
Time of Fluid Failure (Local):	16:50:00
Fluid Brix at Failure:	13.5°
Endurance Time:	20 minutes
Expected Regression-Derived Endurance Time:	24.3 minutes
Difference (ET vs. Reg ET):	-3.3 minutes (-13.7%)

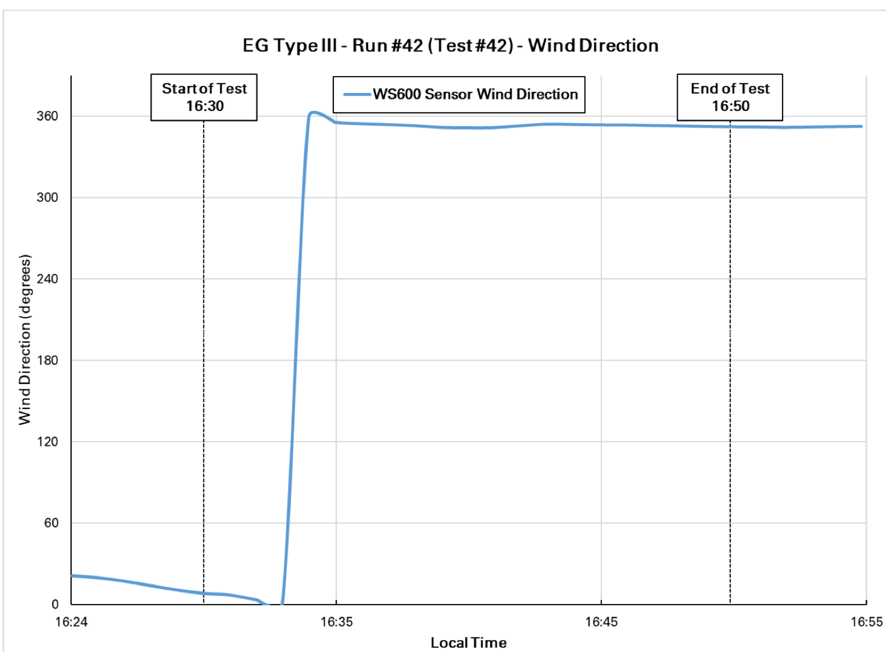


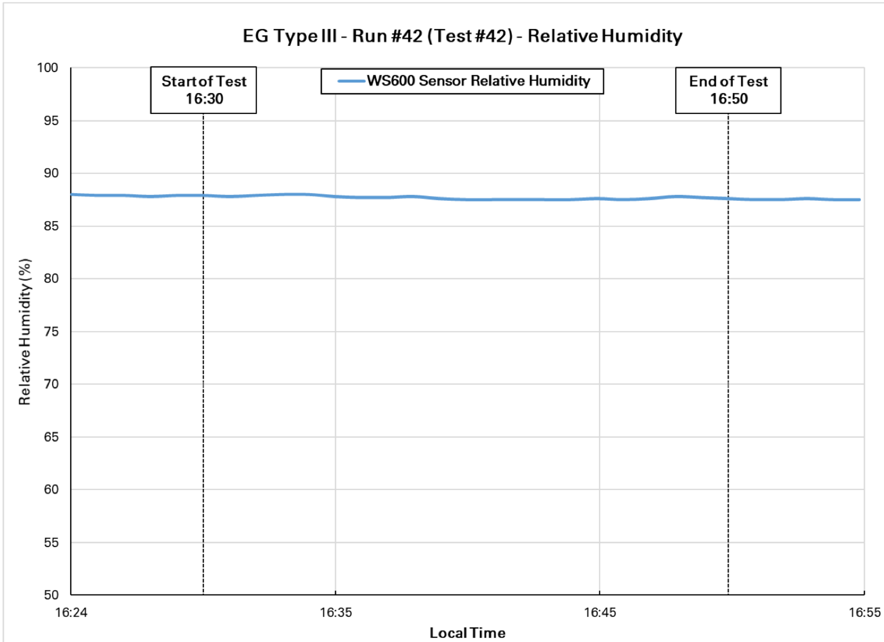
EG Type III - Run #42 (Test #42) - Precipitation Rate
Start of Test 16:30
End of Test 16:50
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:24
16:35
16:45
16:55
Local Time



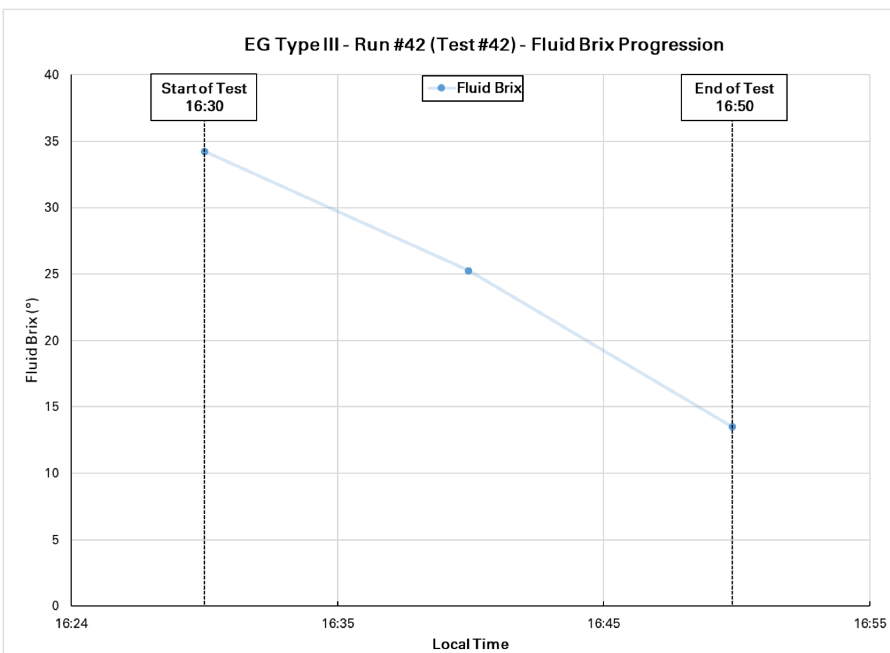
EG Type III - Run #42 (Test #42) - Temperatures
Start of Test 16:30
Initial Fluid Temp: -5.2°C
End of Test 16:50
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:24
16:35
16:45
16:55
Local Time


EG Type III - Run #42 (Test #42) - Wind Speeds
Start of Test 16:30
End of Test 16:50
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:24
16:35
16:45
16:55
Local Time

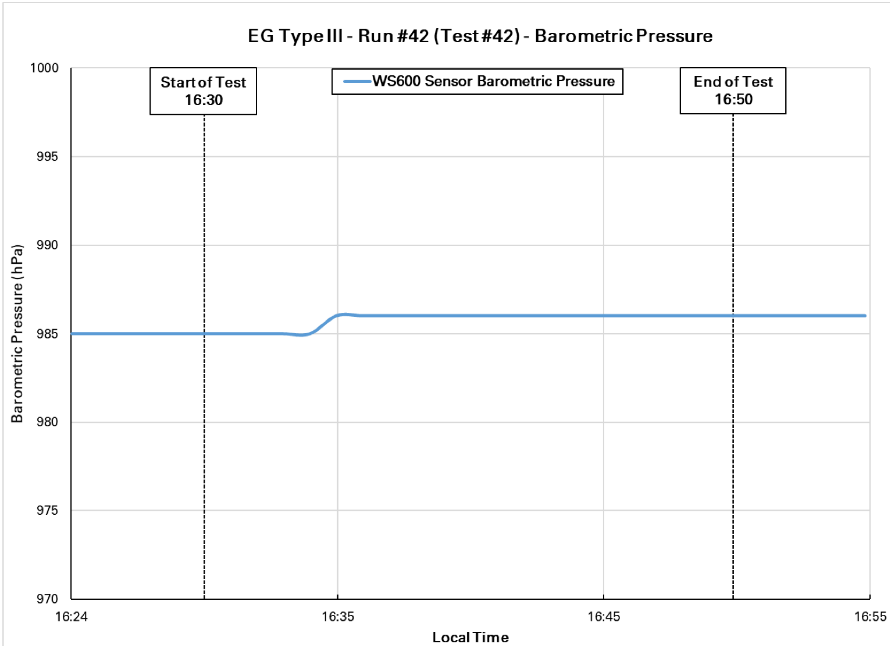

EG Type III - Run #42 (Test #42) - Wind Direction
Start of Test 16:30
End of Test 16:50
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
16:24
16:35
16:45
16:55
Local Time

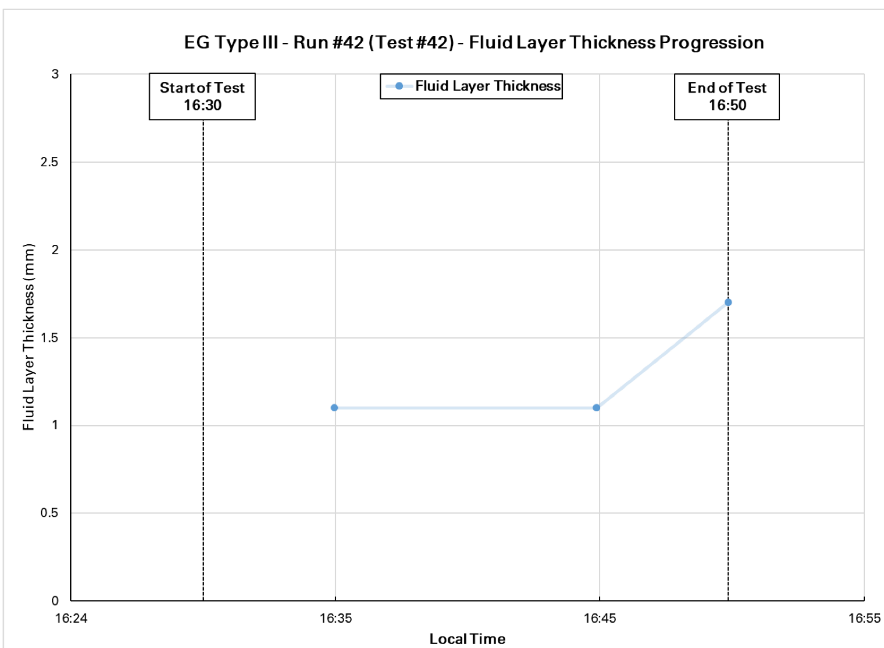


EG Type III - Run #42 (Test #42) - Relative Humidity
Start of Test
16:30
WS600 Sensor Relative Humidity
End of Test
16:50
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
16:24
16:35
16:45
16:55
Local Time

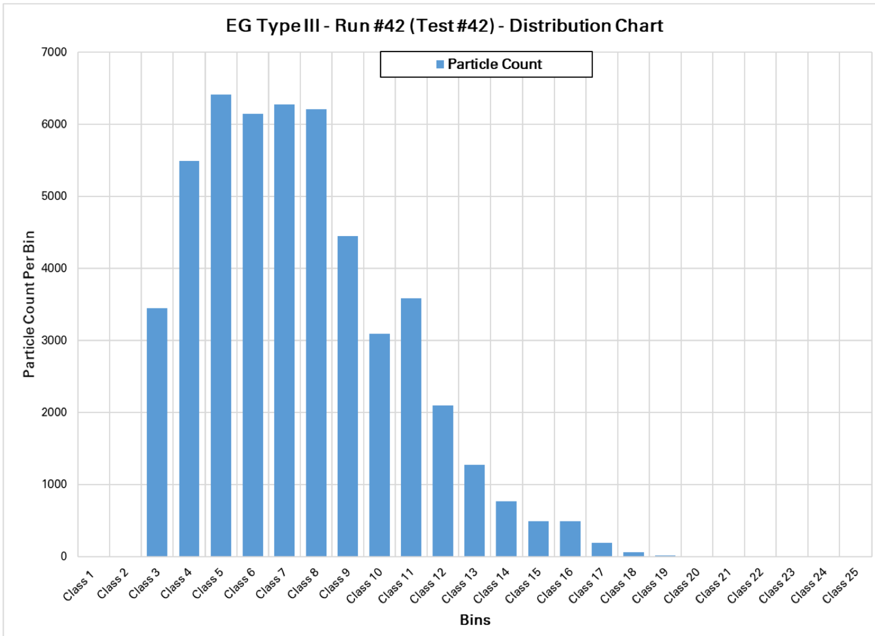


EG Type III - Run #42 (Test #42) - Fluid Brix Progression
Start of Test
16:30
Fluid Brix
End of Test
16:50
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
16:24
16:35
16:45
16:55
Local Time


EG Type III - Run #42 (Test #42) - Barometric Pressure
Start of Test 16:30
WS600 Sensor Barometric Pressure
End of Test 16:50
Barometric Pressure (hPa)
1000
995
990
985
980
975
970
16:24
16:35
16:45
16:55
Local Time


EG Type III - Run #42 (Test #42) - Fluid Layer Thickness Progression
Start of Test 16:30
Fluid Layer Thickness
End of Test 16:50
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:24
16:35
16:45
16:55
Local Time

DATA PACKAGE – EG TYPE III – RUN 42 (TEST 42)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 42 - Test 42/Data Package - EG Type III - Run 42 - Test 42.docx
Final Version 1.0, March 2021

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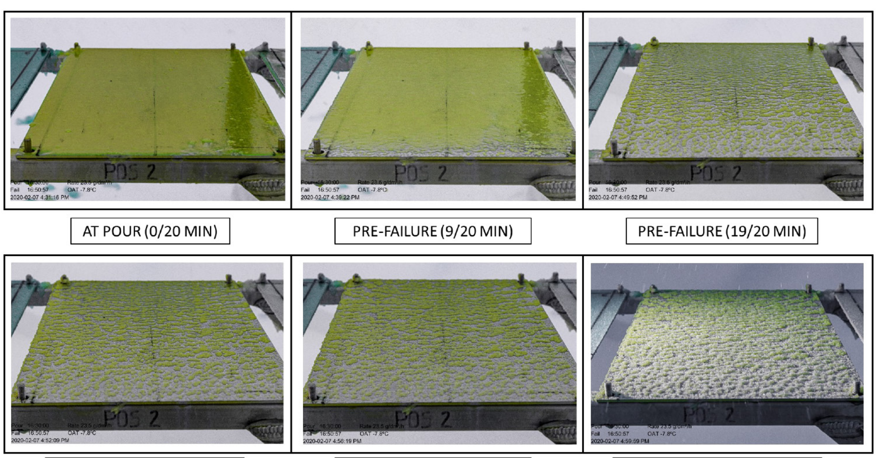
DATA PACKAGE – EG TYPE III – RUN 42 (TEST 42)

AeroClear MAX – Run 42 (Test 42) – Failure Progression Photos



AT POUR (0/20 MIN) | PRE-FAILURE (9/20 MIN) | PRE-FAILURE (19/20 MIN)

POST-FAILURE (22/20 MIN) | POST-FAILURE (26/20 MIN) | POST-FAILURE (29/20 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 42 - Test 42/Data Package - EG Type III - Run 42 - Test 42.docx
Final Version 1.0, March 2021

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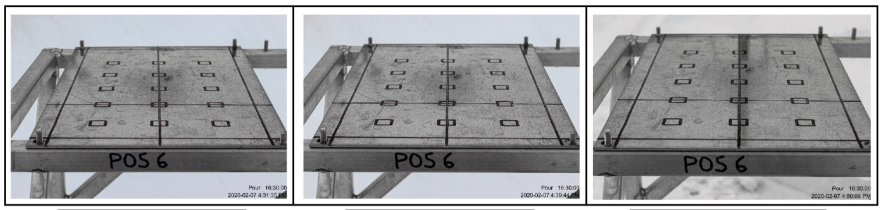
AeroClear MAX – Run 42 (Test 42) – Snow Characteristics Photos

FELT PAD (11/20 MIN) | FELT PAD (20/20 MIN) | FELT PAD (31/20 MIN)



BARE PLATE (1/20 MIN) | BARE PLATE (9/20 MIN) | BARE PLATE (20/20 MIN)

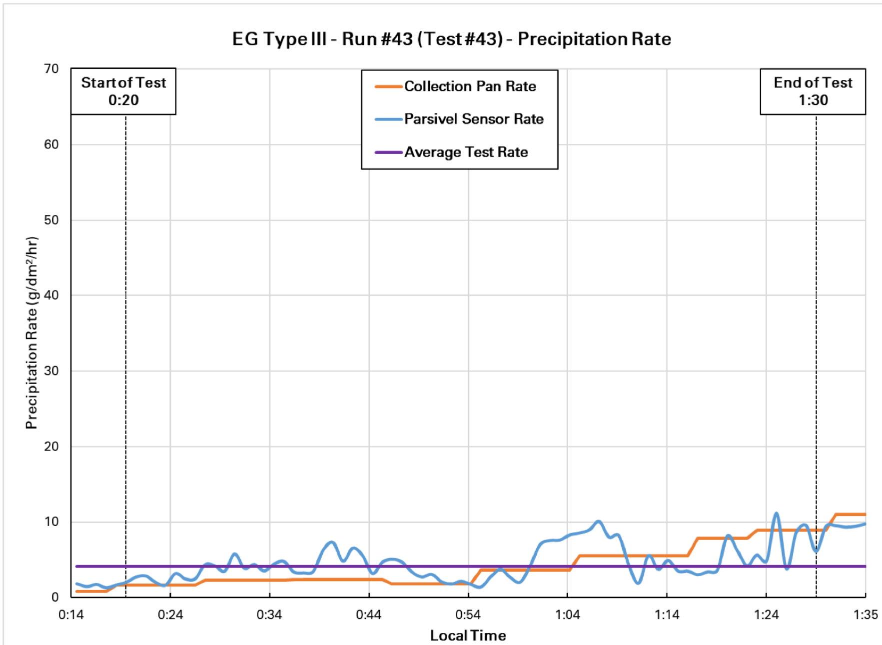
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

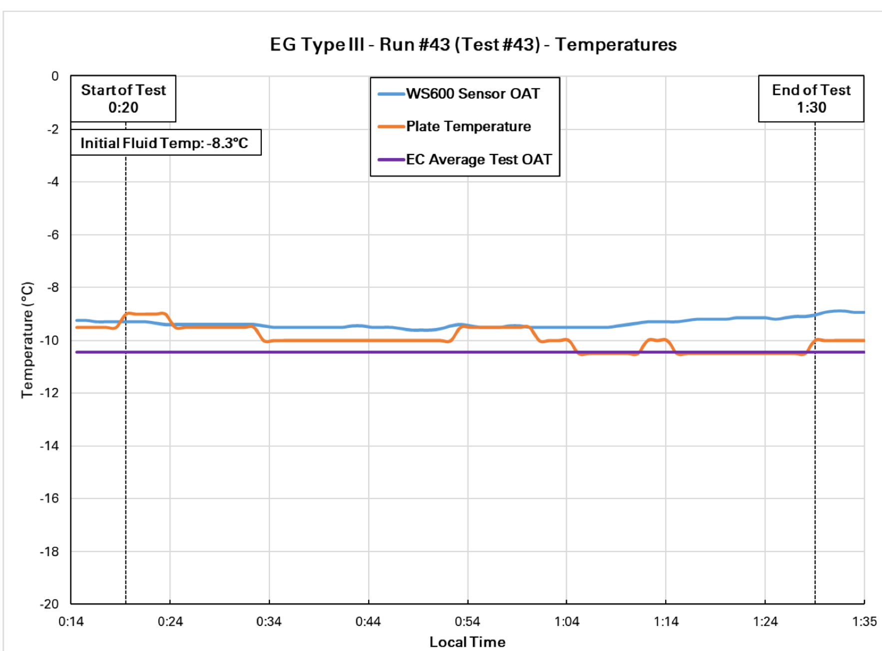
EG TYPE III
RUN #43 (TEST #43) – EG3-43

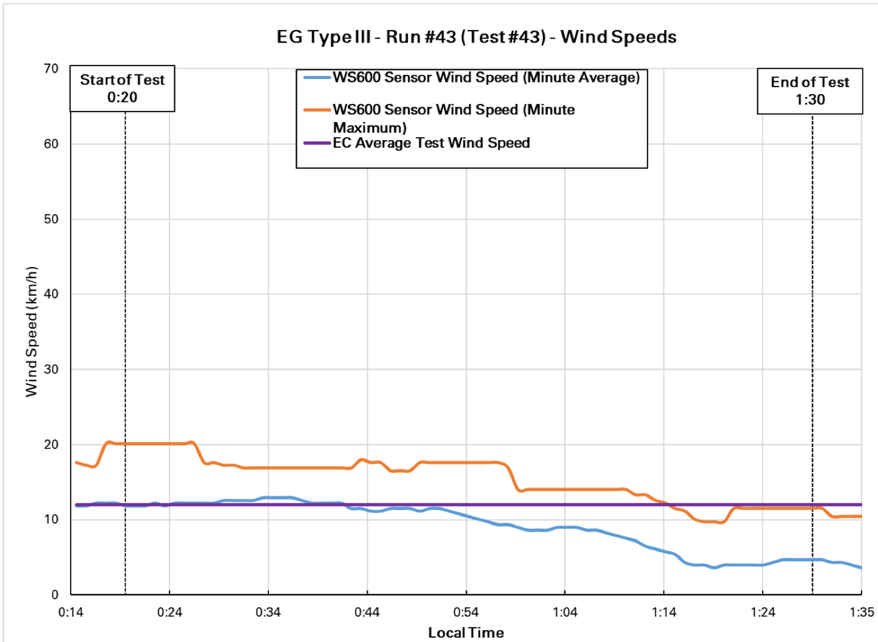
EG Type III – Run #43 (Test #43) – General Test Information

Test Number:	**EG3-43**
Date of Test:	**February 10, 2020**
Average OAT:	**-10.4**
Average Precipitation Rate:	**4.1 g/dm²/h**
Average Wind Speed:	**12.0 km/h**
Average Relative Humidity:	**80.8%**
Pour Time (Local):	**00:20:00**
Time of Fluid Failure (Local):	**01:30:00**
Fluid Brix at Failure:	**17°**
Endurance Time:	**70 minutes**
Expected Regression-Derived Endurance Time:	**76.7 minutes**
Difference (ET vs. Reg ET):	**-6.4 minutes (-8.4%)**

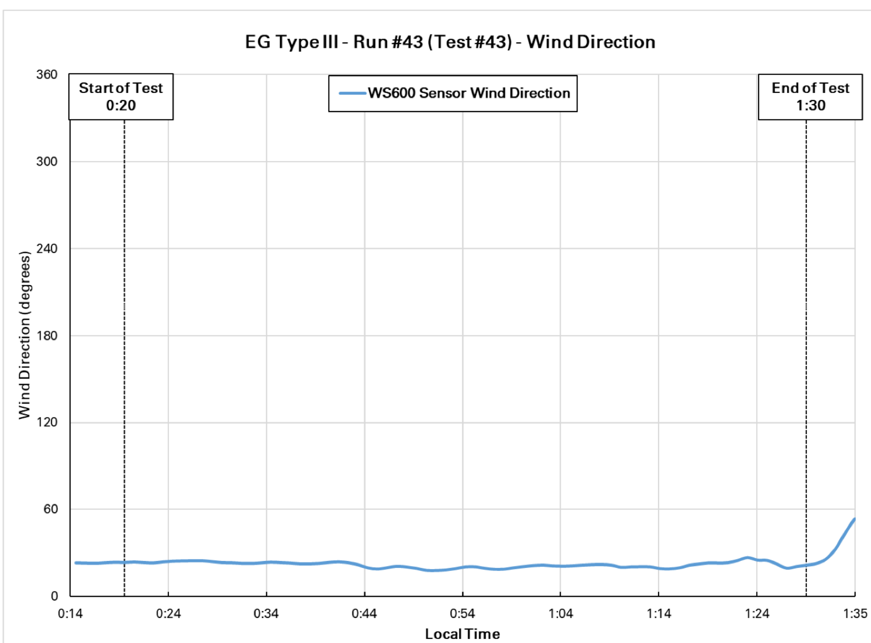


DATA PACKAGE – EG TYPE III – RUN 43 (TEST 43)

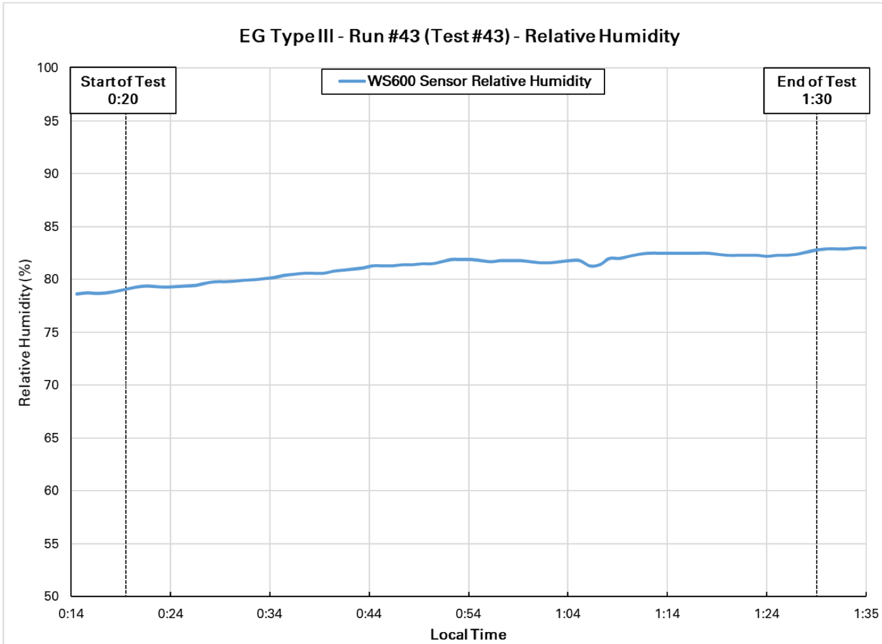




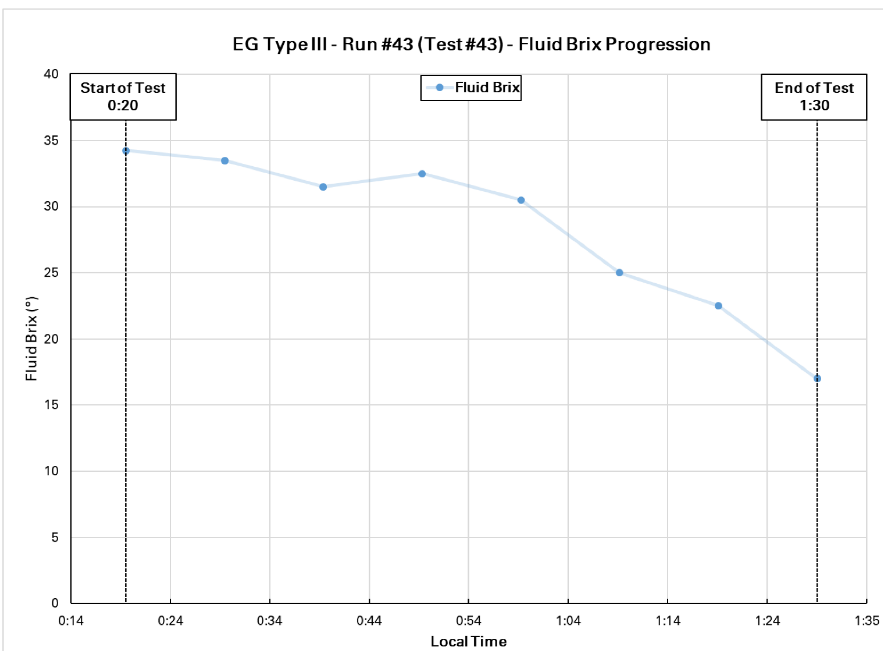
EG Type III - Run #43 (Test #43) - Wind Speeds
Start of Test 0:20
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 1:30
Wind Speed (km/h)
0
10
20
30
40
50
60
70
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

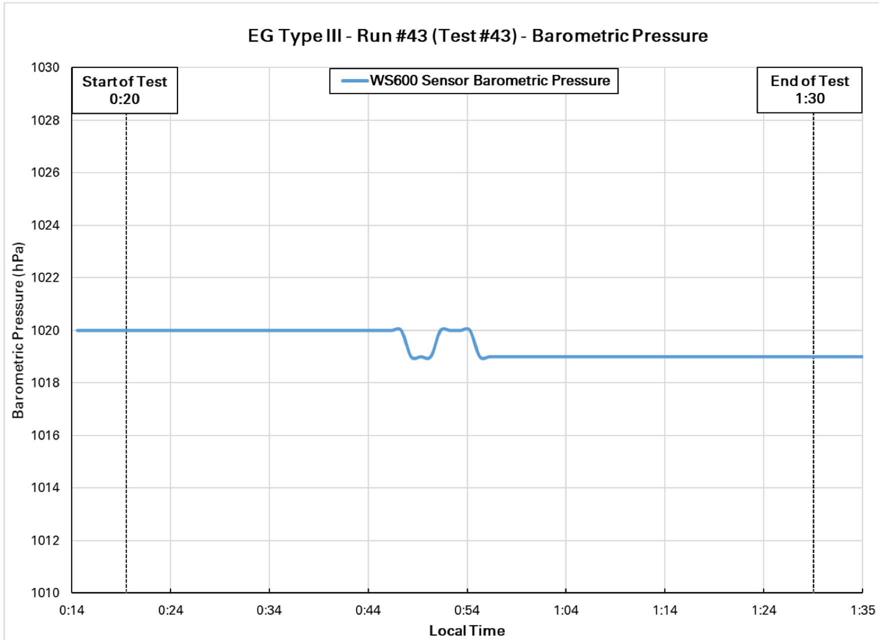


EG Type III - Run #43 (Test #43) - Wind Direction
Start of Test 0:20
WS600 Sensor Wind Direction
End of Test 1:30
Wind Direction (degrees)
0
60
120
180
240
300
360
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

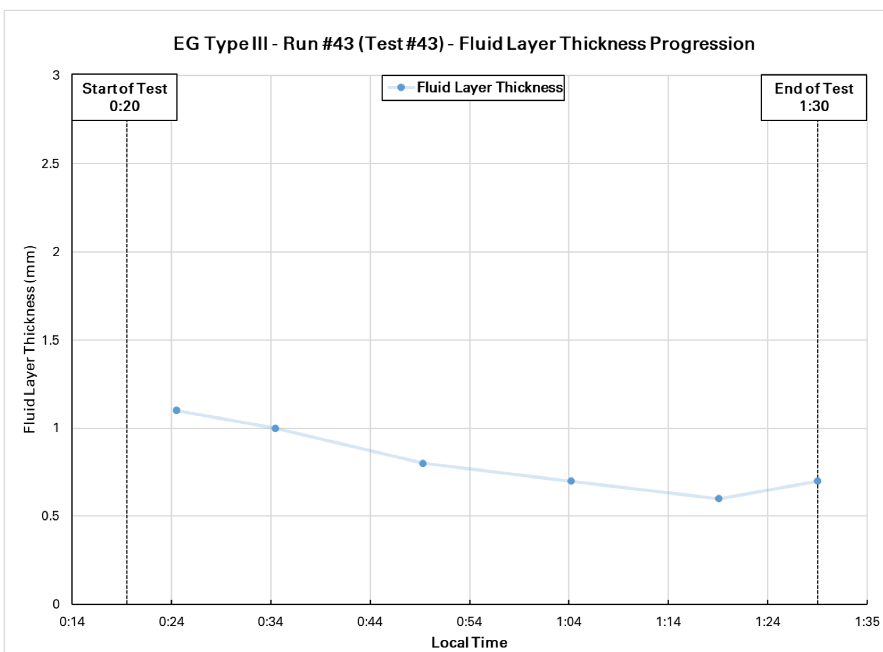


DATA PACKAGE – EG TYPE III – RUN 43 (TEST 43)

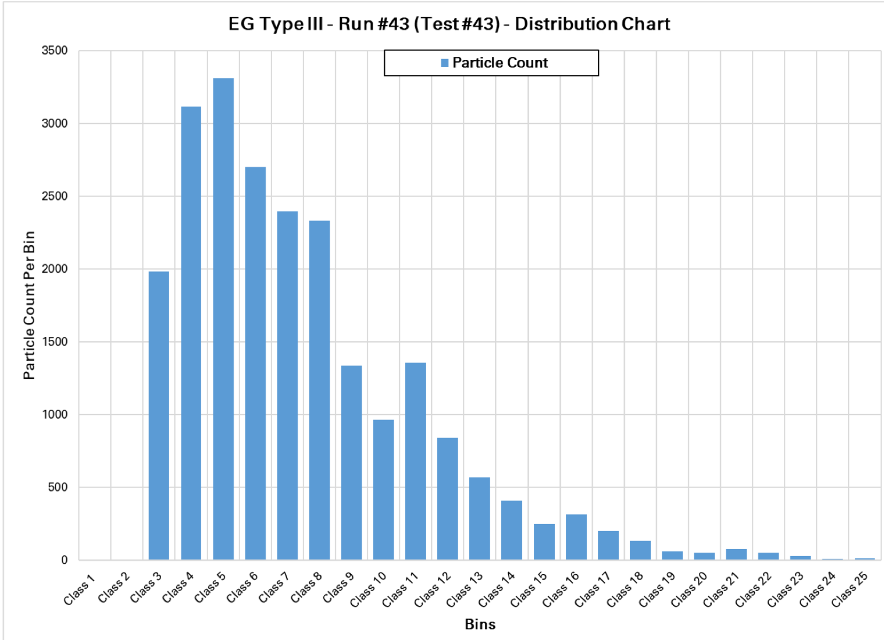




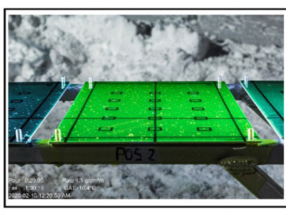
EG Type III - Run #43 (Test #43) - Barometric Pressure
Start of Test 0:20
WS600 Sensor Barometric Pressure
End of Test 1:30
Barometric Pressure (hPa)
1030
1028
1026
1024
1022
1020
1018
1016
1014
1012
1010
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

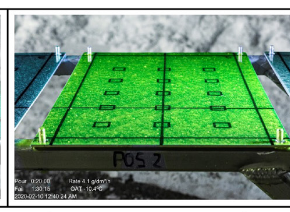


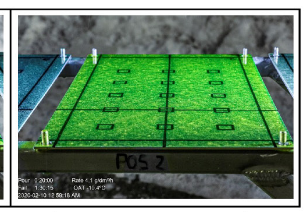
EG Type III - Run #43 (Test #43) - Fluid Layer Thickness Progression
Start of Test 0:20
Fluid Layer Thickness
End of Test 1:30
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

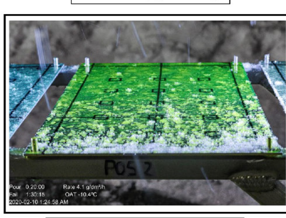


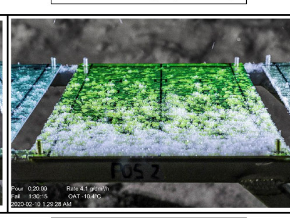
AeroClear MAX – Run 43 (Test 43) – Failure Progression Photos

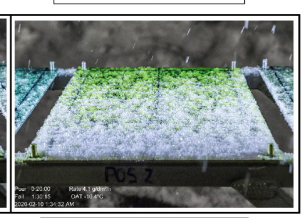

AT POUR (0/70 MIN)


PRE-FAILURE (20/70 MIN)

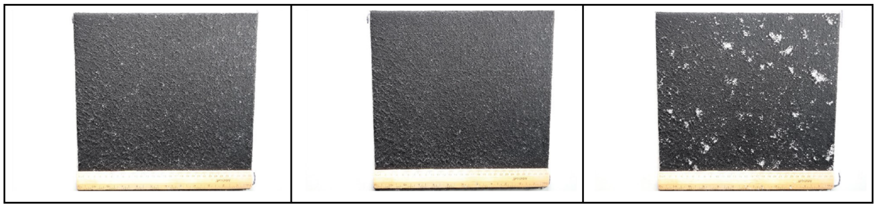

PRE-FAILURE (39/70 MIN)


PRE-FAILURE (64/70 MIN)

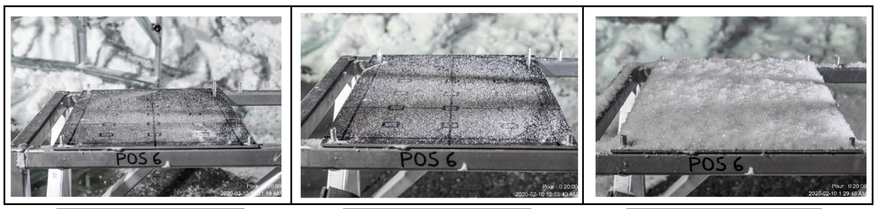

AT FAILURE (70/70 MIN)


POST-FAILURE (74/70 MIN)

AeroClear MAX – Run 43 (Test 43) – Snow Characteristics Photos



FELT PAD (2/70 MIN) | FELT PAD (30/70 MIN) | FELT PAD (60/70 MIN)



BARE PLATE (1/70 MIN) | BARE PLATE (39/70 MIN) | BARE PLATE (69/70 MIN)

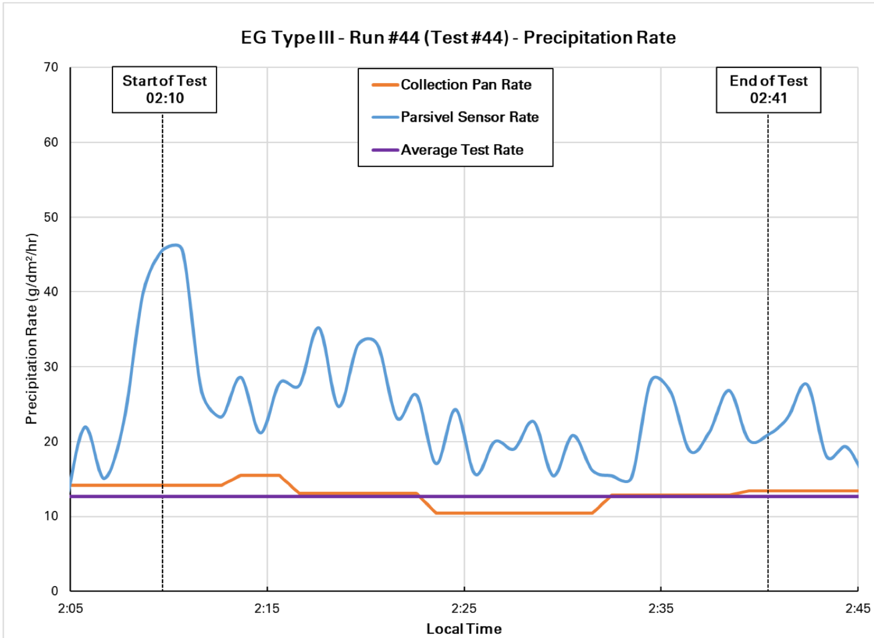
Final Bare Plate Contamination Thickness: **10mm**

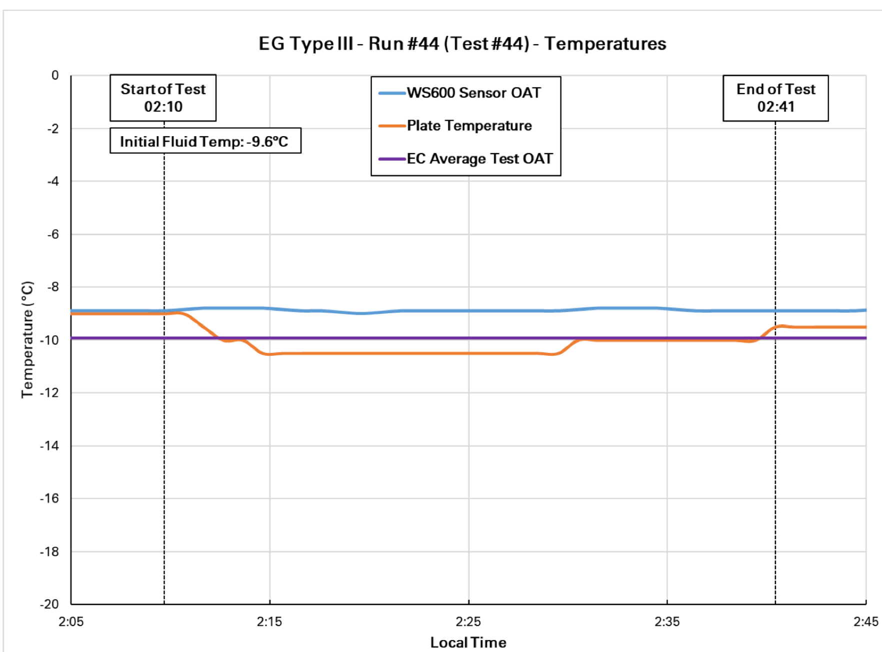
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

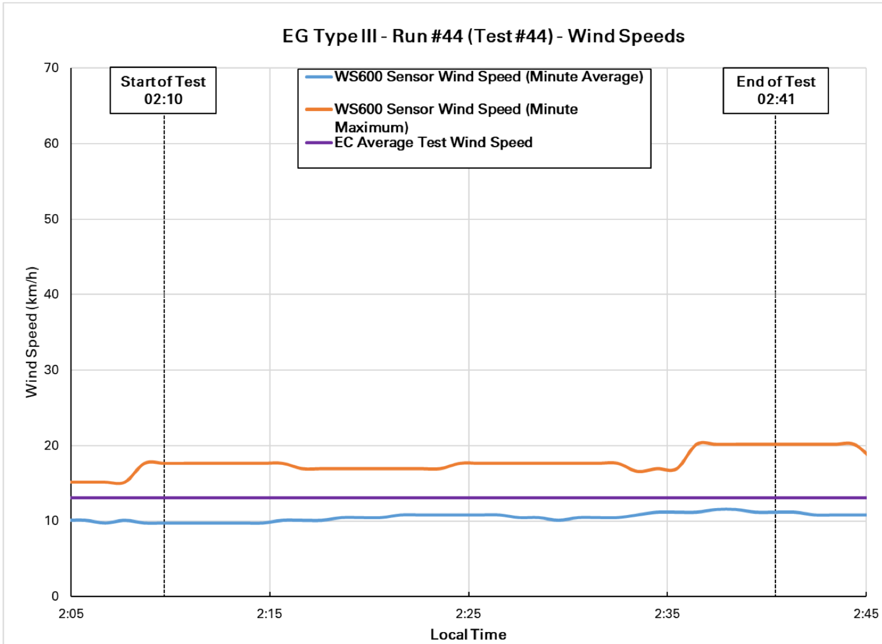
EG TYPE III
RUN #44 (TEST #44) – EG3-44

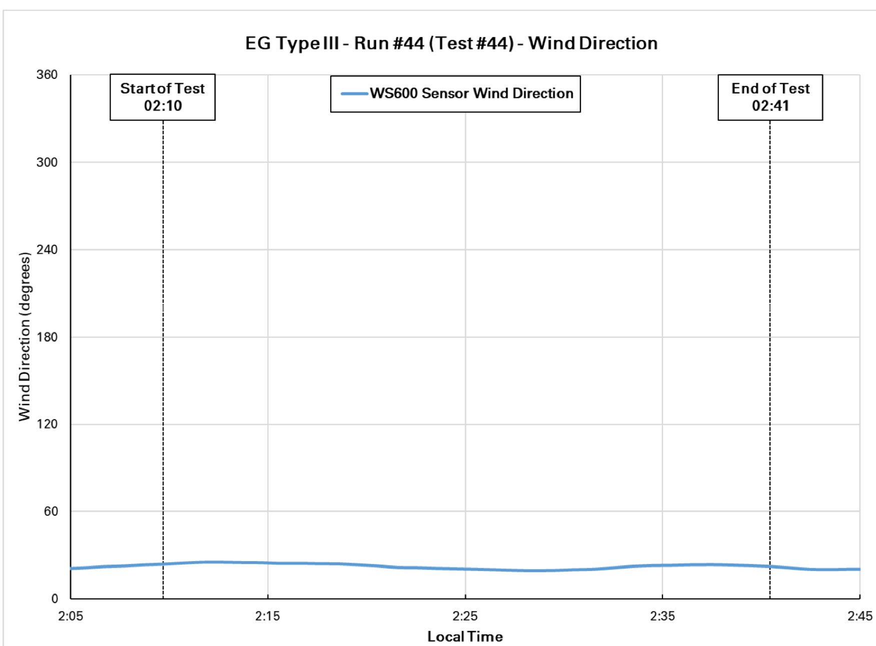
EG Type III – Run #44 (Test #44) – General Test Information

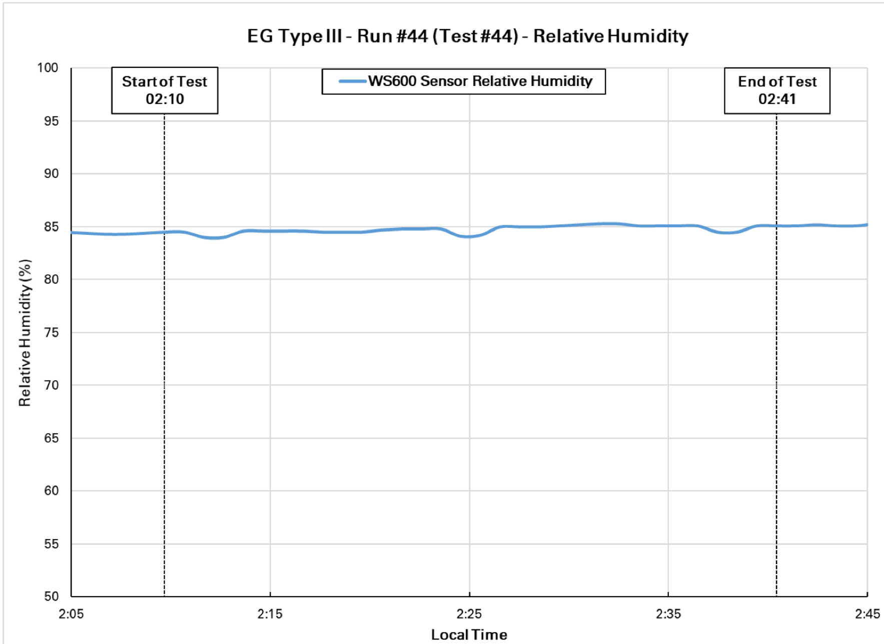
Test Number:	**EG3-44**
Date of Test:	**February 10, 2020**
Average OAT:	**-9.9**
Average Precipitation Rate:	**12.6 g/dm²/h**
Average Wind Speed:	**13.1 km/h**
Average Relative Humidity:	**84.8%**
Pour Time (Local):	**02:10:00**
Time of Fluid Failure (Local):	**02:41:00**
Fluid Brix at Failure:	**14.75°**
Endurance Time:	**31 minutes**
Expected Regression-Derived Endurance Time:	**36.6 minutes**
Difference (ET vs. Reg ET):	**-5.6 minutes (-15.2%)**

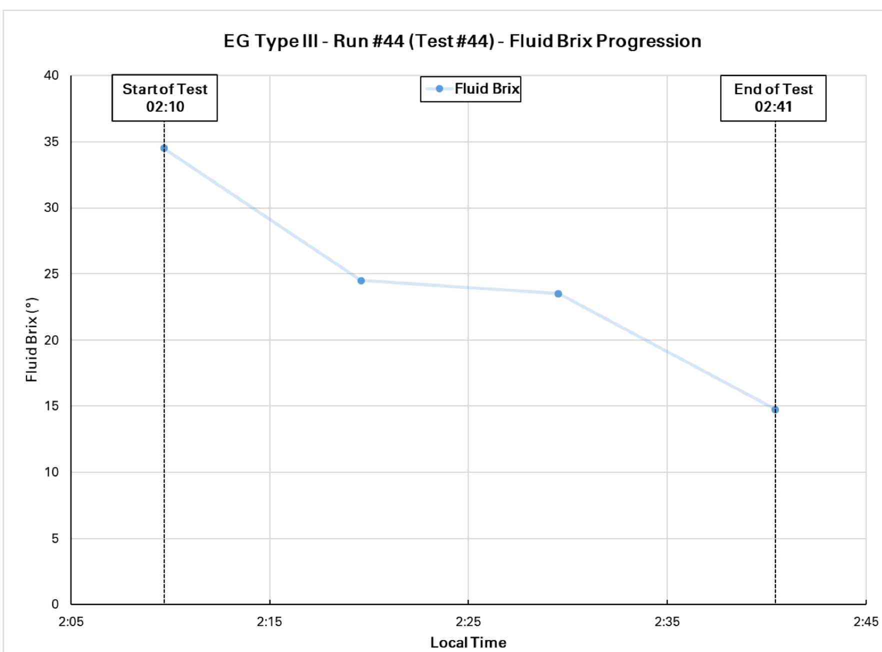

EG Type III - Run #44 (Test #44) - Precipitation Rate
Start of Test 02:10
End of Test 02:41
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
2:05
2:15
2:25
2:35
2:45
Local Time

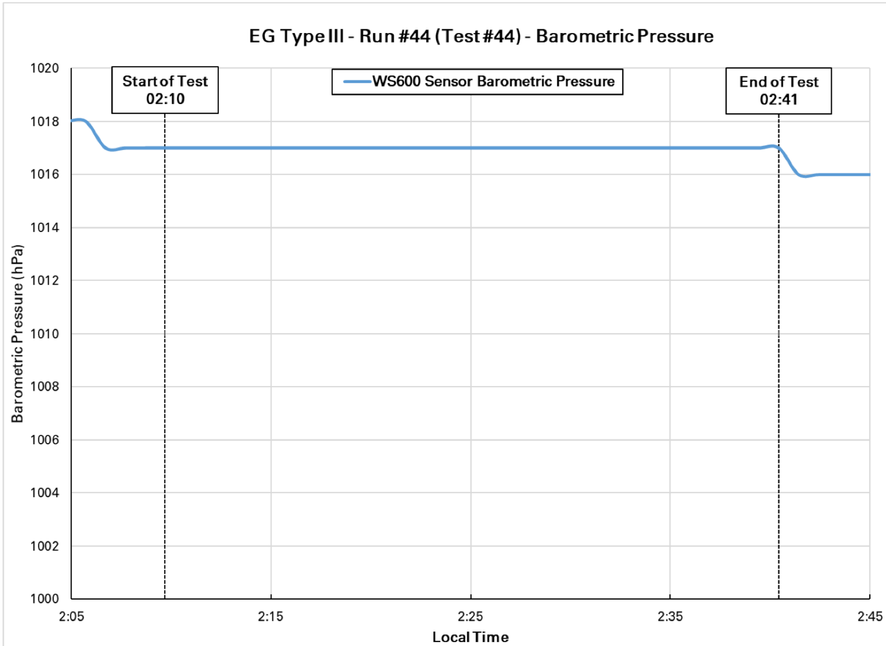

EG Type III - Run #44 (Test #44) - Temperatures
Start of Test 02:10
Initial Fluid Temp: -9.6°C
End of Test 02:41
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
2:05
2:15
2:25
2:35
2:45
Local Time

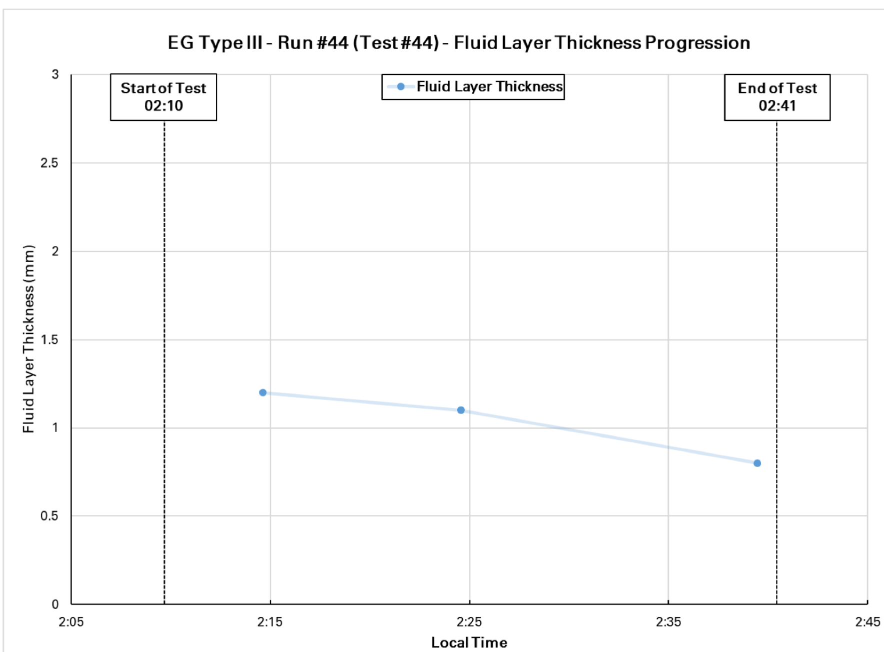

EG Type III - Run #44 (Test #44) - Wind Speeds
Start of Test 02:10
End of Test 02:41
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
2:05
2:15
2:25
2:35
2:45
Local Time

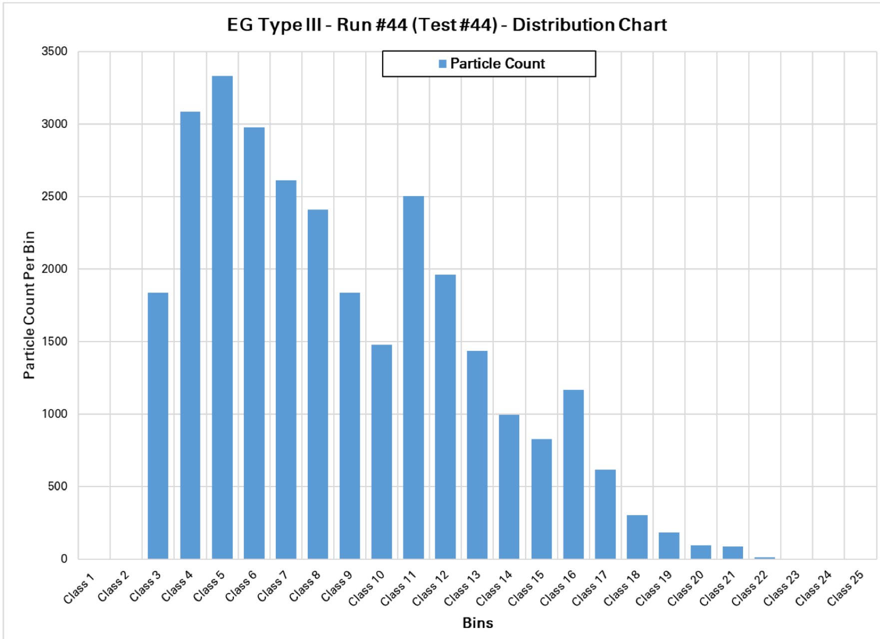

EG Type III - Run #44 (Test #44) - Wind Direction
Start of Test 02:10
End of Test 02:41
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
2:05
2:15
2:25
2:35
2:45
Local Time


EG Type III - Run #44 (Test #44) - Relative Humidity
Start of Test 02:10
WS600 Sensor Relative Humidity
End of Test 02:41
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:05
2:15
2:25
2:35
2:45
Local Time


EG Type III - Run #44 (Test #44) - Fluid Brix Progression
Start of Test 02:10
Fluid Brix
End of Test 02:41
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
2:05
2:15
2:25
2:35
2:45
Local Time

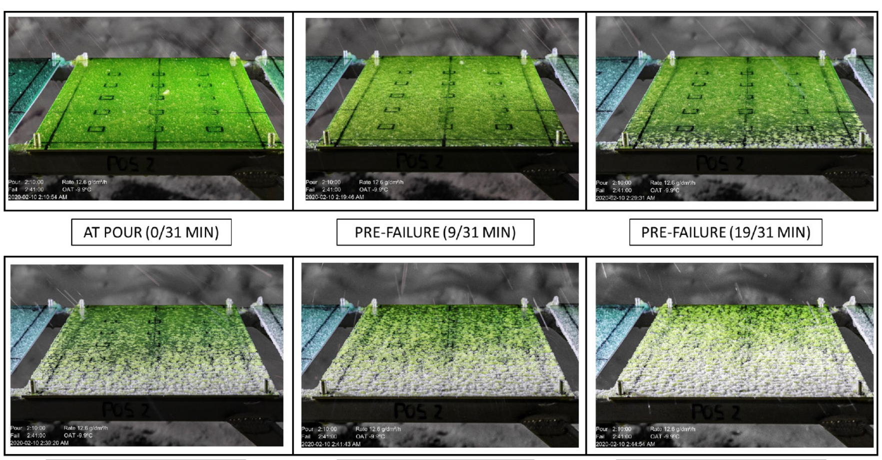

EG Type III - Run #44 (Test #44) - Barometric Pressure
Start of Test 02:10
WS600 Sensor Barometric Pressure
End of Test 02:41
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
2:05
2:15
2:25
2:35
2:45
Local Time


EG Type III - Run #44 (Test #44) - Fluid Layer Thickness Progression
Start of Test 02:10
Fluid Layer Thickness
End of Test 02:41
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
2:05
2:15
2:25
2:35
2:45
Local Time



DATA PACKAGE – EG TYPE III – RUN 44 (TEST 44)

AeroClear MAX – Run 44 (Test 44) – Failure Progression Photos

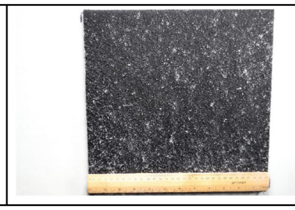


AT POUR (0/31 MIN) | PRE-FAILURE (9/31 MIN) | PRE-FAILURE (19/31 MIN)

PRE-FAILURE (29/31 MIN) | AT FAILURE (31/31 MIN) | POST-FAILURE (34/31 MIN)

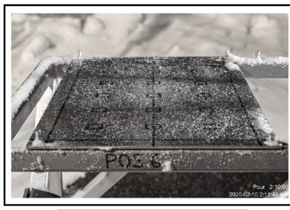
AeroClear MAX – Run 44 (Test 44) – Snow Characteristics Photos

FELT PAD (10/31 MIN)

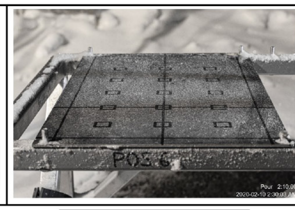


FELT PAD (20/31 MIN)

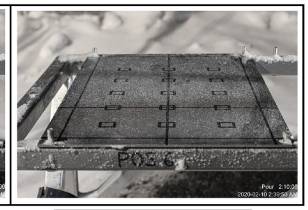
FELT PAD (30/31 MIN)



BARE PLATE (1/31 MIN)



BARE PLATE (20/31 MIN)



BARE PLATE (29/31 MIN)

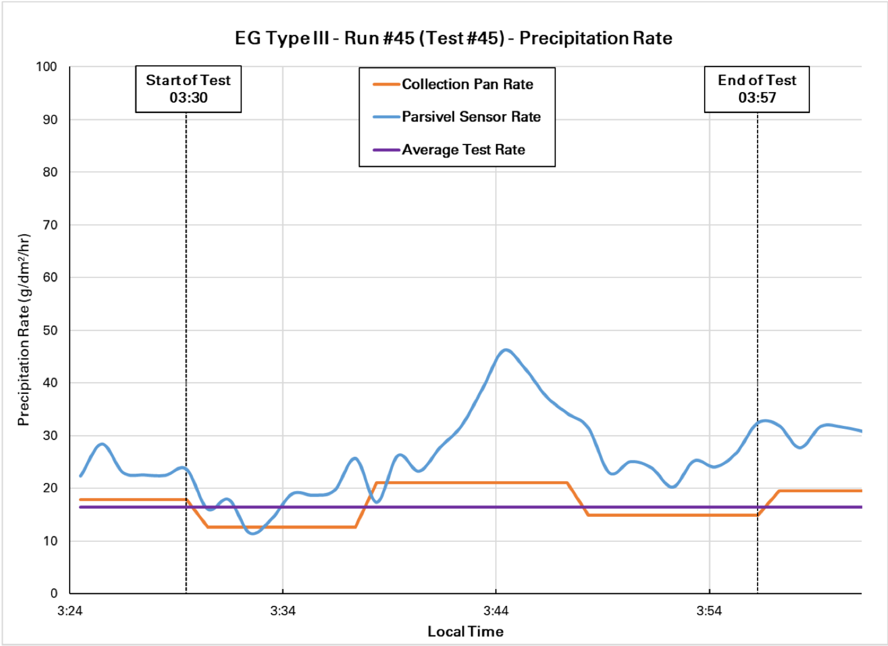
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

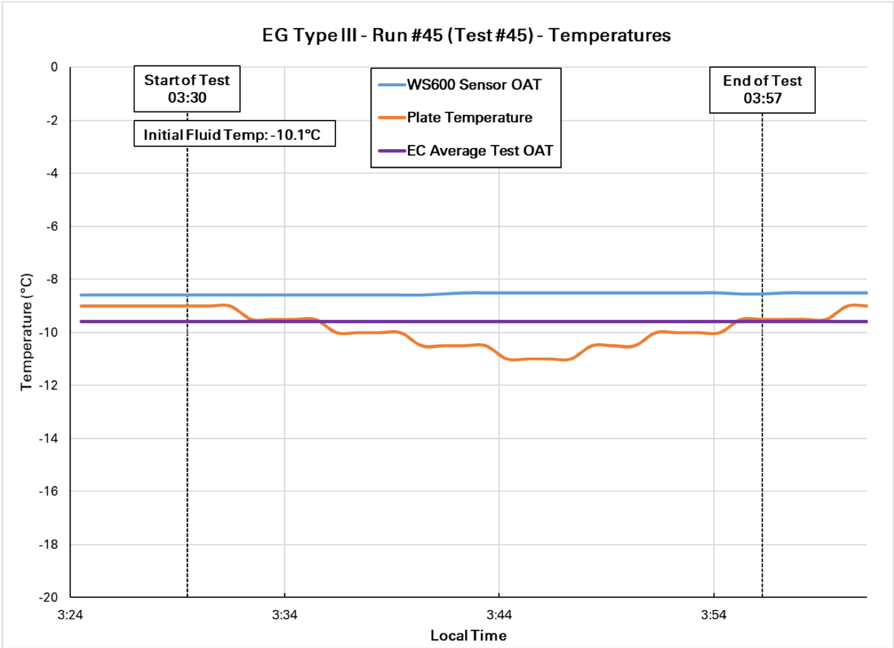
EG TYPE III
RUN #45 (TEST #45) – EG3-45

EG Type III – Run #45 (Test #45) – General Test Information

Test Number:	**EG3-45**
Date of Test:	**February 10, 2020**
Average OAT:	**-9.6**
Average Precipitation Rate:	**16.5 g/dm²/h**
Average Wind Speed:	**13.0 km/h**
Average Relative Humidity:	**85.6%**
Pour Time (Local):	**03:30:00**
Time of Fluid Failure (Local):	**03:57:00**
Fluid Brix at Failure:	**14.5°**
Endurance Time:	**27 minutes**
Expected Regression-Derived Endurance Time:	**30.7 minutes**
Difference (ET vs. Reg ET):	**-3.7 minutes (-12.1%)**

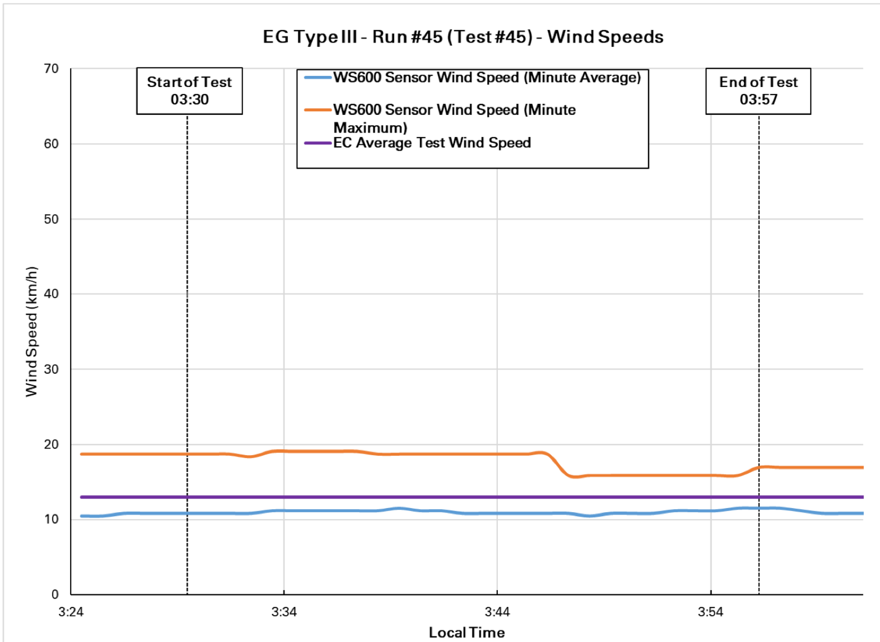


EG Type III - Run #45 (Test #45) - Precipitation Rate
Start of Test 03:30
End of Test 03:57
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
100
90
80
70
60
50
40
30
20
10
0
3:24
3:34
3:44
3:54
Local Time



EG Type III - Run #45 (Test #45) - Temperatures
Start of Test 03:30
Initial Fluid Temp: -10.1°C
End of Test 03:57
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:24
3:34
3:44
3:54
Local Time

DATA PACKAGE – EG TYPE III – RUN 45 (TEST 45)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 45 - Test 45/Data Package - EG Type III - Run 45 - Test 45.docx
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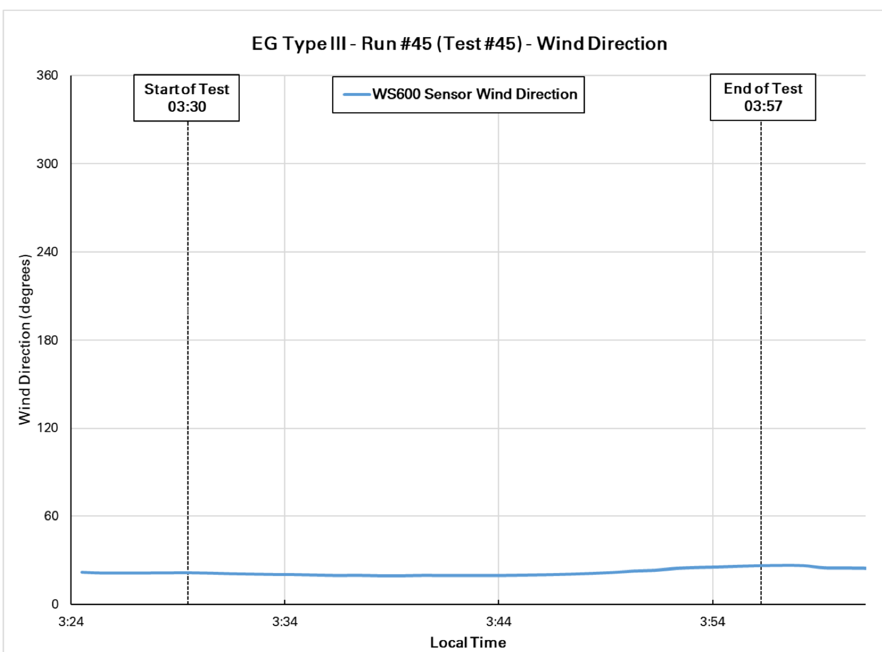
DATA PACKAGE – EG TYPE III – RUN 45 (TEST 45)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 45 - Test 45/Data Package - EG Type III - Run 45 - Test 45.docx
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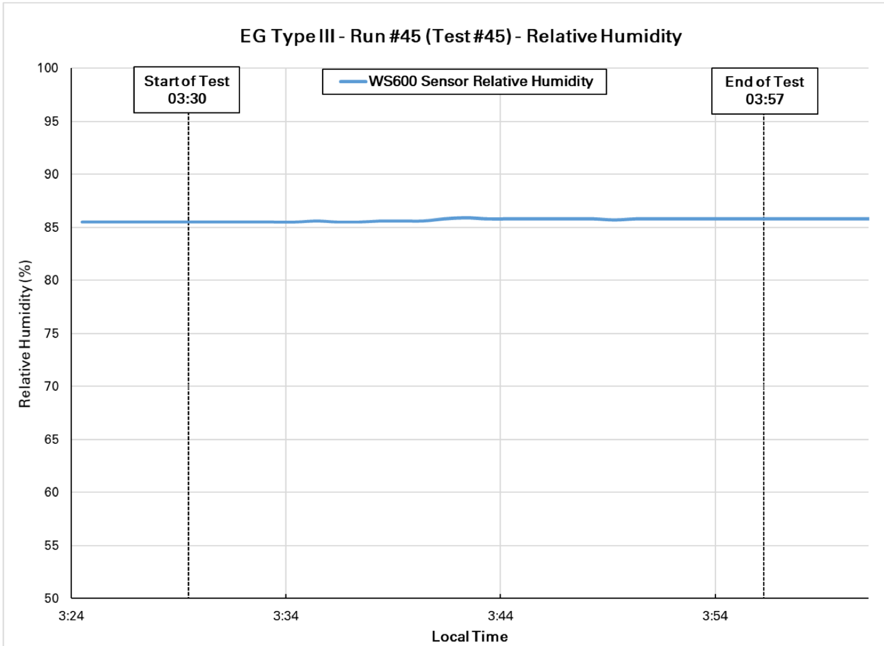
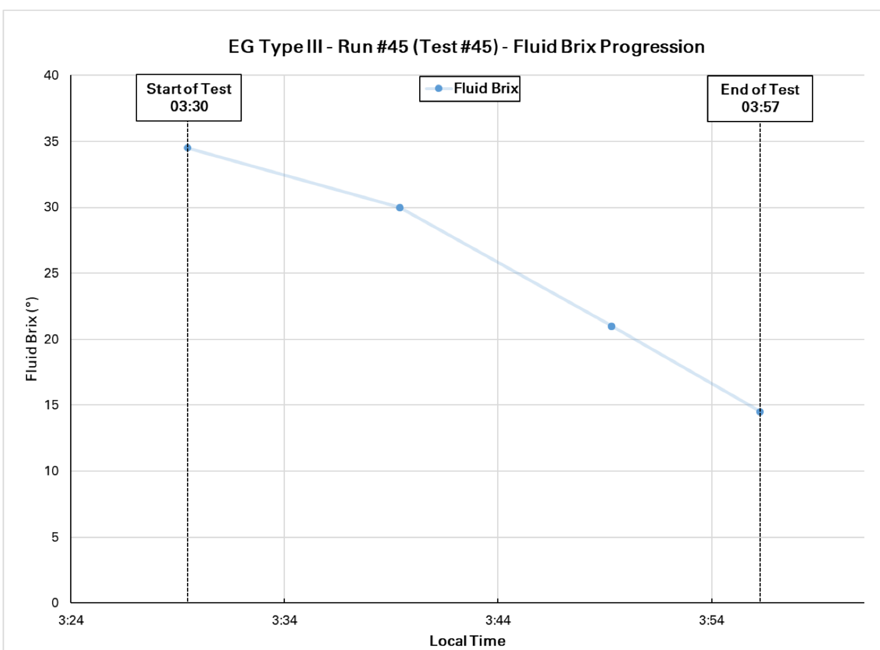
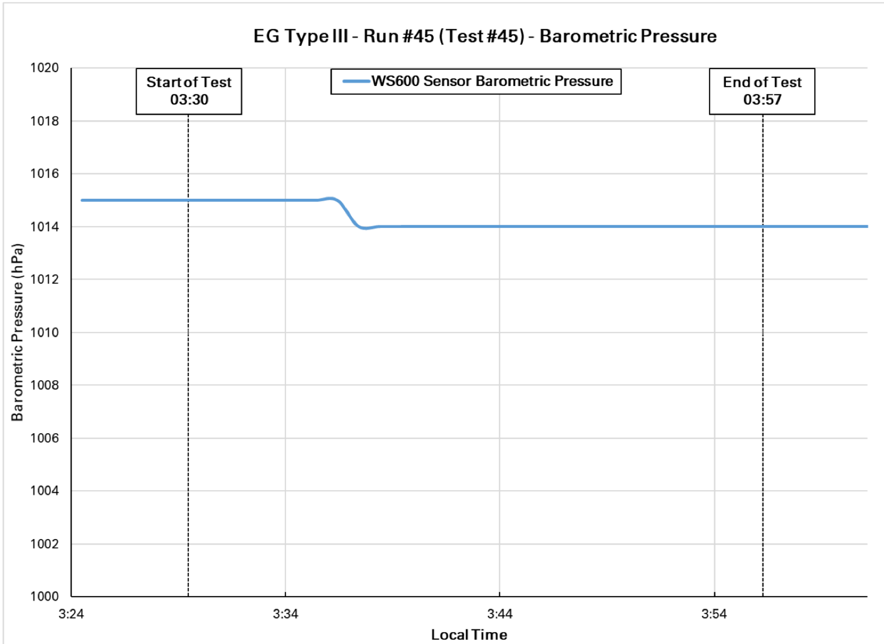
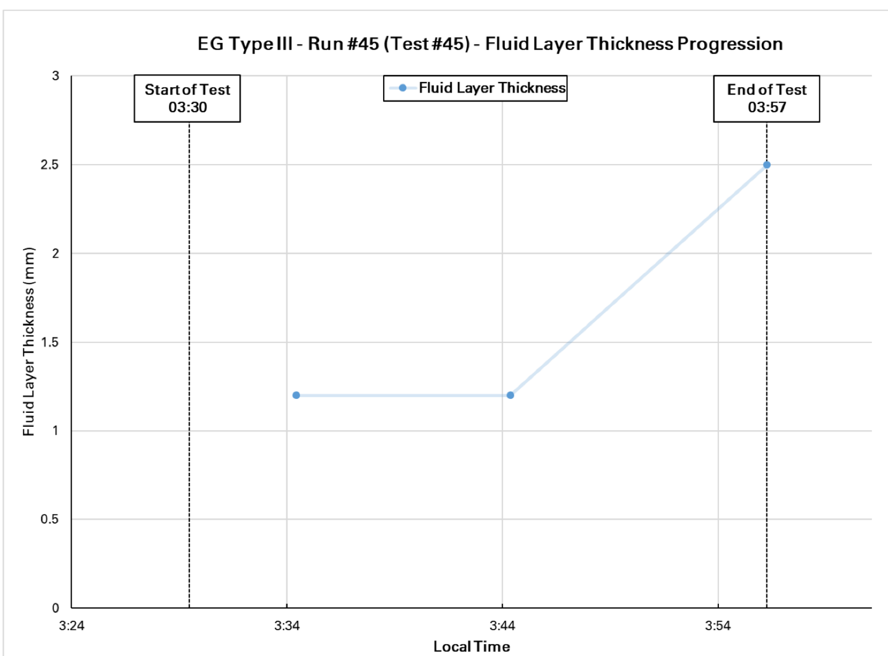
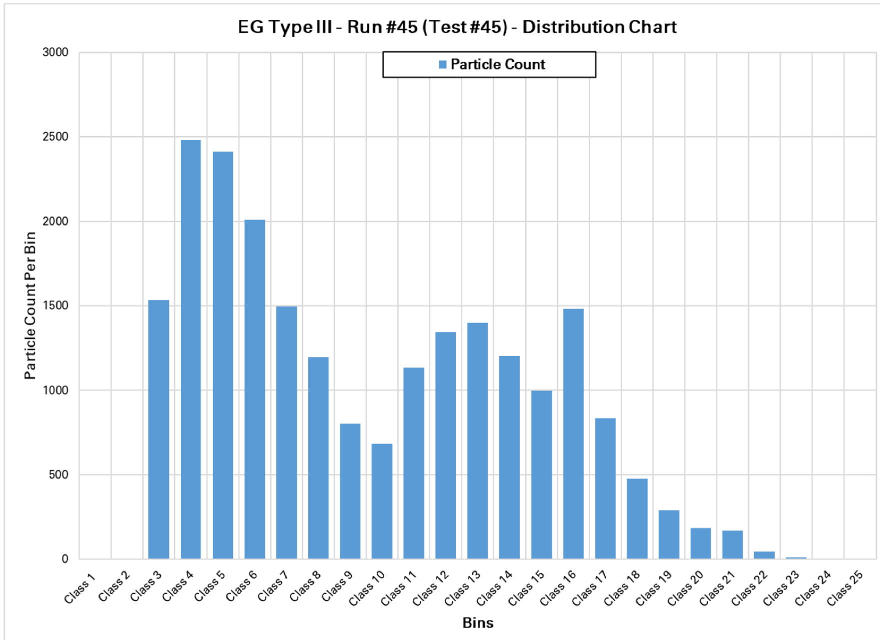

EG Type III - Run #45 (Test #45) - Relative Humidity
Start of Test 03:30
WS600 Sensor Relative Humidity
End of Test 03:57
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:24
3:34
3:44
3:54
Local Time


EG Type III - Run #45 (Test #45) - Fluid Brix Progression
Start of Test 03:30
Fluid Brix
End of Test 03:57
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
3:24
3:34
3:44
3:54
Local Time


EG Type III - Run #45 (Test #45) - Barometric Pressure
Start of Test 03:30
WS600 Sensor Barometric Pressure
End of Test 03:57
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:24
3:34
3:44
3:54
Local Time


EG Type III - Run #45 (Test #45) - Fluid Layer Thickness Progression
Start of Test 03:30
Fluid Layer Thickness
End of Test 03:57
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:24
3:34
3:44
3:54
Local Time

DATA PACKAGE – EG TYPE III – RUN 45 (TEST 45)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 45 - Test 45/Data Package - EG Type III - Run 45 - Test 45.docx
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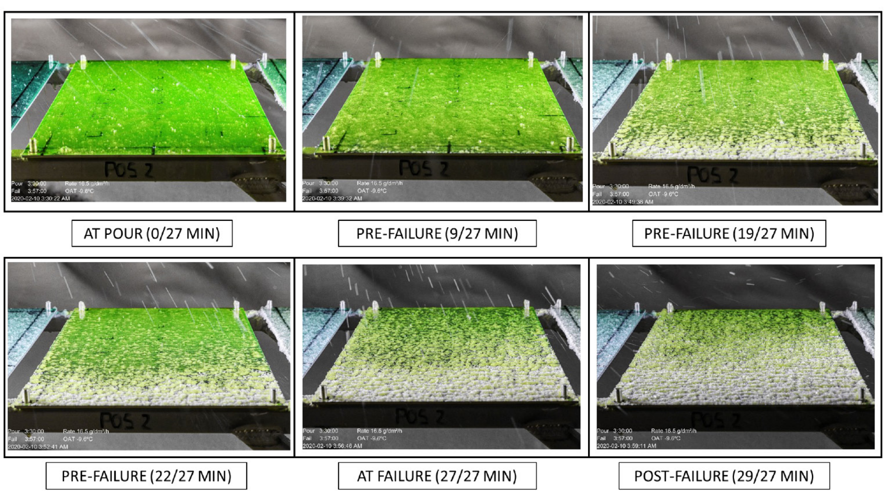
DATA PACKAGE – EG TYPE III – RUN 45 (TEST 45)

AeroClear MAX – Run 45 (Test 45) – Failure Progression Photos



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 45 - Test 45/Data Package - EG Type III - Run 45 - Test 45.docx
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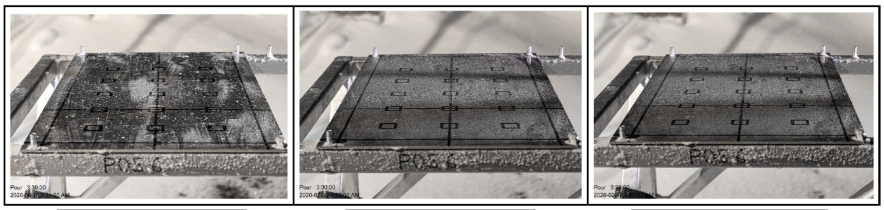
AeroClear MAX – Run 45 (Test 45) – Snow Characteristics Photos

FELT PAD (1/27 MIN) | FELT PAD (10/27 MIN) | FELT PAD (20/27 MIN)



BARE PLATE (1/27 MIN) | BARE PLATE (20/27 MIN) | BARE PLATE (25/27 MIN)

Final Bare Plate Contamination Thickness: **Nil (0 mm)**

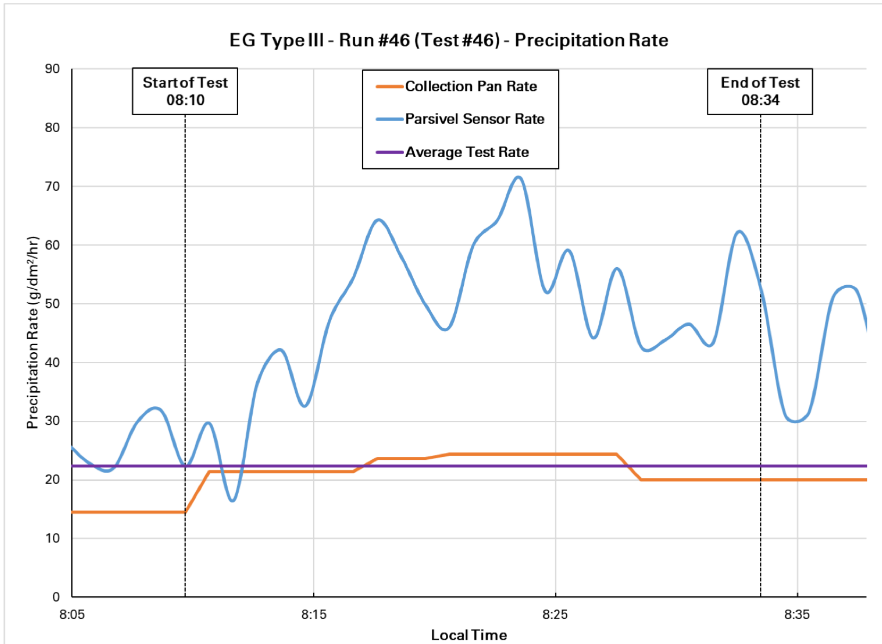
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #46 (TEST #46) – EG3-46

EG Type III – Run #46 (Test #46) – General Test Information

Test Number:	**EG3-46**
Date of Test:	**February 18, 2020**
Average OAT:	**-12.1**
Average Precipitation Rate:	**22.3 g/dm²/h**
Average Wind Speed:	**15.7 km/h**
Average Relative Humidity:	**75.5%**
Pour Time (Local):	**08:10:00**
Time of Fluid Failure (Local):	**08:34:00**
Fluid Brix at Failure:	**16.5°**
Endurance Time:	**24 minutes**
Expected Regression-Derived Endurance Time:	**25.1 minutes**
Difference (ET vs. Reg ET):	**-1.1 minutes (-4.5%)**

DATA PACKAGE – EG TYPE III – RUN 46 (TEST 46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 46 - Test 46/Data Package - EG Type III - Run 46 - Test 46.docx
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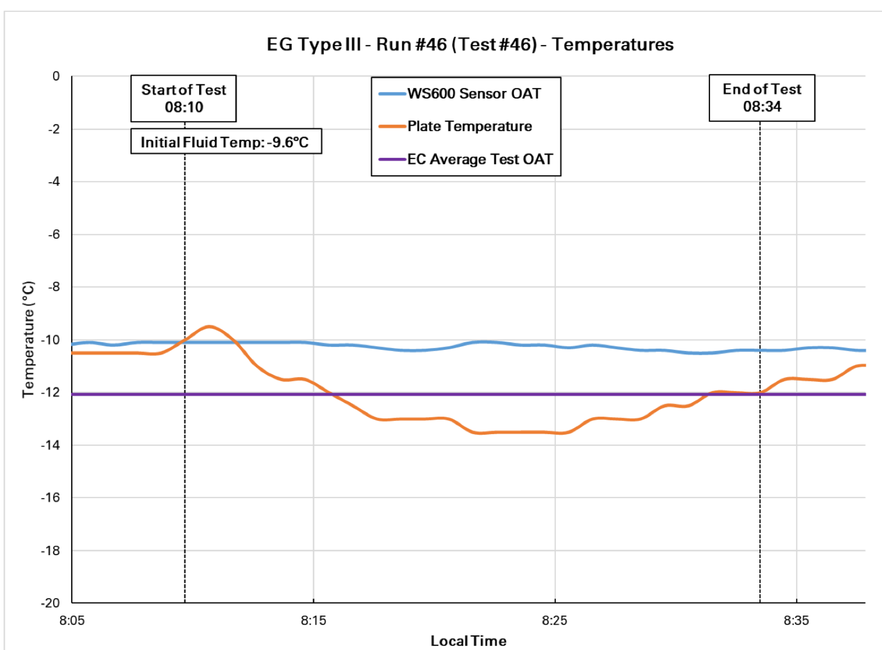
DATA PACKAGE – EG TYPE III – RUN 46 (TEST 46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 46 - Test 46/Data Package - EG Type III - Run 46 - Test 46.docx
Final Version 1.0, March 2021

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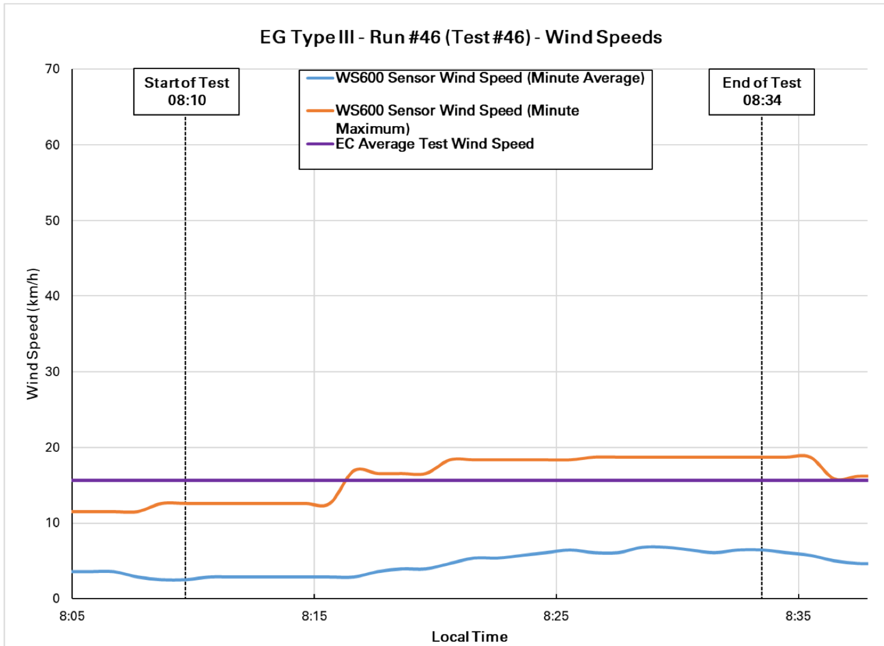
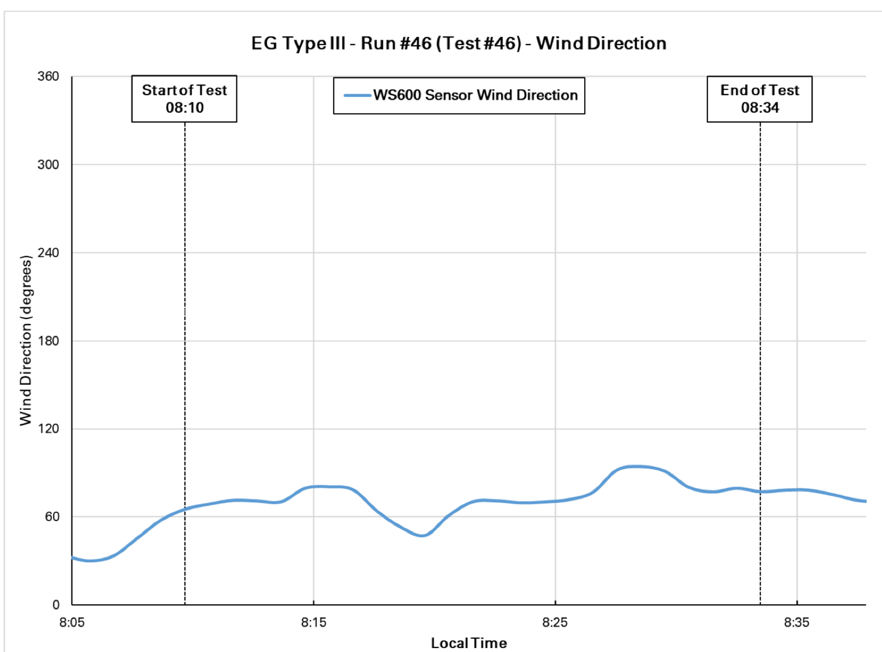
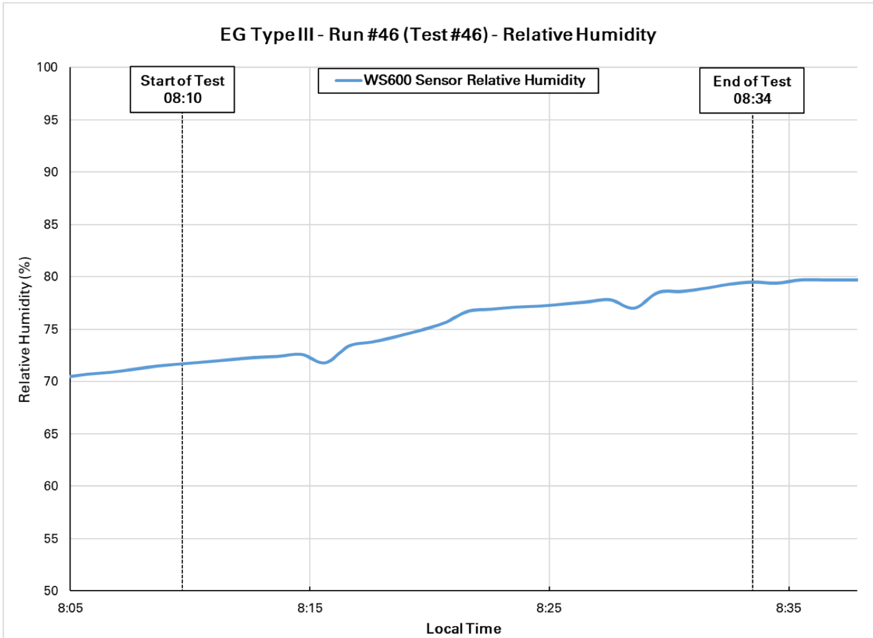
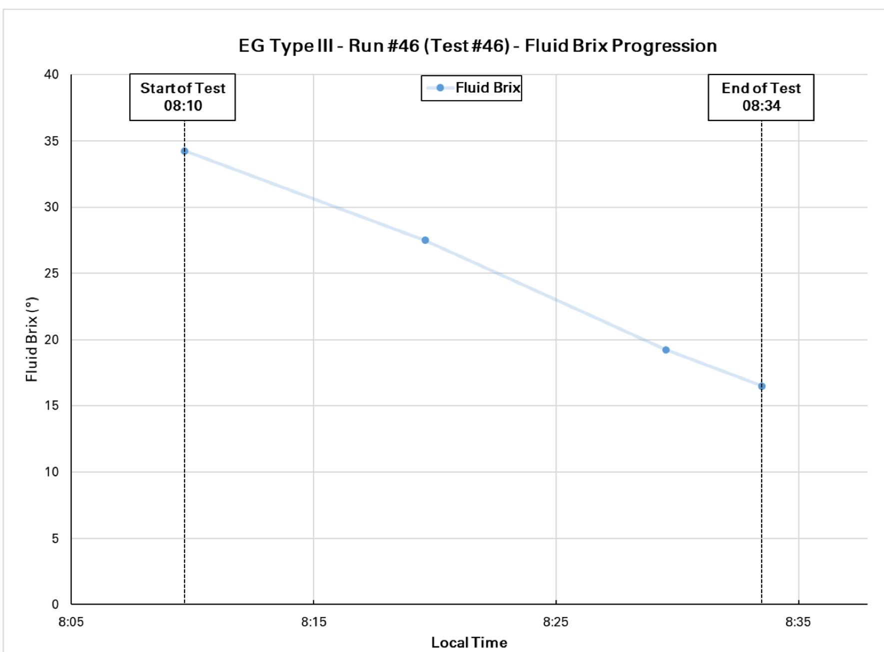

EG Type III - Run #46 (Test #46) - Wind Speeds
Start of Test 08:10
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 08:34
Wind Speed (km/h)
70
60
50
40
30
20
10
0
8:05
8:15
8:25
8:35
Local Time


EG Type III - Run #46 (Test #46) - Wind Direction
Start of Test 08:10
WS600 Sensor Wind Direction
End of Test 08:34
Wind Direction (degrees)
360
300
240
180
120
60
0
8:05
8:15
8:25
8:35
Local Time

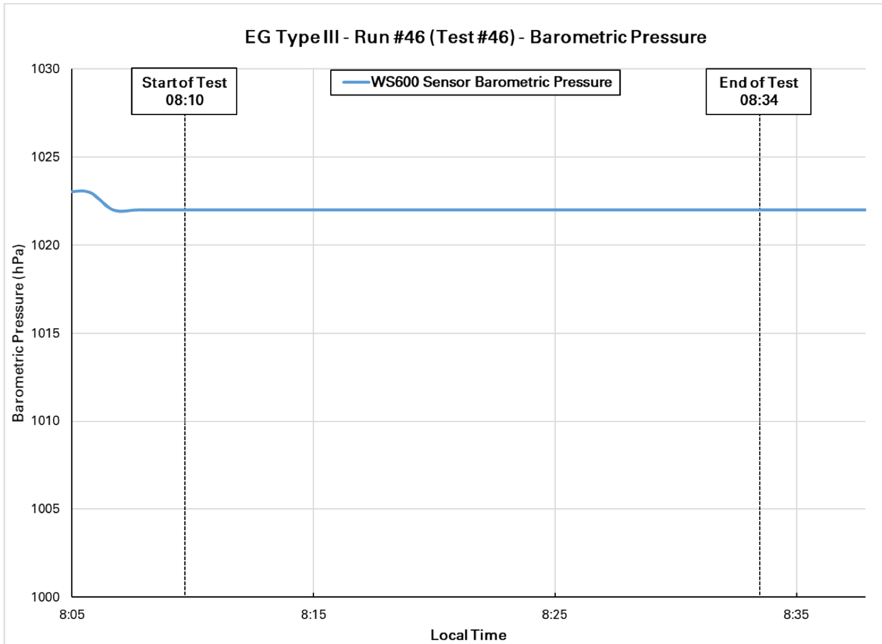


EG Type III - Run #46 (Test #46) - Relative Humidity
Start of Test 08:10
WS600 Sensor Relative Humidity
End of Test 08:34
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
8:05
8:15
8:25
8:35
Local Time



EG Type III - Run #46 (Test #46) - Fluid Brix Progression
Start of Test 08:10
Fluid Brix
End of Test 08:34
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
8:05
8:15
8:25
8:35
Local Time

DATA PACKAGE – EG TYPE III – RUN 46 (TEST 46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 46 - Test 46/Data Package - EG Type III - Run 46 - Test 46.docx
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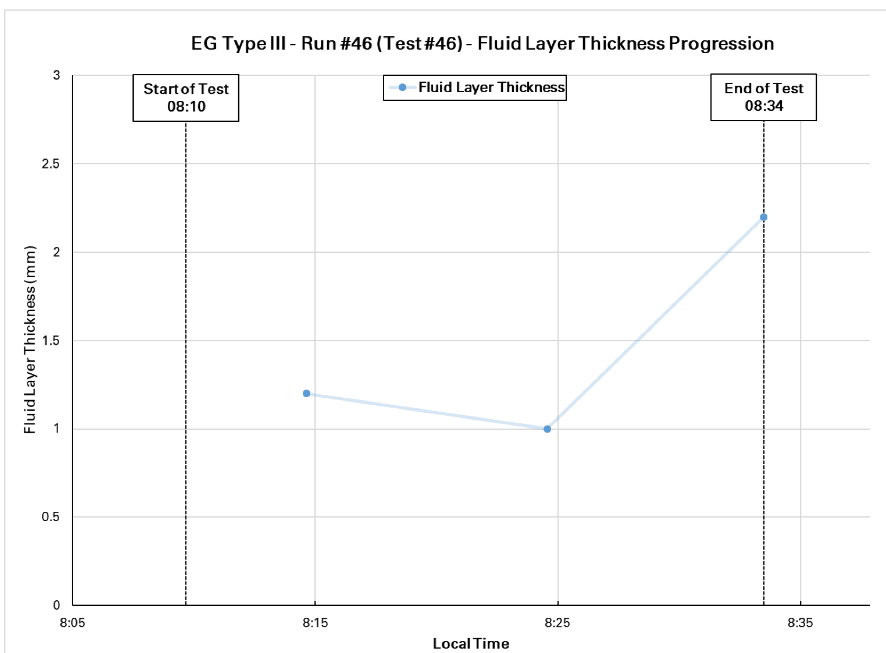
DATA PACKAGE – EG TYPE III – RUN 46 (TEST 46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 46 - Test 46/Data Package - EG Type III - Run 46 - Test 46.docx
Final Version 1.0, March 2021

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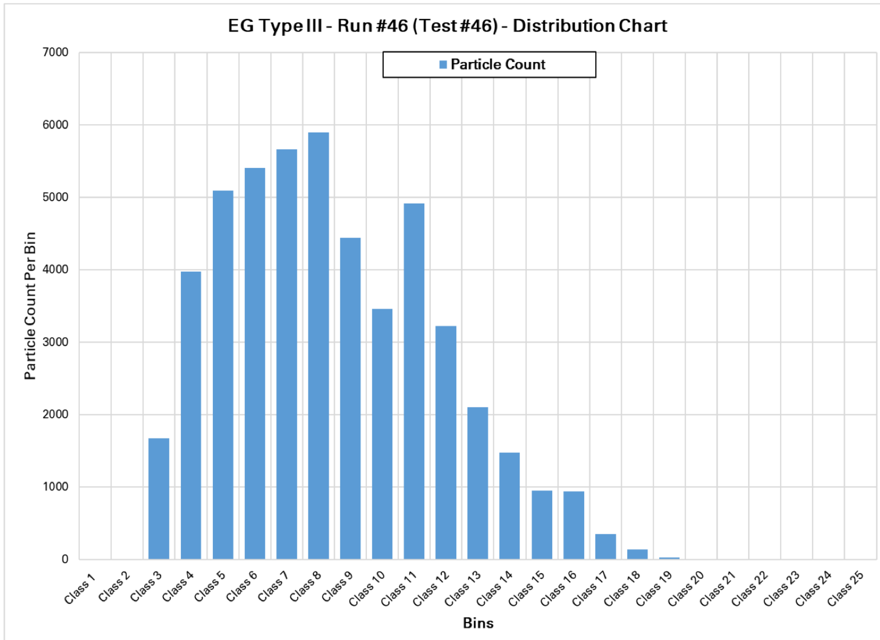
DATA PACKAGE – EG TYPE III – RUN 46 (TEST 46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 46 - Test 46/Data Package - EG Type III - Run 46 - Test 46.docx
Final Version 1.0, March 2021

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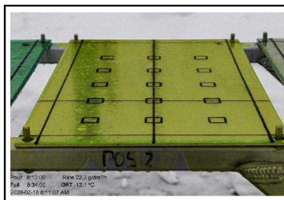
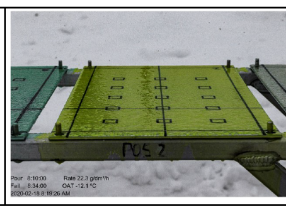
DATA PACKAGE – EG TYPE III – RUN 46 (TEST 46)

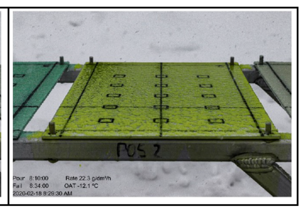
AeroClear MAX – Run 46 (Test 46) – Failure Progression Photos



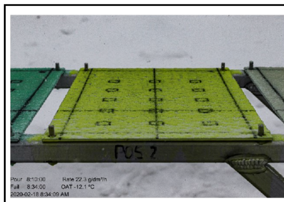
AT POUR (0/24 MIN)



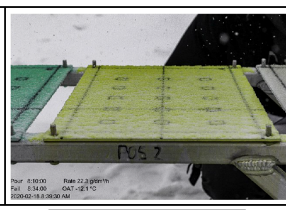
PRE-FAILURE (9/24 MIN)



PRE-FAILURE (19/24 MIN)



AT FAILURE (24/24 MIN)



POST-FAILURE (29/24 MIN)

No Photo Available

POST-FAILURE (-/- MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 46 - Test 46/Data Package - EG Type III - Run 46 - Test 46.docx
Final Version 1.0, March 2021

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AeroClear MAX – Run 46 (Test 46) – Snow Characteristics Photos

FELT PAD (1/24 MIN) | FELT PAD (10/24 MIN) | FELT PAD (20/24 MIN)

BARE PLATE (1/24 MIN) | BARE PLATE (9/24 MIN) | BARE PLATE (19/24 MIN)

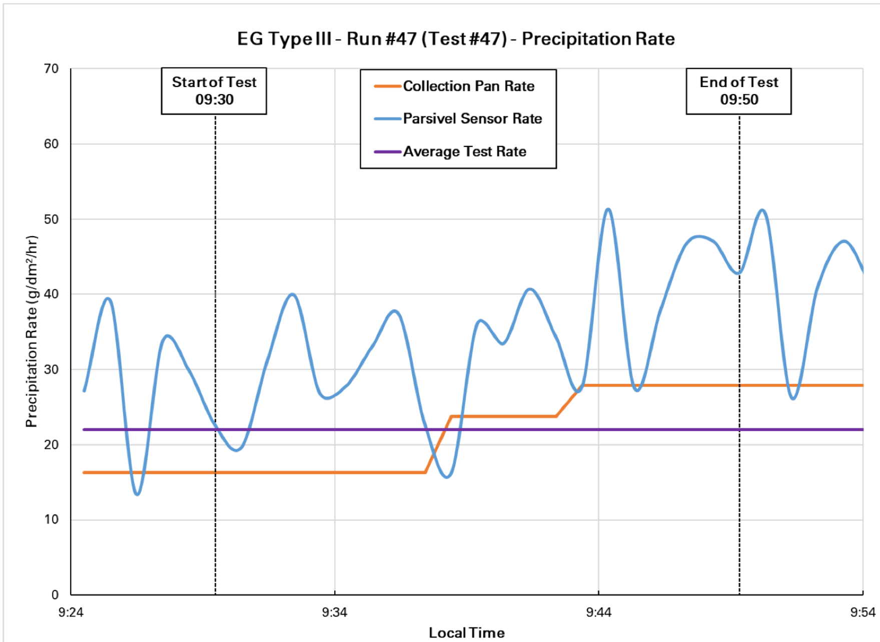
Final Bare Plate Contamination Thickness: **Nil (0mm)**

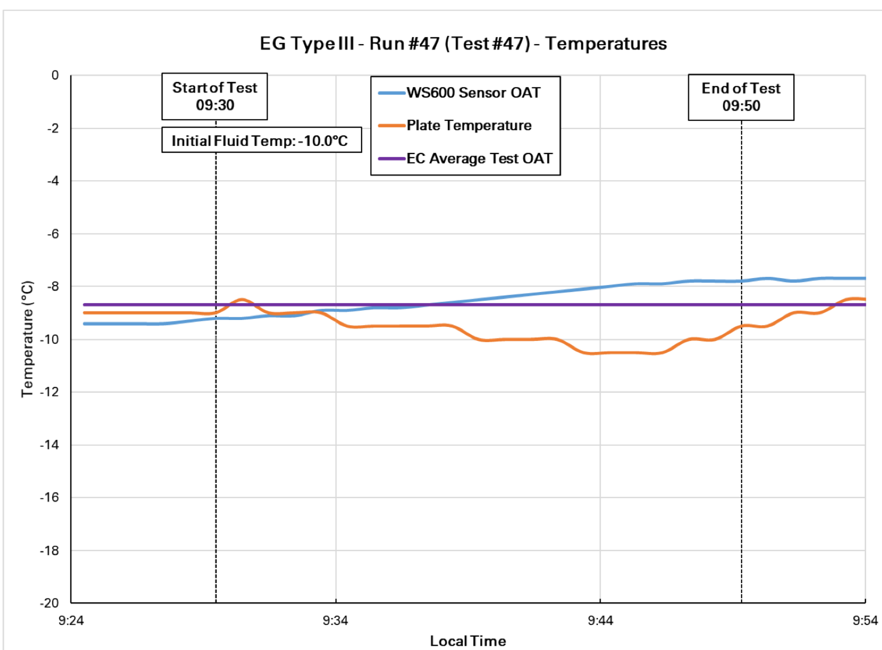
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

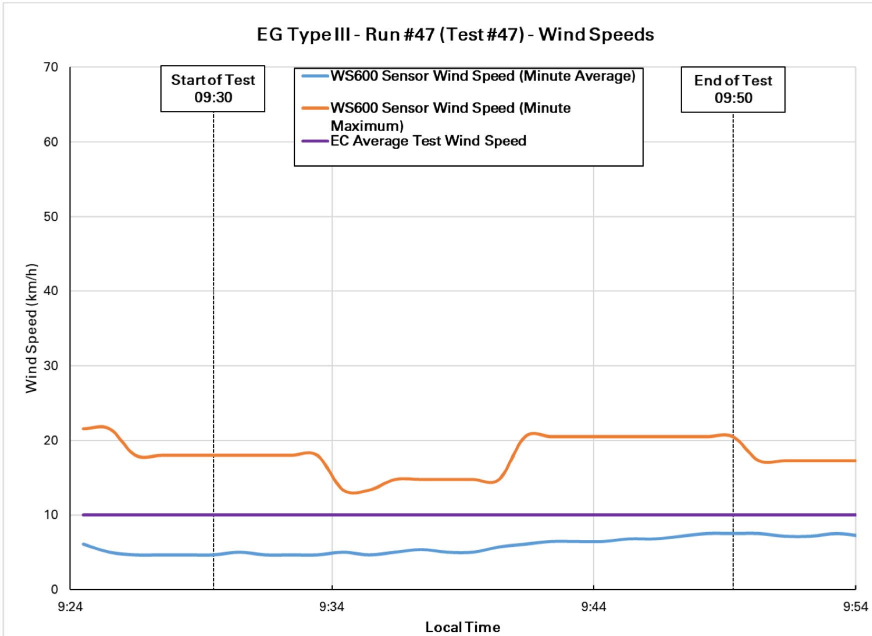
EG TYPE III
RUN #47 (TEST #47) – EG3-47

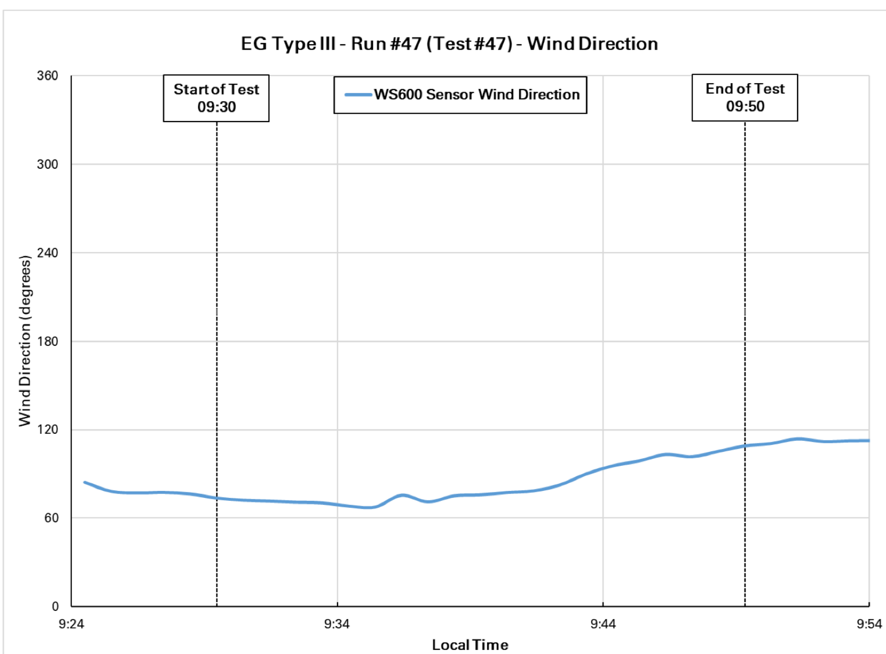
EG Type III – Run #47 (Test #47) – General Test Information

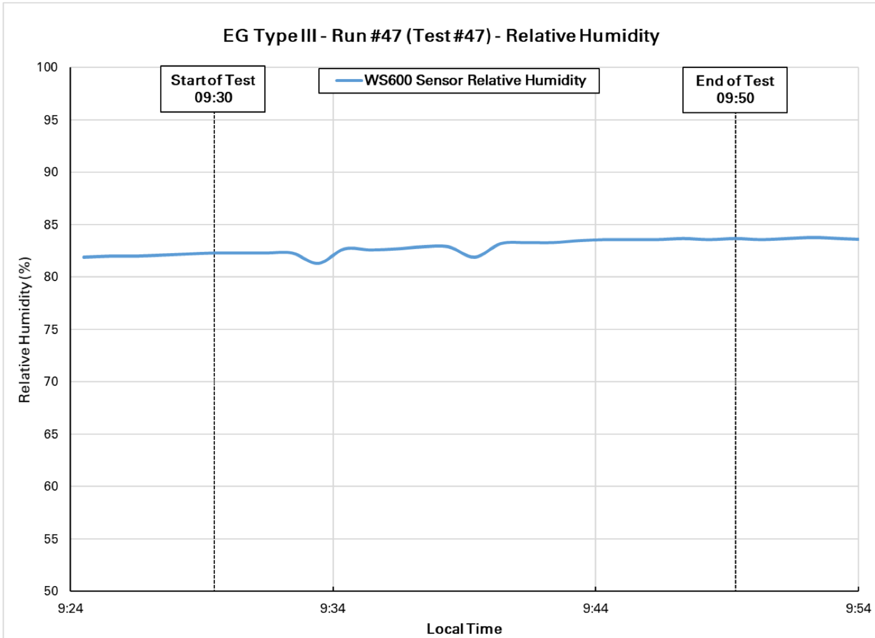
Test Number:	**EG3-47**
Date of Test:	**February 18, 2020**
Average OAT:	**-8.7**
Average Precipitation Rate:	**22.0 g/dm²/h**
Average Wind Speed:	**10.0 km/h**
Average Relative Humidity:	**82.9%**
Pour Time (Local):	**09:30:00**
Time of Fluid Failure (Local):	**09:50:00**
Fluid Brix at Failure:	**16.75°**
Endurance Time:	**20 minutes**
Expected Regression-Derived Endurance Time:	**25.4 minutes**
Difference (ET vs. Reg ET):	**-5.4 minutes (-21.2%)**

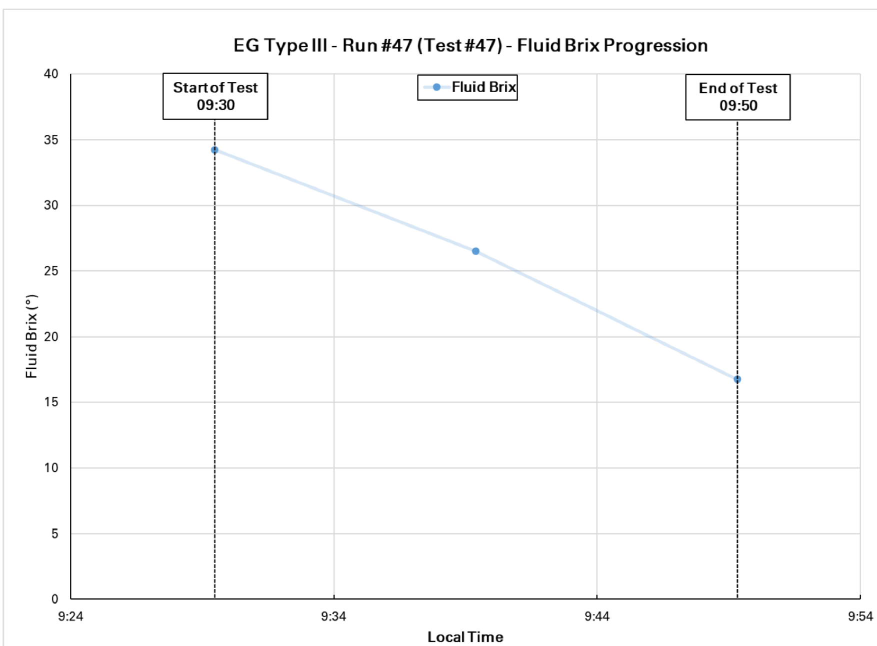

EG Type III - Run #47 (Test #47) - Precipitation Rate
Start of Test 09:30
End of Test 09:50
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
Local Time
0
10
20
30
40
50
60
70
9:24
9:34
9:44
9:54

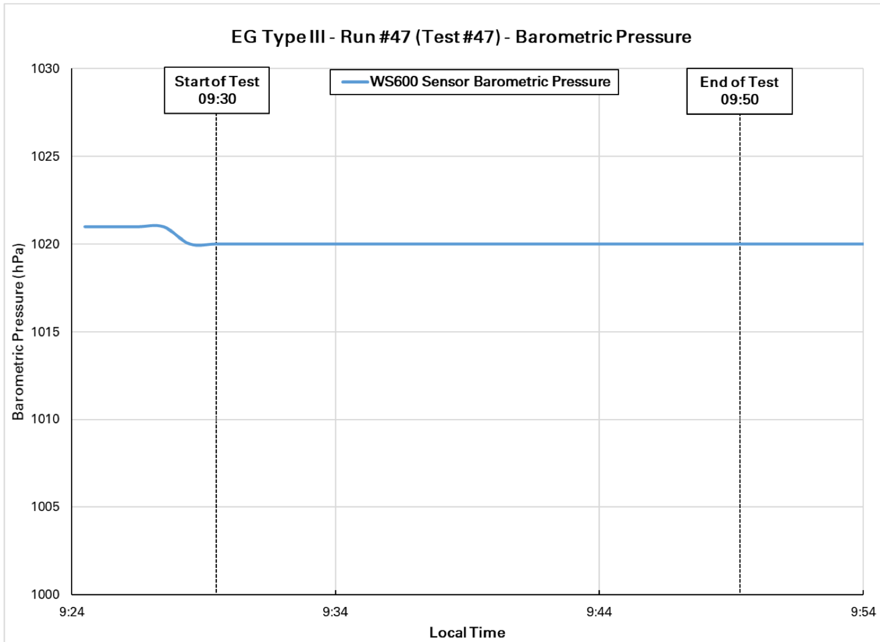

EG Type III - Run #47 (Test #47) - Temperatures
Start of Test 09:30
Initial Fluid Temp: -10.0°C
End of Test 09:50
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
Local Time
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
9:24
9:34
9:44
9:54

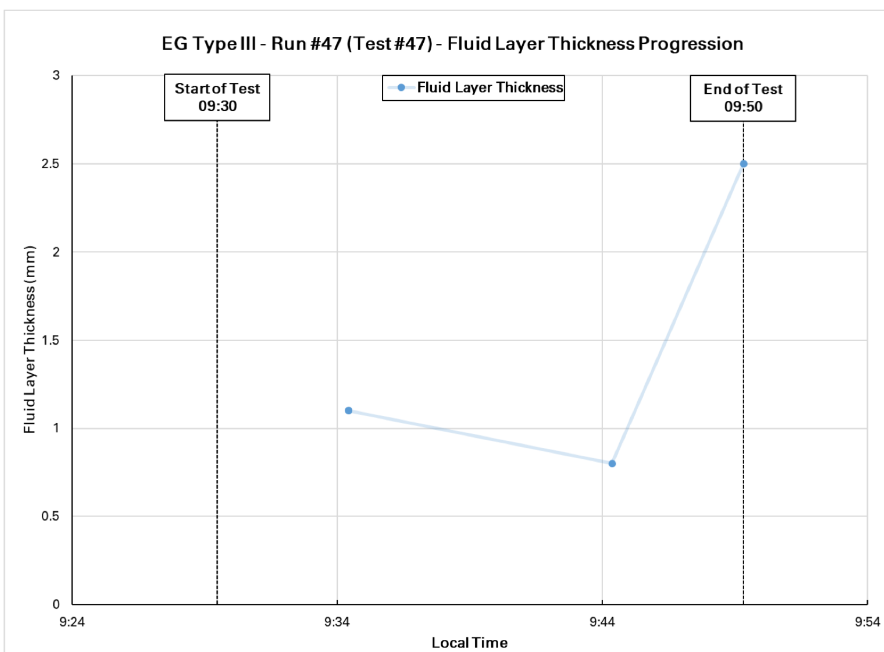

EG Type III - Run #47 (Test #47) - Wind Speeds
Start of Test 09:30
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test 09:50
Wind Speed (km/h)
0
10
20
30
40
50
60
70
9:24
9:34
9:44
9:54
Local Time


EG Type III - Run #47 (Test #47) - Wind Direction
Start of Test 09:30
WS600 Sensor Wind Direction
End of Test 09:50
Wind Direction (degrees)
0
60
120
180
240
300
360
9:24
9:34
9:44
9:54
Local Time

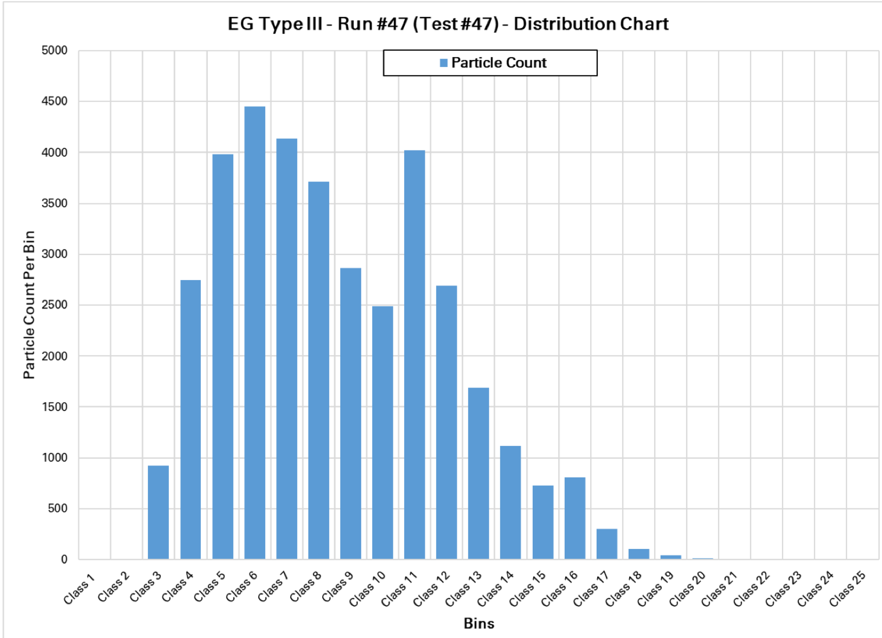

EG Type III - Run #47 (Test #47) - Relative Humidity
Start of Test 09:30
WS600 Sensor Relative Humidity
End of Test 09:50
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
9:24
9:34
9:44
9:54
Local Time


EG Type III - Run #47 (Test #47) - Fluid Brix Progression
Start of Test 09:30
Fluid Brix
End of Test 09:50
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
9:24
9:34
9:44
9:54
Local Time


EG Type III - Run #47 (Test #47) - Barometric Pressure
Start of Test 09:30
WS600 Sensor Barometric Pressure
End of Test 09:50
Barometric Pressure (hPa)
1030
1025
1020
1015
1010
1005
1000
9:24
9:34
9:44
9:54
Local Time


EG Type III - Run #47 (Test #47) - Fluid Layer Thickness Progression
Start of Test 09:30
Fluid Layer Thickness
End of Test 09:50
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
9:24
9:34
9:44
9:54
Local Time

DATA PACKAGE – EG TYPE III – RUN 47 (TEST 47)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 47 - Test 47/Data Package - EG Type III - Run 47 - Test 47.docx
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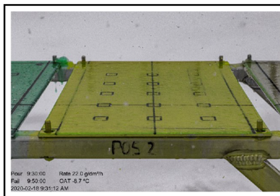
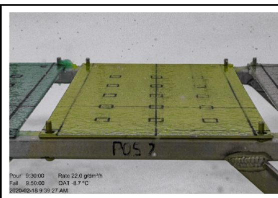
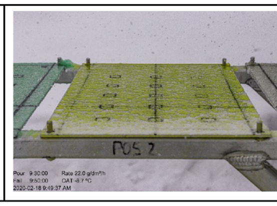
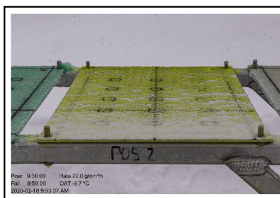
DATA PACKAGE – EG TYPE III – RUN 47 (TEST 47)

AeroClear MAX – Run 47 (Test 47) – Failure Progression Photos

		
AT POUR (0/20 MIN)	PRE-FAILURE (9/20 MIN)	AT FAILURE (20/20 MIN)
	No Photo Available	No Photo Available
POST-FAILURE (23/20 MIN)	POST-FAILURE (-/- MIN)	POST-FAILURE (-/- MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 47 - Test 47/Data Package - EG Type III - Run 47 - Test 47.docx
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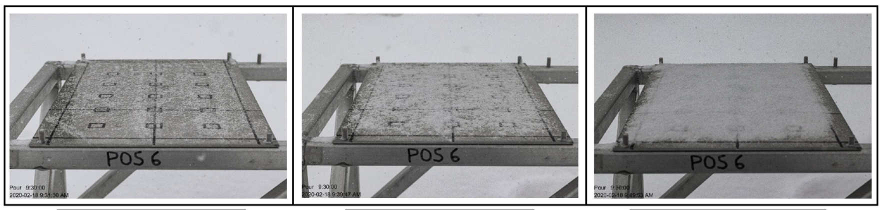
AeroClear MAX – Run 47 (Test 47) – Snow Characteristics Photos

FELT PAD (1/20 MIN) FELT PAD (10/20 MIN) FELT PAD (20/20 MIN)



BARE PLATE (1/20 MIN) BARE PLATE (9/20 MIN) BARE PLATE (19/20 MIN)

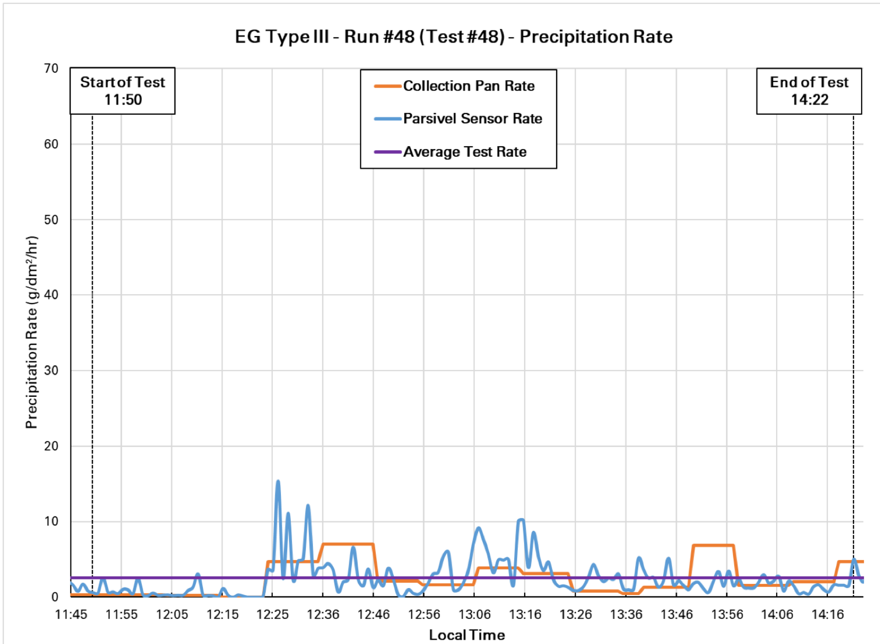
Final Bare Plate Contamination Thickness: **Nil (0mm)**

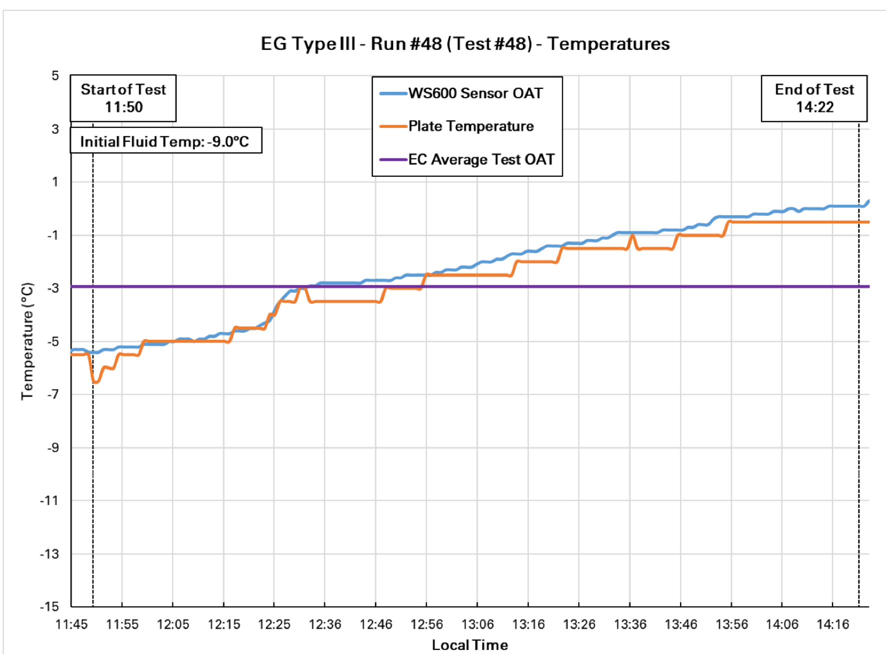
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

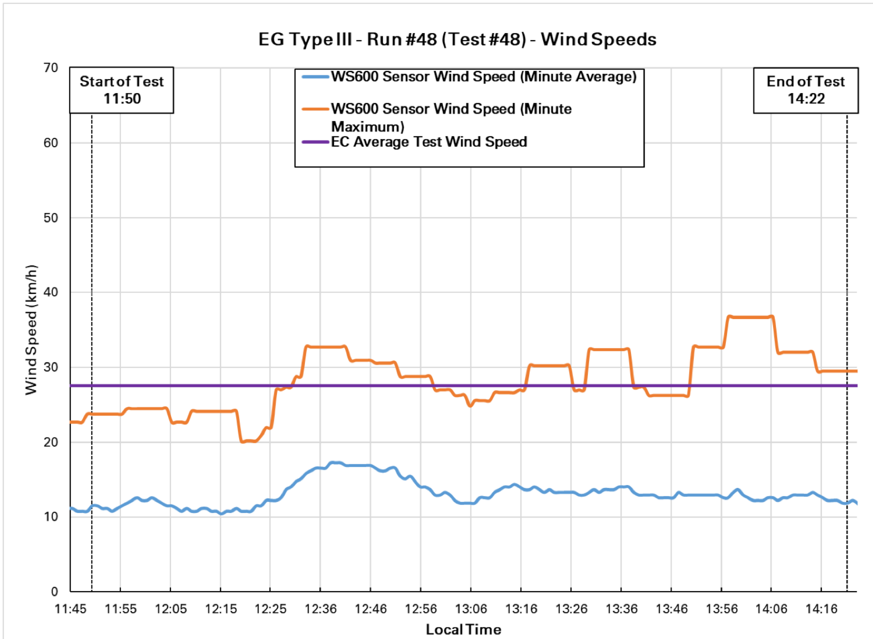
EG TYPE III
RUN #48 (TEST #48) – EG3-48

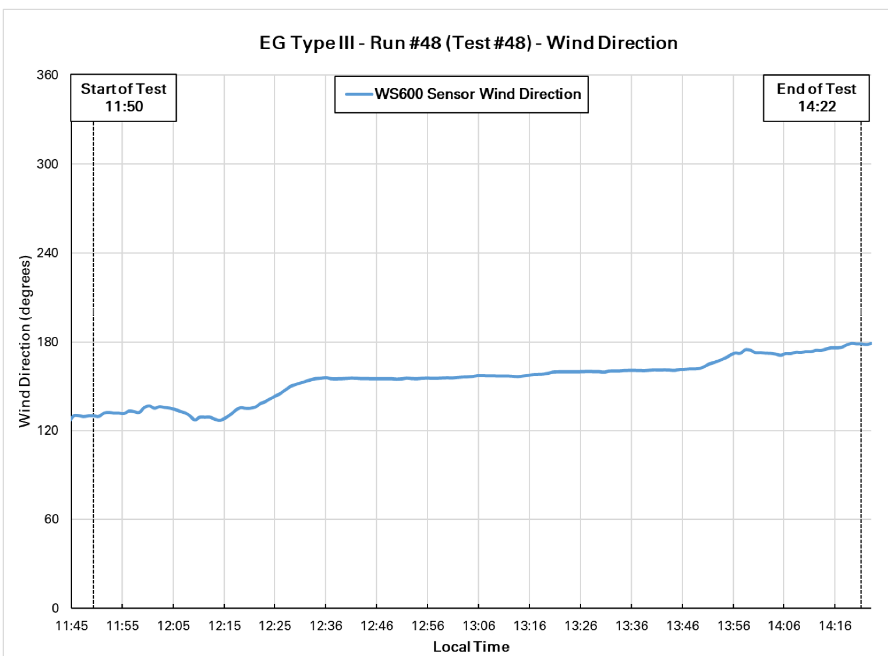
EG Type III – Run #48 (Test #48) – General Test Information

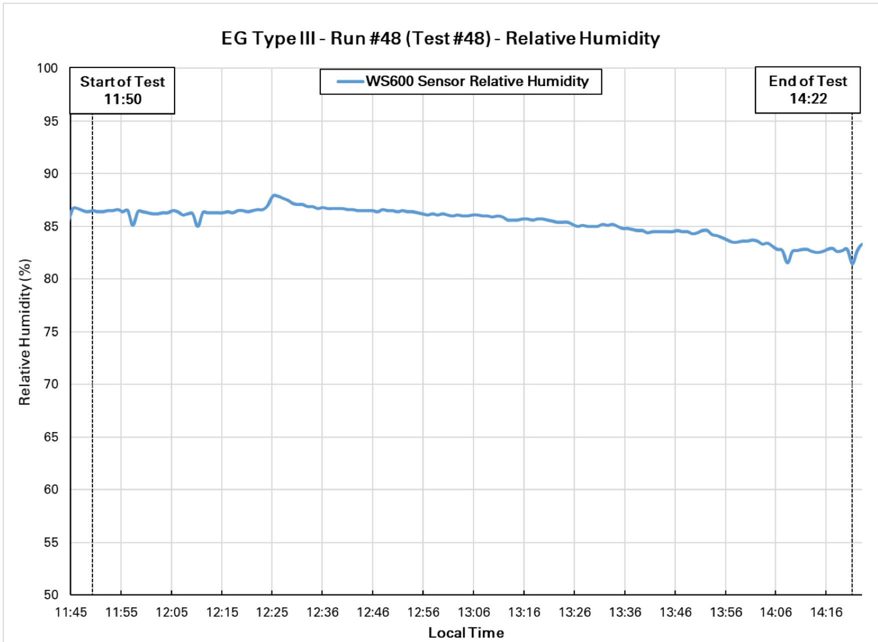
Test Number:	EG3-48
Date of Test:	February 18, 2020
Average OAT:	-2.9
Average Precipitation Rate:	2.5 g/dm²/h
Average Wind Speed:	27.5 km/h
Average Relative Humidity:	86.5%
Pour Time (Local):	11:50:00
Time of Fluid Failure (Local):	14:22:00
Fluid Brix at Failure:	4°
Endurance Time:	152 minutes
Expected Regression-Derived Endurance Time:	105.4 minutes
Difference (ET vs. Reg ET):	+46.8 minutes (+44.4%)

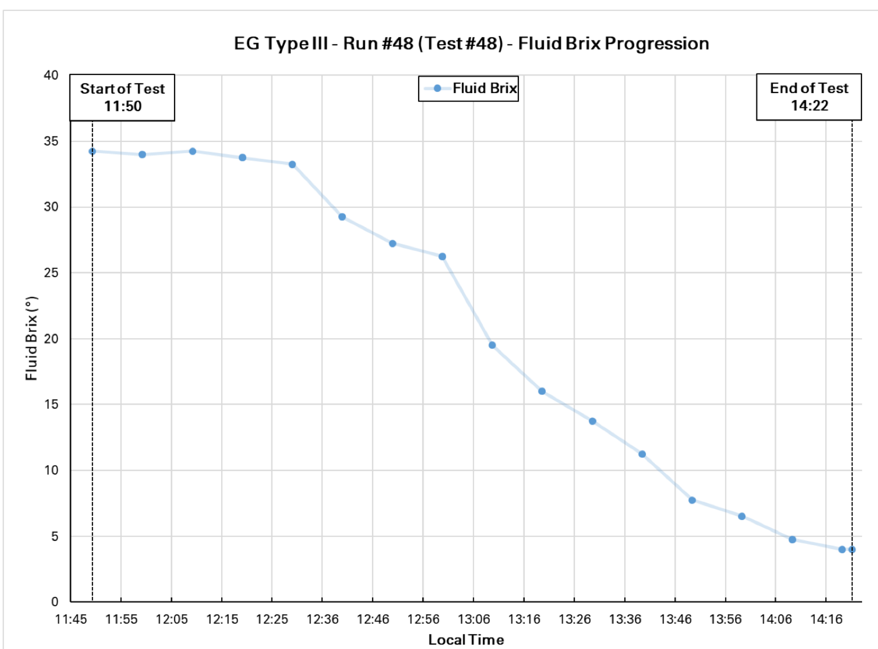

EG Type III - Run #48 (Test #48) - Precipitation Rate
Start of Test 11:50
End of Test 14:22
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
11:45
11:55
12:05
12:15
12:25
12:36
12:46
12:56
13:06
13:16
13:26
13:36
13:46
13:56
14:06
14:16
Local Time

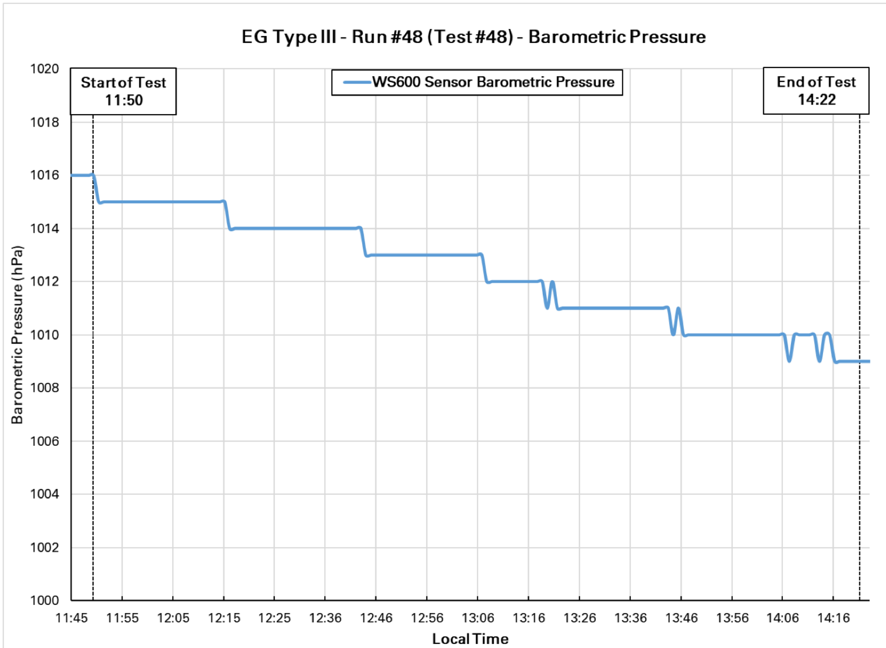

EG Type III - Run #48 (Test #48) - Temperatures
Start of Test 11:50
End of Test 14:22
Initial Fluid Temp: -9.0°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
11:45
11:55
12:05
12:15
12:25
12:36
12:46
12:56
13:06
13:16
13:26
13:36
13:46
13:56
14:06
14:16
Local Time


EG Type III - Run #48 (Test #48) - Wind Speeds
Start of Test 11:50
End of Test 14:22
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
11:45
11:55
12:05
12:15
12:25
12:36
12:46
12:56
13:06
13:16
13:26
13:36
13:46
13:56
14:06
14:16

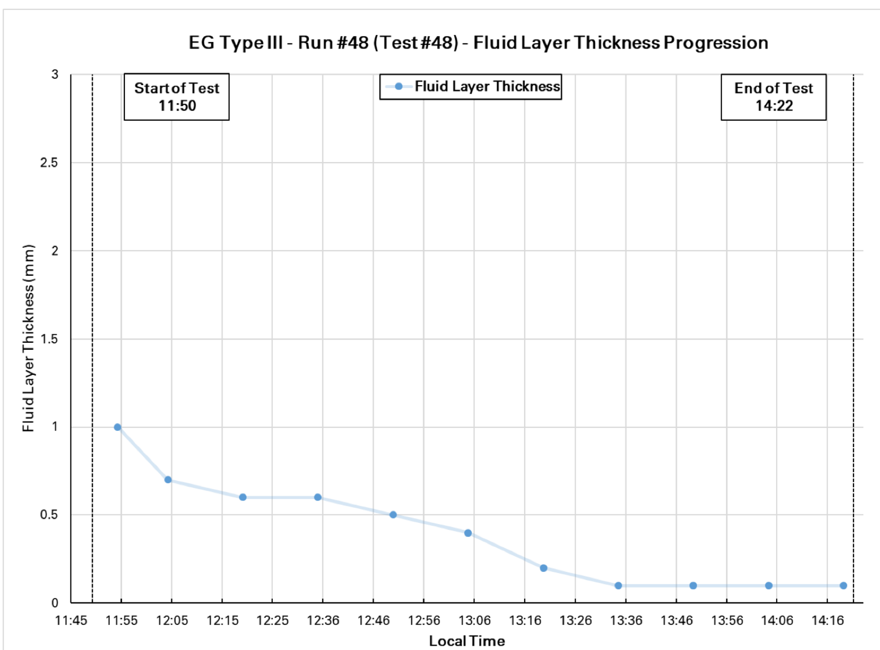

EG Type III - Run #48 (Test #48) - Wind Direction
Start of Test 11:50
WS600 Sensor Wind Direction
End of Test 14:22
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
11:45
11:55
12:05
12:15
12:25
12:36
12:46
12:56
13:06
13:16
13:26
13:36
13:46
13:56
14:06
14:16

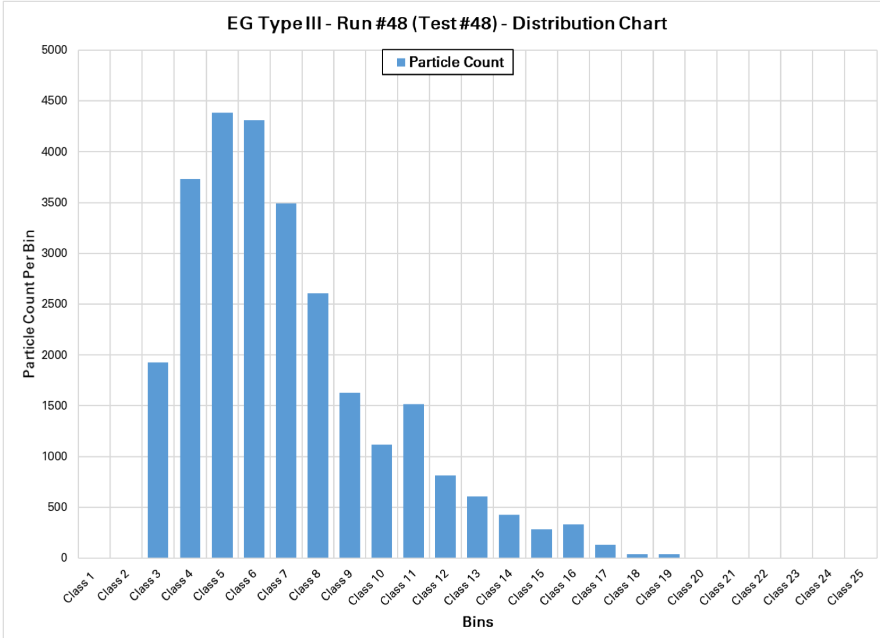

EG Type III - Run #48 (Test #48) - Relative Humidity
Start of Test 11:50
WS600 Sensor Relative Humidity
End of Test 14:22
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
11:45 11:55 12:05 12:15 12:25 12:36 12:46 12:56 13:06 13:16 13:26 13:36 13:46 13:56 14:06 14:16
Local Time


EG Type III - Run #48 (Test #48) - Fluid Brix Progression
Start of Test 11:50
Fluid Brix
End of Test 14:22
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
11:45 11:55 12:05 12:15 12:25 12:36 12:46 12:56 13:06 13:16 13:26 13:36 13:46 13:56 14:06 14:16
Local Time

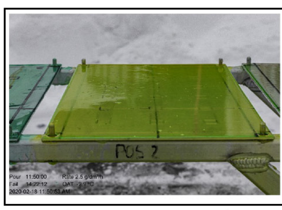


DATA PACKAGE – EG TYPE III – RUN 48 (TEST 48)

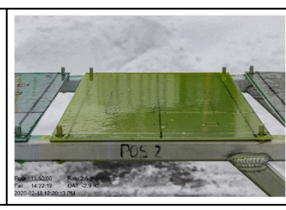




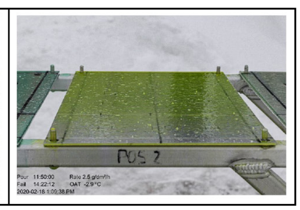
AeroClear MAX – Run 48 (Test 48) – Failure Progression Photos



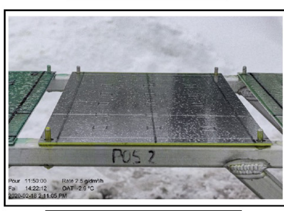
AT POUR (0/152 MIN)



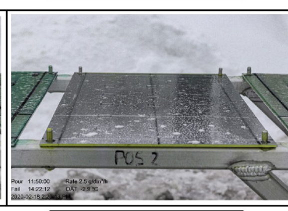
PRE-FAILURE (30/152 MIN)



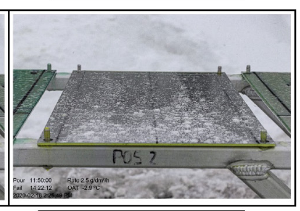
PRE-FAILURE (79/152 MIN)



PRE-FAILURE (141/152 MIN)

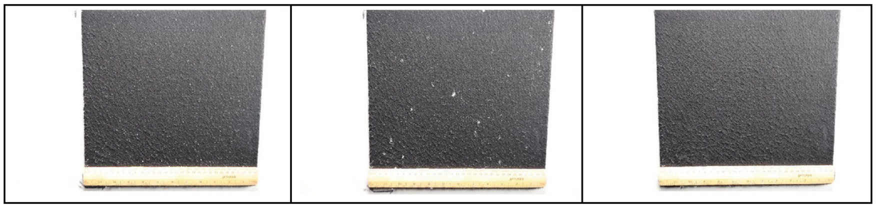


AT FAILURE (150/152 MIN)

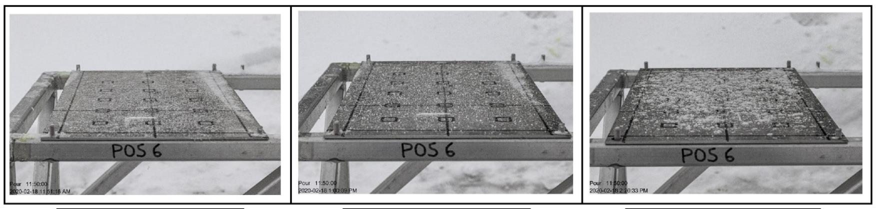


POST-FAILURE (155/152 MIN)

AeroClear MAX – Run 48 (Test 48) – Snow Characteristics Photos



FELT PAD (30/152 MIN) | FELT PAD (110/152 MIN) | FELT PAD (141/152 MIN)



BARE PLATE (1/152 MIN) | BARE PLATE (70/152 MIN) | BARE PLATE (150/152 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

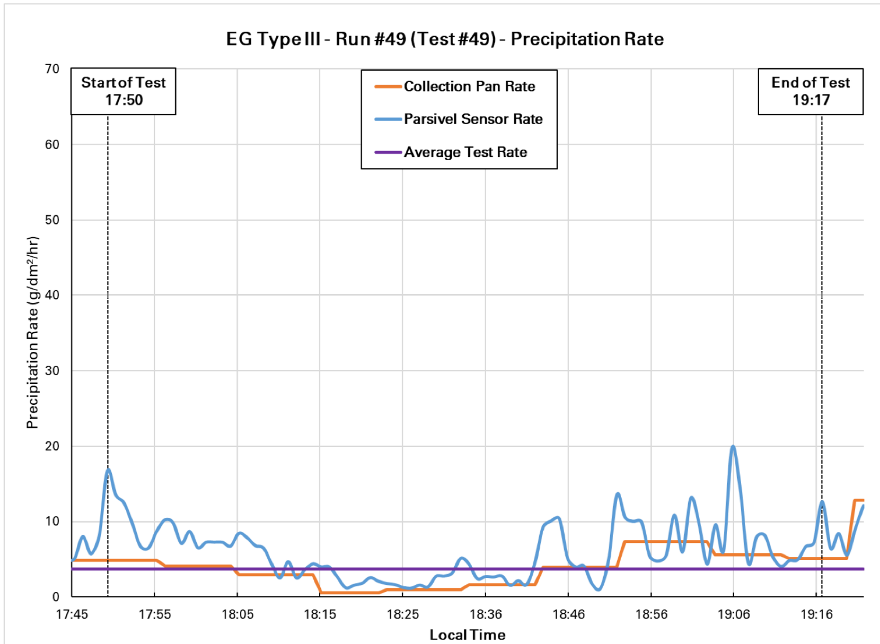
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #49 (TEST #49) – EG3-49

EG Type III – Run #49 (Test #49) – General Test Information

Test Number:	**EG3-49**
Date of Test:	**February 26, 2020**
Average OAT:	**-0.3**
Average Precipitation Rate:	**3.7 g/dm²/h**
Average Wind Speed:	**27.0 km/h**
Average Relative Humidity:	**82.9%**
Pour Time (Local):	**17:50:00**
Time of Fluid Failure (Local):	**19:17:00**
Fluid Brix at Failure:	**3°**
Endurance Time:	**87 minutes**
Expected Regression-Derived Endurance Time:	**81.9 minutes**
Difference (ET vs. Reg ET):	**+5.6 minutes (+6.9%)**

DATA PACKAGE – EG TYPE III – RUN 49 (TEST 49)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 49 - Test 49/Data Package - EG Type III - Run 49 - Test 49.docx
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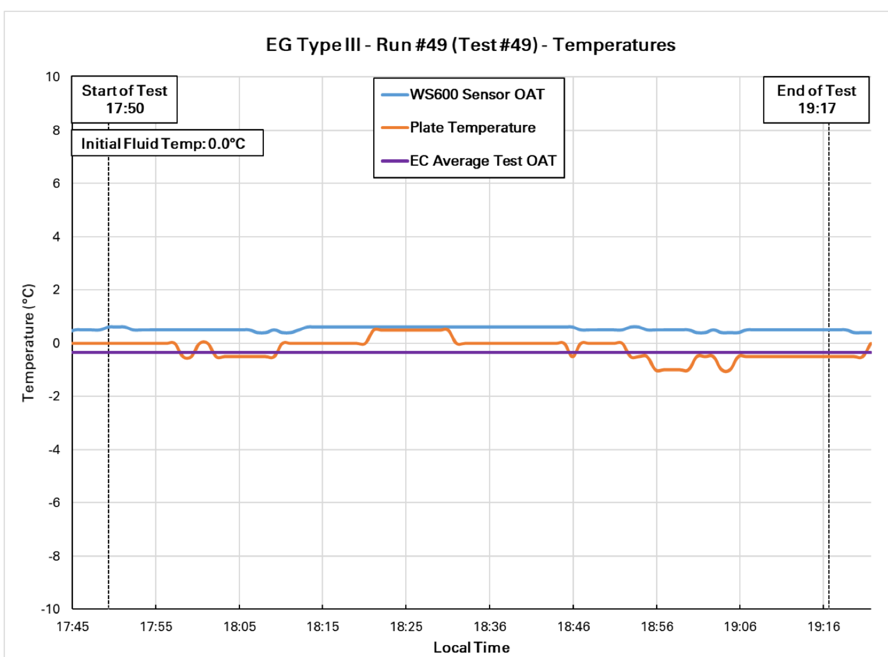
DATA PACKAGE – EG TYPE III – RUN 49 (TEST 49)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 49 - Test 49/Data Package - EG Type III - Run 49 - Test 49.docx
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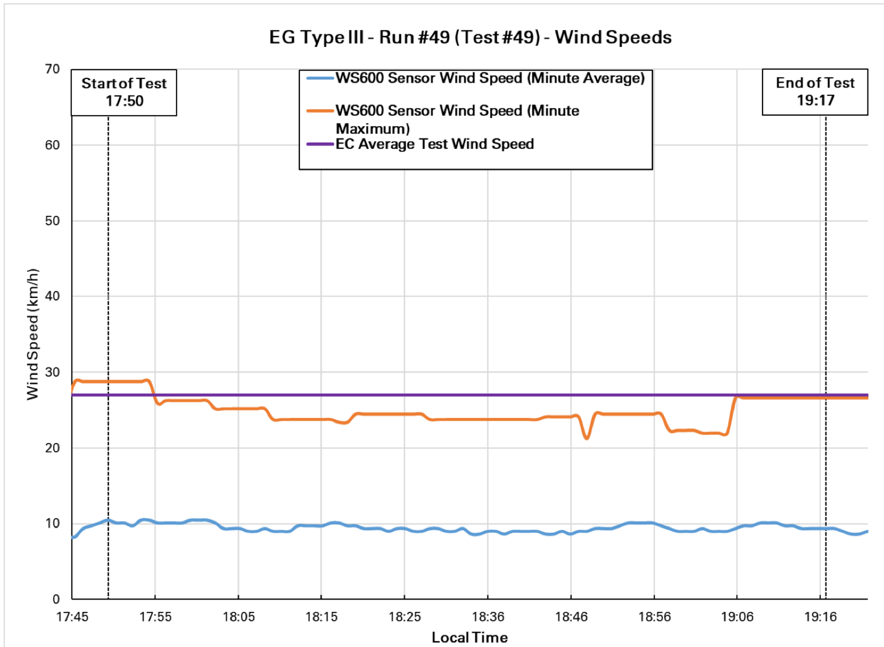
DATA PACKAGE – EG TYPE III – RUN 49 (TEST 49)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 49 - Test 49/Data Package - EG Type III - Run 49 - Test 49.docx
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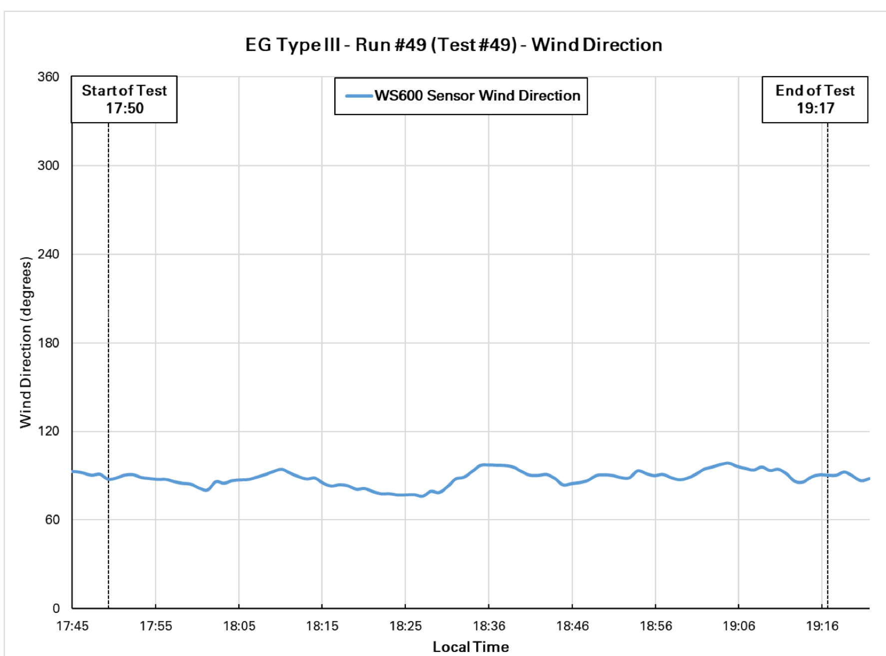
DATA PACKAGE – EG TYPE III – RUN 49 (TEST 49)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 49 - Test 49/Data Package - EG Type III - Run 49 - Test 49.docx
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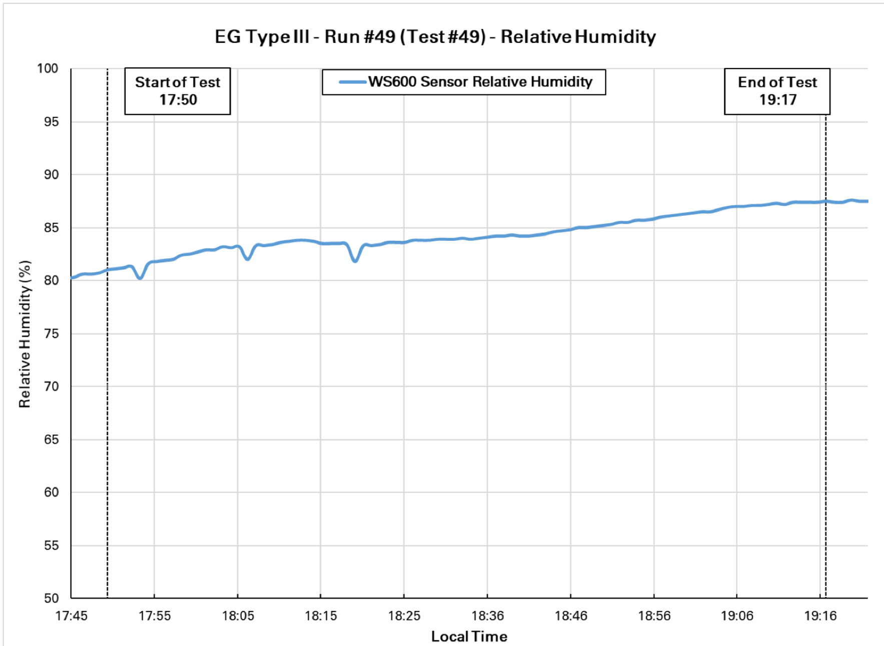
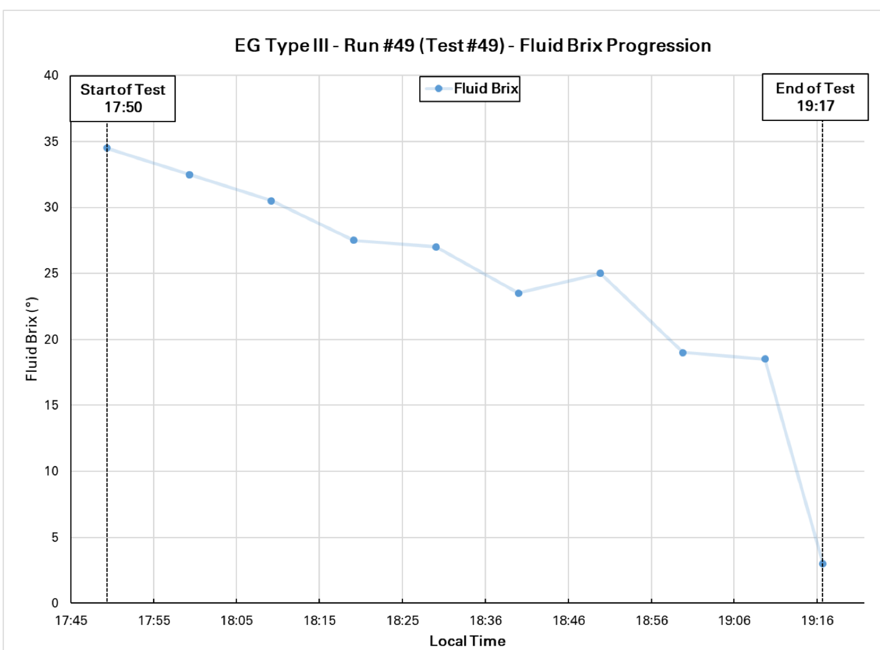
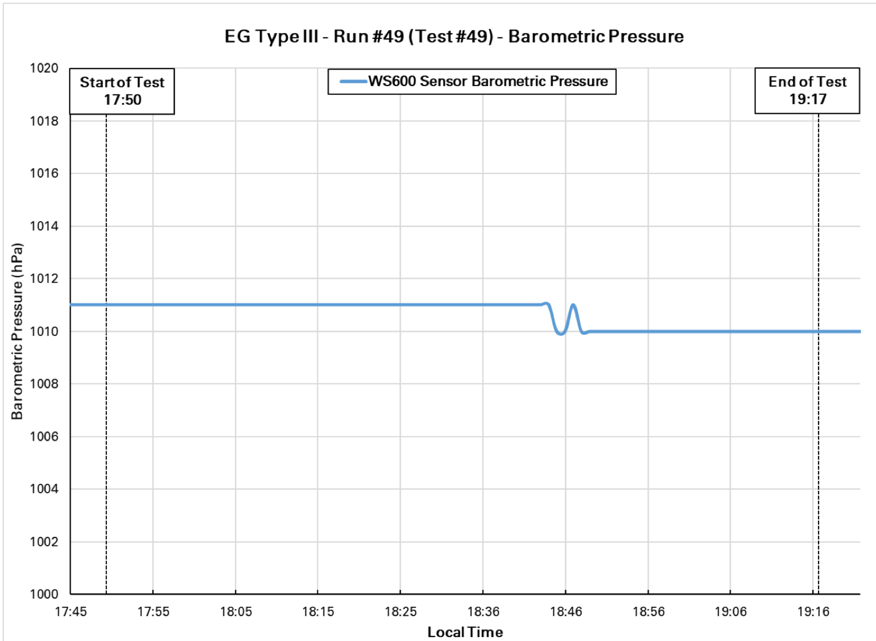
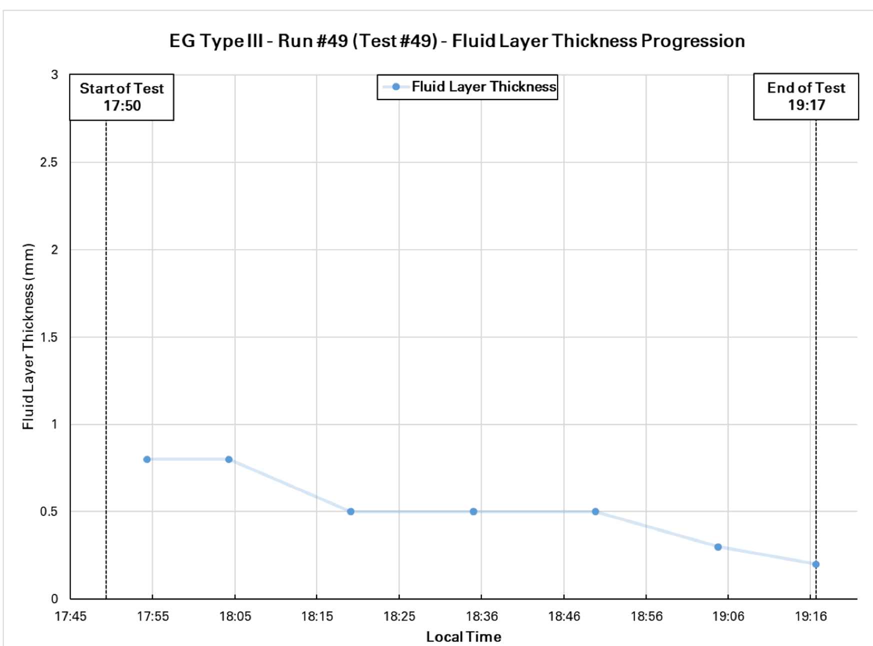


EG Type III - Run #49 (Test #49) - Relative Humidity
Start of Test 17:50
WS600 Sensor Relative Humidity
End of Test 19:17
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
17:45
17:55
18:05
18:15
18:25
18:36
18:46
18:56
19:06
19:16
Local Time

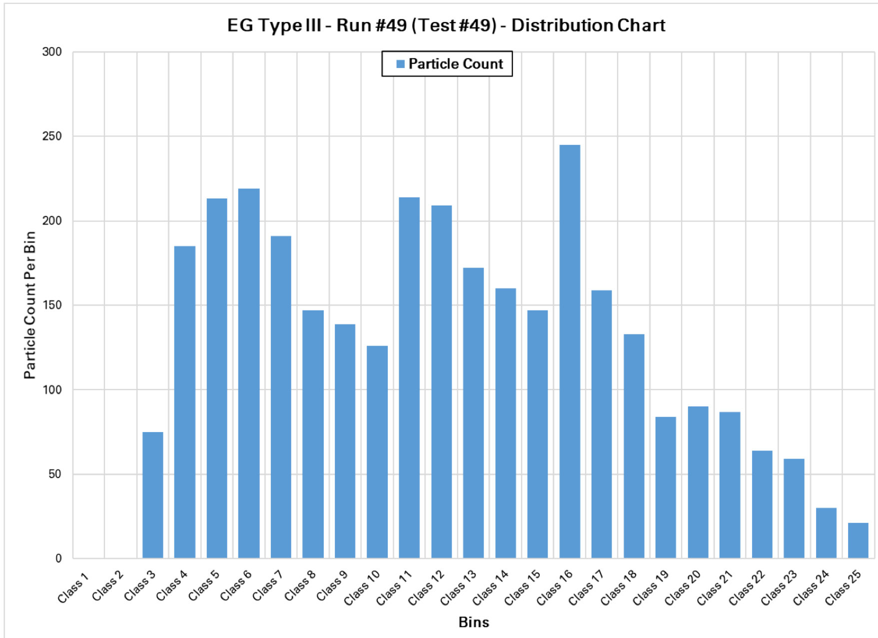


EG Type III - Run #49 (Test #49) - Fluid Brix Progression
Start of Test 17:50
Fluid Brix
End of Test 19:17
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
17:45
17:55
18:05
18:15
18:25
18:36
18:46
18:56
19:06
19:16
Local Time


EG Type III - Run #49 (Test #49) - Barometric Pressure
Start of Test 17:50
WS600 Sensor Barometric Pressure
End of Test 19:17
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
17:45
17:55
18:05
18:15
18:25
18:36
18:46
18:56
19:06
19:16
Local Time


EG Type III - Run #49 (Test #49) - Fluid Layer Thickness Progression
Start of Test 17:50
Fluid Layer Thickness
End of Test 19:17
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
17:45
17:55
18:05
18:15
18:25
18:36
18:46
18:56
19:06
19:16
Local Time

DATA PACKAGE – EG TYPE III – RUN 49 (TEST 49)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 49 - Test 49/Data Package - EG Type III - Run 49 - Test 49.docx
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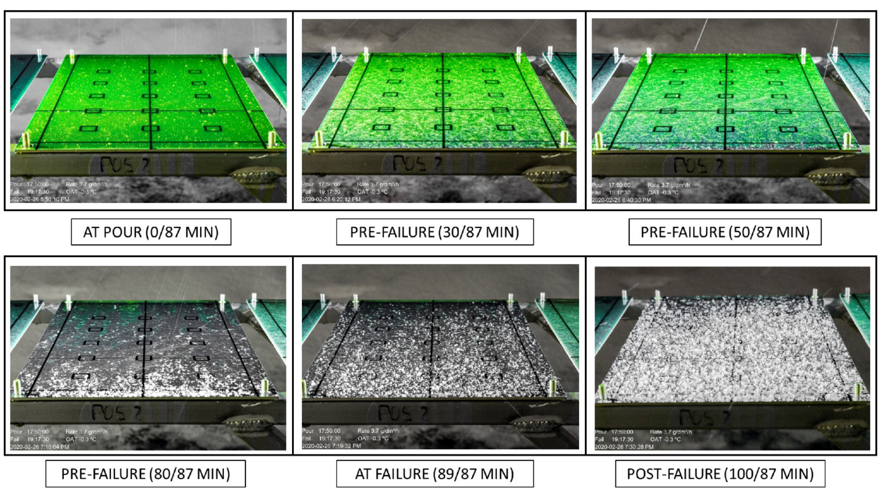
DATA PACKAGE – EG TYPE III – RUN 49 (TEST 49)

AeroClear MAX – Run 49 (Test 49) – Failure Progression Photos



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 49 - Test 49/Data Package - EG Type III - Run 49 - Test 49.docx
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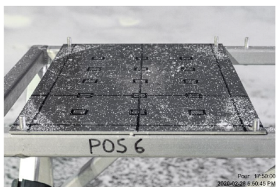
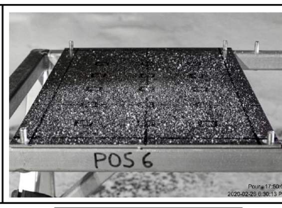
AeroClear MAX – Run 49 (Test 49) – Snow Characteristics Photos

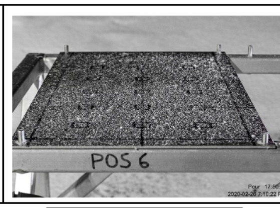
No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (0/87 MIN)



BARE PLATE (40/87 MIN)



BARE PLATE (80/87 MIN)

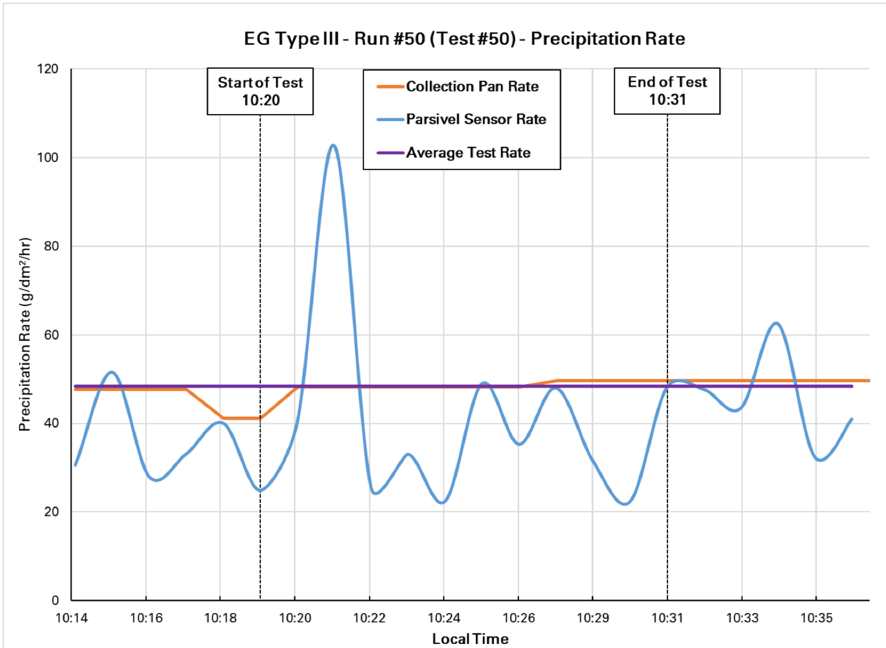
Final Bare Plate Contamination Thickness: **1.7mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

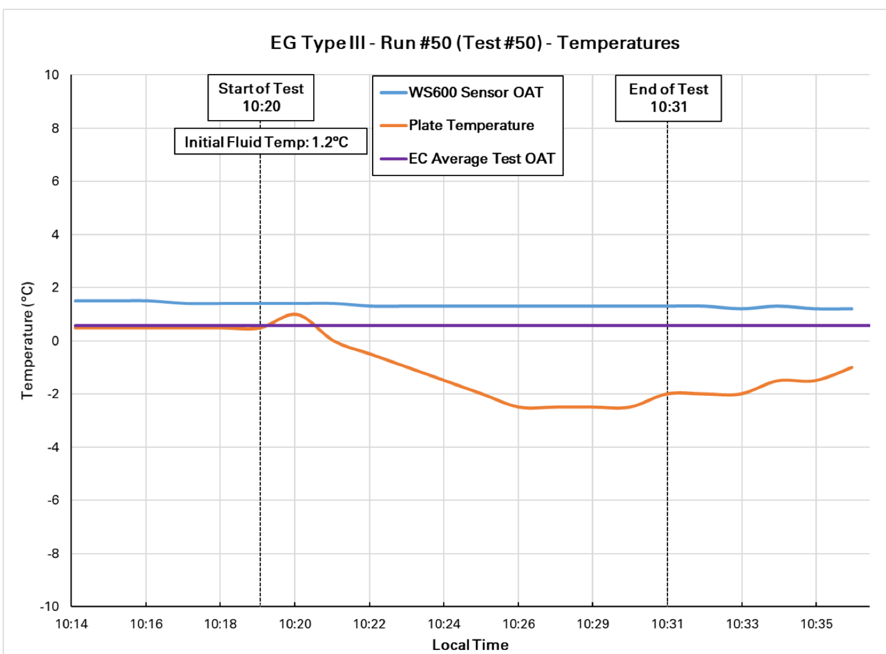
EG TYPE III
RUN #50 (TEST #50) – EG3-50

EG Type III – Run #50 (Test #50) – General Test Information

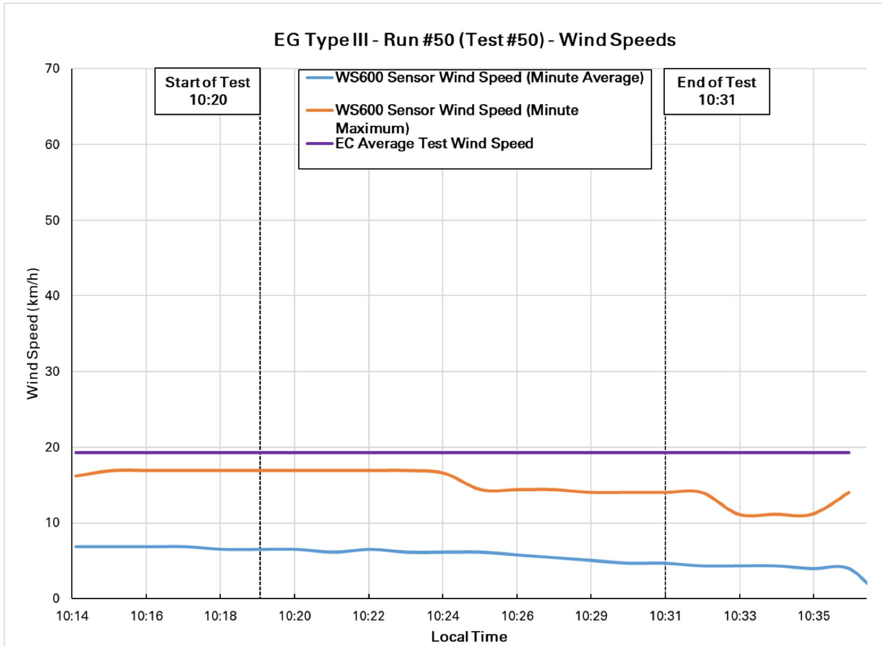
Test Number:	**EG3-50**
Date of Test:	**February 27, 2020**
Average OAT:	**0.6**
Average Precipitation Rate:	**48.3 g/dm²/h**
Average Wind Speed:	**19.3 km/h**
Average Relative Humidity:	**91.3%**
Pour Time (Local):	**10:20:00**
Time of Fluid Failure (Local):	**10:31:00**
Fluid Brix at Failure:	**9°**
Endurance Time:	**11 minutes**
Expected Regression-Derived Endurance Time:	**15.1 minutes**
Difference (ET vs. Reg ET):	**-3.4 minutes (-22.4%)**



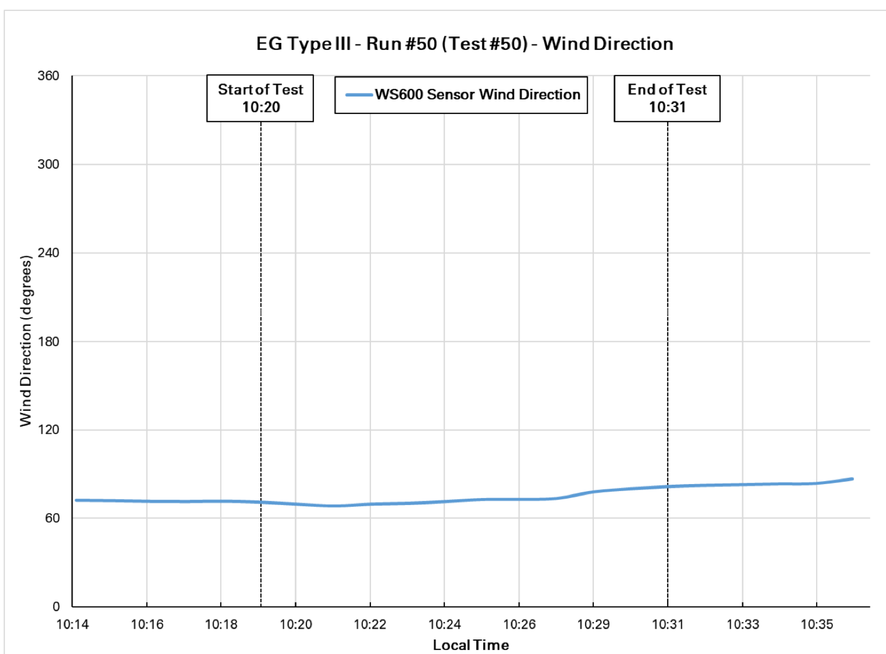
EG Type III - Run #50 (Test #50) - Precipitation Rate
Start of Test 10:20
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 10:31
Precipitation Rate (g/dm²/hr)
120
100
80
60
40
20
0
10:14
10:16
10:18
10:20
10:22
10:24
10:26
10:29
10:31
10:33
10:35
Local Time



EG Type III - Run #50 (Test #50) - Temperatures
Start of Test 10:20
Initial Fluid Temp: 1.2°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 10:31
Temperature (°C)
10
8
6
4
2
0
-2
-4
-6
-8
-10
10:14
10:16
10:18
10:20
10:22
10:24
10:26
10:29
10:31
10:33
10:35
Local Time

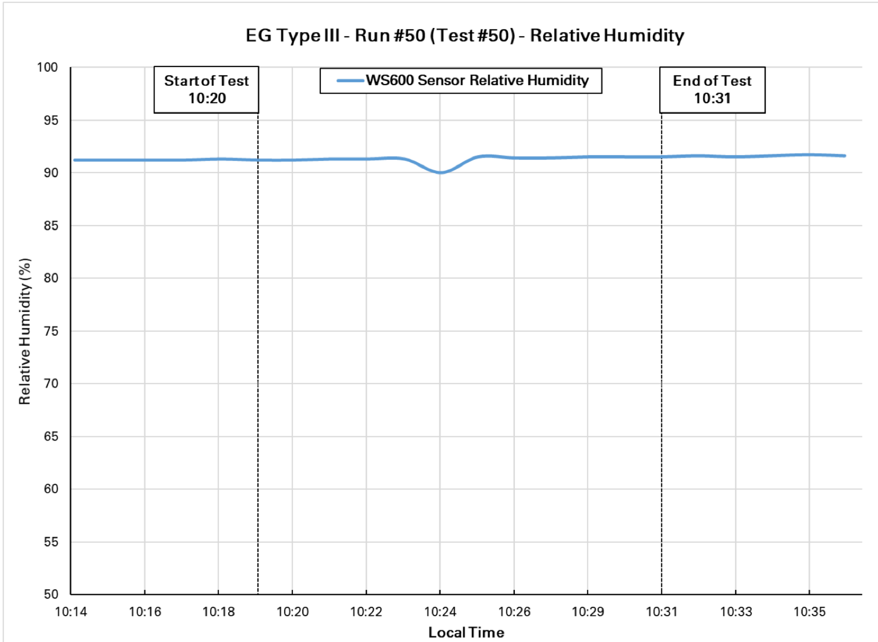


EG Type III - Run #50 (Test #50) - Wind Speeds
Start of Test 10:20
End of Test 10:31
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
10:14
10:16
10:18
10:20
10:22
10:24
10:26
10:29
10:31
10:33
10:35



EG Type III - Run #50 (Test #50) - Wind Direction
Start of Test 10:20
WS600 Sensor Wind Direction
End of Test 10:31
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
10:14
10:16
10:18
10:20
10:22
10:24
10:26
10:29
10:31
10:33
10:35

DATA PACKAGE – EG TYPE III – RUN 50 (TEST 50)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 50 - Test 50/Data Package - EG Type III - Run 50 - Test 50.docx
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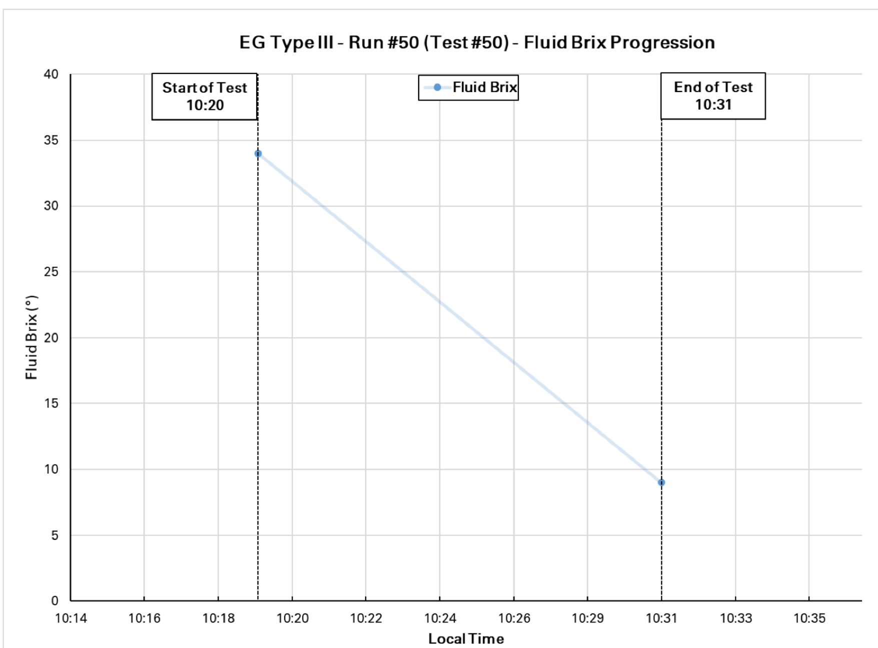
DATA PACKAGE – EG TYPE III – RUN 50 (TEST 50)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 50 - Test 50/Data Package - EG Type III - Run 50 - Test 50.docx
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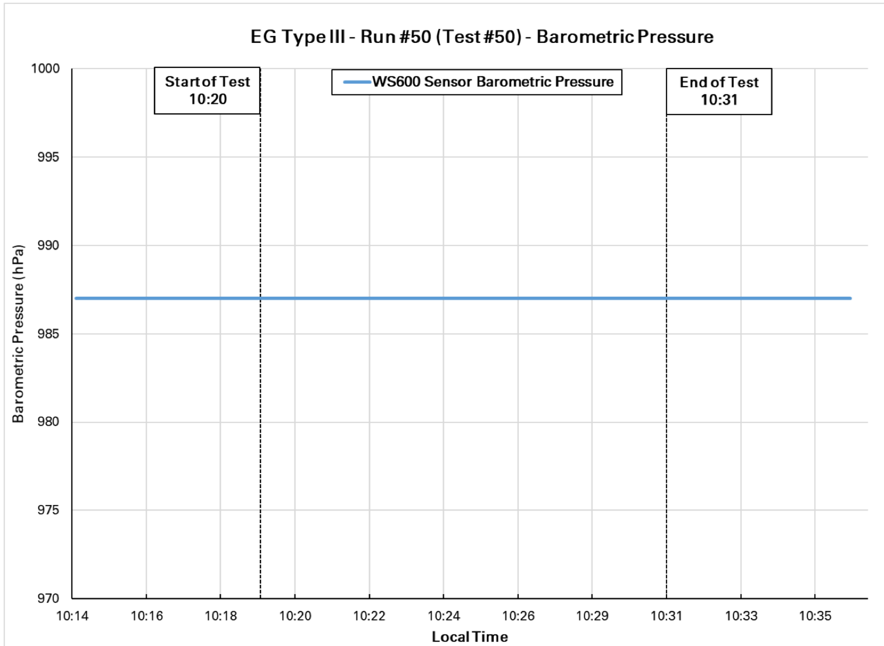
DATA PACKAGE – EG TYPE III – RUN 50 (TEST 50)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 50 - Test 50/Data Package - EG Type III - Run 50 - Test 50.docx
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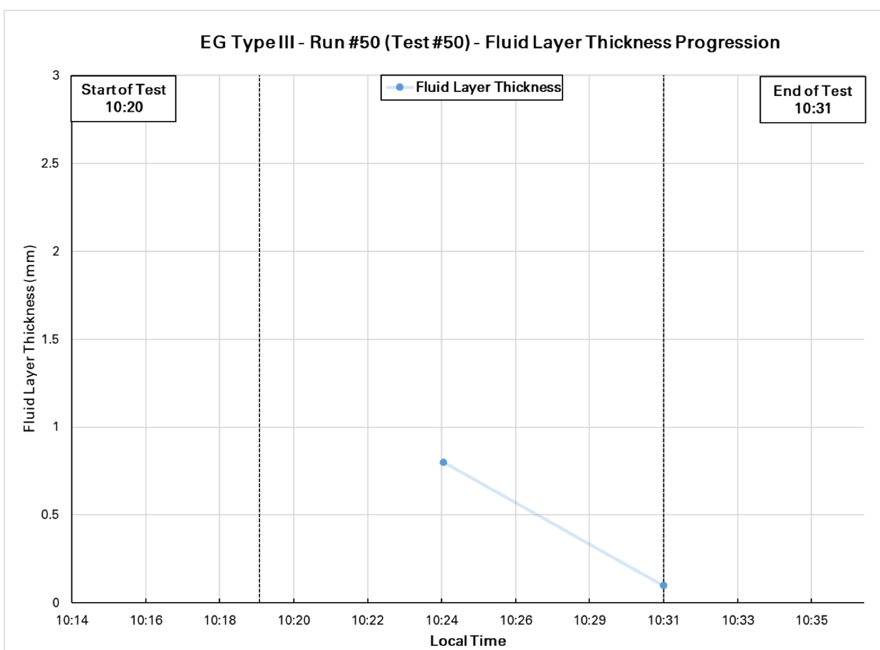
DATA PACKAGE – EG TYPE III – RUN 50 (TEST 50)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 50 - Test 50/Data Package - EG Type III - Run 50 - Test 50.docx
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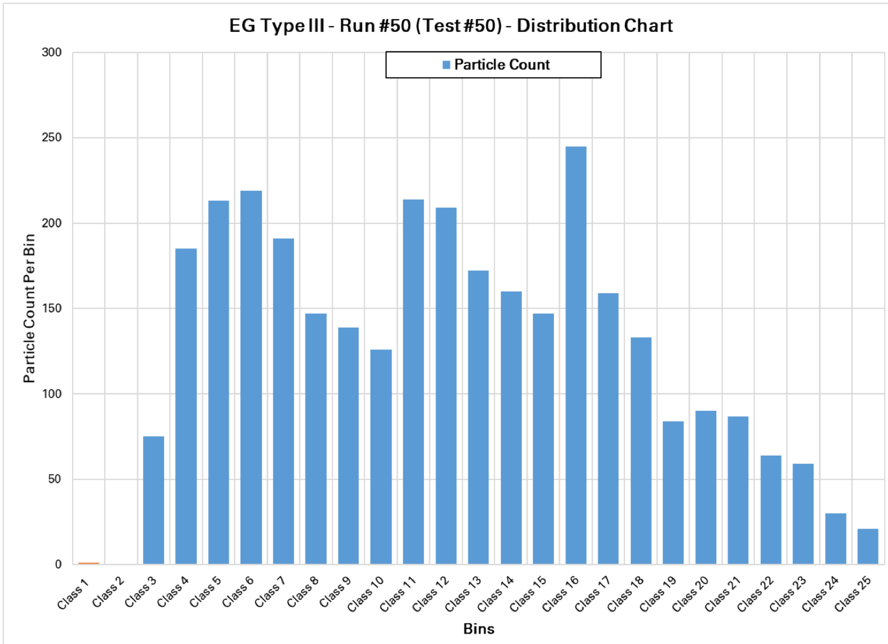
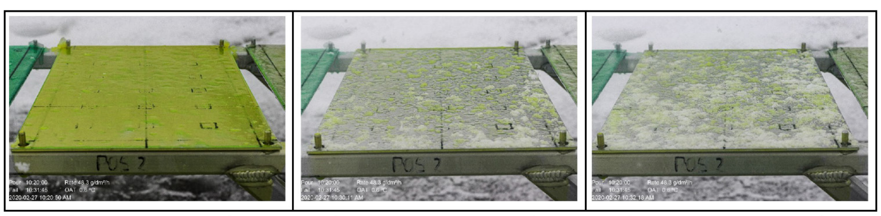
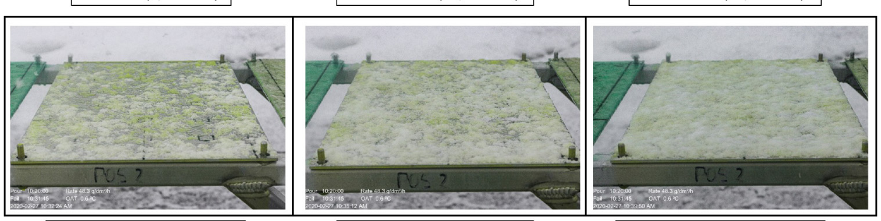


AeroClear MAX – Run 50 (Test 50) – Failure Progression Photos

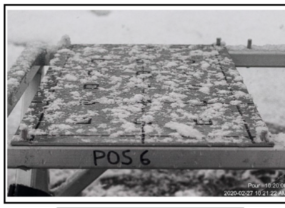
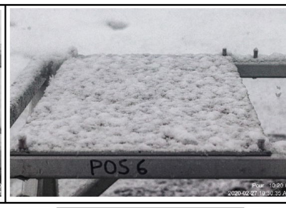
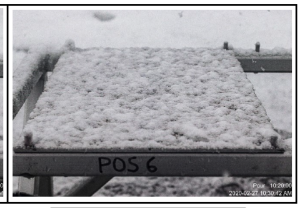


AT POUR (0/11 MIN) | PRE-FAILURE (10/11 MIN) | AT FAILURE (12/11 MIN)



AT FAILURE (12/11 MIN) | POST-FAILURE (15/11 MIN) | POST-FAILURE (19/11 MIN)

AeroClear MAX – Run 50 (Test 50) – Snow Characteristics Photos

No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)
		
BARE PLATE (1/11 MIN)	BARE PLATE (10/11 MIN)	BARE PLATE (20/11 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

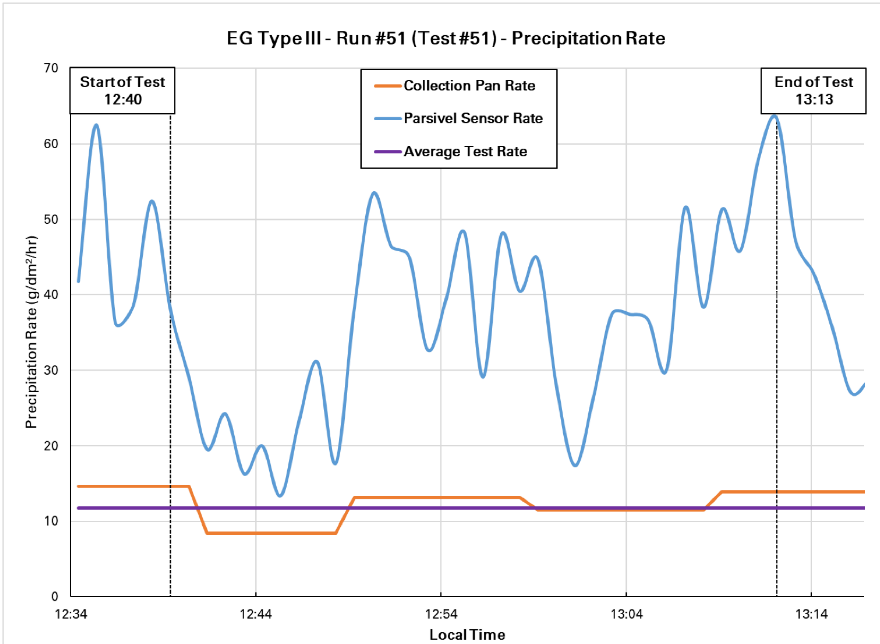
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

EG TYPE III
RUN #51 (TEST #51) – EG3-51

EG Type III – Run #51 (Test #51) – General Test Information

Test Number:	**EG3-51**
Date of Test:	**February 27, 2020**
Average OAT:	**-1.4**
Average Precipitation Rate:	**11.8 g/dm²/h**
Average Wind Speed:	**38.0 km/h**
Average Relative Humidity:	**93.5%**
Pour Time (Local):	**12:40:00**
Time of Fluid Failure (Local):	**13:13:00**
Fluid Brix at Failure:	**8°**
Endurance Time:	**33 minutes**
Expected Regression-Derived Endurance Time:	**38.3 minutes**
Difference (ET vs. Reg ET):	**-4.6 minutes (-11.9%)**

DATA PACKAGE – EG TYPE III – RUN 51 (TEST 51)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 51 - Test 51/Data Package - EG Type III - Run 51 - Test 51.docx
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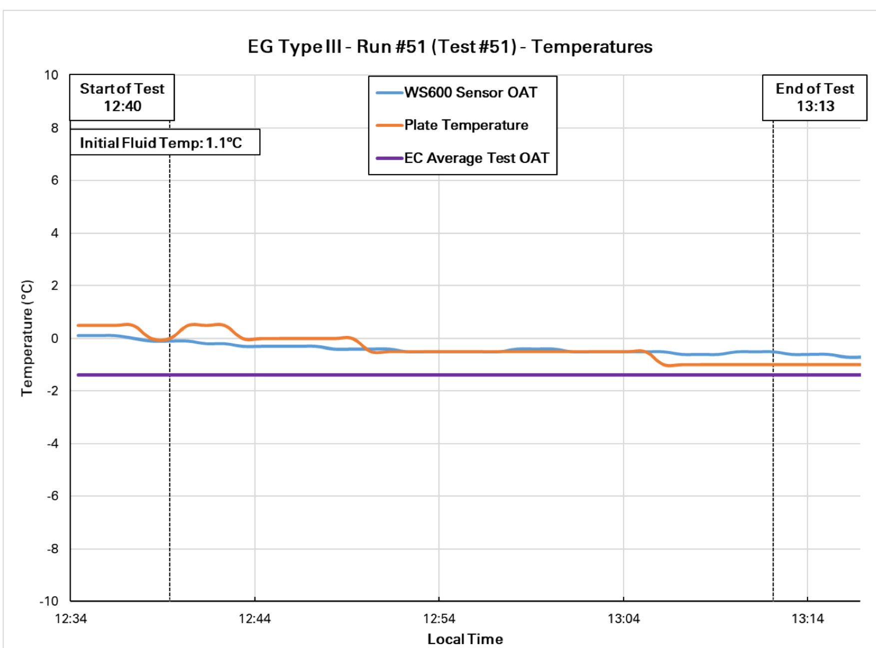
DATA PACKAGE – EG TYPE III – RUN 51 (TEST 51)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 51 - Test 51/Data Package - EG Type III - Run 51 - Test 51.docx
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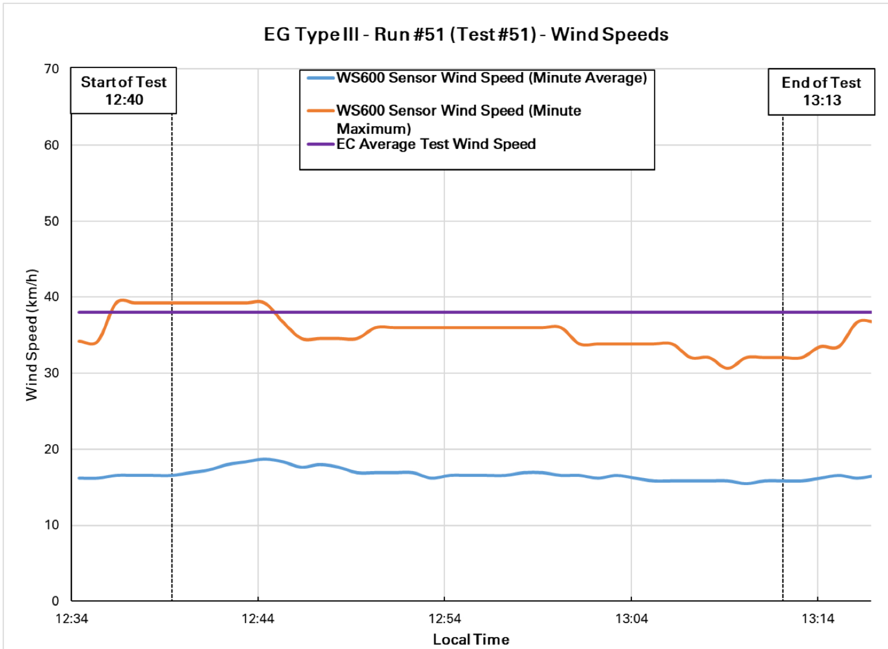
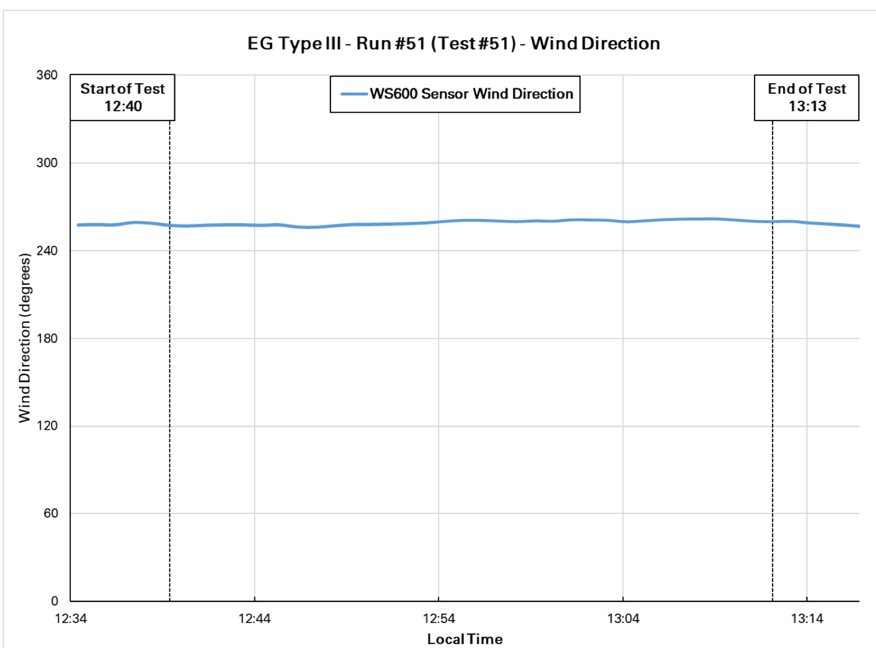
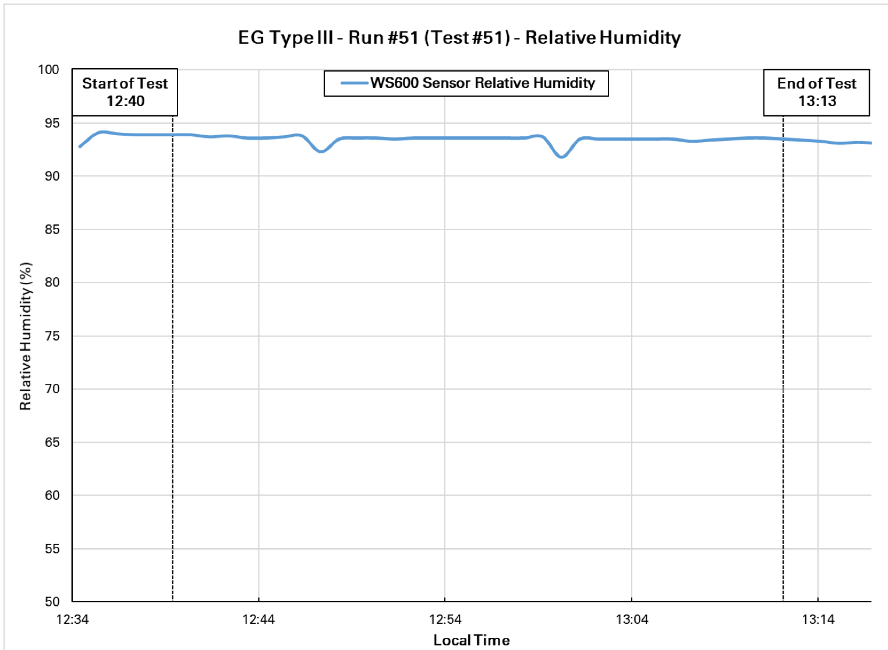
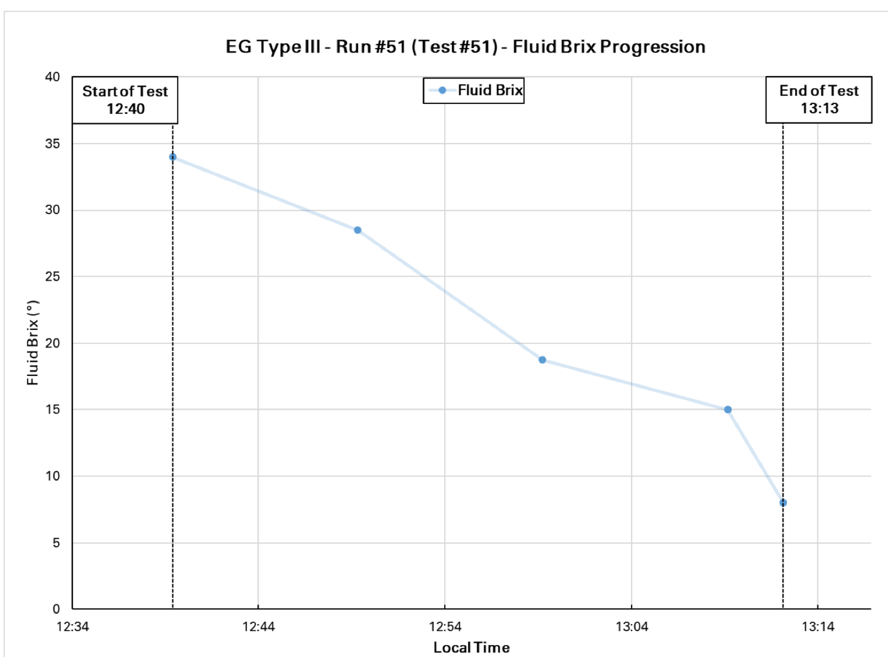


EG Type III - Run #51 (Test #51) - Wind Speeds
Start of Test 12:40
End of Test 13:13
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
12:34
12:44
12:54
13:04
13:14
Local Time

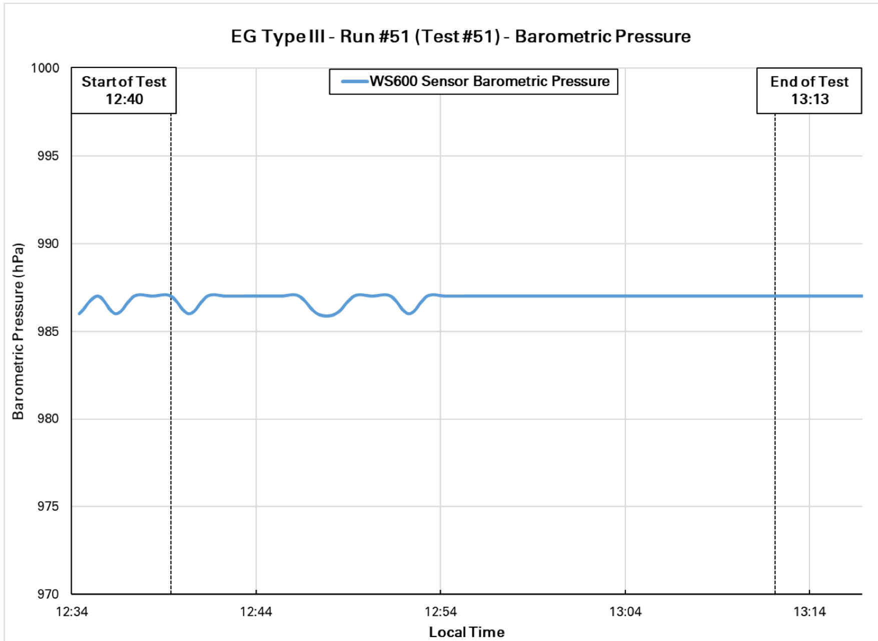


EG Type III - Run #51 (Test #51) - Wind Direction
Start of Test 12:40
End of Test 13:13
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
12:34
12:44
12:54
13:04
13:14
Local Time


EG Type III - Run #51 (Test #51) - Relative Humidity
Start of Test 12:40
WS600 Sensor Relative Humidity
End of Test 13:13
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
12:34
12:44
12:54
13:04
13:14
Local Time


EG Type III - Run #51 (Test #51) - Fluid Brix Progression
Start of Test 12:40
Fluid Brix
End of Test 13:13
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
12:34
12:44
12:54
13:04
13:14
Local Time

DATA PACKAGE – EG TYPE III – RUN 51 (TEST 51)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 51 - Test 51/Data Package - EG Type III - Run 51 - Test 51.docx
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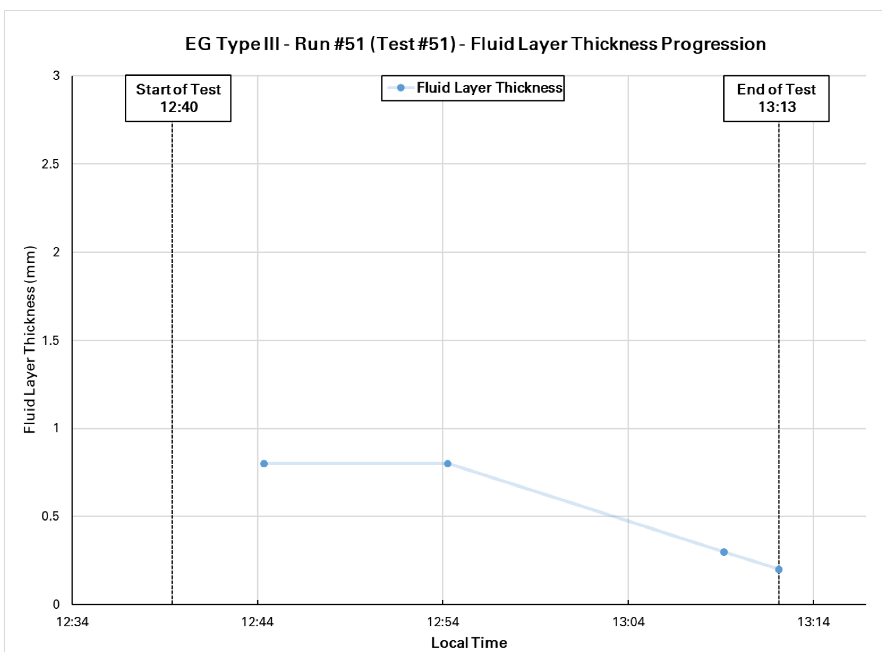
DATA PACKAGE – EG TYPE III – RUN 51 (TEST 51)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 51 - Test 51/Data Package - EG Type III - Run 51 - Test 51.docx
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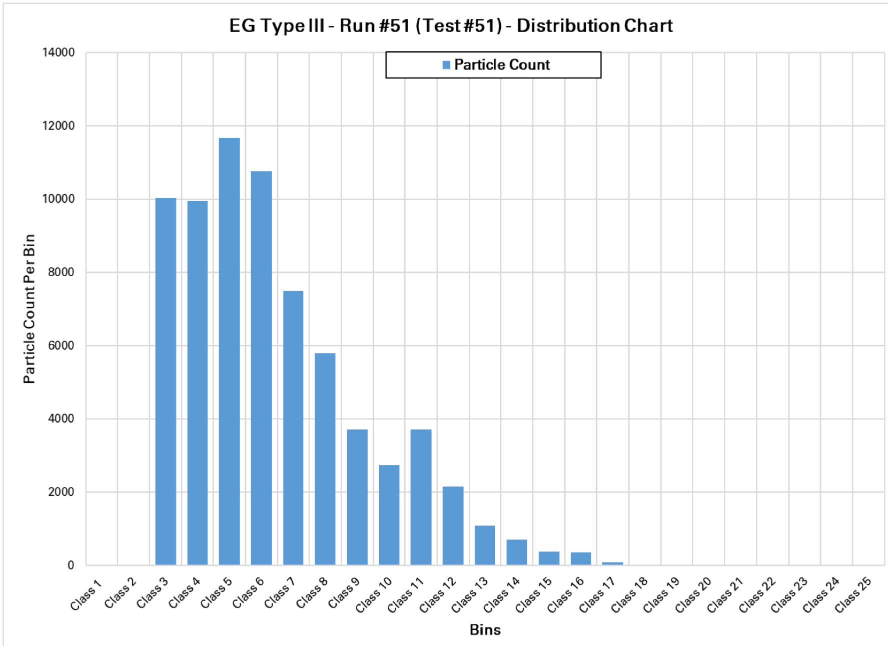
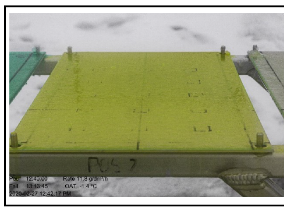
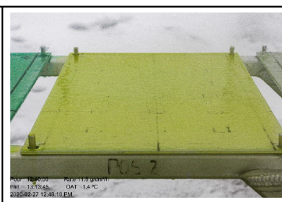
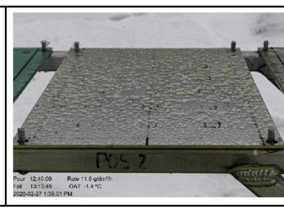
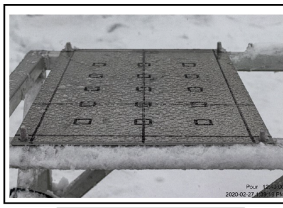
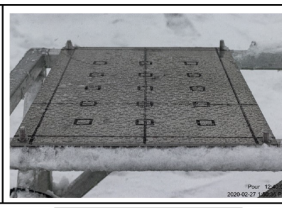
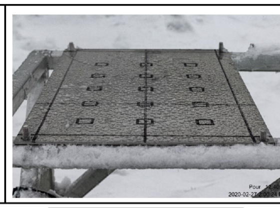


AeroClear MAX – Run 51 (Test 51) – Failure Progression Photos

		
AT POUR (2/33 MIN)	PRE-FAILURE (8/33 MIN)	POST-FAILURE (59/33 MIN)
No Photo Available	No Photo Available	No Photo Available
POST-FAILURE (-/- MIN)	POST-FAILURE (-/- MIN)	POST-FAILURE (-/- MIN)

AeroClear MAX – Run 51 (Test 51) – Snow Characteristics Photos

No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)
		
BARE PLATE (59/33 MIN)	BARE PLATE (70/33 MIN)	BARE PLATE (80/33 MIN)

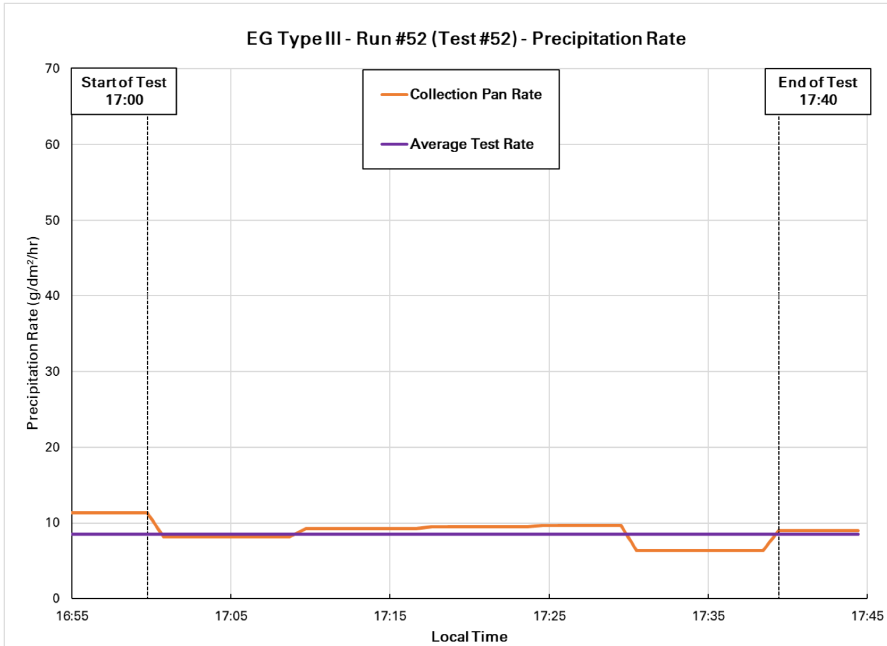
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

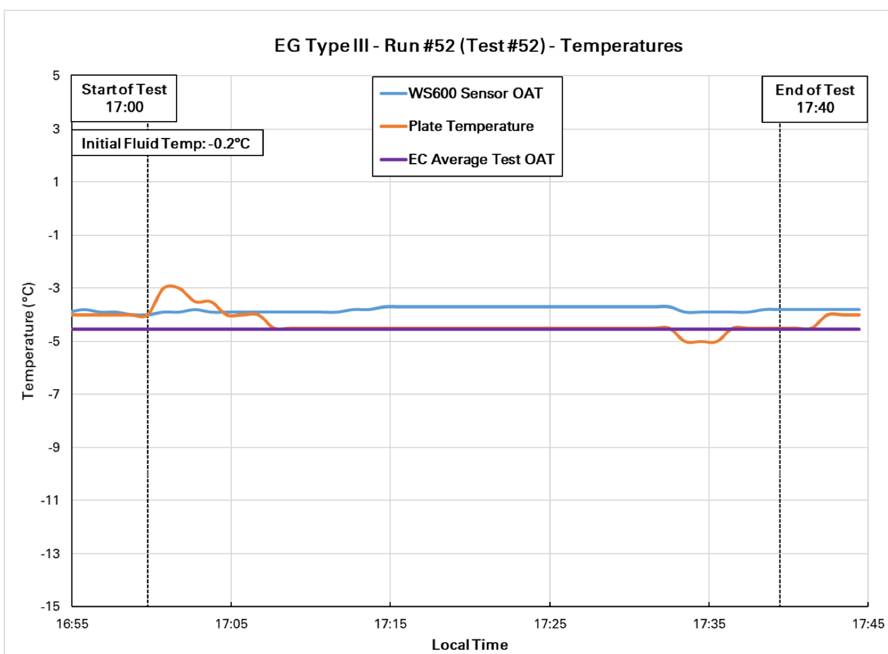
EG TYPE III
RUN #52 (TEST #52) – EG3-52

EG Type III – Run #52 (Test #52) – General Test Information

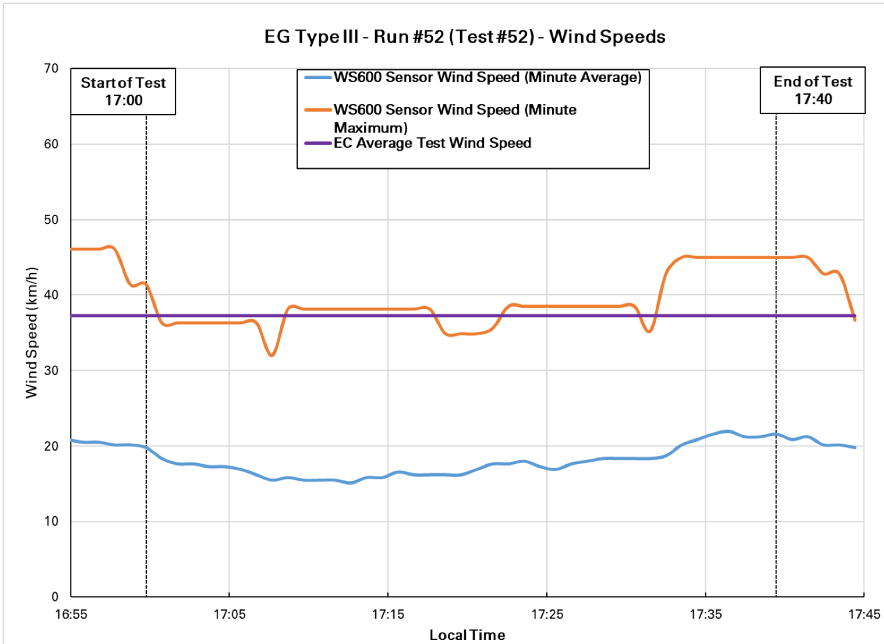
Test Number:	**EG3-52**
Date of Test:	**February 27, 2020**
Average OAT:	**-4.5**
Average Precipitation Rate:	**8.5 g/dm²/h**
Average Wind Speed:	**37.2 km/h**
Average Relative Humidity:	**90.5%**
Pour Time (Local):	**17:00:00**
Time of Fluid Failure (Local):	**17:40:00**
Fluid Brix at Failure:	**11°**
Endurance Time:	**40 minutes**
Expected Regression-Derived Endurance Time:	**47.3 minutes**
Difference (ET vs. Reg ET):	**-6.9 minutes (-14.5%)**

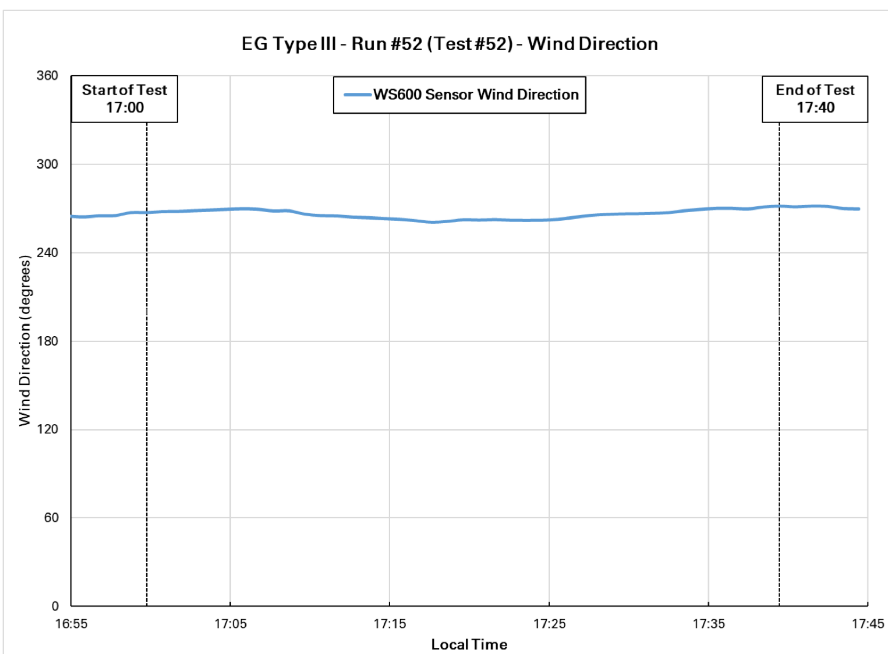


EG Type III - Run #52 (Test #52) - Precipitation Rate
Start of Test 17:00
End of Test 17:40
Collection Pan Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:55
17:05
17:15
17:25
17:35
17:45
Local Time

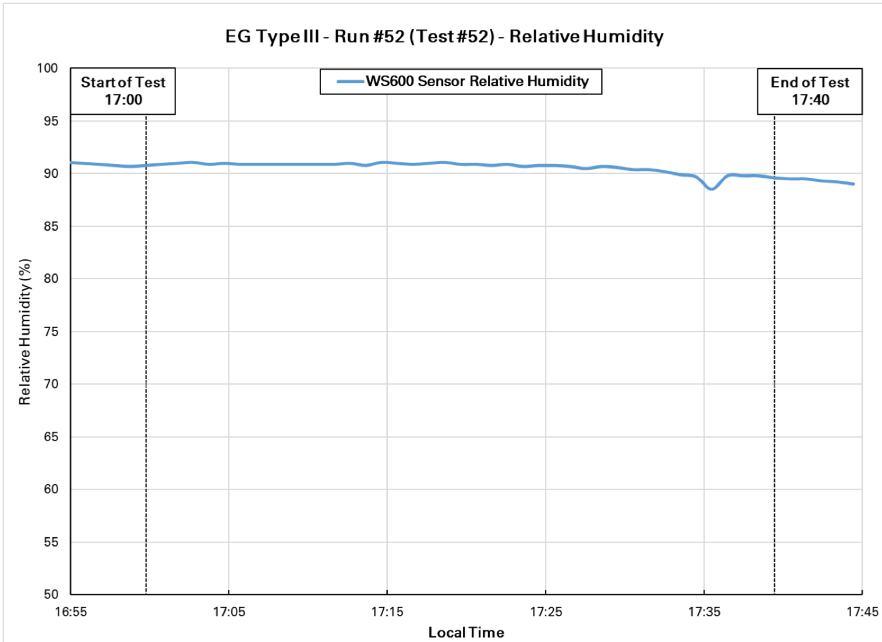


EG Type III - Run #52 (Test #52) - Temperatures
Start of Test 17:00
Initial Fluid Temp: -0.2°C
End of Test 17:40
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
16:55
17:05
17:15
17:25
17:35
17:45
Local Time


EG Type III - Run #52 (Test #52) - Wind Speeds
Start of Test 17:00
End of Test 17:40
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:55
17:05
17:15
17:25
17:35
17:45
Local Time


EG Type III - Run #52 (Test #52) - Wind Direction
Start of Test 17:00
End of Test 17:40
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
16:55
17:05
17:15
17:25
17:35
17:45
Local Time

DATA PACKAGE – EG TYPE III – RUN 52 (TEST 52)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 52 - Test 52/Data Package - EG Type III - Run 52- Test 52.docx
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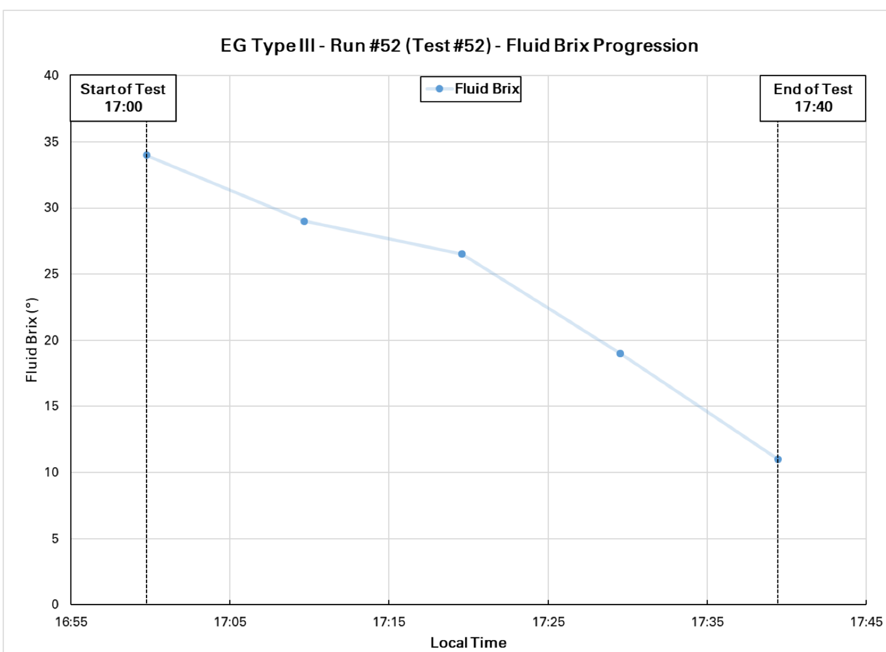
DATA PACKAGE – EG TYPE III – RUN 52 (TEST 52)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/EG Type III/EG Type III - Run 52 - Test 52/Data Package - EG Type III - Run 52- Test 52.docx
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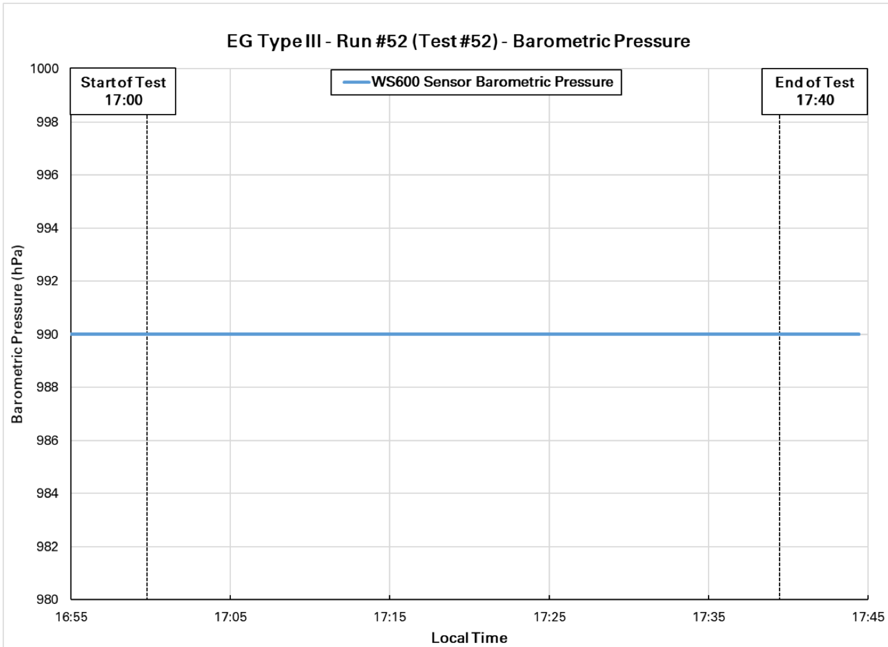
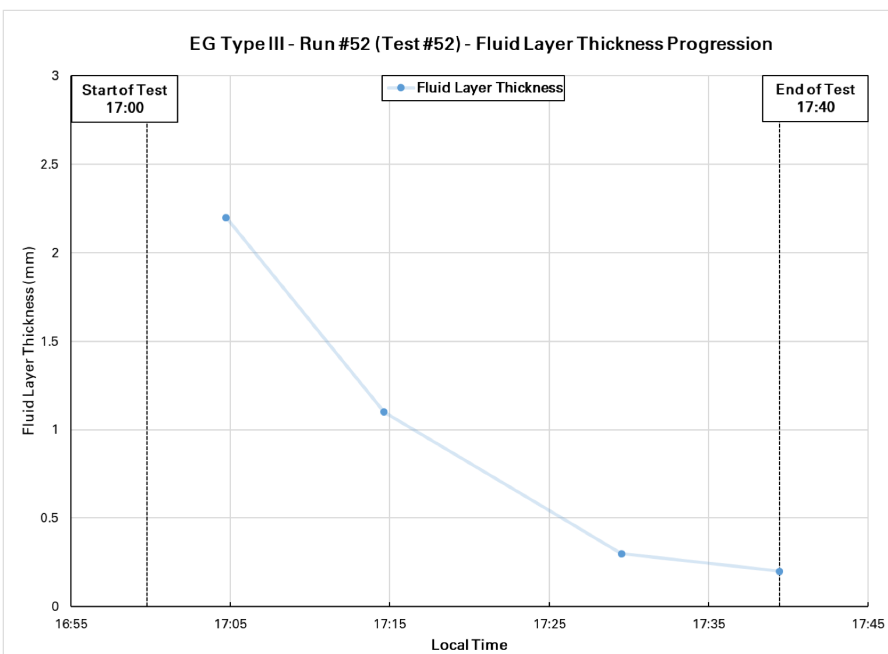
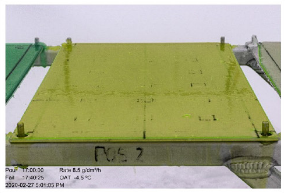
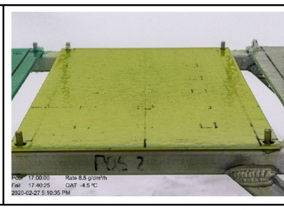

EG Type III - Run #52 (Test #52) - Barometric Pressure
Start of Test 17:00
WS600 Sensor Barometric Pressure
End of Test 17:40
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
16:55
17:05
17:15
17:25
17:35
17:45
Local Time


EG Type III - Run #52 (Test #52) - Fluid Layer Thickness Progression
Start of Test 17:00
Fluid Layer Thickness
End of Test 17:40
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:55
17:05
17:15
17:25
17:35
17:45
Local Time

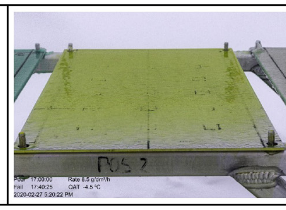
AeroClear MAX – Run 52 (Test 52) – Failure Progression Photos



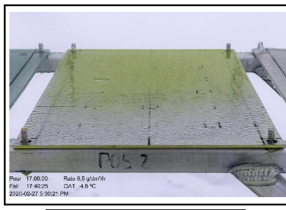
AT POUR (0/40 MIN)



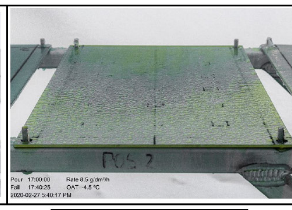
PRE-FAILURE (10/40 MIN)



PRE-FAILURE (20/40 MIN)



PRE-FAILURE (30/40 MIN)



AT FAILURE (40/40 MIN)

POST-FAILURE (44/40 MIN)

AeroClear MAX – Run 52 (Test 52) – Snow Characteristics Photos

No Felt Pad Photos

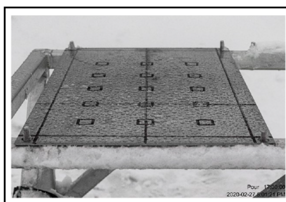
FELT PAD (-/- MIN)

No Felt Pad Photos

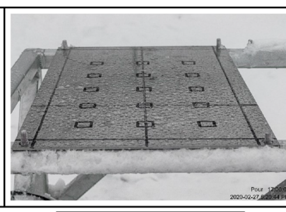
FELT PAD (-/- MIN)

No Felt Pad Photos

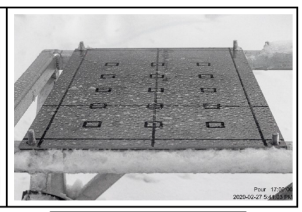
FELT PAD (-/- MIN)



BARE PLATE (1/40 MIN)



BARE PLATE (20/40 MIN)



BARE PLATE (41/40 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

Particle Size Classes Explained

After determining the volume equivalent diameter (D) and the particle speed (V), the OTT Parsivel² subdivides the particles into appropriate classes. The scale of this classification is smaller for small, slow particles than for large and fast particles.

C.1 Class limits

The measured particles are subdivided into D and V classes in a two-dimensional field, wherein there are 32 different D and V classes so that there are a total of 32 x 32 = 1024 classes.

Classification according to volume-equivalent diameter

Class number	Mid-value of class [mm]	Class spread [mm]
1	0.062	0.125
2	0.187	0.125
3	0.312	0.125
4	0.437	0.125
5	0.562	0.125
6	0.687	0.125
7	0.812	0.125
8	0.937	0.125
9	1.062	0.125
10	1.187	0.125
11	1.375	0.250
12	1.625	0.250
13	1.875	0.250
14	2.125	0.250
15	2.375	0.250
16	2.750	0.500
17	3.250	0.500
18	3.750	0.500
19	4.250	0.500
20	4.750	0.500
21	5.500	1.000
22	6.500	1.000
23	7.500	1.000
24	8.500	1.000
25	9.500	1.000
26	11.000	2.000
27	13.000	2.000
28	15.000	2.000
29	17.000	2.000
30	19.000	2.000
31	21.500	3.000
32	24.500	3.000

Note:
Class 1 and class 2 are limits and are not evaluated at the current time in measurements using the OTT Parsivel² since they are outside the measurement range of the device.

APPENDIX F

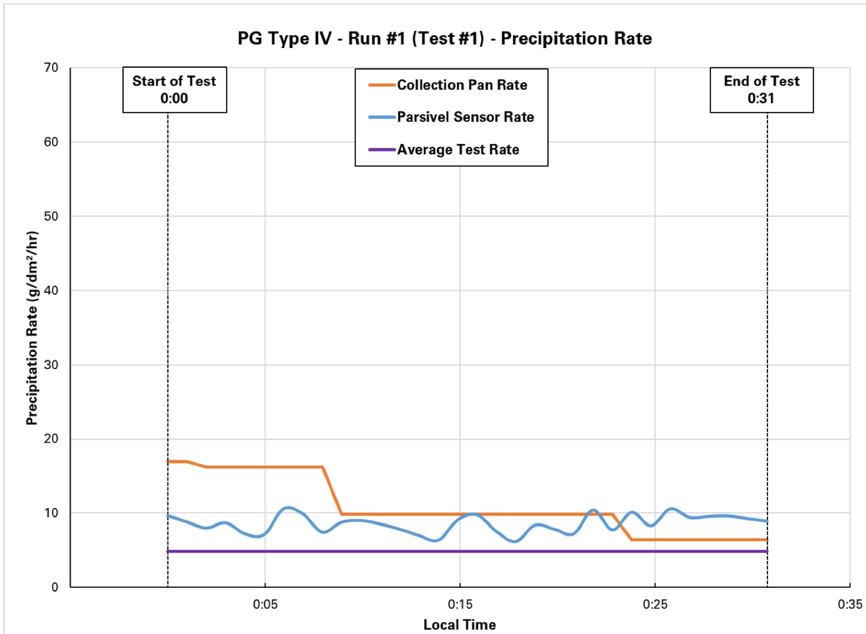
DATA PACKAGES – NATURAL SNOW CHARACTERIZATION
PG TYPE IV RUNS

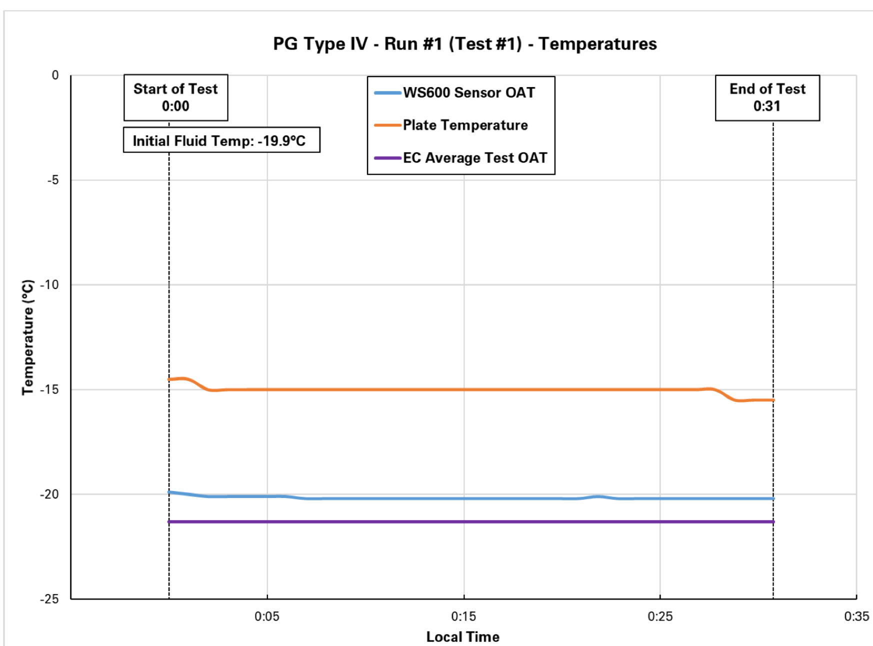
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN 1 (TEST #1) – PG4-1

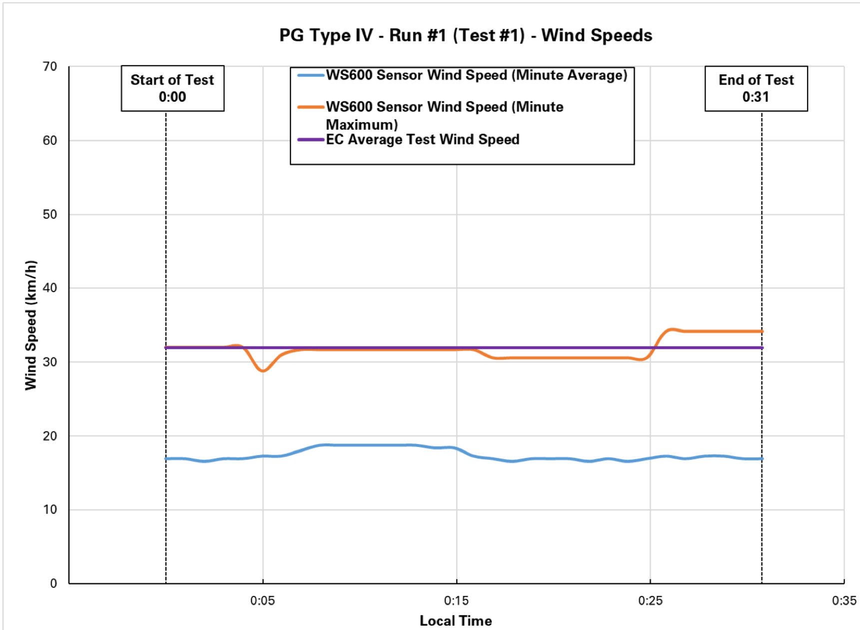
PG Type IV – Run #1 (Test #1) – General Test Information

Test Number:	**PG4-1**
Date of Test:	**January 20, 2019**
Average OAT:	**-21.3**
Average Precipitation Rate:	**4.85 g/dm²/h**
Average Wind Speed:	**31.93 km/h**
Average Relative Humidity:	**72.05%**
Pour Time (Local):	**0:00:00**
Time of Fluid Failure (Local):	**0:31:00**
Fluid Brix at Failure:	**30°**
Endurance Time:	**31 minutes**
Expected Regression-Derived Endurance Time:	**77.1 minutes**
Difference (ET vs. Reg ET):	**-46.1 minutes (-148.7%)**


PG Type IV - Run #1 (Test #1) - Precipitation Rate
Start of Test
0:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test
0:31
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
0:05
0:15
0:25
0:35
Local Time


PG Type IV - Run #1 (Test #1) - Temperatures
Start of Test
0:00
Initial Fluid Temp: -19.9°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test
0:31
Temperature (°C)
0
-5
-10
-15
-20
-25
0:05
0:15
0:25
0:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN 1 (TEST 1)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 1 - Test 1/Data Package - PG Type IV - Run 1 - Test 1.docx
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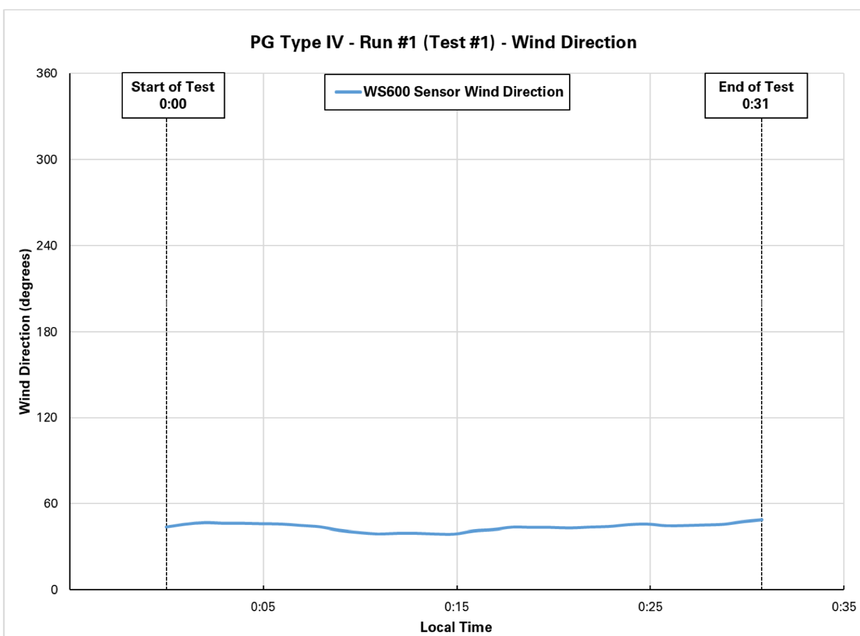
DATA PACKAGE – PG TYPE IV – RUN 1 (TEST 1)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 1 - Test 1/Data Package - PG Type IV - Run 1 - Test 1.docx
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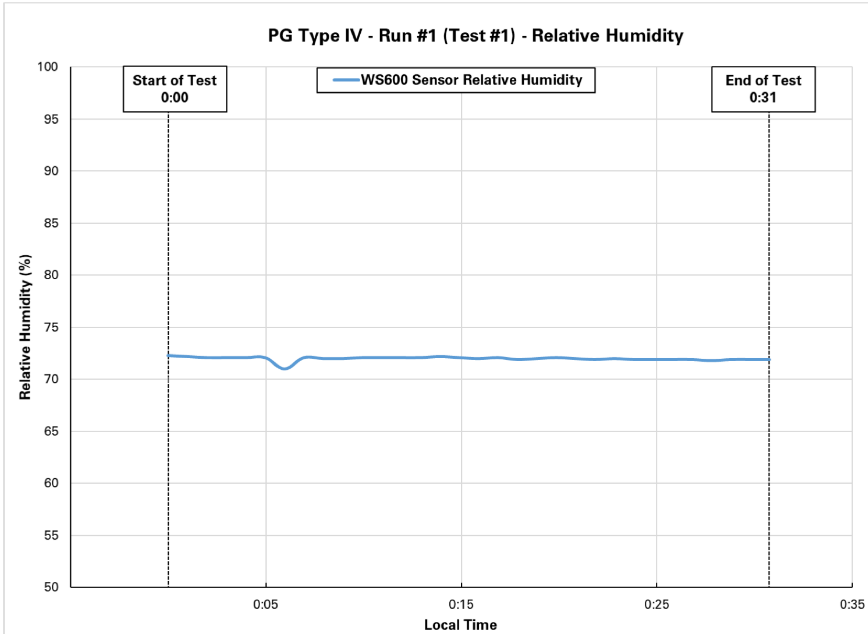
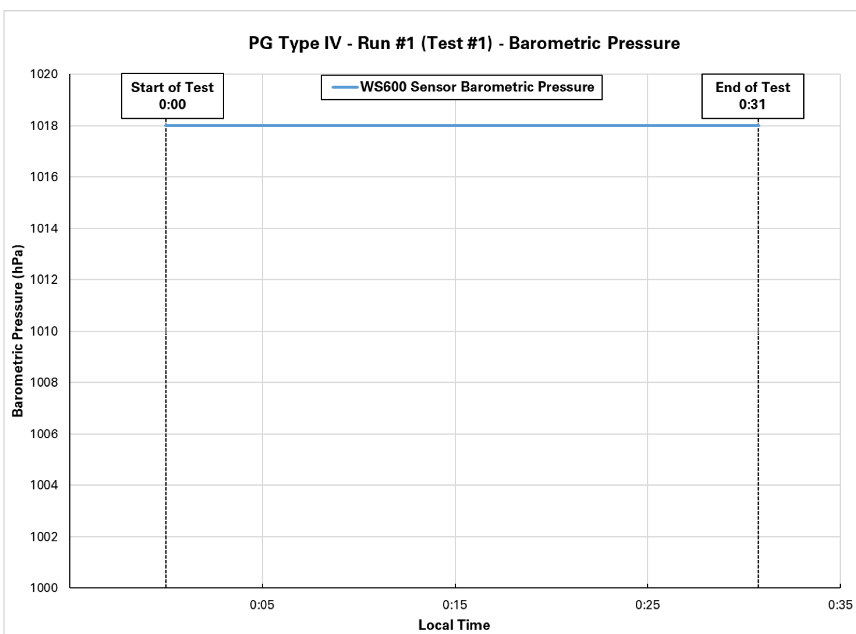
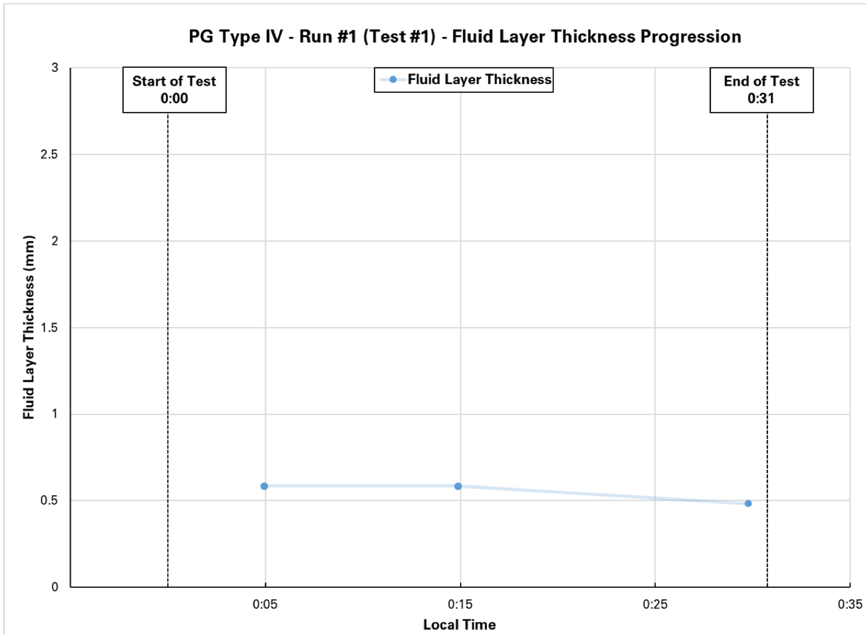

PG Type IV - Run #1 (Test #1) - Relative Humidity
Start of Test 0:00
WS600 Sensor Relative Humidity
End of Test 0:31
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
0:05
0:15
0:25
0:35
Local Time


PG Type IV - Run #1 (Test #1) - Barometric Pressure
Start of Test 0:00
WS600 Sensor Barometric Pressure
End of Test 0:31
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
0:05
0:15
0:25
0:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN 1 (TEST 1)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 1 - Test 1/Data Package - PG Type IV - Run 1 - Test 1.docx
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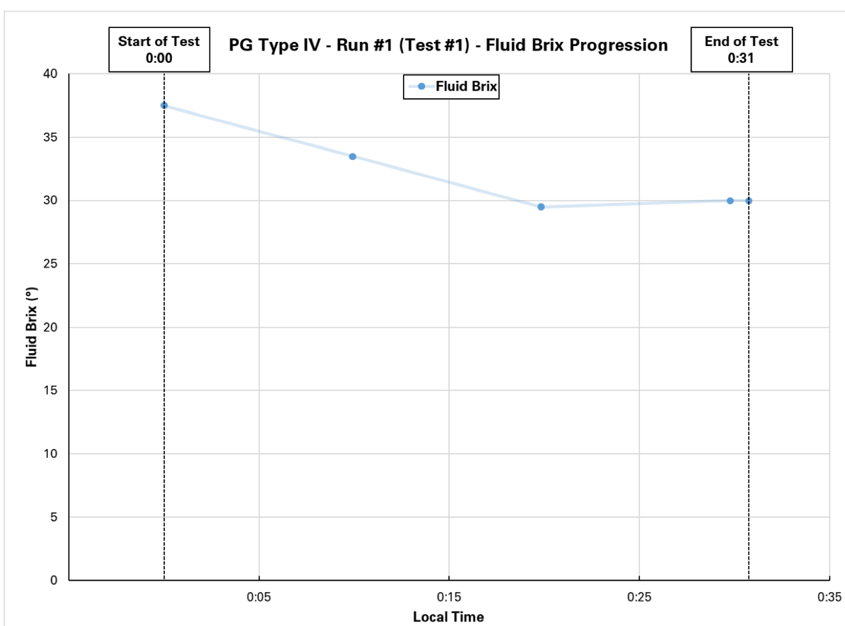
DATA PACKAGE – PG TYPE IV – RUN 1 (TEST 1)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 1 - Test 1/Data Package - PG Type IV - Run 1 - Test 1.docx
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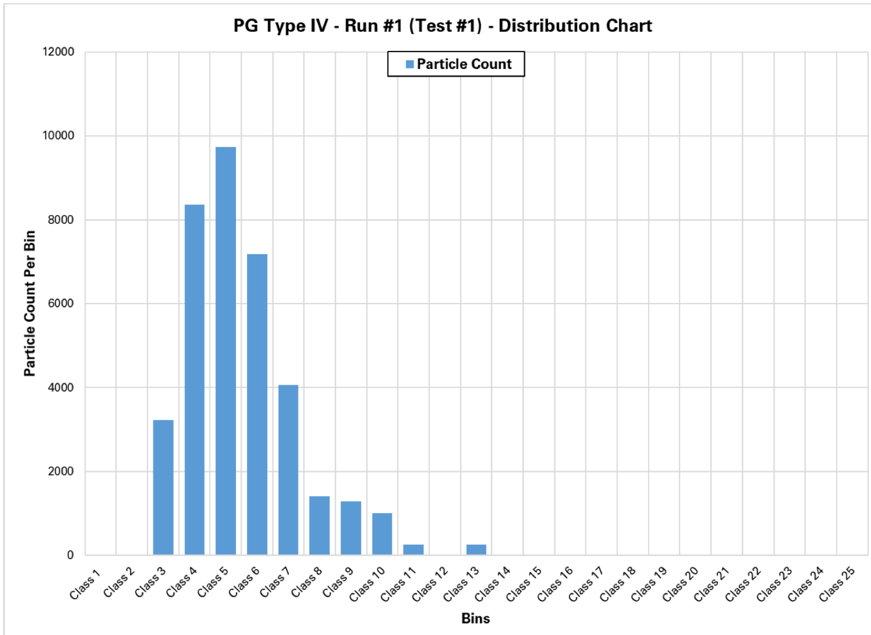
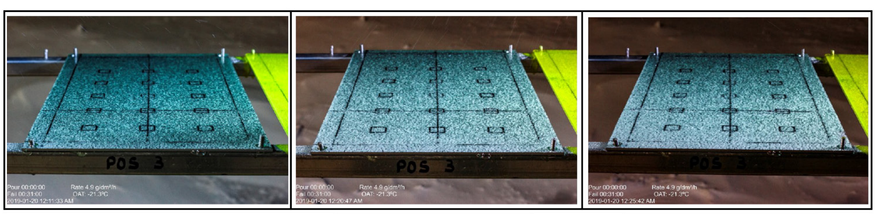
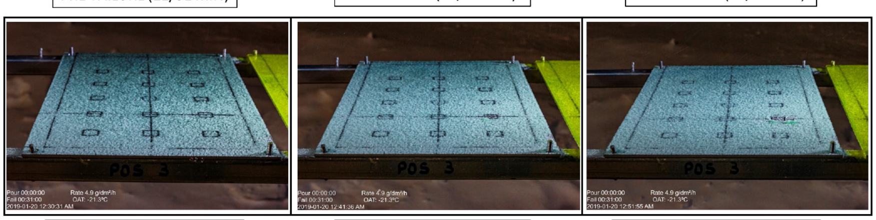


Polar Guard Advance – Run 1 (Test 1) – Failure Progression Photos

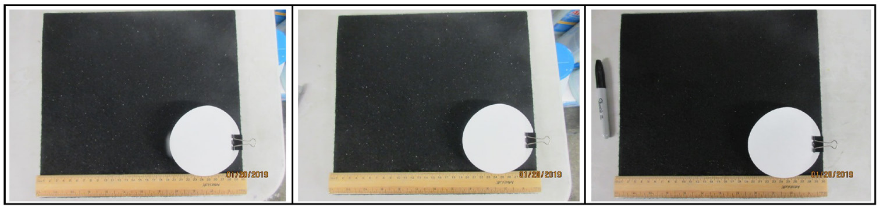


PRE-FAILURE (11/31 MIN) | PRE-FAILURE (20/31 MIN) | PRE-FAILURE (25/31 MIN)

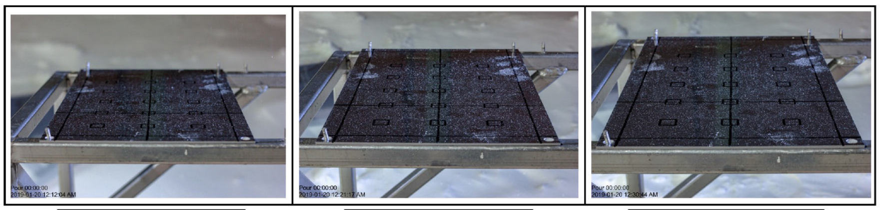


AT FAILURE (31/31 MIN) | POST-FAILURE(41/31 MIN) | POST-FAILURE (51/31 MIN)

Polar Guard Advance – Run 1 (Test 1) – Snow Characteristics Photos



FELT PAD (13/31 MIN) FELT PAD (21/31 MIN) FELT PAD (31/31 MIN)



BARE PLATE (12/31 MIN) BARE PLATE 21/31 MIN) BARE PLATE (31/31 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

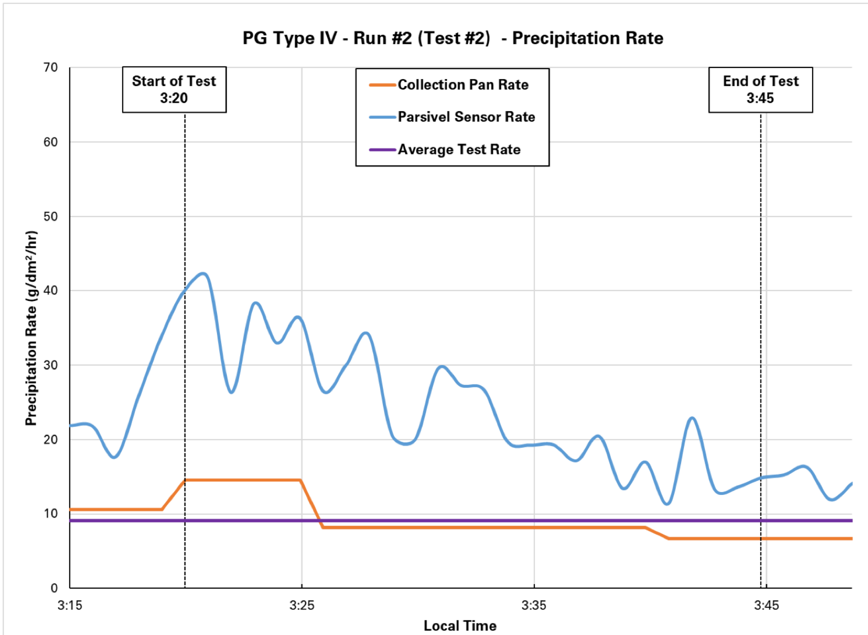
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #2 (TEST #2) – PG4-2

PG Type IV – Run #2 (Test #2) – General Test Information

Test Number:	**PG4-2**
Date of Test:	**January 20, 2019**
Average OAT:	**-19.8**
Average Precipitation Rate:	**9.1 g/dm²/h**
Average Wind Speed:	**35 km/h**
Average Relative Humidity:	**74.21%**
Pour Time (Local):	**3:20:00**
Time of Fluid Failure (Local):	**3:45:00**
Fluid Brix at Failure:	**27.5°**
Endurance Time:	**25 minutes**
Expected Regression-Derived Endurance Time:	**48.6 minutes**
Difference (ET vs. Reg ET):	**+23.6 minutes (+48.5%)**

DATA PACKAGE – PG TYPE IV – RUN 2 (TEST 2)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 2 - Test 2/Data Package - PG Type IV - Run 2 - Test 2.docx
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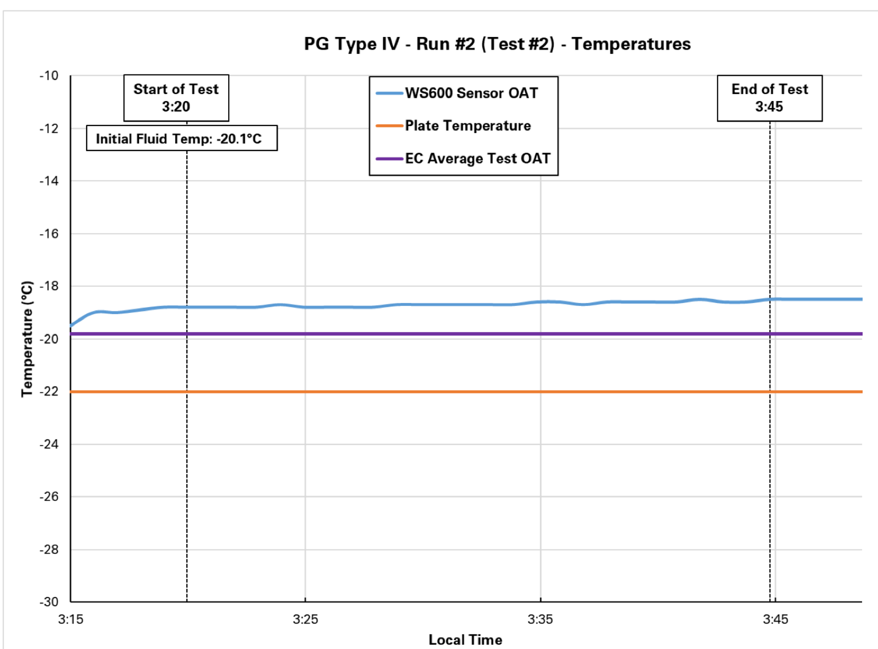
DATA PACKAGE – PG TYPE IV – RUN 2 (TEST 2)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 2 - Test 2/Data Package - PG Type IV - Run 2 - Test 2.docx
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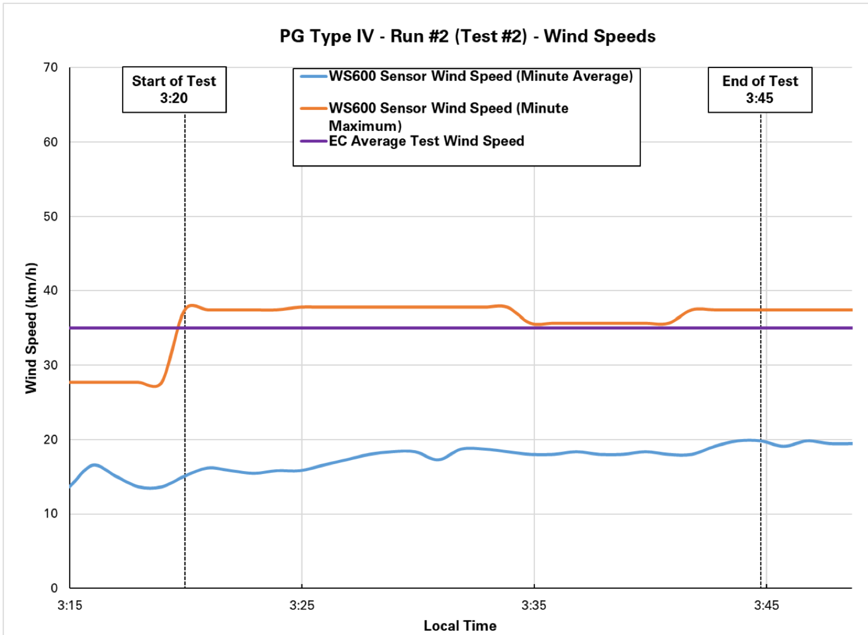
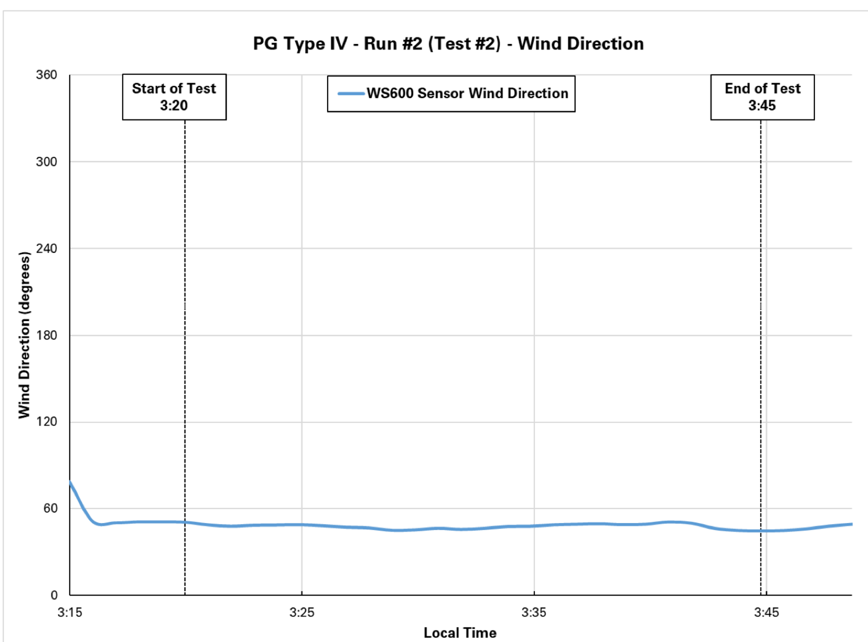
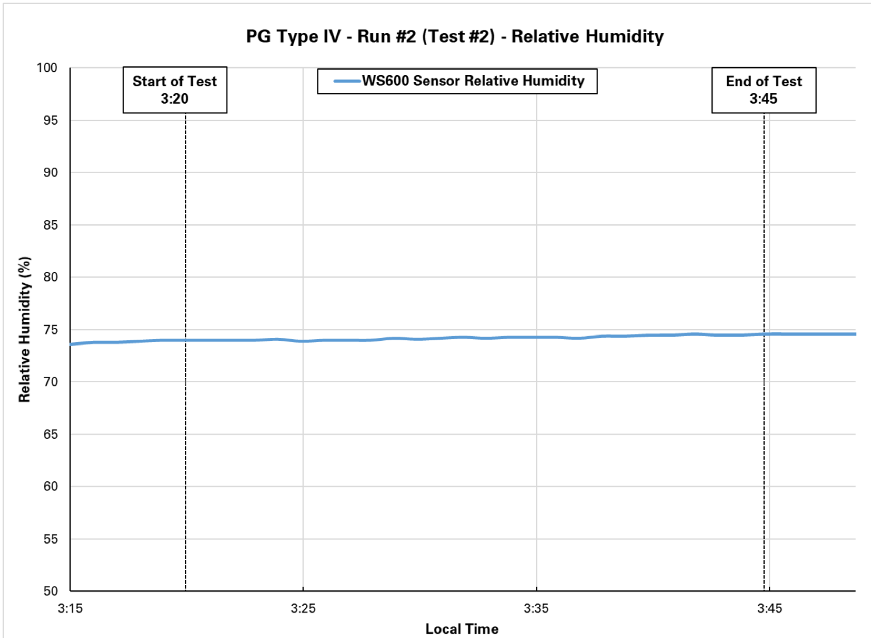


PG Type IV - Run #2 (Test #2) - Wind Speeds
Start of Test 3:20
End of Test 3:45
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
3:15
3:25
3:35
3:45
Local Time



PG Type IV - Run #2 (Test #2) - Wind Direction
Start of Test 3:20
WS600 Sensor Wind Direction
End of Test 3:45
Wind Direction (degrees)
0
60
120
180
240
300
360
3:15
3:25
3:35
3:45
Local Time

DATA PACKAGE – PG TYPE IV – RUN 2 (TEST 2)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 2 - Test 2/Data Package - PG Type IV - Run 2 - Test 2.docx
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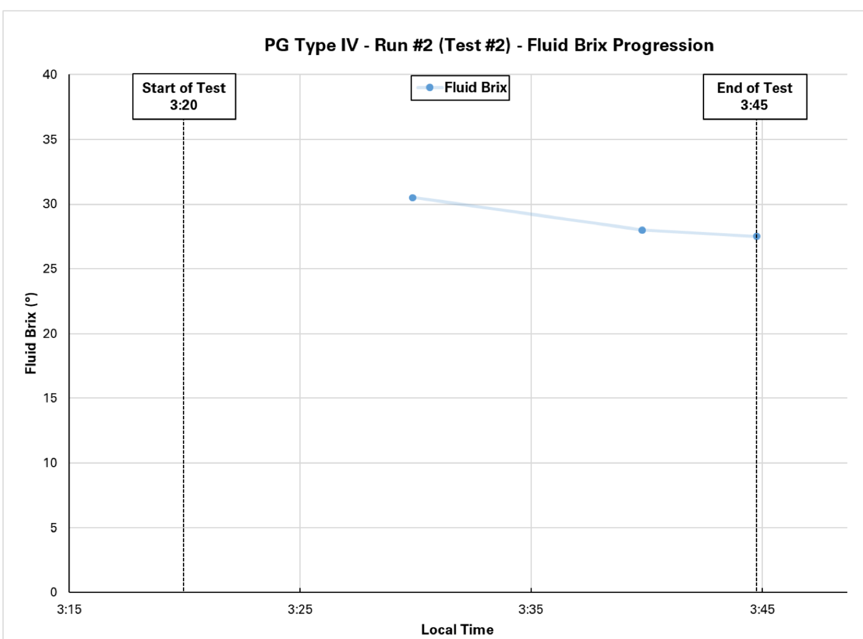
DATA PACKAGE – PG TYPE IV – RUN 2 (TEST 2)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 2 - Test 2/Data Package - PG Type IV - Run 2 - Test 2.docx
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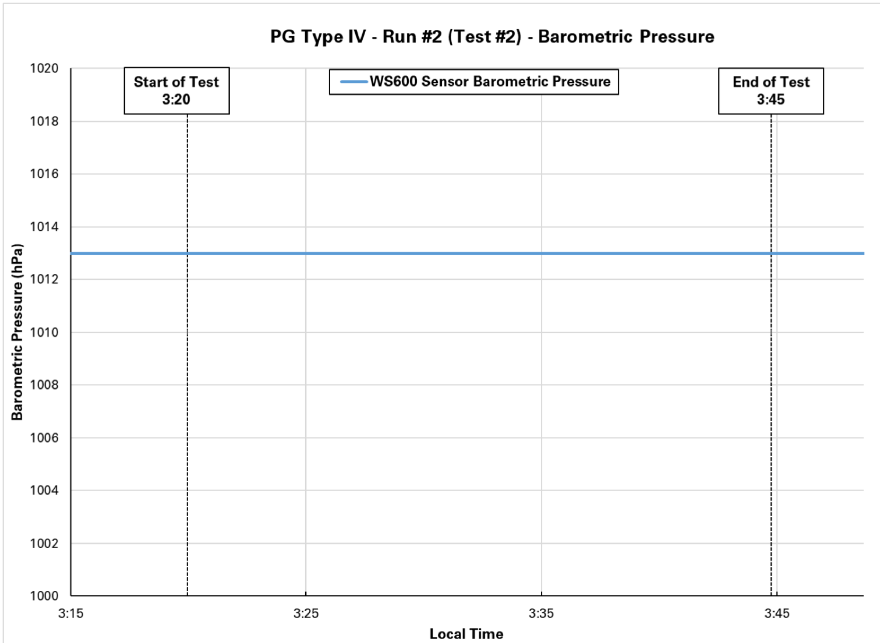
DATA PACKAGE – PG TYPE IV – RUN 2 (TEST 2)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 2 - Test 2/Data Package - PG Type IV - Run 2 - Test 2.docx
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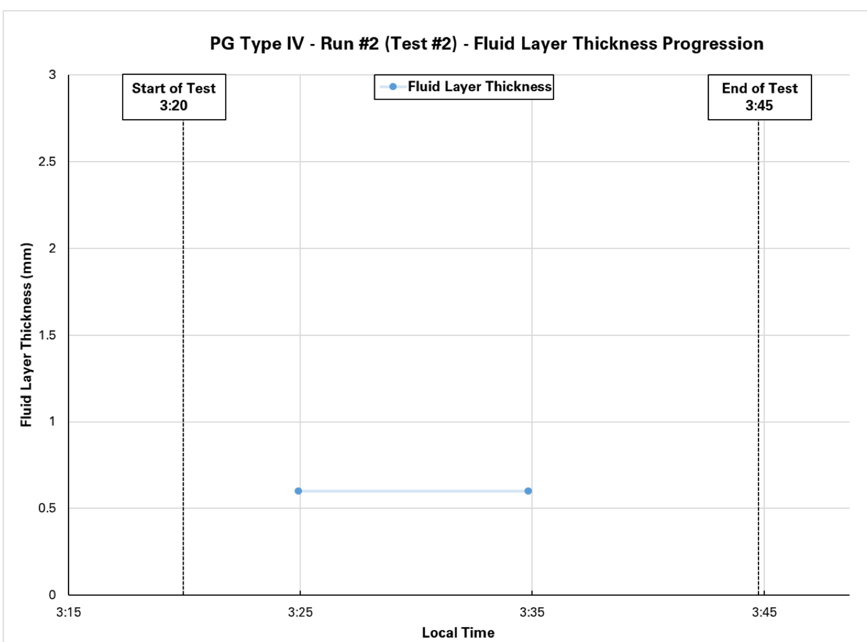
DATA PACKAGE – PG TYPE IV – RUN 2 (TEST 2)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 2 - Test 2/Data Package - PG Type IV - Run 2 - Test 2.docx
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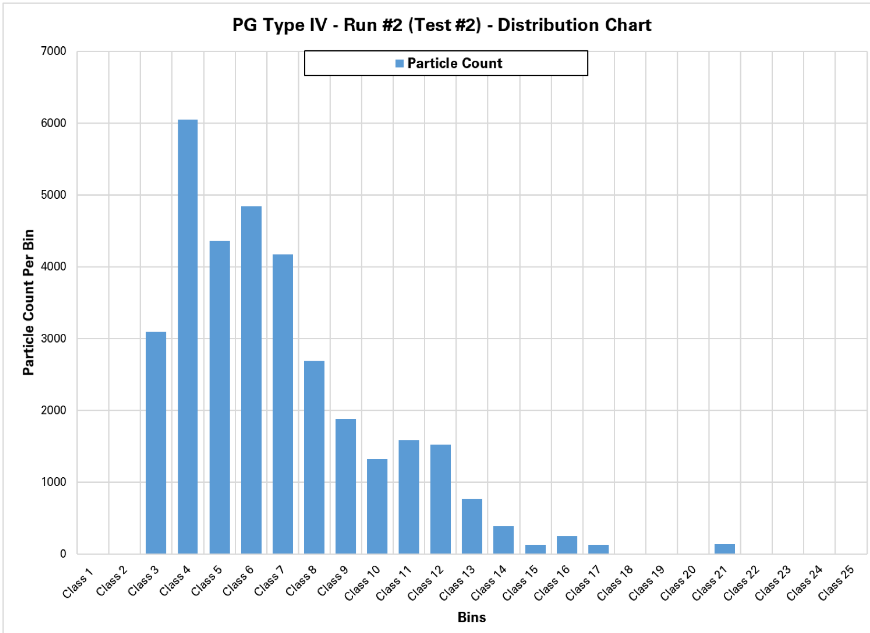
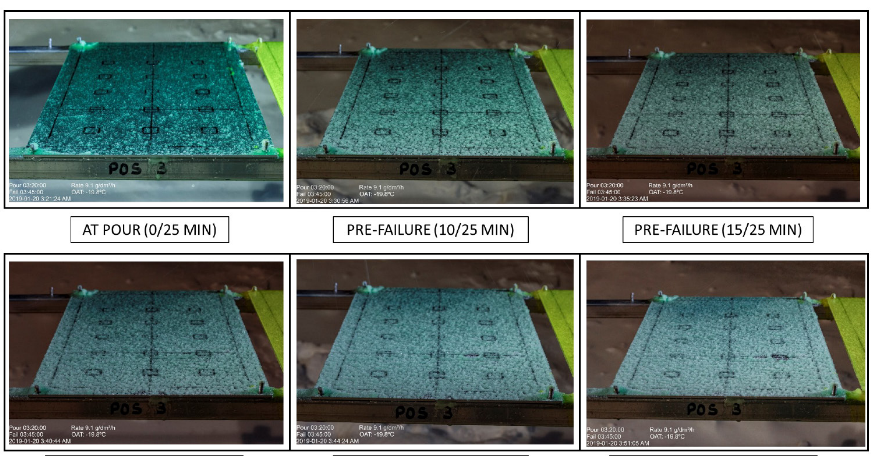


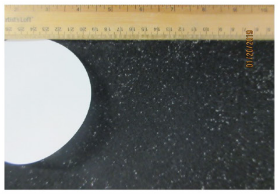
Polar Guard Advance – Run 2 (Test 2) – Failure Progression Photos



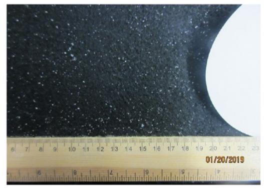
AT POUR (0/25 MIN) | PRE-FAILURE (10/25 MIN) | PRE-FAILURE (15/25 MIN)

PRE-FAILURE (20/25 MIN) | AT FAILURE (25/25 MIN) | POST-FAILURE (31/25 MIN)

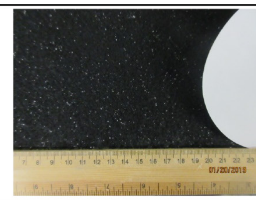
Polar Guard Advance – Run 2 (Test 2) – Snow Characteristics Photos



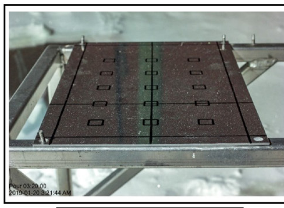
FELT PAD (1/25 MIN)



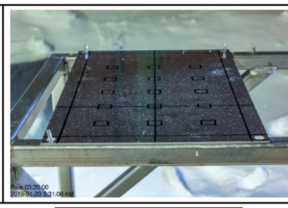
FELT PAD (10/25 MIN)



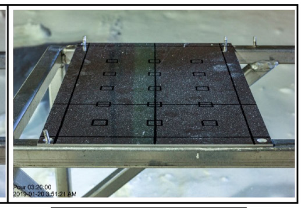
FELT PAD (33/25 MIN)



BARE PLATE (1/25 MIN)



BARE PLATE 10/25 MIN)



BARE PLATE (31/25 MIN)

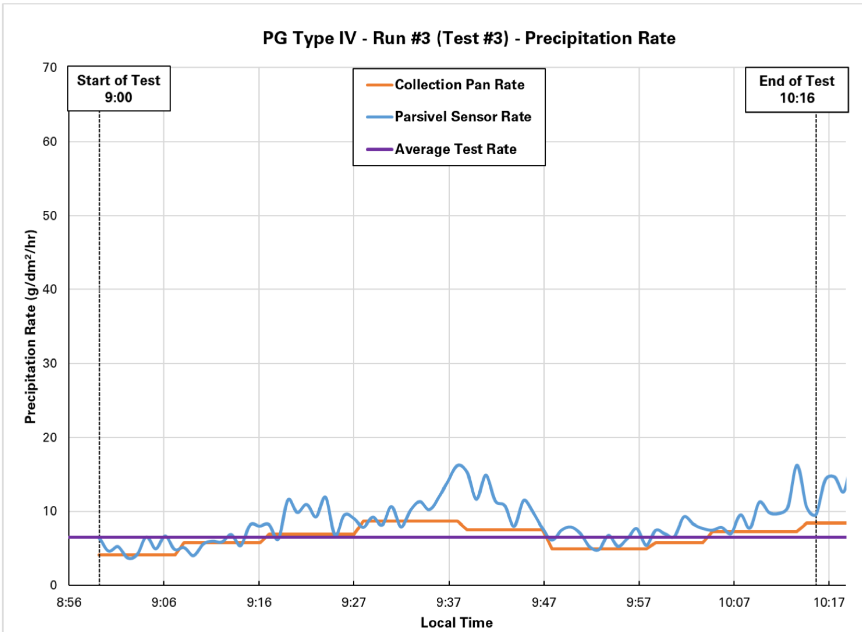
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

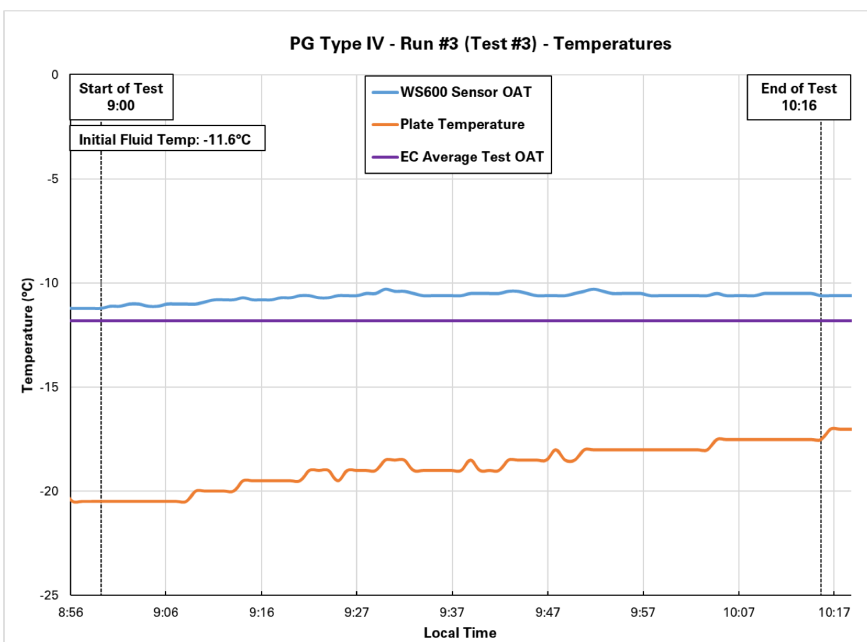
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #3 (TEST #3) – PG4-3

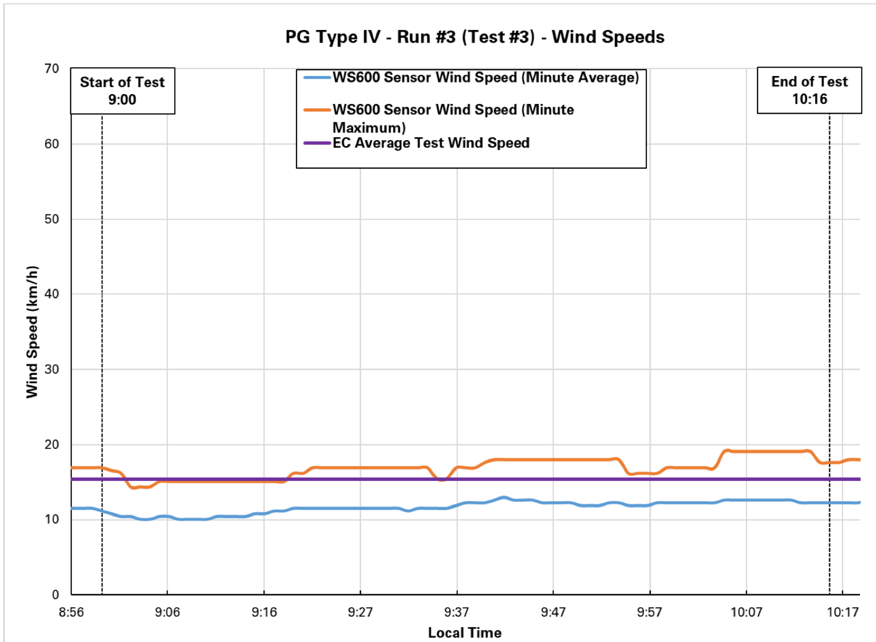
PG Type IV – Run #3 (Test #3) – General Test Information

Test Number:	**PG4-3**
Date of Test:	**January 23, 2019**
Average OAT:	**-11.8**
Average Precipitation Rate:	**6.54 g/dm²/h**
Average Wind Speed:	**15.4 km/h**
Average Relative Humidity:	**80.86%**
Pour Time (Local):	**9:00:00**
Time of Fluid Failure (Local):	**10:16:00**
Fluid Brix at Failure:	**14.5°**
Endurance Time:	**76 minutes**
Expected Regression-Derived Endurance Time:	**79.5 minutes**
Difference (ET vs. Reg ET):	**-3.5 minutes (-4.4%)**


PG Type IV - Run #3 (Test #3) - Precipitation Rate
Start of Test 9:00
End of Test 10:16
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
8:56
9:06
9:16
9:27
9:37
9:47
9:57
10:07
10:17
Local Time


PG Type IV - Run #3 (Test #3) - Temperatures
Start of Test 9:00
Initial Fluid Temp: -11.6°C
End of Test 10:16
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-5
-10
-15
-20
-25
8:56
9:06
9:16
9:27
9:37
9:47
9:57
10:07
10:17
Local Time

DATA PACKAGE – PG TYPE IV – RUN 3 (TEST 3)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 3 - Test 3/Data Package - PG Type IV - Run 3 - Test 3.docx
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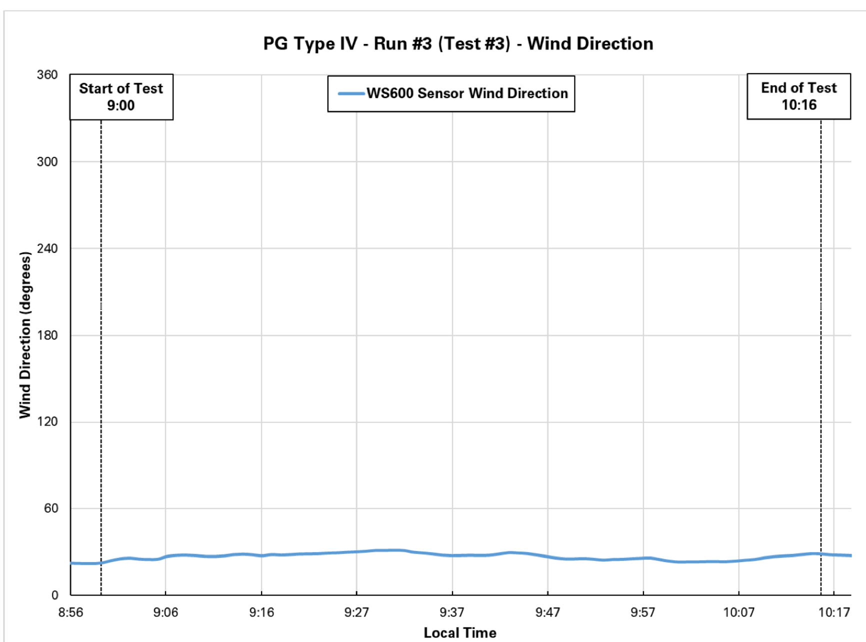
DATA PACKAGE – PG TYPE IV – RUN 3 (TEST 3)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 3 - Test 3/Data Package - PG Type IV - Run 3 - Test 3.docx
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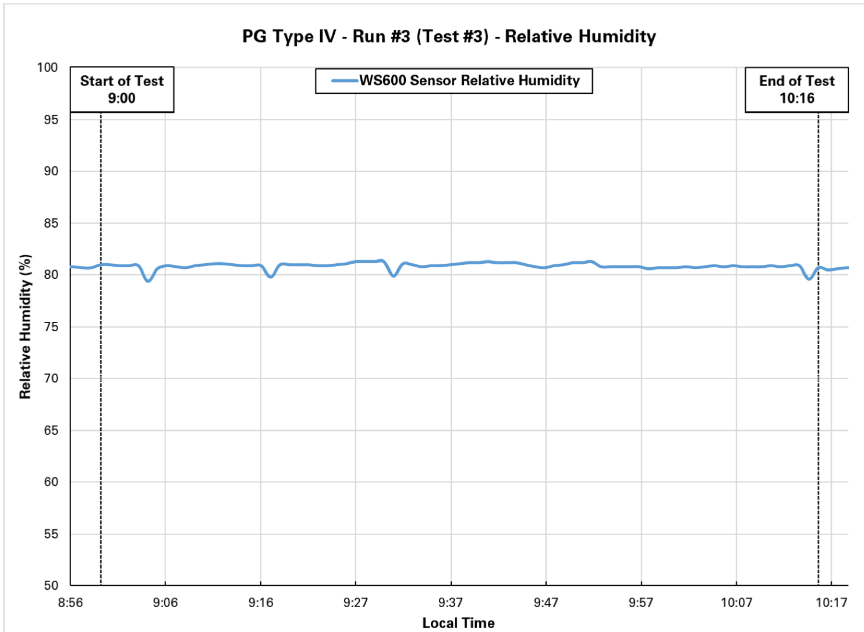
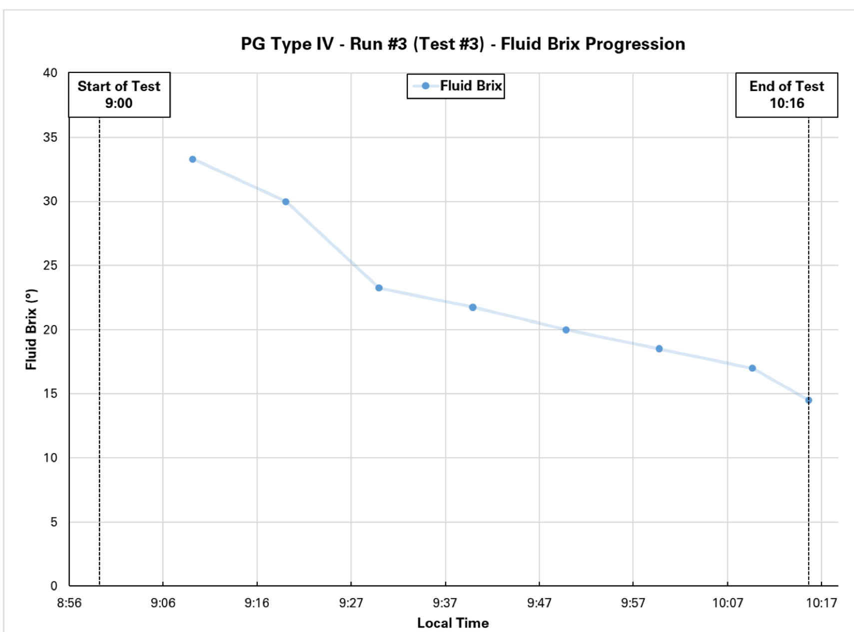
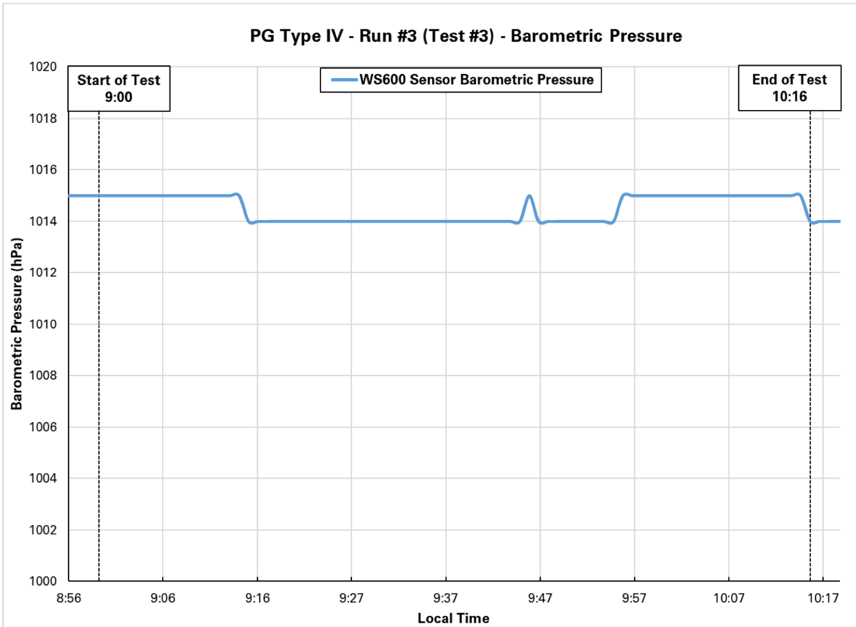
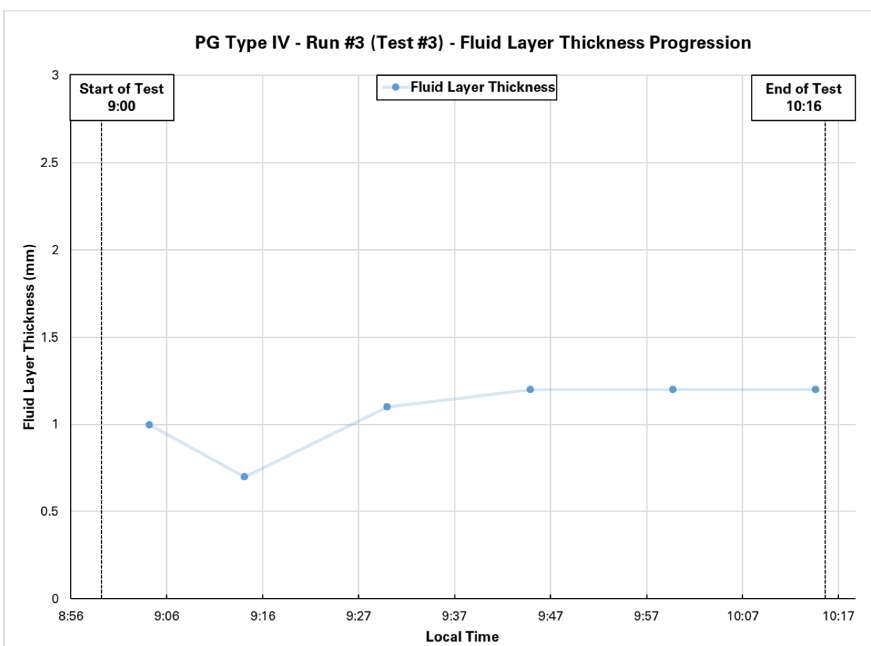
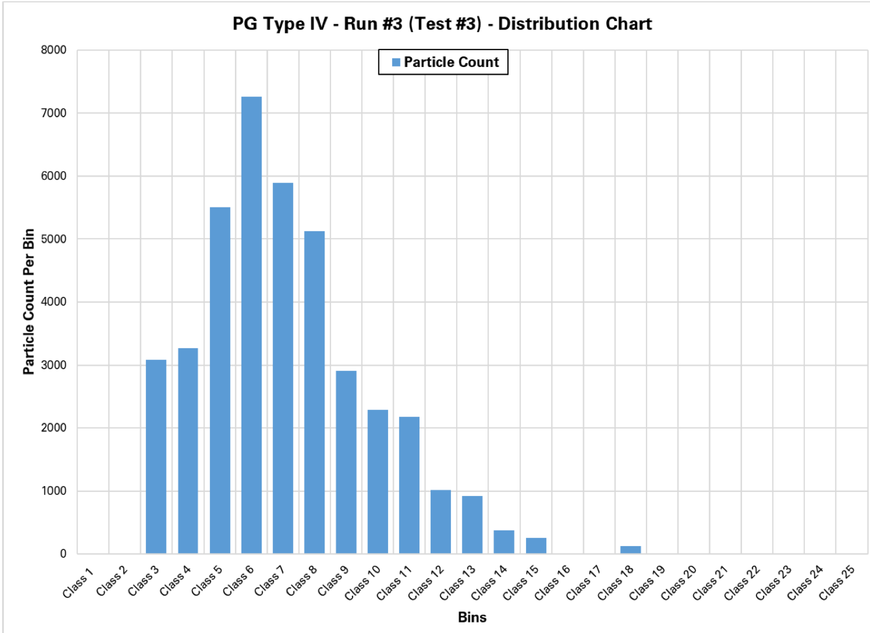


DATA PACKAGE – PG TYPE IV – RUN 3 (TEST 3)



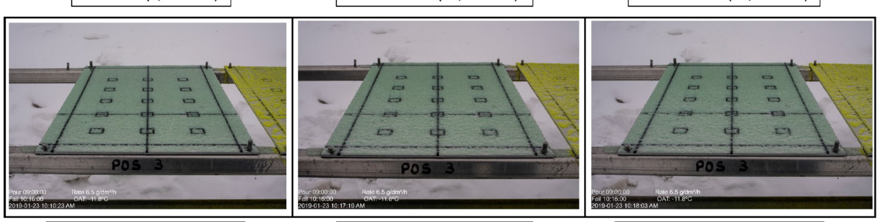

PG Type IV - Run #3 (Test #3) - Barometric Pressure
Start of Test 9:00
WS600 Sensor Barometric Pressure
End of Test 10:16
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
8:56
9:06
9:16
9:27
9:37
9:47
9:57
10:07
10:17
Local Time


PG Type IV - Run #3 (Test #3) - Fluid Layer Thickness Progression
Start of Test 9:00
Fluid Layer Thickness
End of Test 10:16
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
8:56
9:06
9:16
9:27
9:37
9:47
9:57
10:07
10:17
Local Time



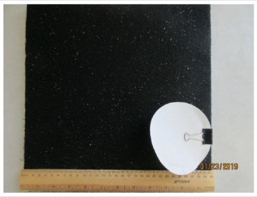
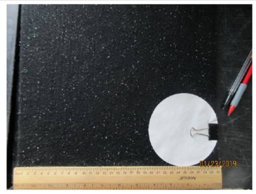
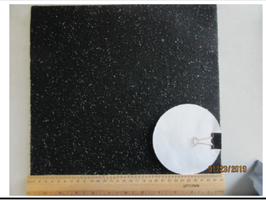
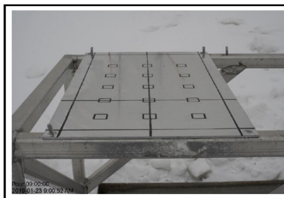
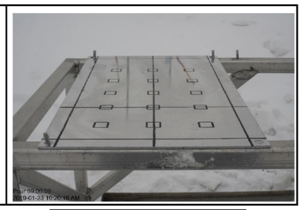
Polar Guard Advance – Run 3 (Test 3) – Failure Progression Photos

AT POUR (0/76 MIN) | PRE-FAILURE (20/76 MIN) | PRE-FAILURE (40/76 MIN)



PRE-FAILURE (70/76 MIN) | AT FAILURE (77/76 MIN) | POST-FAILURE (83/76 MIN)

Polar Guard Advance – Run 3 (Test 3) – Snow Characteristics Photos

		
FELT PAD (12/76 MIN)	FELT PAD (39/76 MIN)	FELT PAD (80/76 MIN)
		
BARE PLATE (0/76 MIN)	BARE PLATE 40/76 MIN)	BARE PLATE (80/76 MIN)

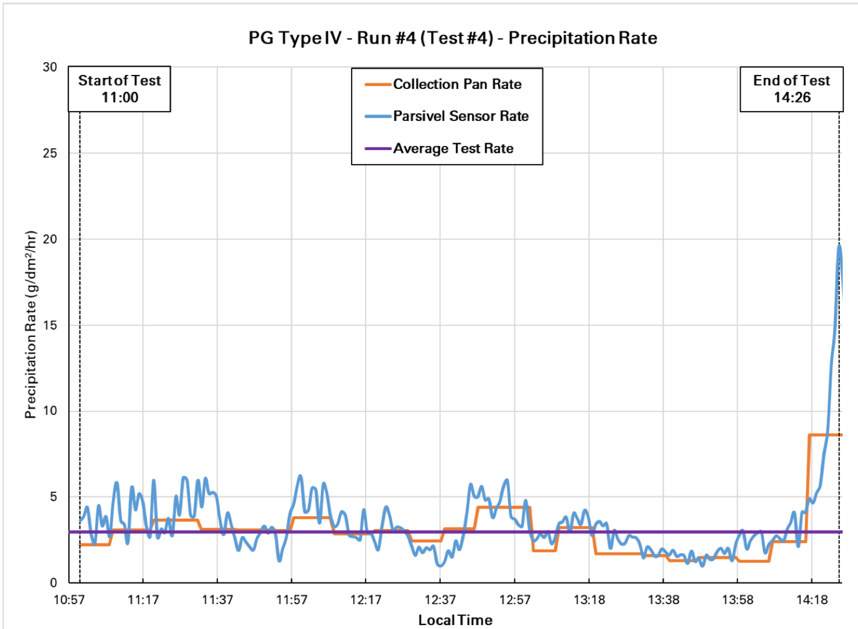
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

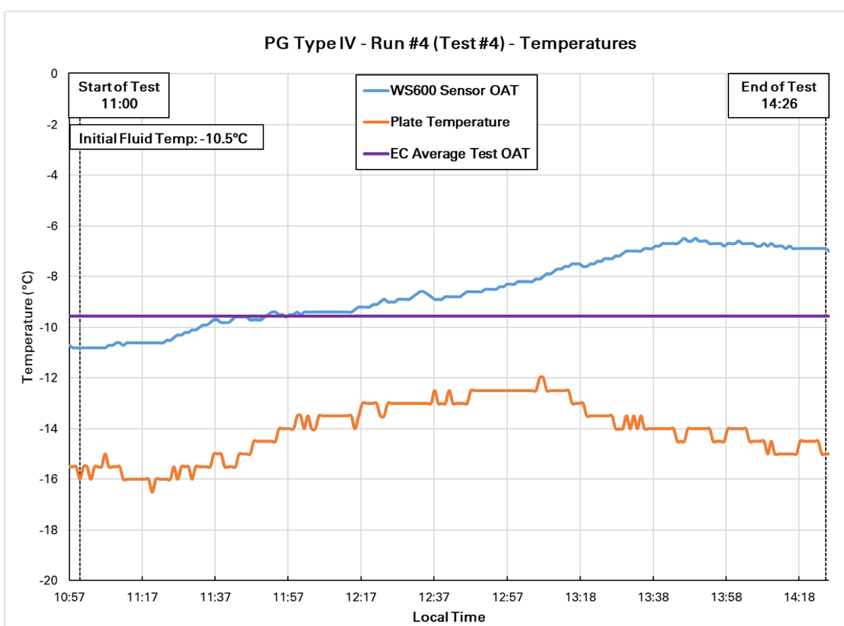
PG TYPE IV
RUN #4 (TEST #4) – PG4-4

PG Type IV – Run #4 (Test #4) – General Test Information

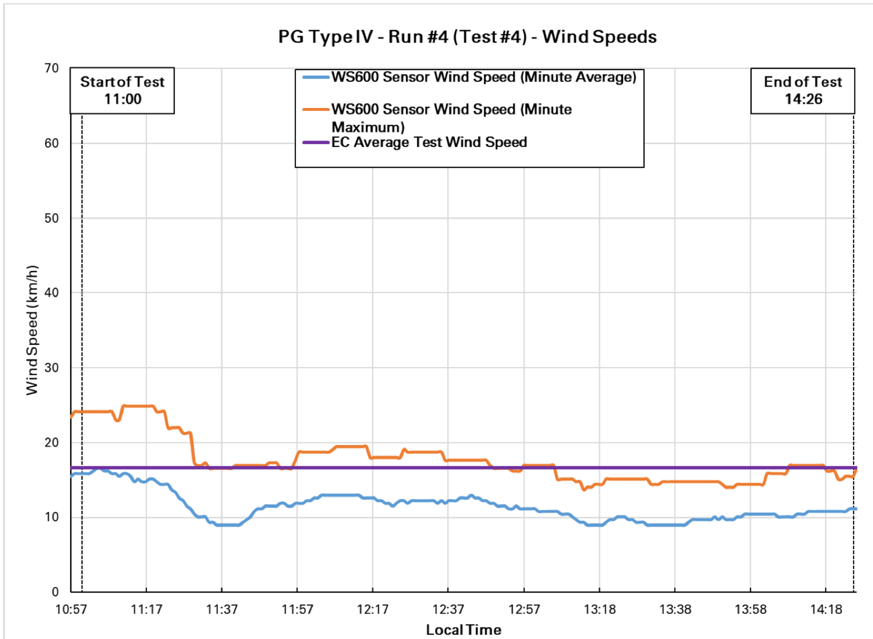
Test Number:	PG4-4
Date of Test:	January 23, 2019
Average OAT:	-9.6
Average Precipitation Rate:	3 g/dm²/h
Average Wind Speed:	16.6 km/h
Average Relative Humidity:	81.45%
Pour Time (Local):	11:00:00
Time of Fluid Failure (Local):	14:26:00
Fluid Brix at Failure:	12.75°
Endurance Time:	206 minutes
Expected Regression-Derived Endurance Time:	167.9 minutes
Difference (ET vs. Reg ET):	+38.1 minutes (+22.7%)

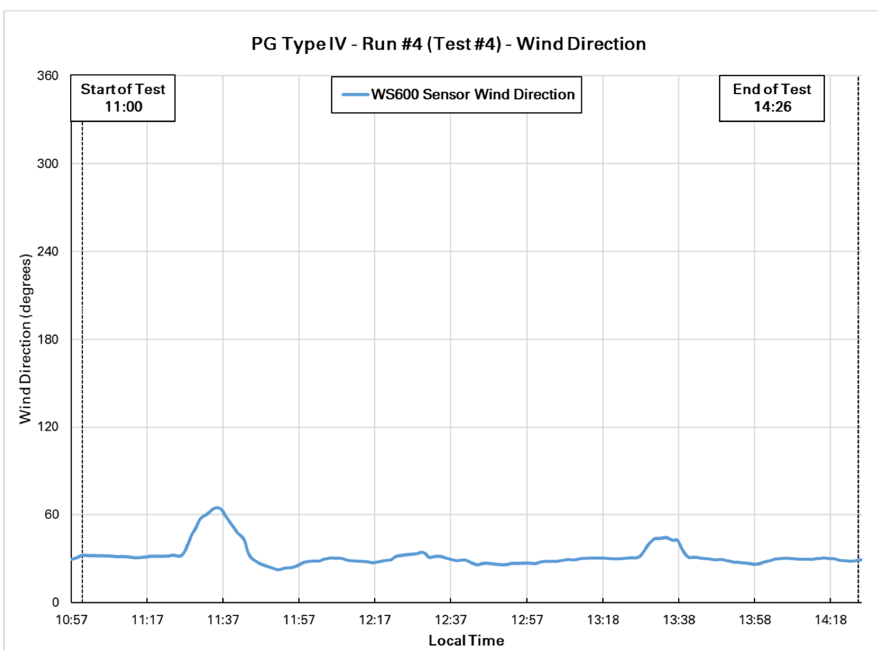


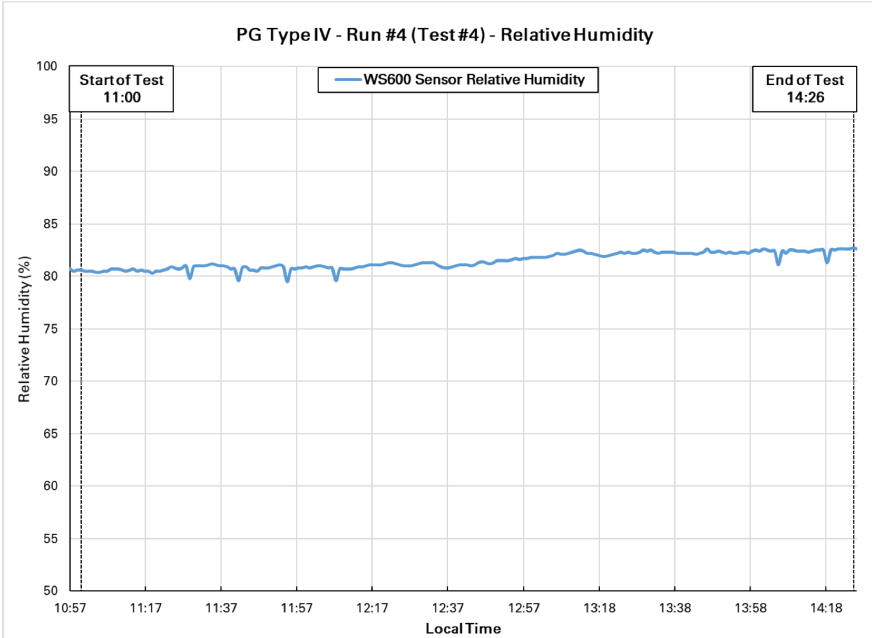
PG Type IV - Run #4 (Test #4) - Precipitation Rate
Start of Test 11:00
End of Test 14:26
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
5
10
15
20
25
30
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18
Local Time

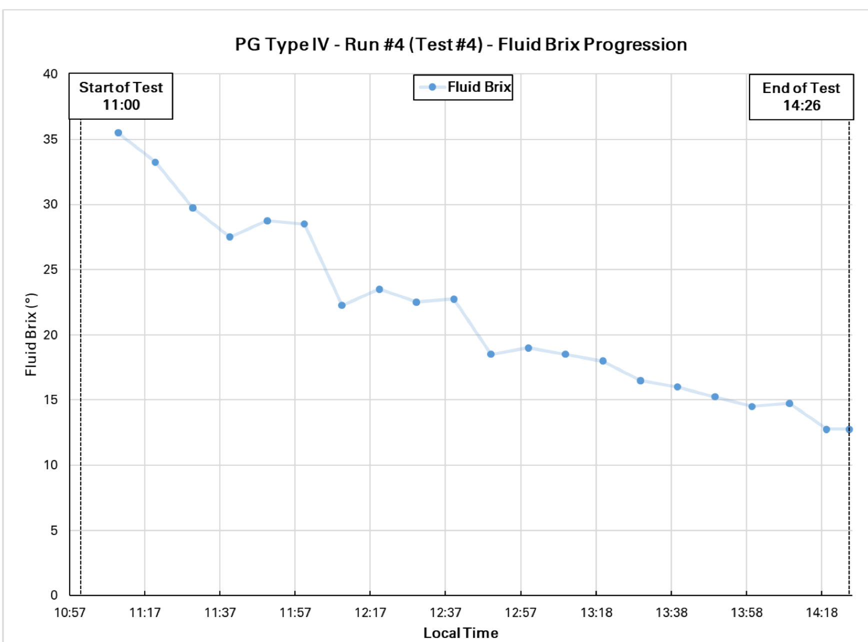


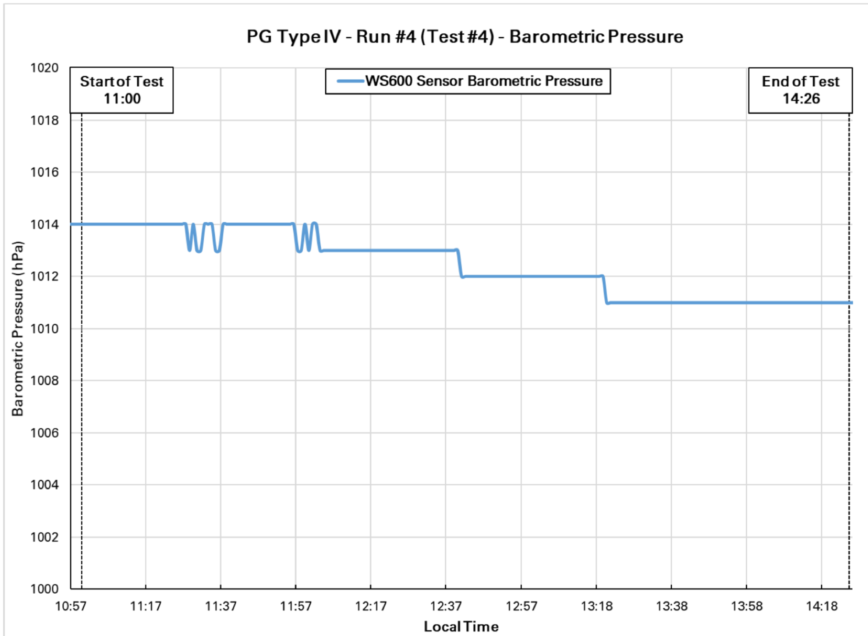
PG Type IV - Run #4 (Test #4) - Temperatures
Start of Test 11:00
Initial Fluid Temp: -10.5°C
End of Test 14:26
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18
Local Time

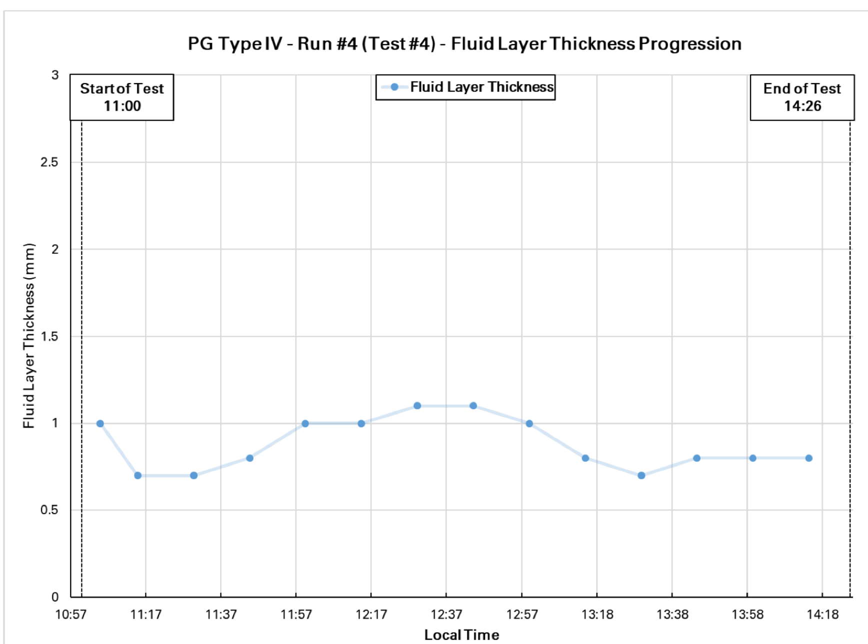

PG Type IV - Run #4 (Test #4) - Wind Speeds
Start of Test 11:00
End of Test 14:26
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18

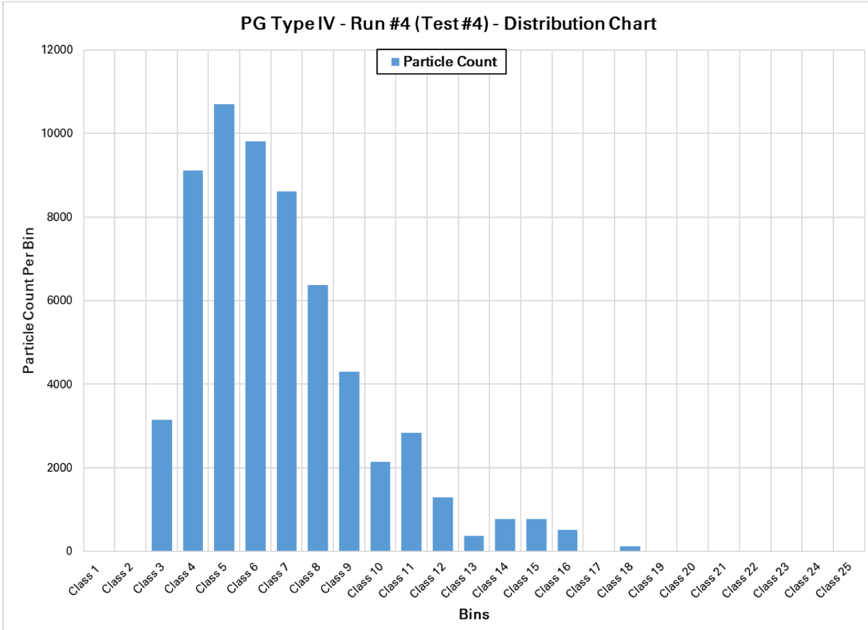

PG Type IV - Run #4 (Test #4) - Wind Direction
Start of Test 11:00
End of Test 14:26
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18


PG Type IV - Run #4 (Test #4) - Relative Humidity
Start of Test 11:00
WS600 Sensor Relative Humidity
End of Test 14:26
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18
Local Time


PG Type IV - Run #4 (Test #4) - Fluid Brix Progression
Start of Test 11:00
Fluid Brix
End of Test 14:26
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18
Local Time

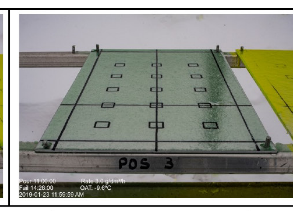

PG Type IV - Run #4 (Test #4) - Barometric Pressure
Start of Test 11:00
WS600 Sensor Barometric Pressure
End of Test 14:26
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18
Local Time


PG Type IV - Run #4 (Test #4) - Fluid Layer Thickness Progression
Start of Test 11:00
Fluid Layer Thickness
End of Test 14:26
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:57
11:17
11:37
11:57
12:17
12:37
12:57
13:18
13:38
13:58
14:18
Local Time

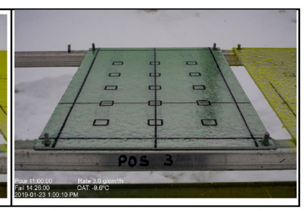


Polar Guard Advance – Run 4 (Test 4) – Failure Progression Photos

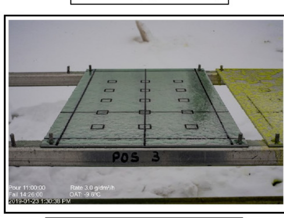
AT POUR (0/206 MIN)



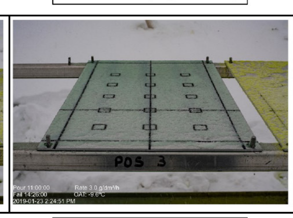
PRE-FAILURE (59/206 MIN)



PRE-FAILURE (120/206 MIN)



PRE-FAILURE (150/206 MIN)

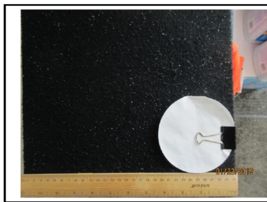


AT FAILURE (205/206 MIN)

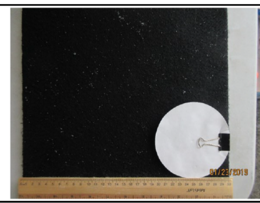
POST-FAILURE (214/206 MIN)

DATA PACKAGE – PG TYPE IV – RUN 4 (TEST 4)

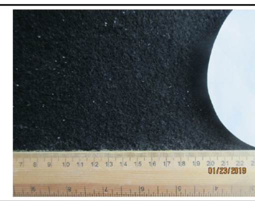
Polar Guard Advance – Run 4 (Test 4) – Snow Characteristics Photos



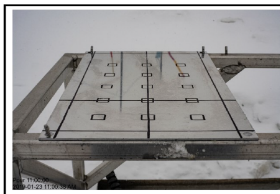
FELT PAD (29/206 MIN)



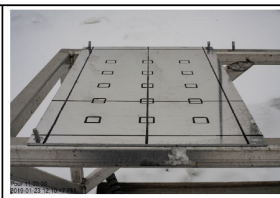
FELT PAD (160/206 MIN)



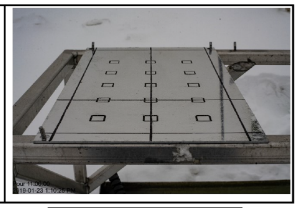
FELT PAD (190/206 MIN)



BARE PLATE (0/206 MIN)



BARE PLATE 70/206 MIN)



BARE PLATE (190/206 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 4 - Test 4/Data Package - PG Type IV - Run 4 - Test 4.docx
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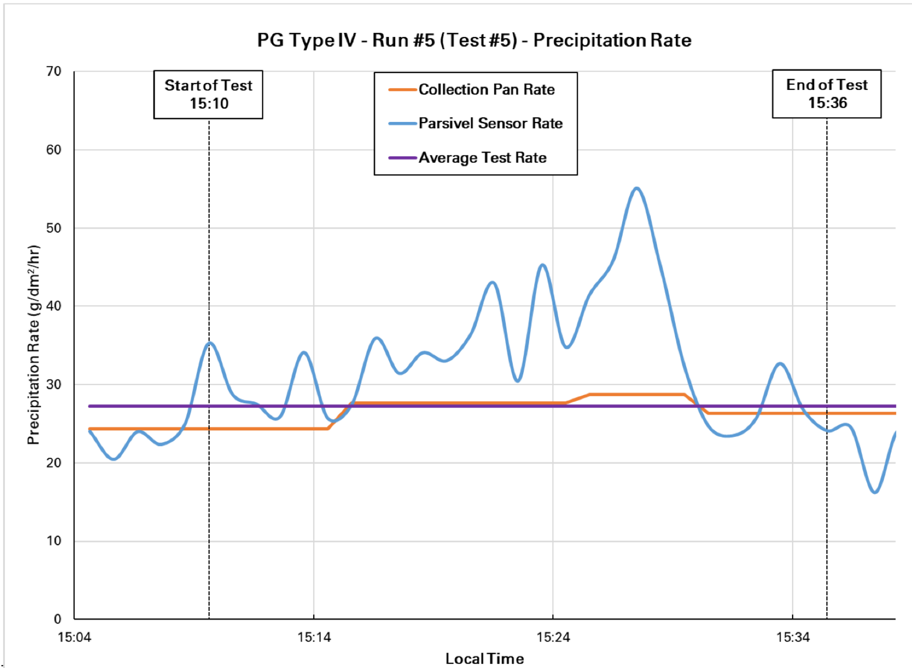
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #5 (TEST #5) – PG4-5

PG Type IV – Run #5 (Test #5) – General Test Information

Test Number:	**PG4-5**
Date of Test:	**January 23, 2019**
Average OAT:	**-8.6**
Average Precipitation Rate:	**27 g/dm²/h**
Average Wind Speed:	**18 km/h**
Average Relative Humidity:	**85.02%**
Pour Time (Local):	**15:10:00**
Time of Fluid Failure (Local):	**15:36:00**
Fluid Brix at Failure:	**17.25°**
Endurance Time:	**26 minutes**
Expected Regression-Derived Endurance Time:	**28.6 minutes**
Difference (ET vs. Reg ET):	**-2.6 minutes (-9%)**

DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 5 - Test 5/Data Package - PG Type IV - Run 5 - Test 5.docx
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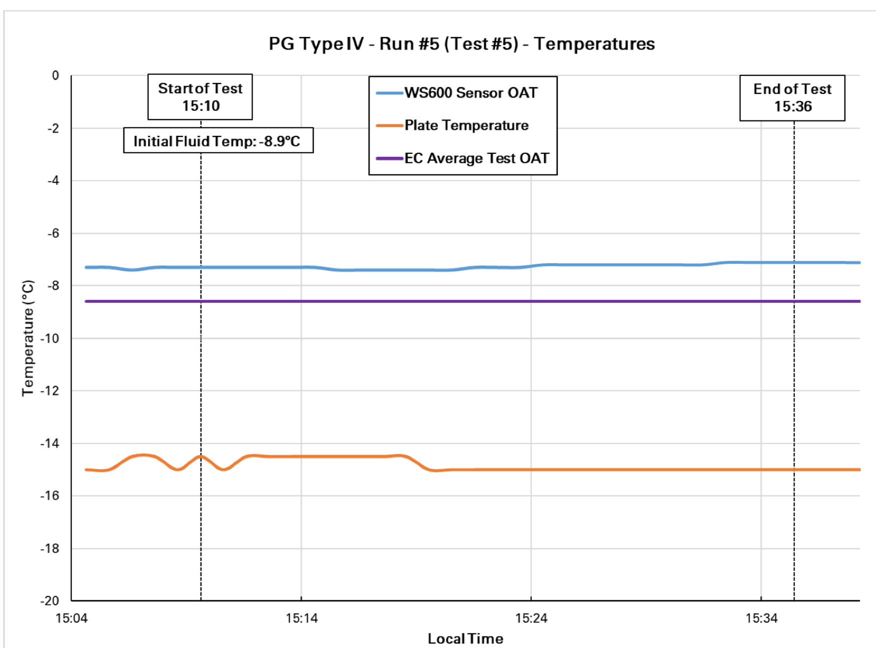
DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 5 - Test 5/Data Package - PG Type IV - Run 5 - Test 5.docx
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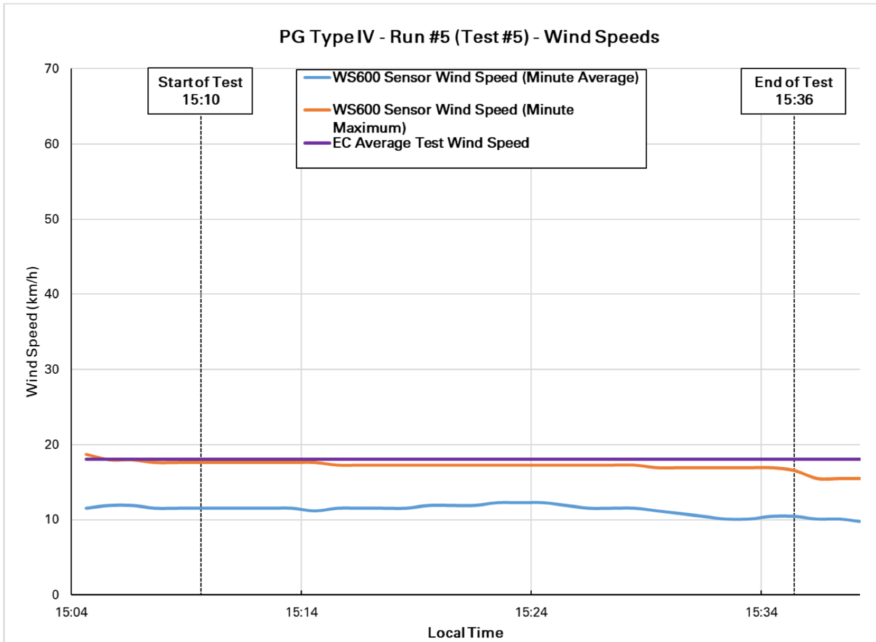
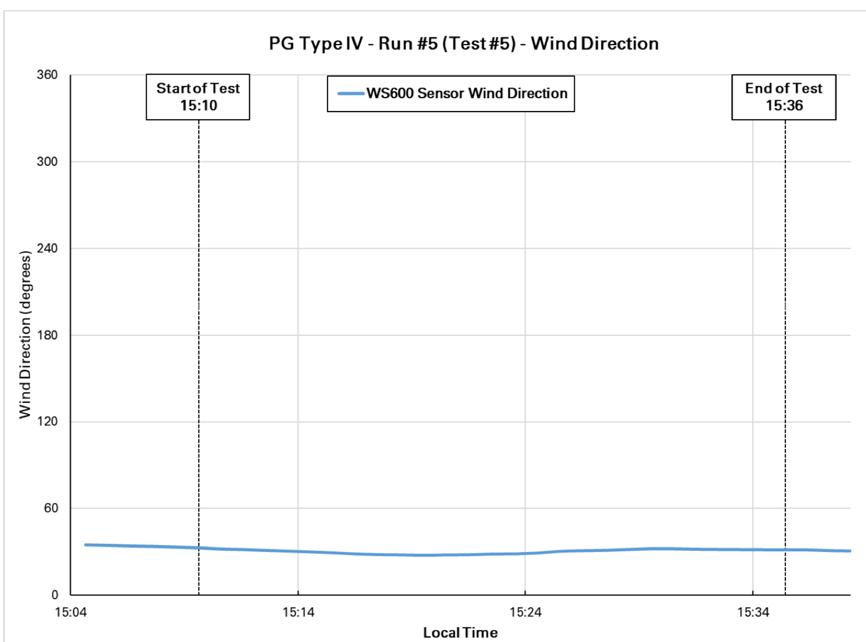
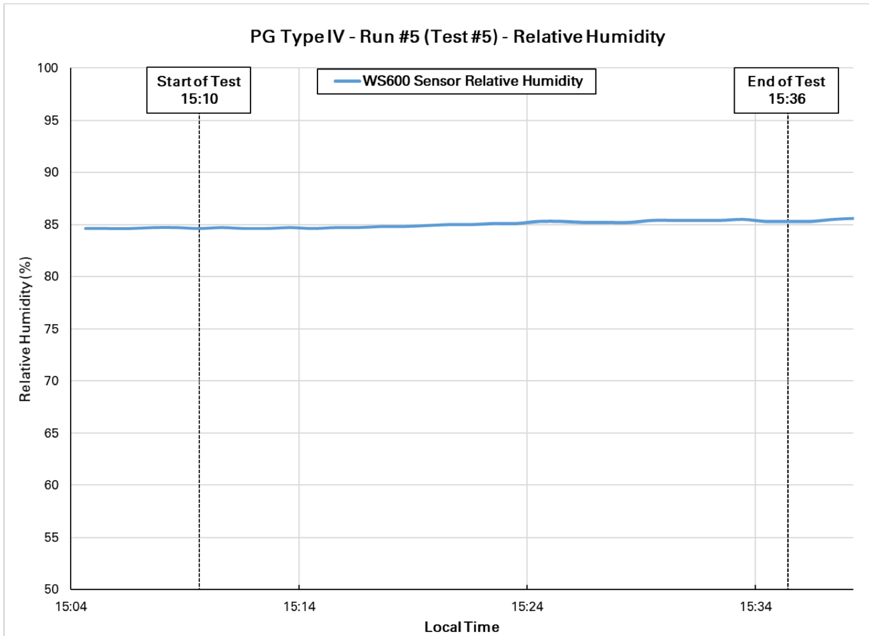

PG Type IV - Run #5 (Test #5) - Wind Speeds
Start of Test 15:10
End of Test 15:36
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
15:04
15:14
15:24
15:34
Local Time


PG Type IV - Run #5 (Test #5) - Wind Direction
Start of Test 15:10
End of Test 15:36
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
15:04
15:14
15:24
15:34
Local Time

DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 5 - Test 5/Data Package - PG Type IV - Run 5 - Test 5.docx
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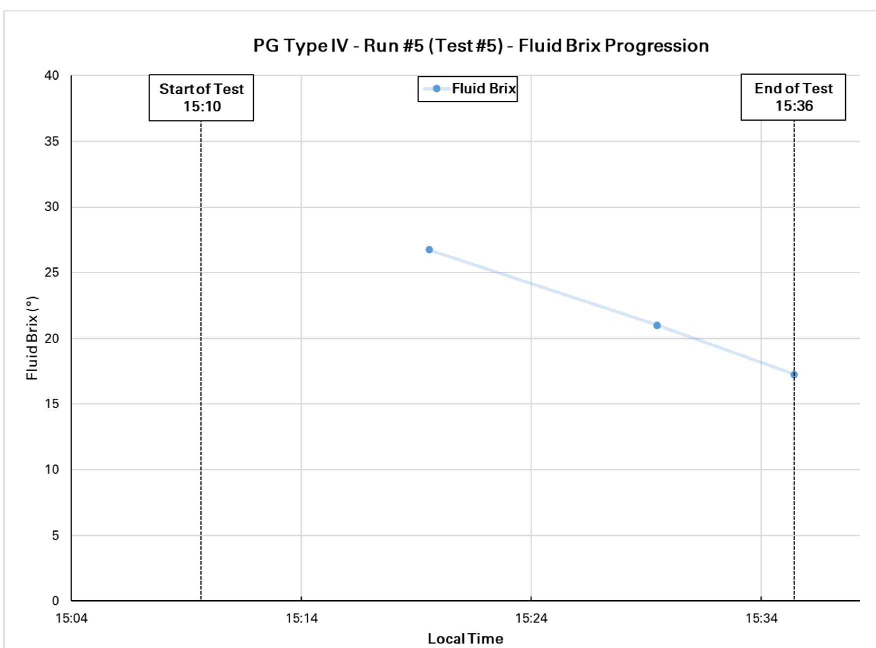
DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 5 - Test 5/Data Package - PG Type IV - Run 5 - Test 5.docx
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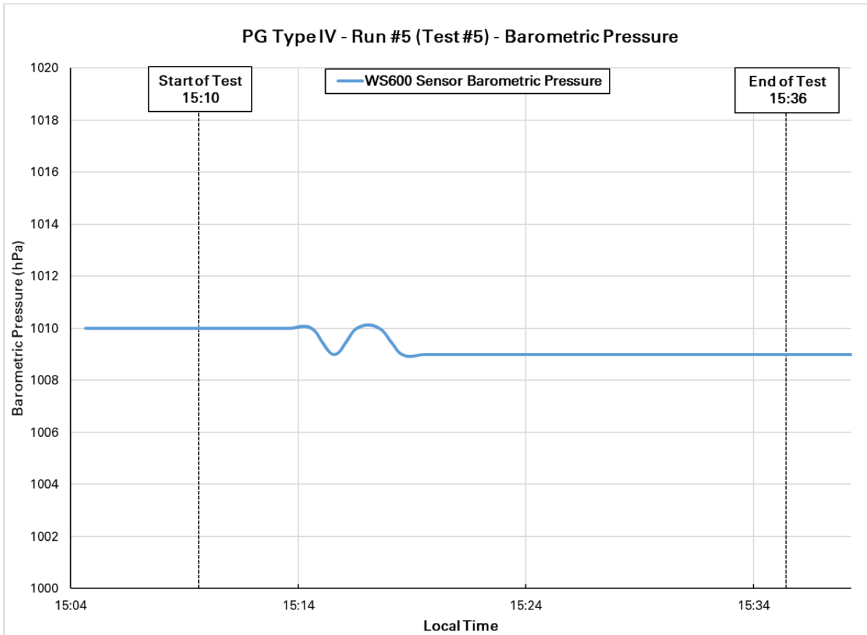
DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 5 - Test 5/Data Package - PG Type IV - Run 5 - Test 5.docx
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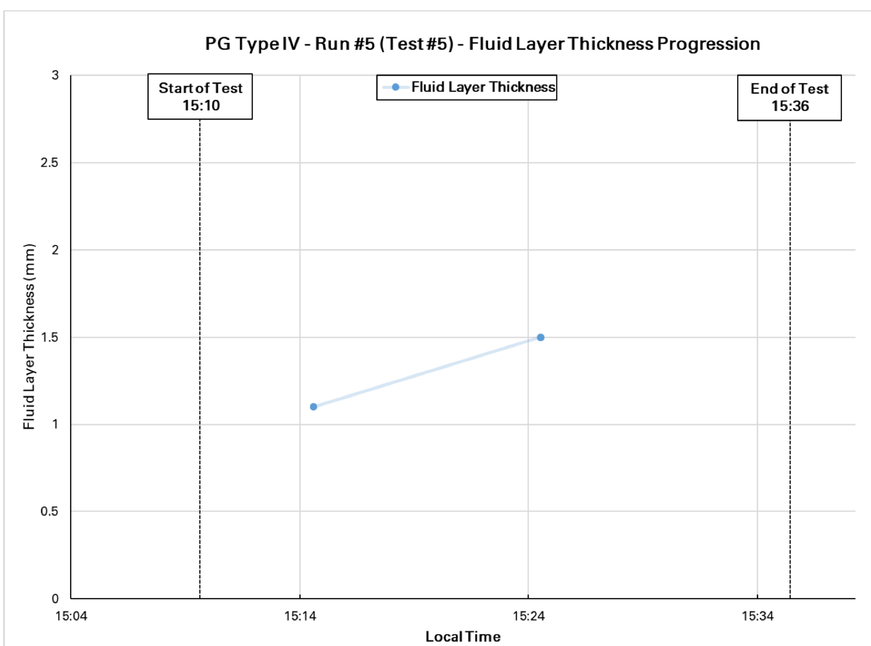
DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 5 - Test 5/Data Package - PG Type IV - Run 5 - Test 5.docx
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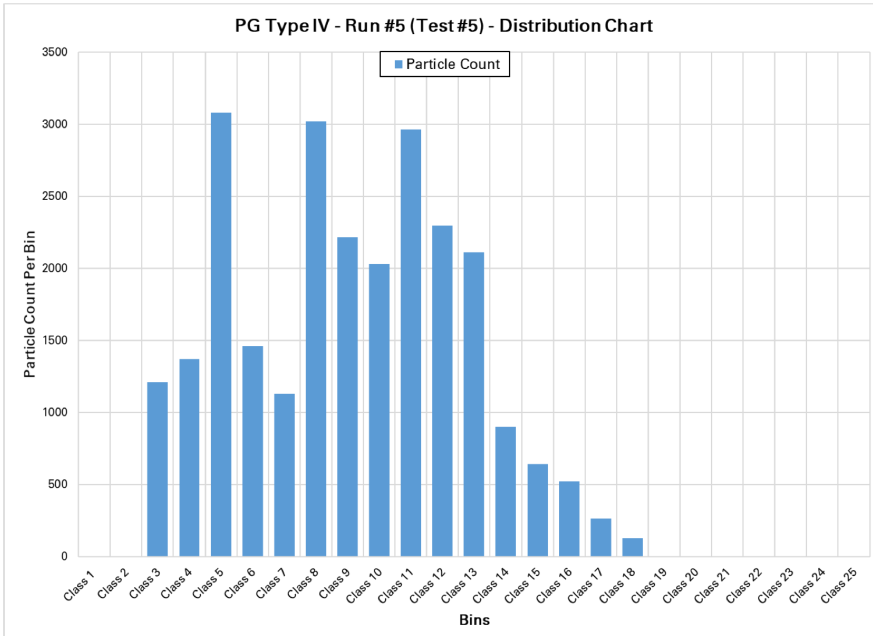
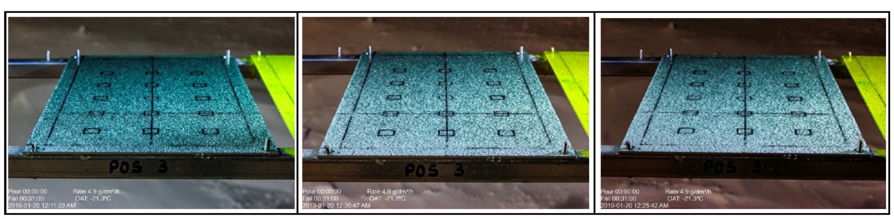
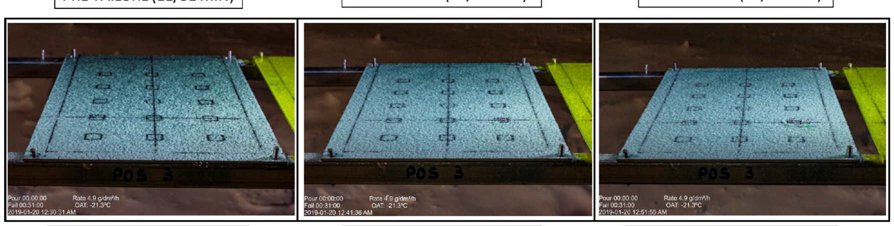


Polar Guard Advance – Run 5 (Test 5) – Failure Progression Photos



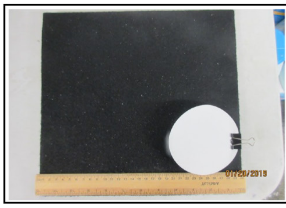
PRE-FAILURE (11/31 MIN) | PRE-FAILURE (20/31 MIN) | PRE-FAILURE (25/31 MIN)



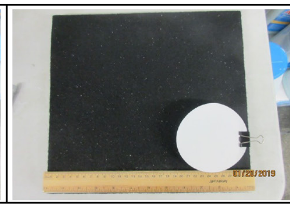
AT FAILURE (31/31 MIN) | POST-FAILURE(41/31 MIN) | POST-FAILURE (51/31 MIN)

DATA PACKAGE – PG TYPE IV – RUN 5 (TEST 5)

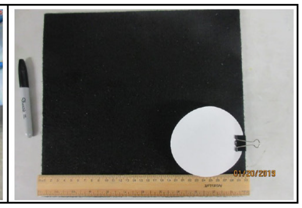
Polar Guard Advance – Run 5 (Test 5) – Snow Characteristics Photos



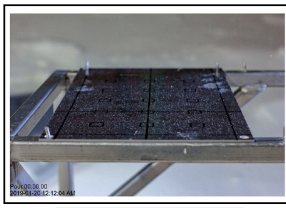
FELT PAD (13/31 MIN)



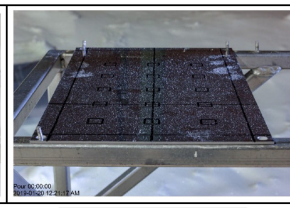
FELT PAD (21/31 MIN)



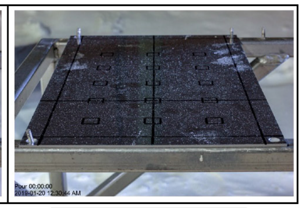
FELT PAD (31/31 MIN)



BARE PLATE (12/31 MIN)



BARE PLATE 21/31 MIN)



BARE PLATE (31/31 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

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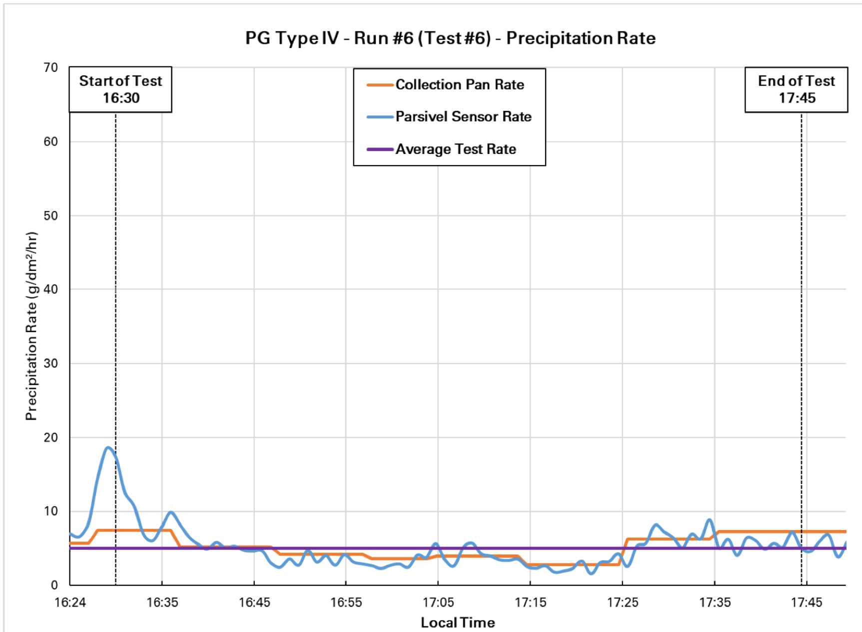
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #6 (TEST #6) – PG4-6

PG Type IV – Run #6 (Test #6) – General Test Information

Test Number:	PG4-6
Date of Test:	January 29, 2019
Average OAT:	-10.5
Average Precipitation Rate:	5.04 g/dm²/h
Average Wind Speed:	18.60 km/h
Average Relative Humidity:	82.70%
Pour Time (Local):	16:30:00
Time of Fluid Failure (Local):	17:45:00
Fluid Brix at Failure:	19.5°
Endurance Time:	75 minutes
Expected Regression-Derived Endurance Time:	103.8 minutes
Difference (ET vs. Reg ET):	-28.8 minutes (-27.8%)

DATA PACKAGE – PG TYPE IV – RUN 6 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 6 - Test 6/Data Package - PG Type IV - Run 6 - Test 6.docx
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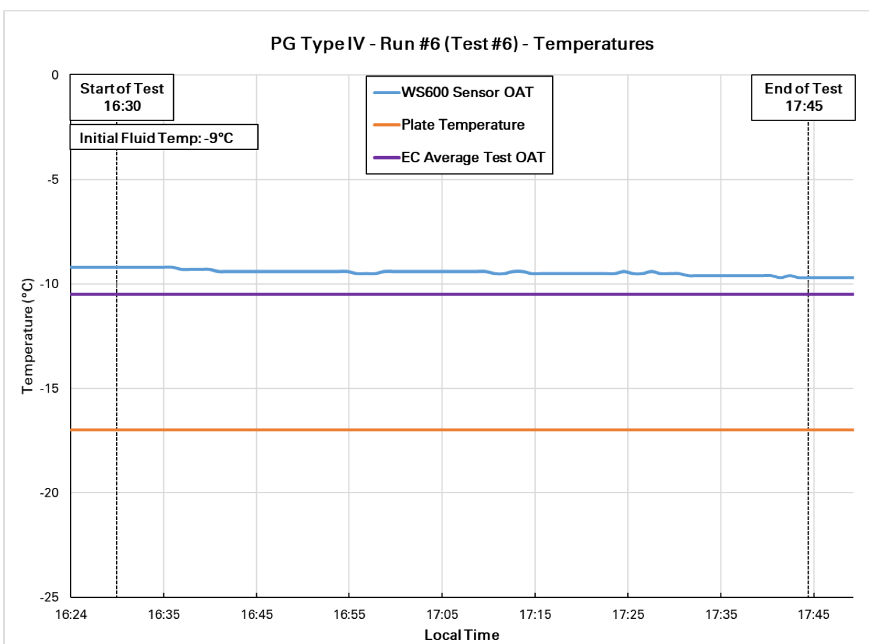
DATA PACKAGE – PG TYPE IV – RUN 6 (TEST 6)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 6 - Test 6/Data Package - PG Type IV - Run 6 - Test 6.docx
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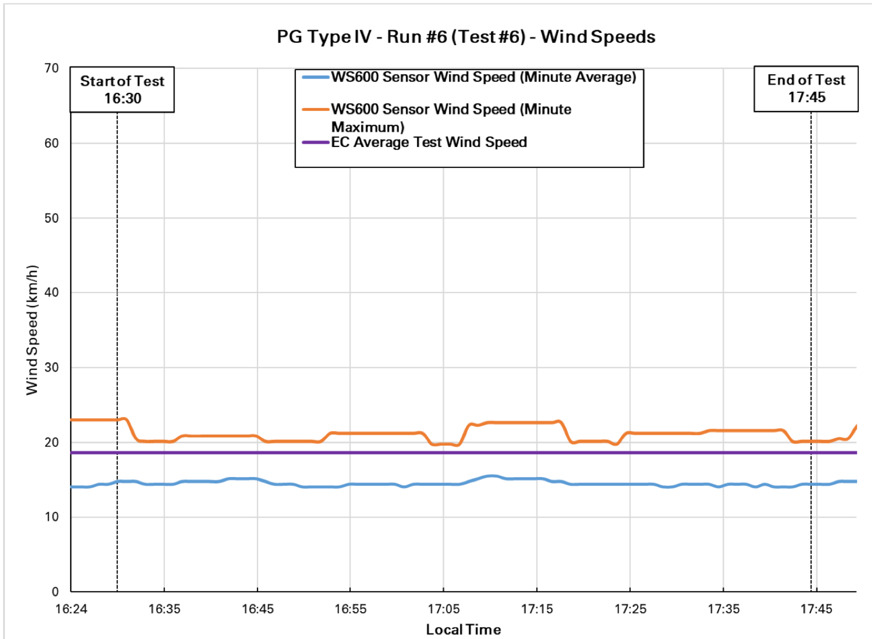
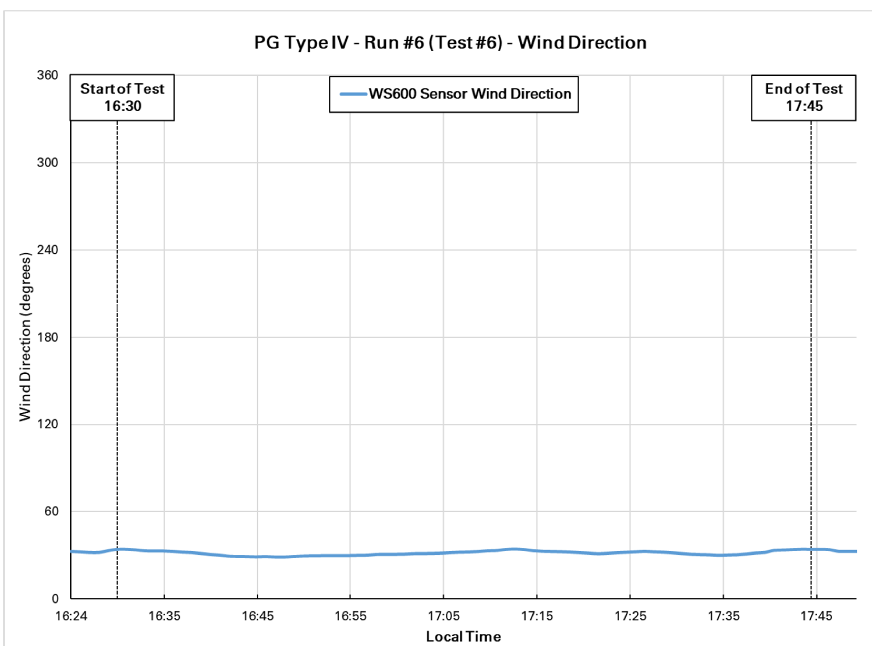
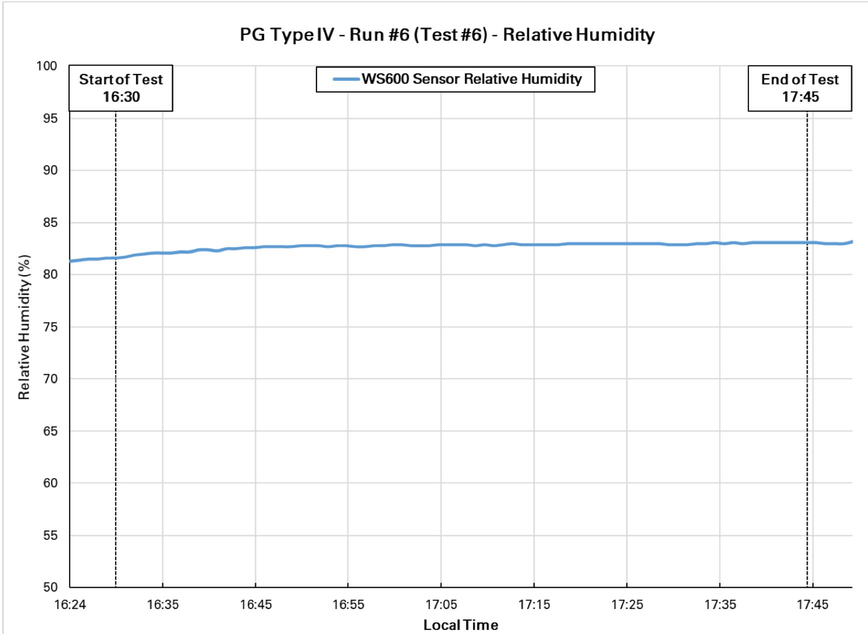


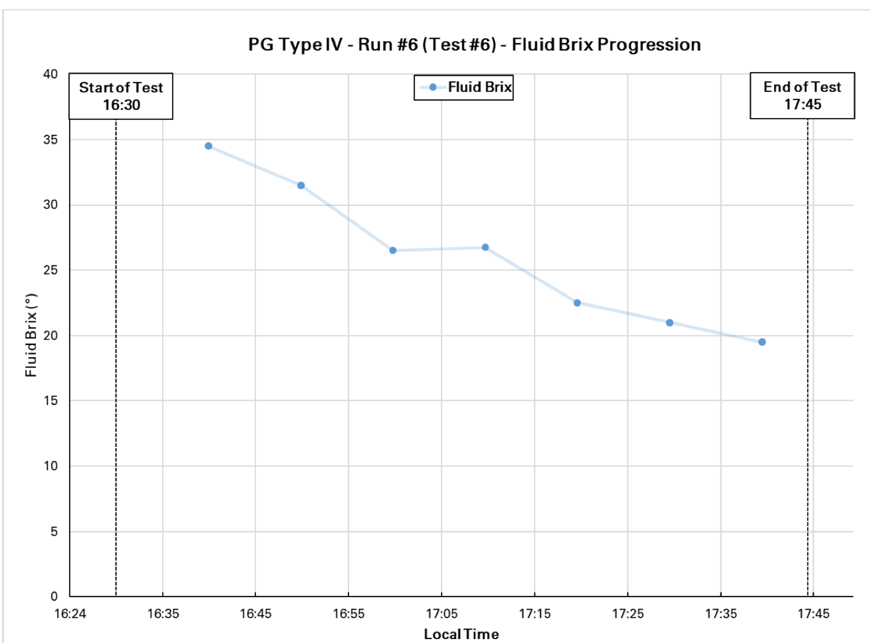
PG Type IV - Run #6 (Test #6) - Wind Speeds
Start of Test 16:30
End of Test 17:45
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
17:45
Local Time



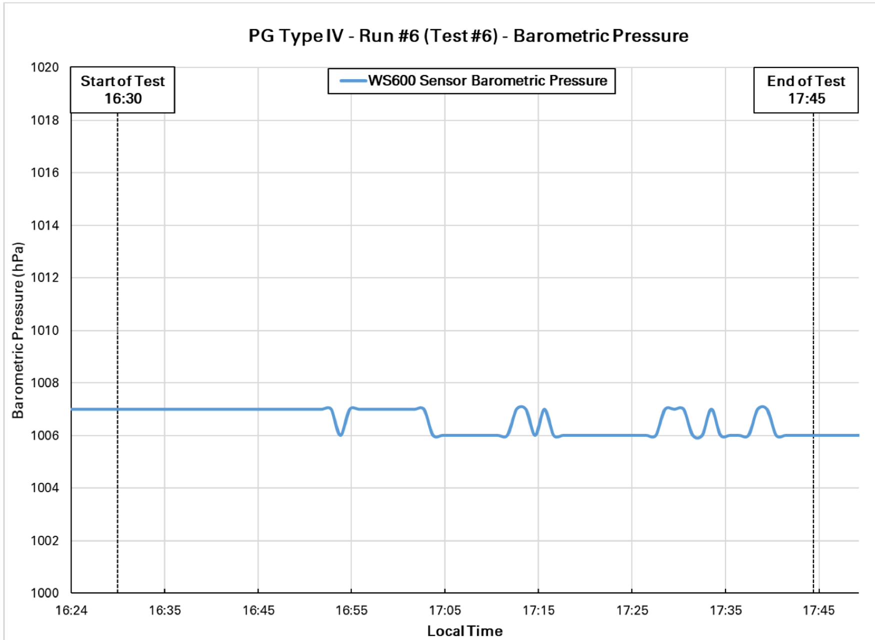
PG Type IV - Run #6 (Test #6) - Wind Direction
Start of Test 16:30
WS600 Sensor Wind Direction
End of Test 17:45
Wind Direction (degrees)
0
60
120
180
240
300
360
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
17:45
Local Time



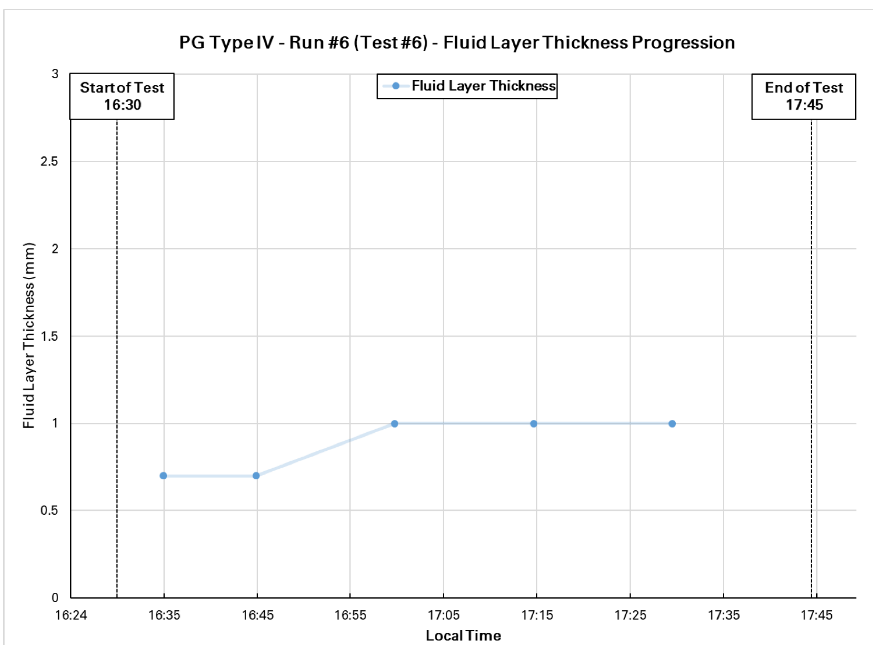
PG Type IV - Run #6 (Test #6) - Relative Humidity
Start of Test 16:30
WS600 Sensor Relative Humidity
End of Test 17:45
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
17:45
Local Time



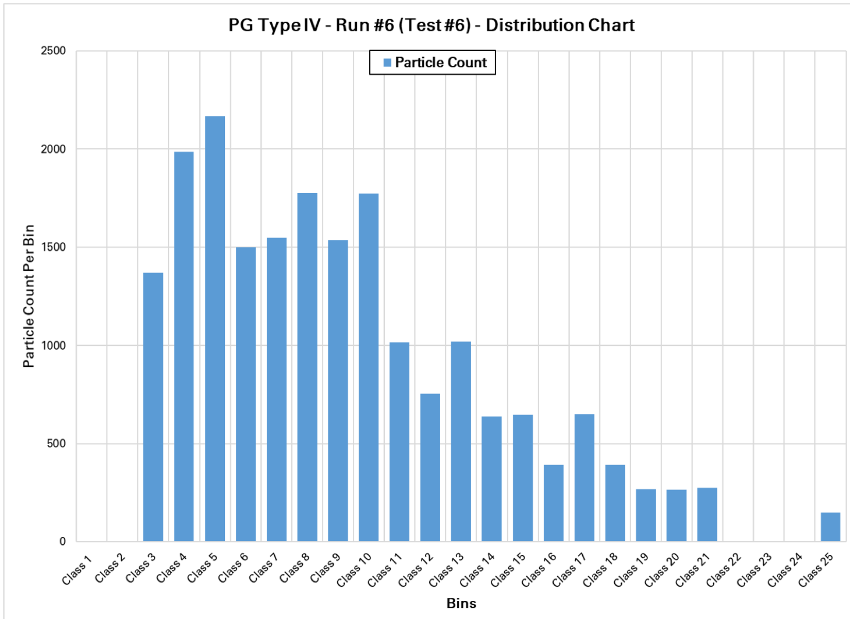
PG Type IV - Run #6 (Test #6) - Fluid Brix Progression
Start of Test 16:30
Fluid Brix
End of Test 17:45
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
17:45
Local Time



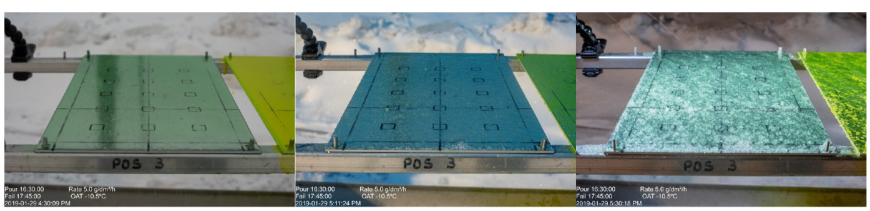
PG Type IV - Run #6 (Test #6) - Barometric Pressure
Start of Test 16:30
WS600 Sensor Barometric Pressure
End of Test 17:45
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
17:45
Local Time



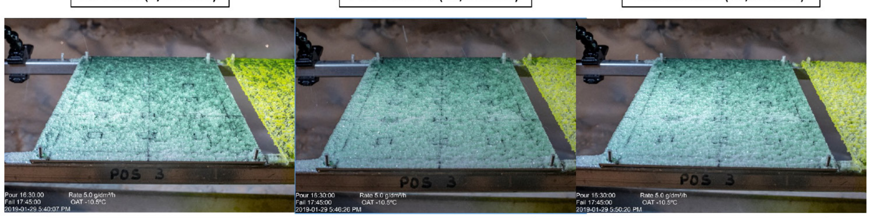
PG Type IV - Run #6 (Test #6) - Fluid Layer Thickness Progression
Start of Test 16:30
Fluid Layer Thickness
End of Test 17:45
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:24
16:35
16:45
16:55
17:05
17:15
17:25
17:35
17:45
Local Time



Polar Guard Advance – Run 6 (Test 6) – Failure Progression Photos



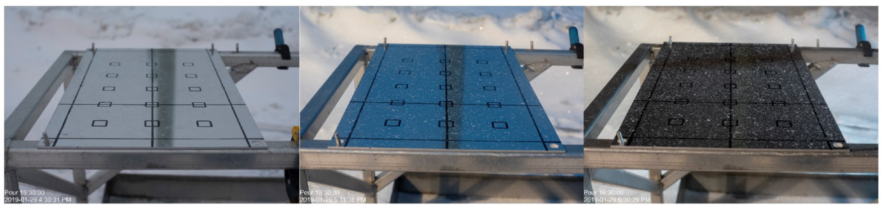
AT POUR (0/75 MIN) | PRE-FAILURE (41/75 MIN) | PRE-FAILURE (60/75 MIN)



PRE-FAILURE (70/75 MIN) | POST-FAILURE (76/75 MIN) | POST-FAILURE (80/75 MIN)

Polar Guard Advance – Run 6 (Test 6) – Snow Characteristics Photos

FELT PAD (1/75 MIN) | FELT PAD (40/75 MIN) | FELT PAD (70/75 MIN)



BARE PLATE (0/75 MIN) | BARE PLATE (41/75 MIN) | BARE PLATE (60/75 MIN)

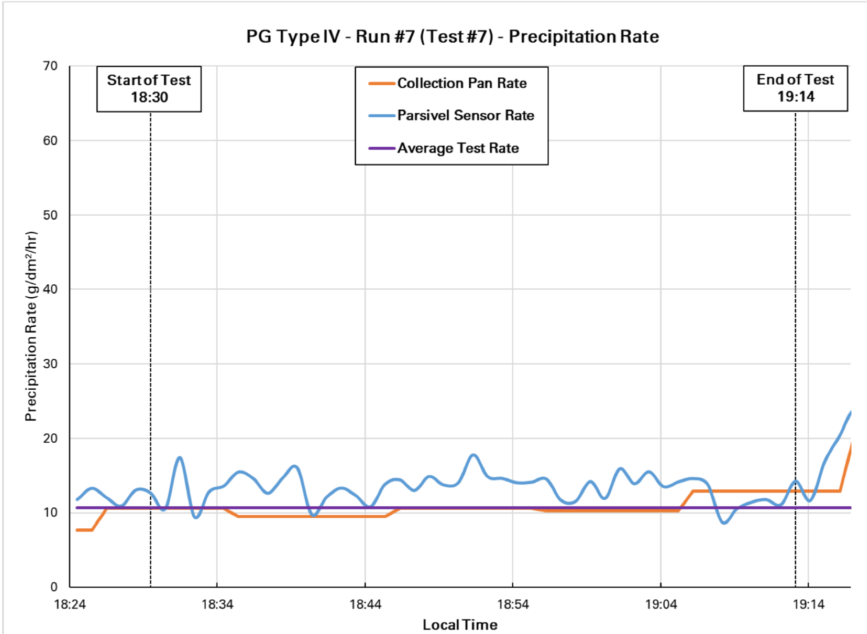
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

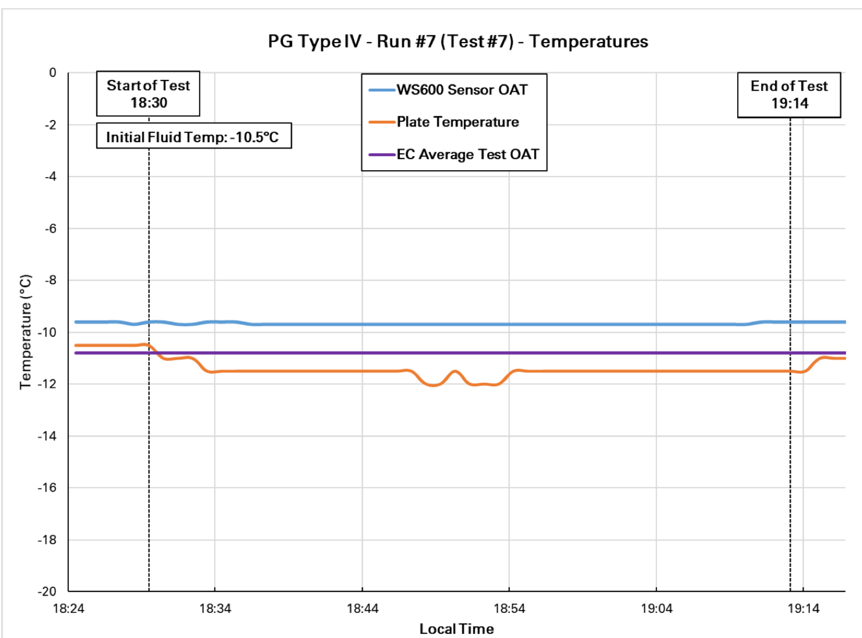
PG TYPE IV
RUN #7 (TEST #7) – PG4-7

PG Type IV – Run #7 (Test #7) – General Test Information

Test Number:	PG4-7
Date of Test:	January 29, 2019
Average OAT:	-10.8
Average Precipitation Rate:	10.7 g/dm²/h
Average Wind Speed:	18 km/h
Average Relative Humidity:	82.96%
Pour Time (Local):	18:30:00
Time of Fluid Failure (Local):	19:14:00
Fluid Brix at Failure:	20°
Endurance Time:	44 minutes
Expected Regression-Derived Endurance Time:	55.3 minutes
Difference (ET vs. Reg ET):	-11.3 minutes (-20.4%)



DATA PACKAGE – PG TYPE IV – RUN 7 (TEST 7)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 7 - Test 7/Data Package - PG Type IV - Run 7 - Test 7.docx
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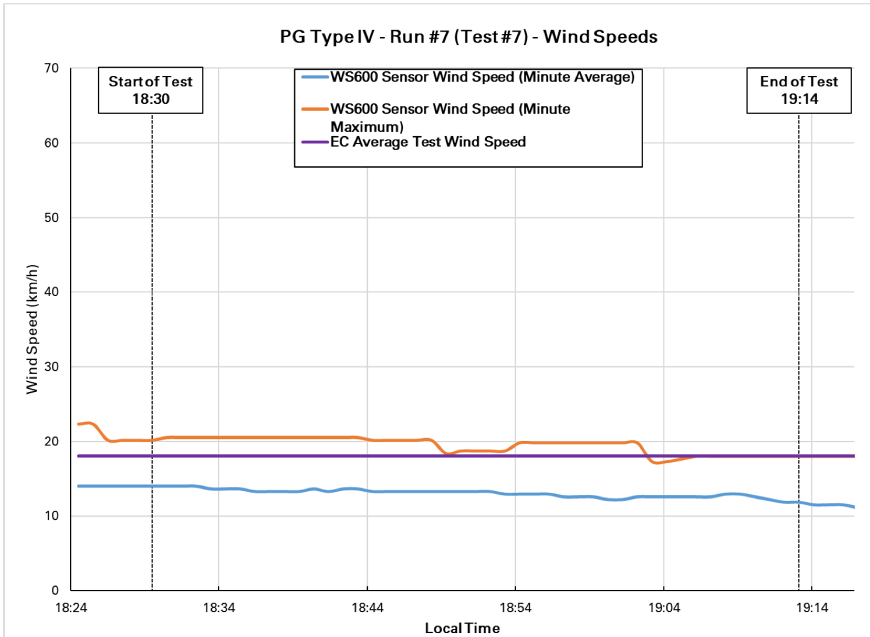
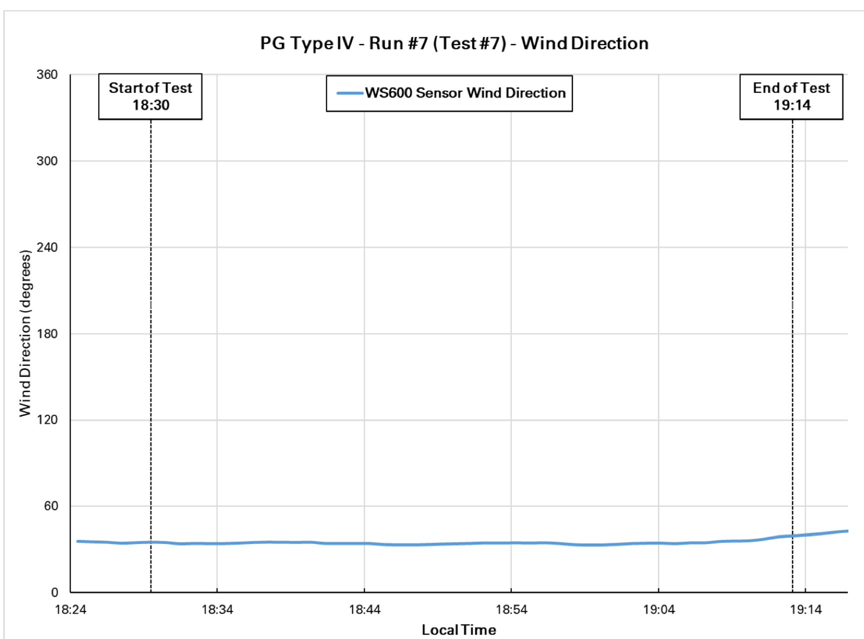
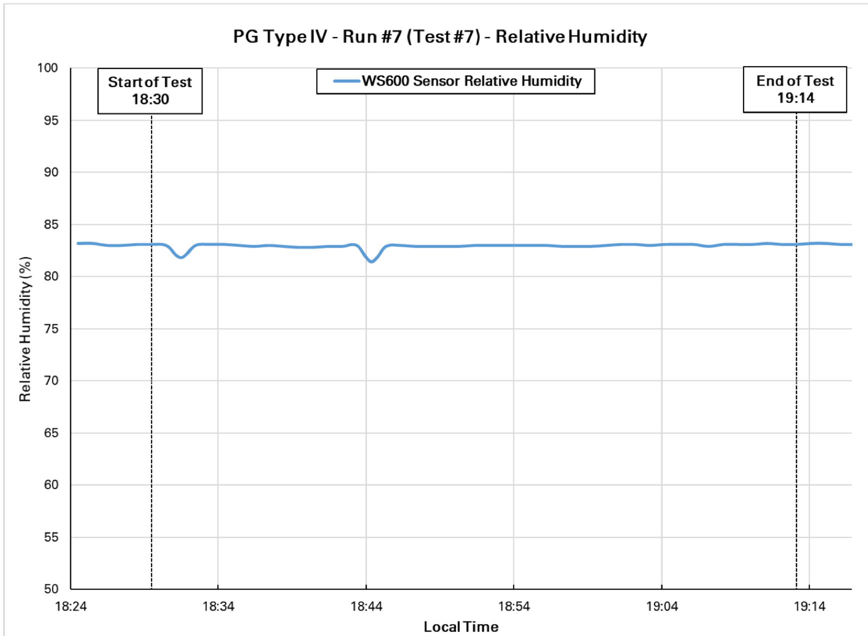
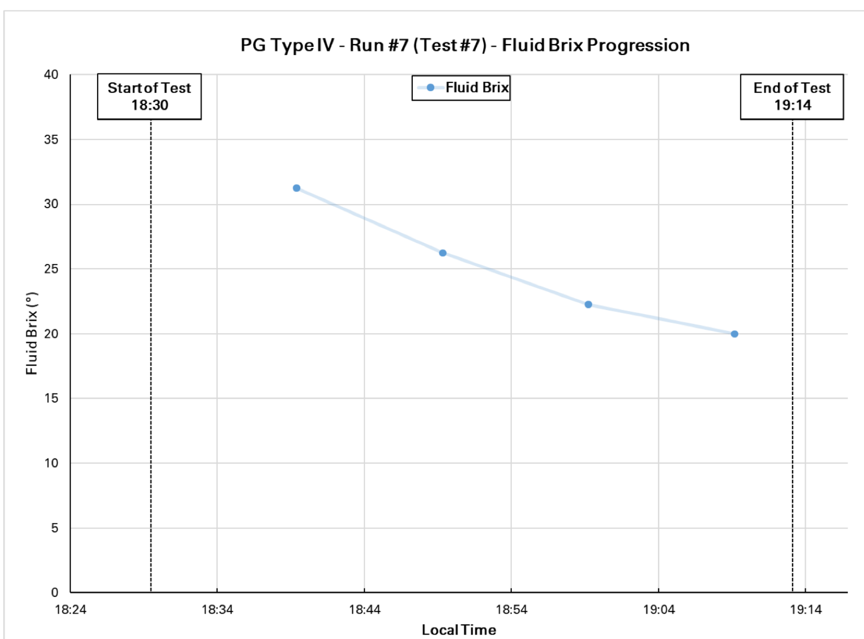
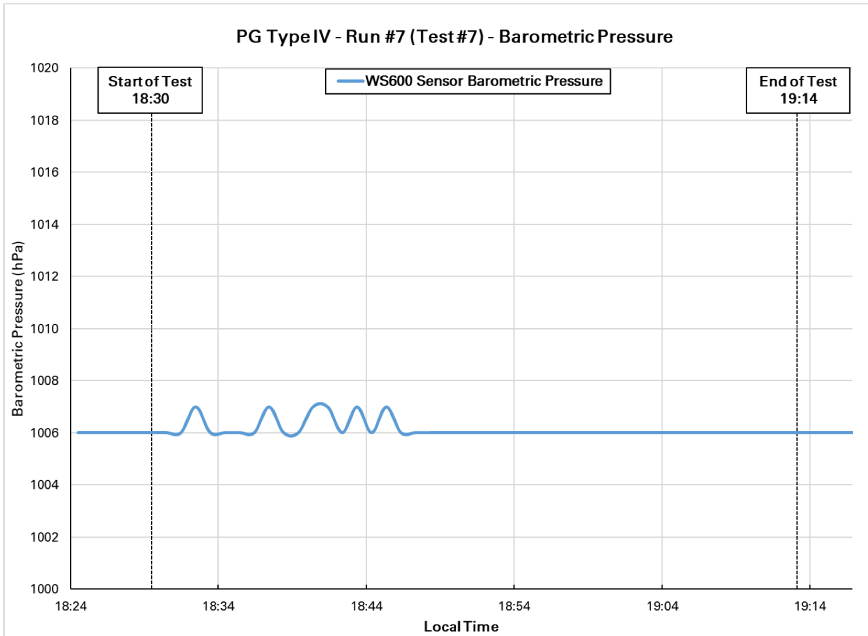
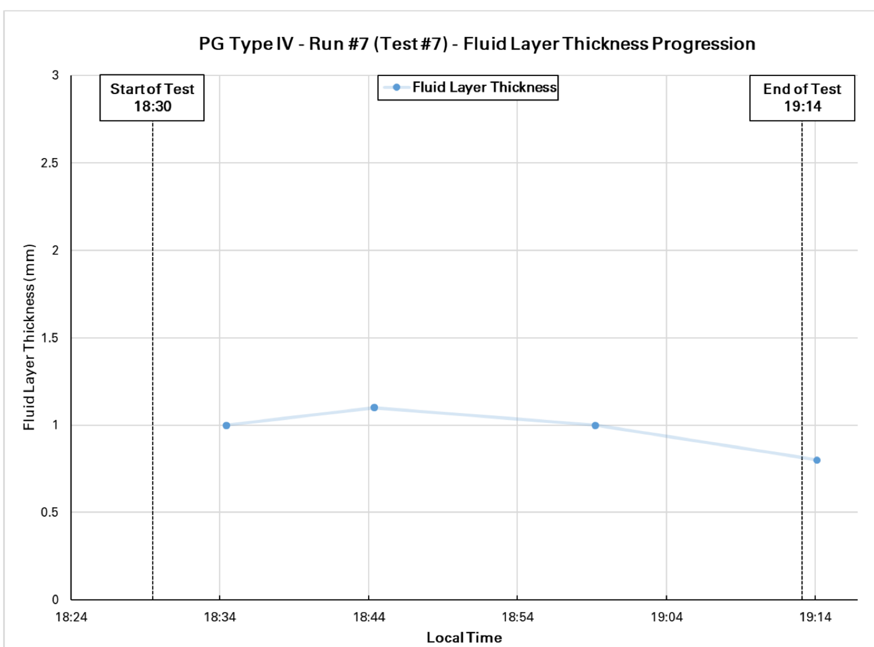

PG Type IV - Run #7 (Test #7) - Wind Speeds
Start of Test 18:30
End of Test 19:14
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
18:24
18:34
18:44
18:54
19:04
19:14
Local Time

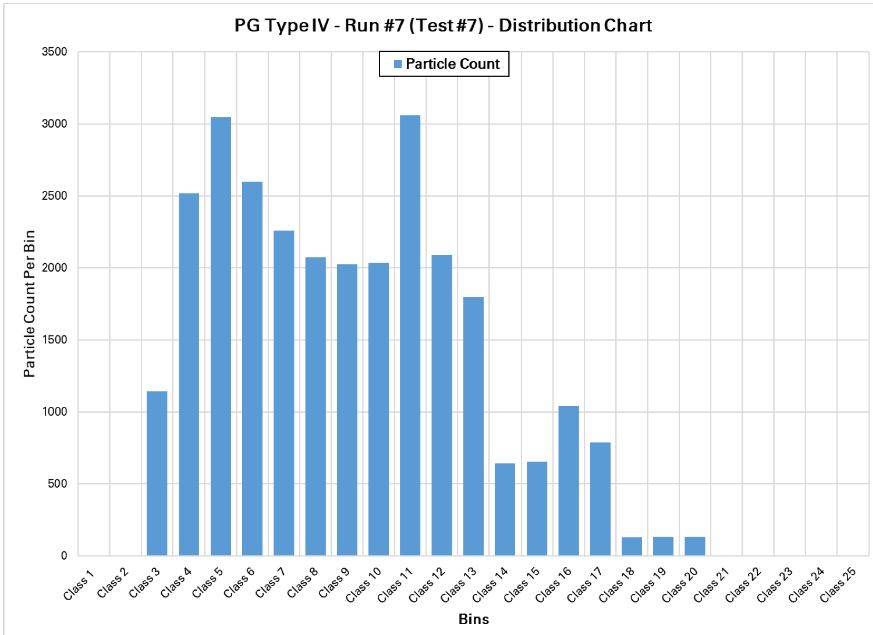

PG Type IV - Run #7 (Test #7) - Wind Direction
Start of Test 18:30
WS600 Sensor Wind Direction
End of Test 19:14
Wind Direction (degrees)
0
60
120
180
240
300
360
18:24
18:34
18:44
18:54
19:04
19:14
Local Time


PG Type IV - Run #7 (Test #7) - Relative Humidity
Start of Test
18:30
WS600 Sensor Relative Humidity
End of Test
19:14
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
18:24
18:34
18:44
18:54
19:04
19:14
Local Time

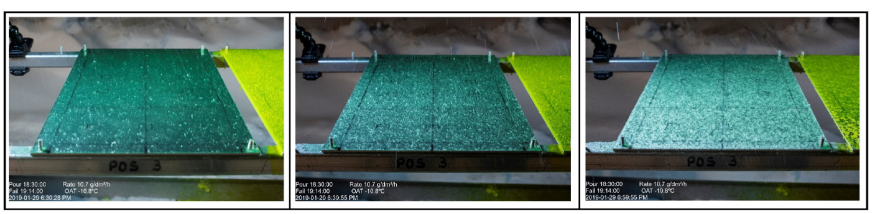

PG Type IV - Run #7 (Test #7) - Fluid Brix Progression
Start of Test
18:30
Fluid Brix
End of Test
19:14
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
18:24
18:34
18:44
18:54
19:04
19:14
Local Time


PG Type IV - Run #7 (Test #7) - Barometric Pressure
Start of Test 18:30
WS600 Sensor Barometric Pressure
End of Test 19:14
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
18:24
18:34
18:44
18:54
19:04
19:14
Local Time

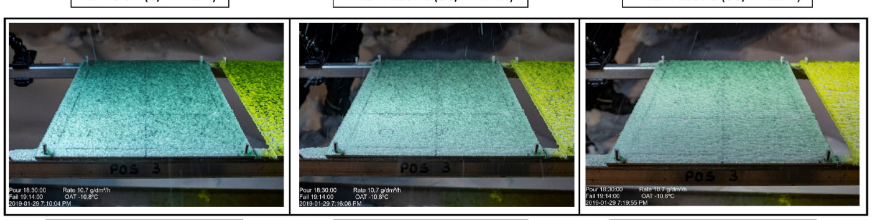

PG Type IV - Run #7 (Test #7) - Fluid Layer Thickness Progression
Start of Test 18:30
Fluid Layer Thickness
End of Test 19:14
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
18:24
18:34
18:44
18:54
19:04
19:14
Local Time



Polar Guard Advance – Run 7 (Test 7) – Failure Progression Photos

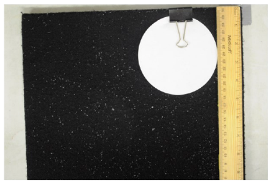


AT POUR (0/44 MIN) | PRE-FAILURE (10/44 MIN) | PRE-FAILURE (30/44 MIN)



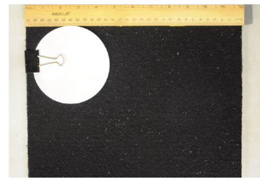
PRE-FAILURE (40/44 MIN) | POST FAILURE (46/44 MIN) | POST-FAILURE (49/44 MIN)

Polar Guard Advance – Run 7 (Test 7) – Snow Characteristics Photos

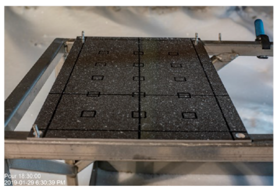


FELT PAD (0/44 MIN)

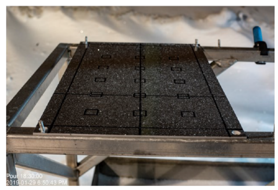
FELT PAD (30/44 MIN)



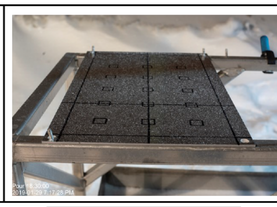
FELT PAD (40/44 MIN)



BARE PLATE (0/44 MIN)



BARE PLATE 20/44 MIN)



BARE PLATE (47/44 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

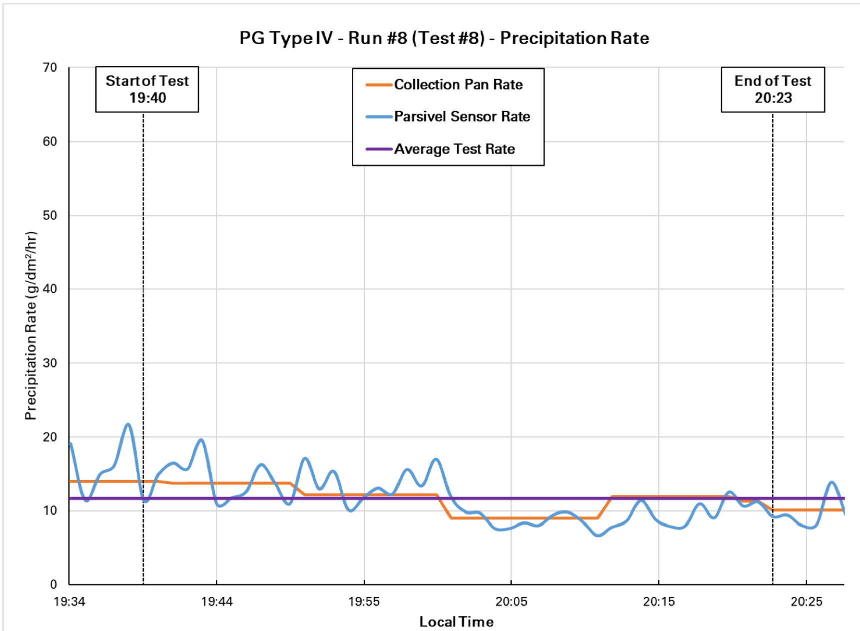
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

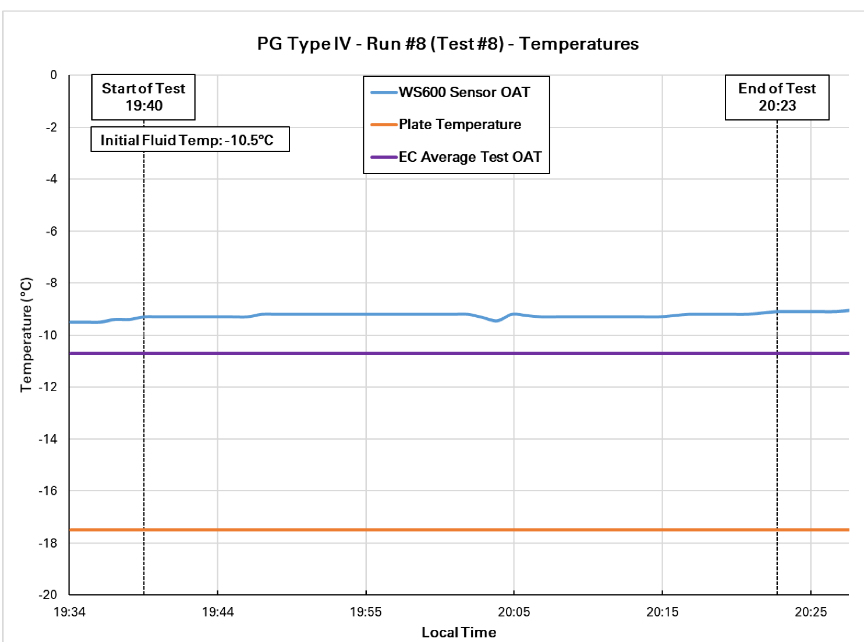
PG TYPE IV
RUN #8 (TEST #8) – PG4-8

DATA PACKAGE – PG TYPE IV – RUN 8

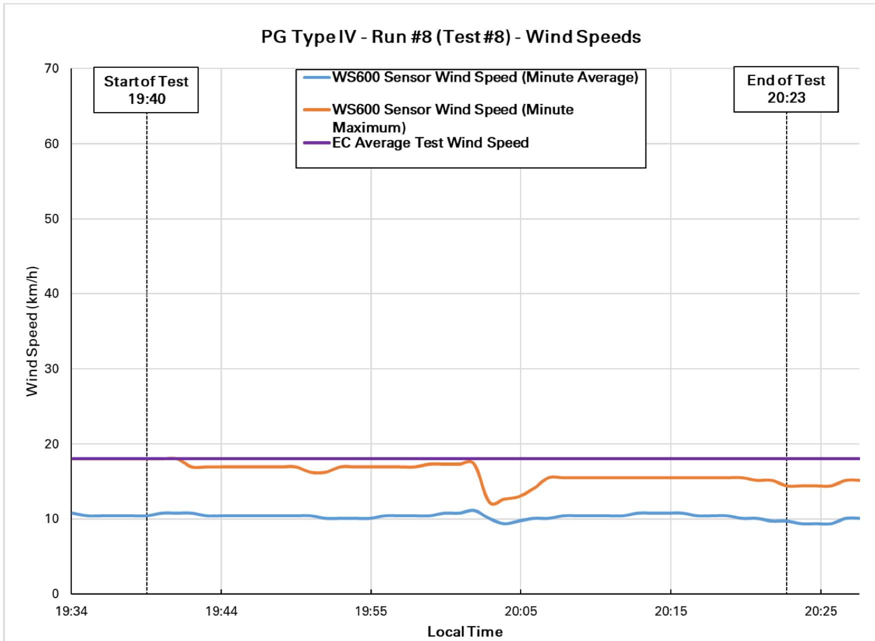
PG Type IV – Run #8 (Test #8) – General Test Information

Test Number:	**PG4-8**
Date of Test:	**January 29, 2019**
Average OAT:	**-10.7**
Average Precipitation Rate:	**11.7 g/dm²/h**
Average Wind Speed:	**18 km/h**
Average Relative Humidity:	**83.61%**
Pour Time (Local):	**19:40:00**
Time of Fluid Failure (Local):	**20:23:00**
Fluid Brix at Failure:	**20.25°**
Endurance Time:	**43 minutes**
Expected Regression-Derived Endurance Time:	**51.6 minutes**
Difference (ET vs. Reg ET):	**-8.6 minutes (-16.6%)**


PG Type IV - Run #8 (Test #8) - Precipitation Rate
Start of Test 19:40
End of Test 20:23
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
19:34
19:44
19:55
20:05
20:15
20:25
Local Time


PG Type IV - Run #8 (Test #8) - Temperatures
Start of Test 19:40
Initial Fluid Temp: -10.5°C
End of Test 20:23
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
19:34
19:44
19:55
20:05
20:15
20:25
Local Time

DATA PACKAGE – PG TYPE IV – RUN 8



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 8 - Test 8/Data Package - PG Type IV - Run 8 - Test 8.docx
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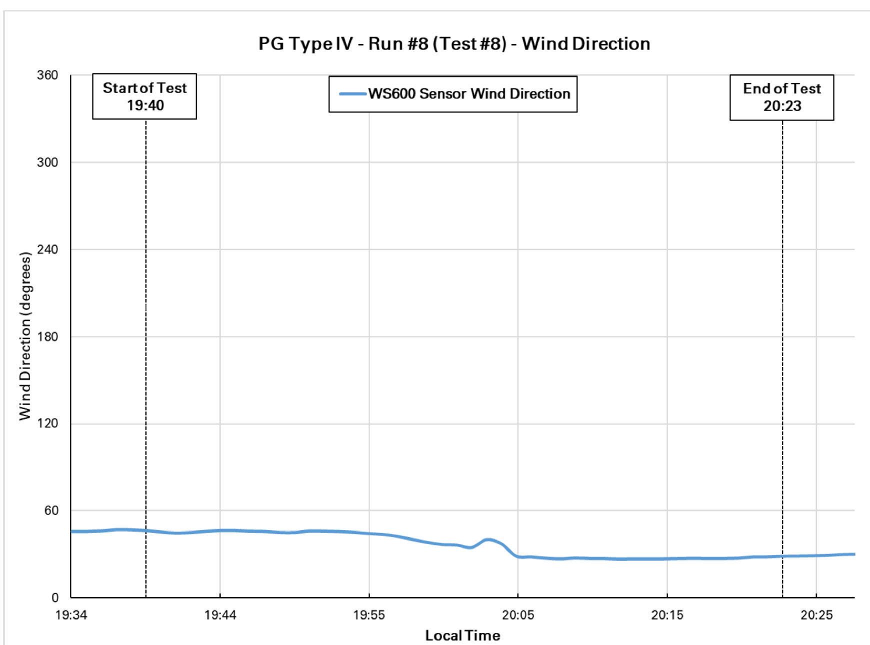
DATA PACKAGE – PG TYPE IV – RUN 8



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 8 - Test 8/Data Package - PG Type IV - Run 8 - Test 8.docx
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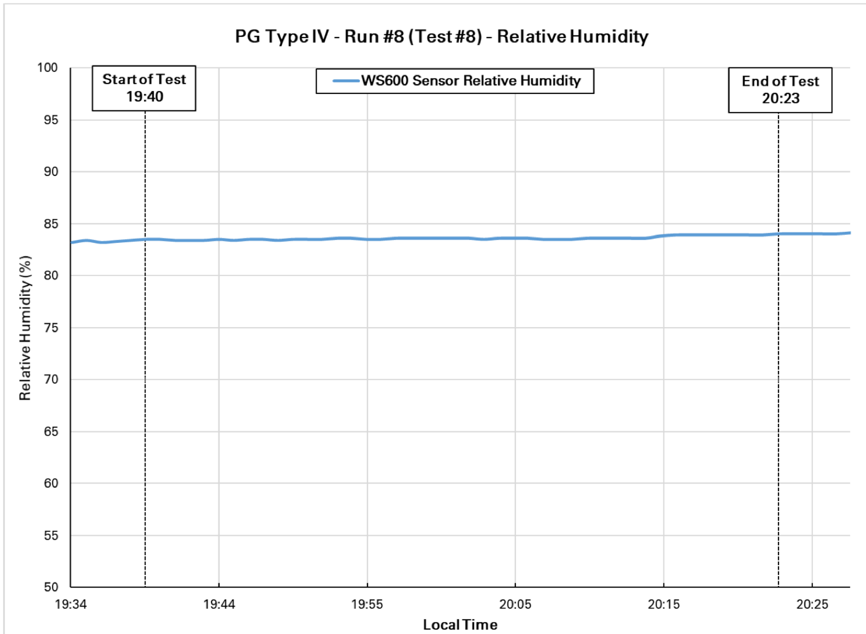
DATA PACKAGE – PG TYPE IV – RUN 8



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 8 - Test 8/Data Package - PG Type IV - Run 8 - Test 8.docx
Final Version 1.0, February 2021

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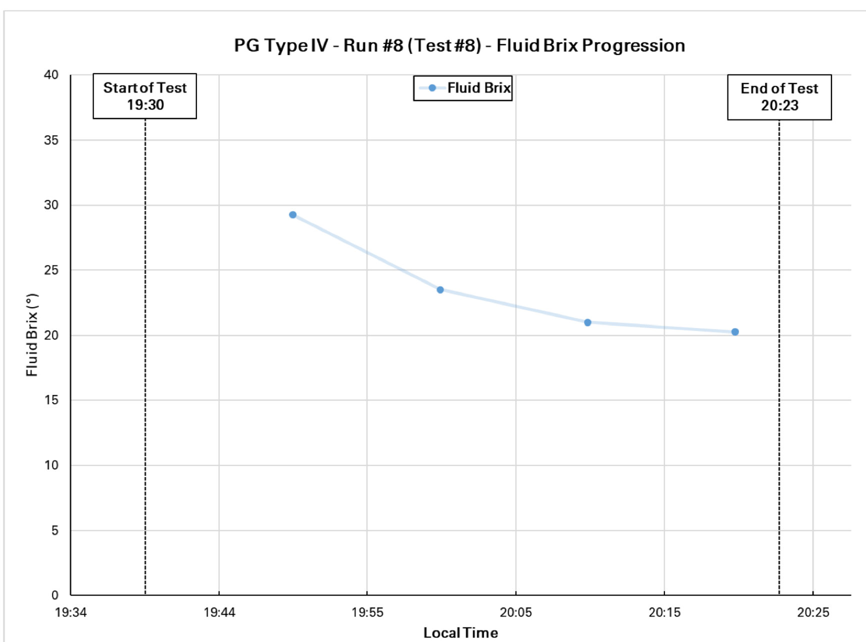
DATA PACKAGE – PG TYPE IV – RUN 8



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 8 - Test 8/Data Package - PG Type IV - Run 8 - Test 8.docx
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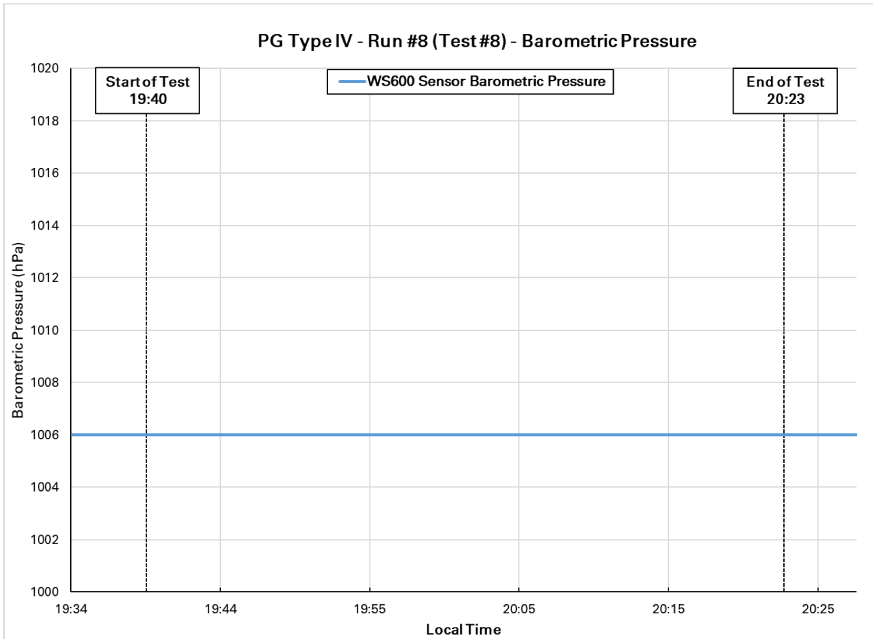
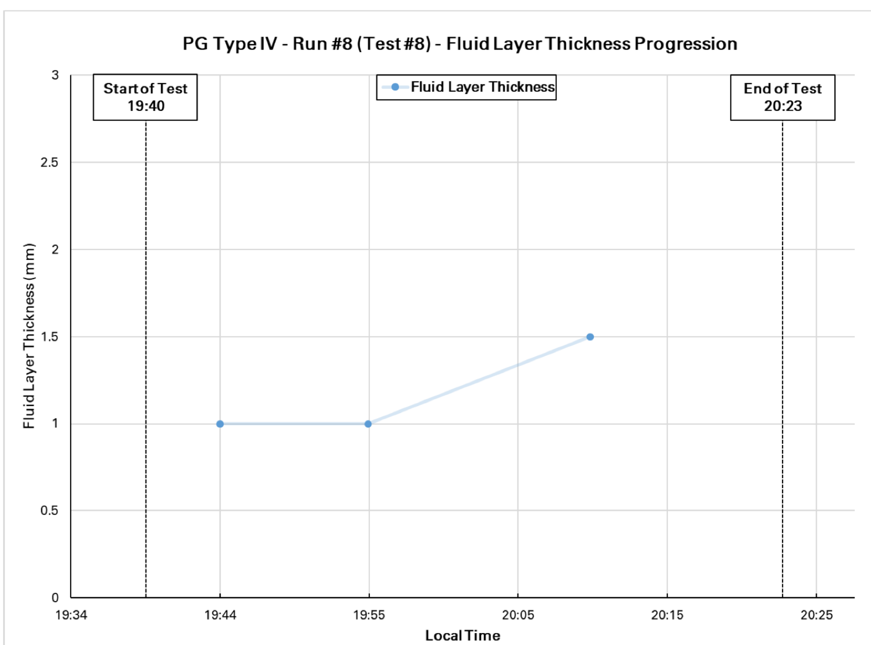
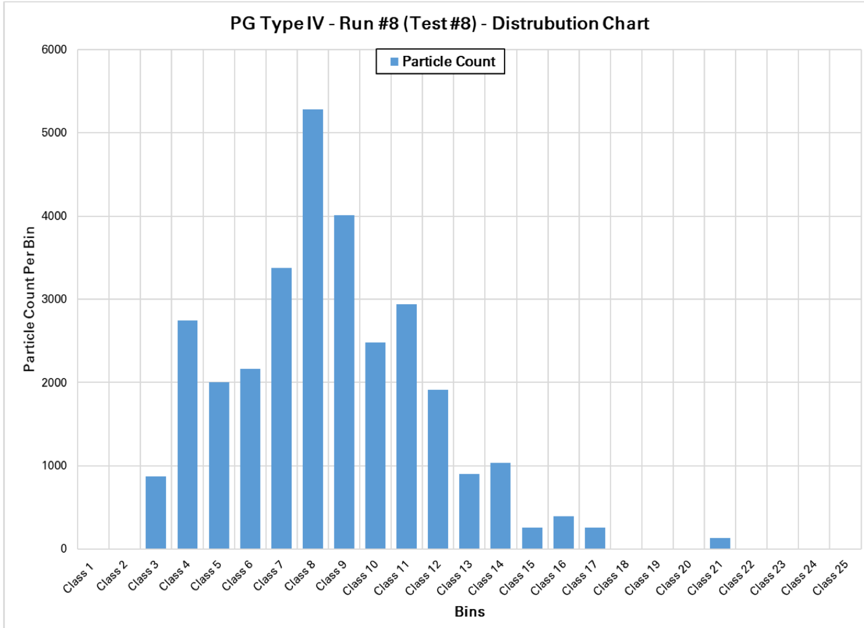
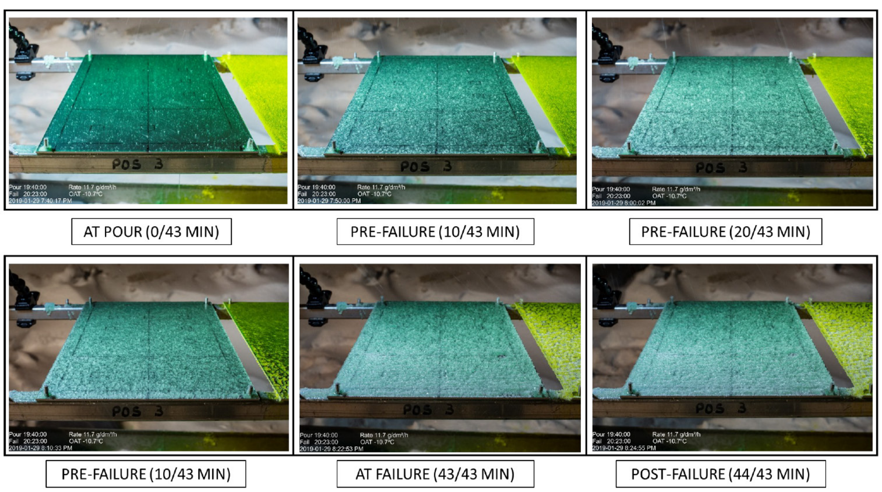


DATA PACKAGE – PG TYPE IV – RUN 8

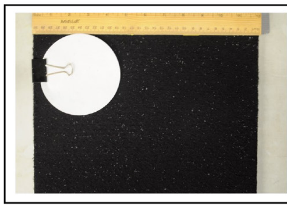




Polar Guard Advance – Run 8 (Test 8) – Failure Progression Photos

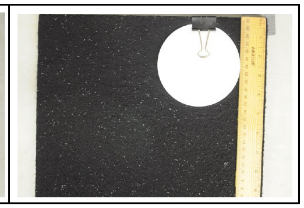


Polar Guard Advance – Run 8 (Test 8) – Snow Characteristics Photos

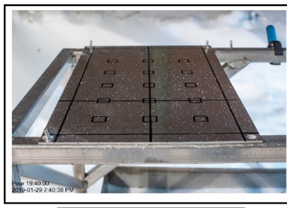


FELT PAD (10/43 MIN)

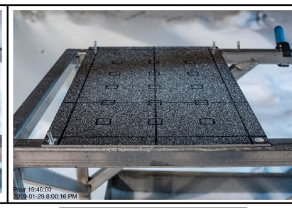
FELT PAD (20/43 MIN)



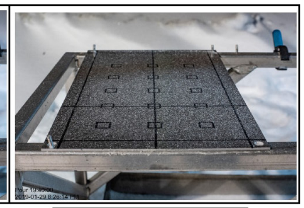
FELT PAD (40/43 MIN)



BARE PLATE (0/43 MIN)



BARE PLATE 20/43 MIN)



BARE PLATE (46/43 MIN)

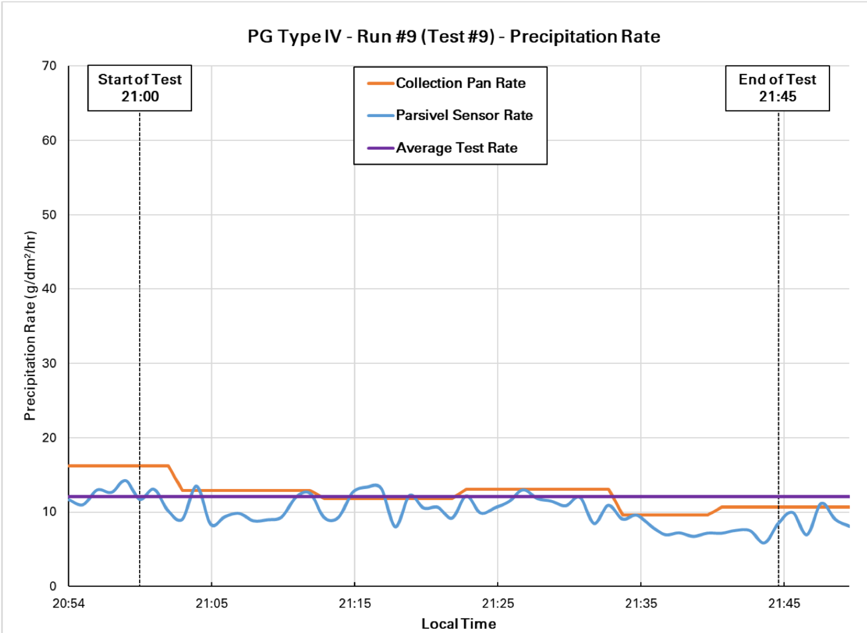
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

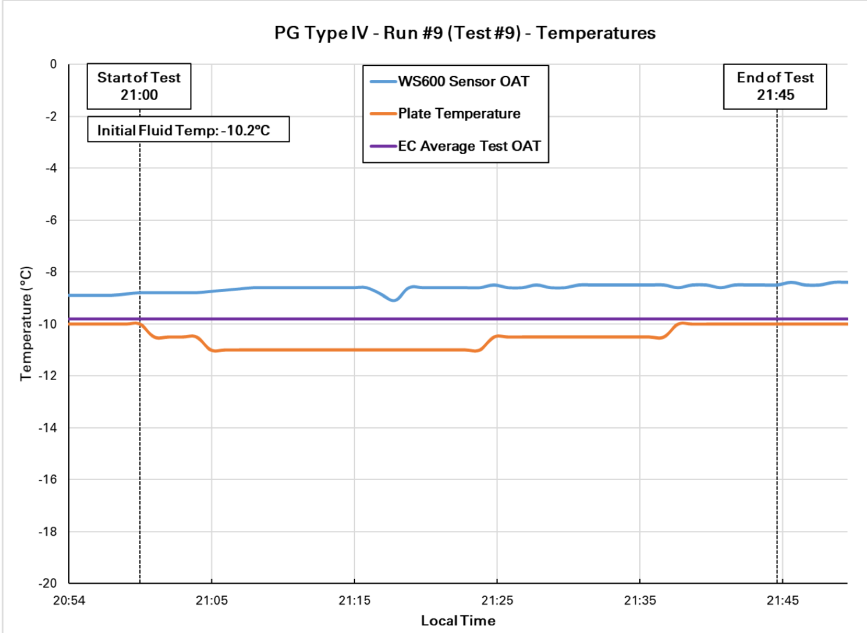
PG TYPE IV
RUN #9 (TEST #9) – PG4-9

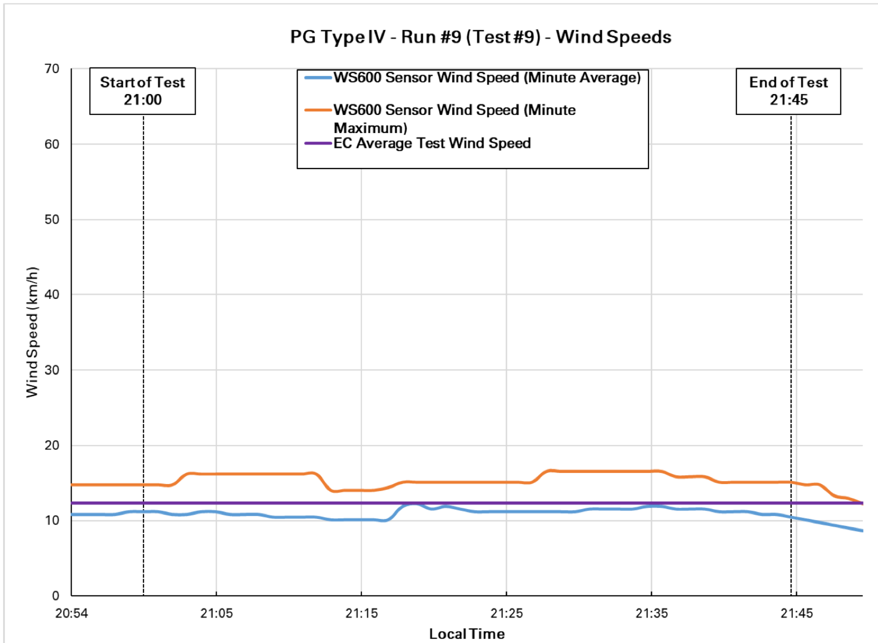
PG Type IV – Run #9 (Test #9) – General Test Information

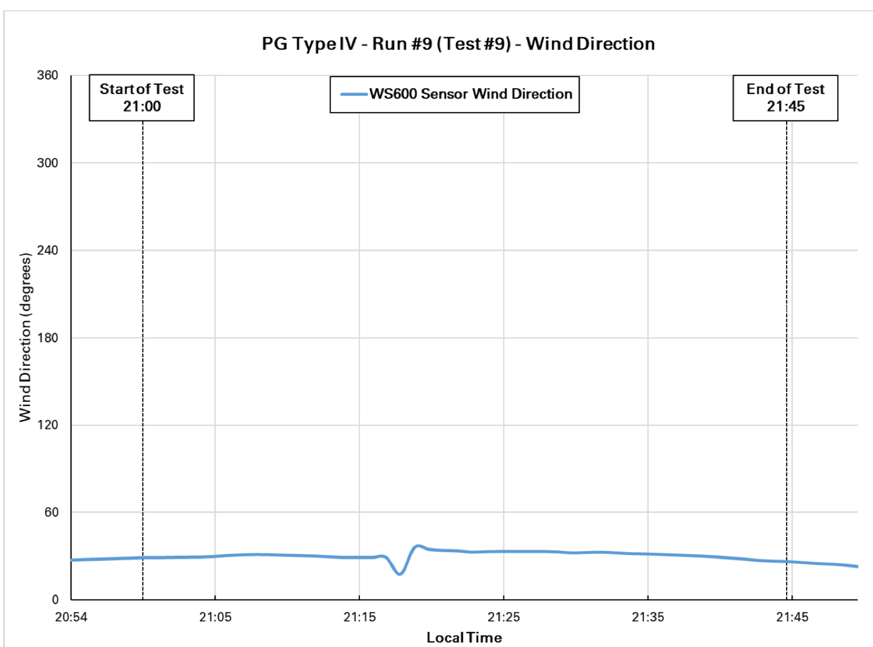
Test Number:	**PG4-9**
Date of Test:	**January 29, 2019**
Average OAT:	**-9.8**
Average Precipitation Rate:	**12.1 g/dm²/h**
Average Wind Speed:	**12.3 km/h**
Average Relative Humidity:	**84.7%**
Pour Time (Local):	**21:00:00**
Time of Fluid Failure (Local):	**21:45:00**
Fluid Brix at Failure:	**19.25°**
Endurance Time:	**45 minutes**
Expected Regression-Derived Endurance Time:	**52.2 minutes**
Difference (ET vs. Reg ET):	**-7.2 minutes (-13.8%)**

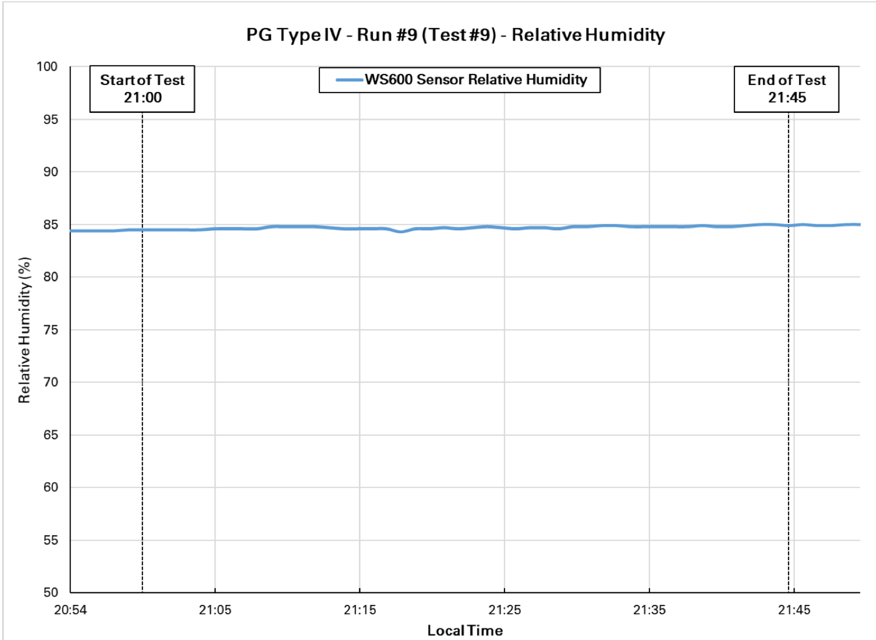


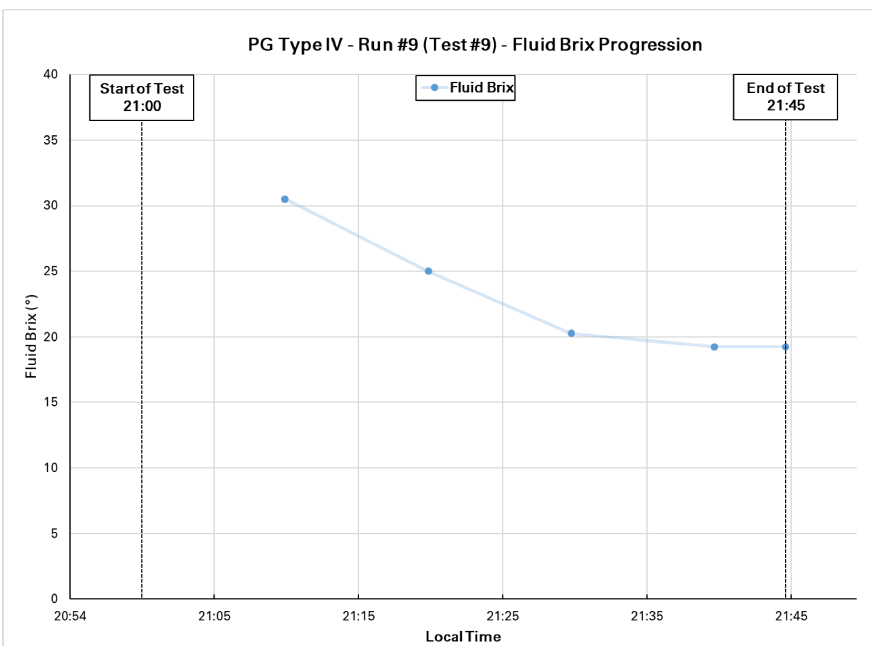
DATA PACKAGE – PG TYPE IV – RUN 9 (TEST 9)

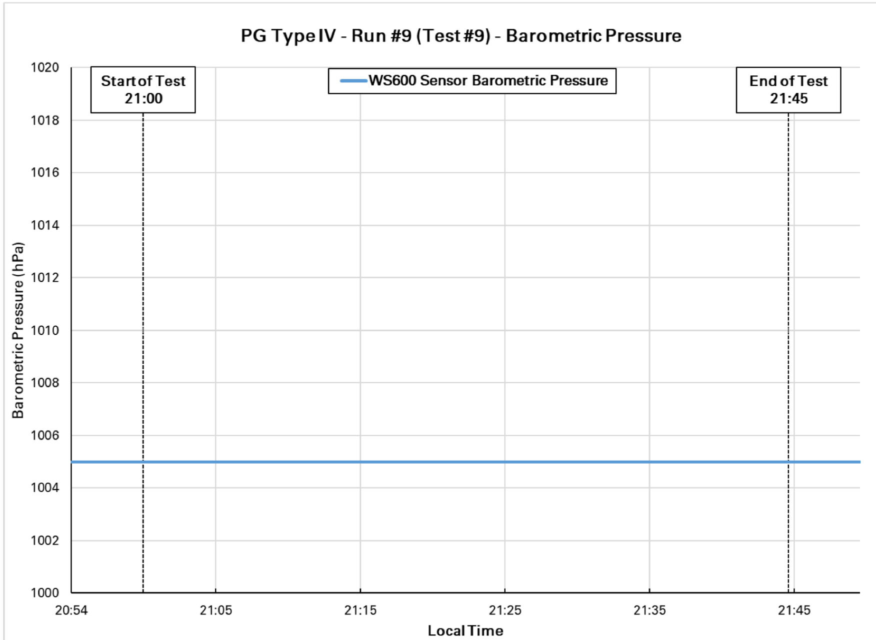


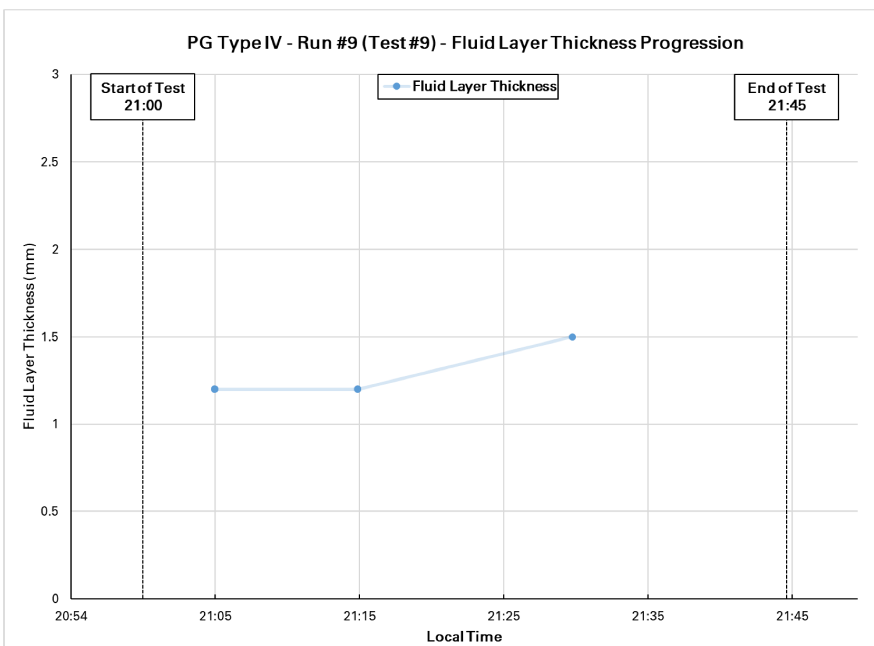

PG Type IV - Run #9 (Test #9) - Wind Speeds
Start of Test 21:00
End of Test 21:45
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
20:54
21:05
21:15
21:25
21:35
21:45
Local Time

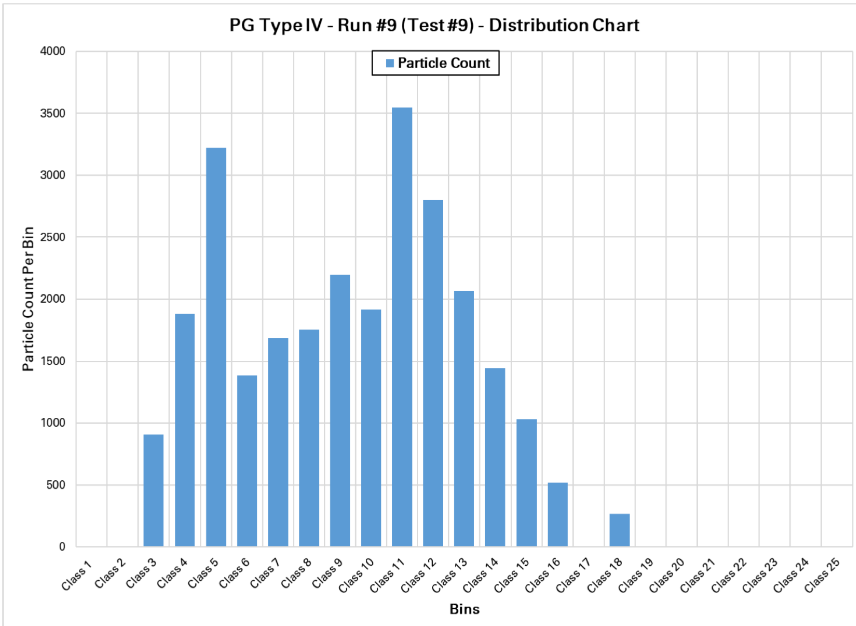

PG Type IV - Run #9 (Test #9) - Wind Direction
Start of Test 21:00
End of Test 21:45
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
20:54
21:05
21:15
21:25
21:35
21:45
Local Time


PG Type IV - Run #9 (Test #9) - Relative Humidity
Start of Test 21:00
WS600 Sensor Relative Humidity
End of Test 21:45
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:54
21:05
21:15
21:25
21:35
21:45
Local Time

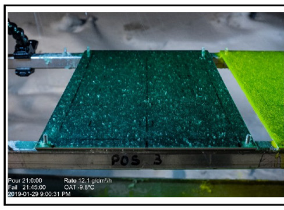

PG Type IV - Run #9 (Test #9) - Fluid Brix Progression
Start of Test 21:00
Fluid Brix
End of Test 21:45
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:54
21:05
21:15
21:25
21:35
21:45
Local Time

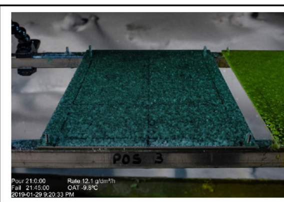

PG Type IV - Run #9 (Test #9) - Barometric Pressure
Start of Test 21:00
WS600 Sensor Barometric Pressure
End of Test 21:45
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
20:54
21:05
21:15
21:25
21:35
21:45
Local Time

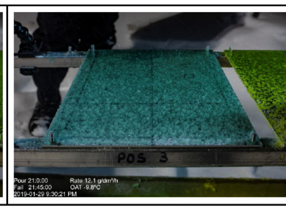

PG Type IV - Run #9 (Test #9) - Fluid Layer Thickness Progression
Start of Test 21:00
Fluid Layer Thickness
End of Test 21:45
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
20:54
21:05
21:15
21:25
21:35
21:45
Local Time



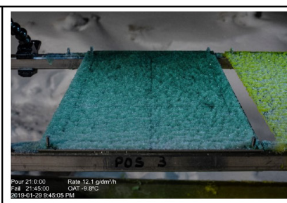
Polar Guard Advance – Run 9 (Test 9) – Failure Progression Photos

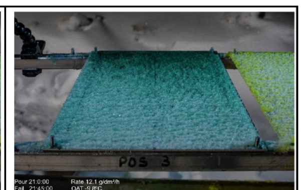

AT POUR (0/45 MIN)


PRE-FAILURE (20/45 MIN)


PRE-FAILURE (30/45 MIN)


PRE-FAILURE (40/45 MIN)


AT FAILURE (45/45 MIN)

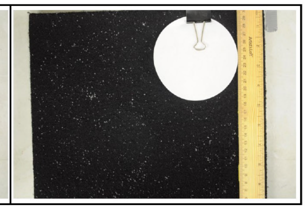

POST-FAILURE (49/45 MIN)

DATA PACKAGE – PG TYPE IV – RUN 9 (TEST 9)

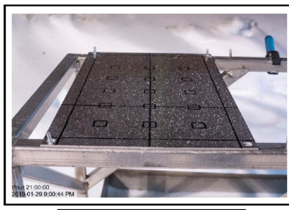
Polar Guard Advance – Run 9 (Test 9) – Snow Characteristics Photos

FELT PAD (0/45 MIN)

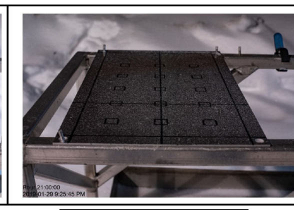
FELT PAD (20/45 MIN)



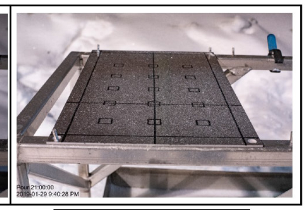
FELT PAD (40/45 MIN)



BARE PLATE (0/45 MIN)



BARE PLATE 25/45 MIN)



BARE PLATE (40/45 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 9 - Test 9/Data Package - PG Type IV - Run 9 - Test 9.docx
Final Version 1.0, February 2021

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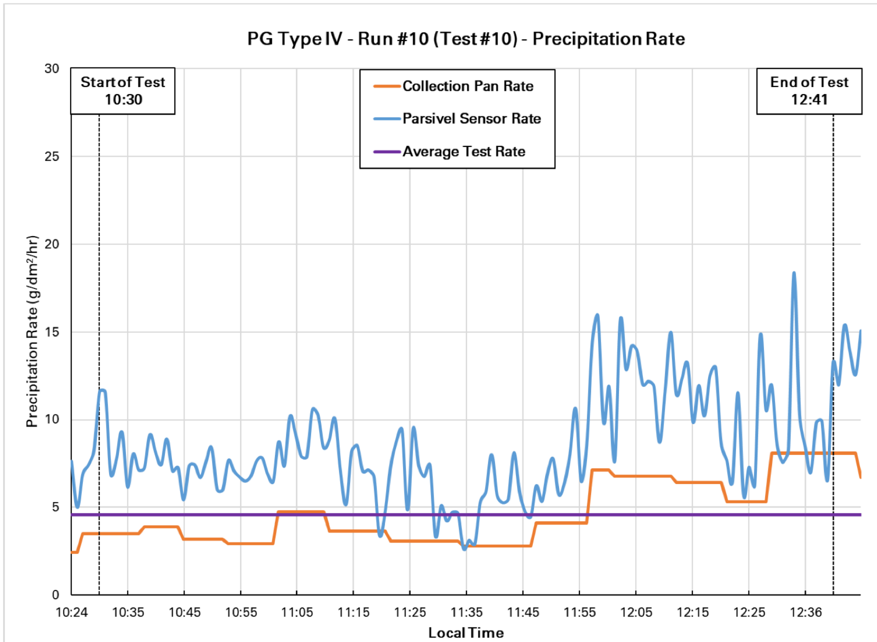
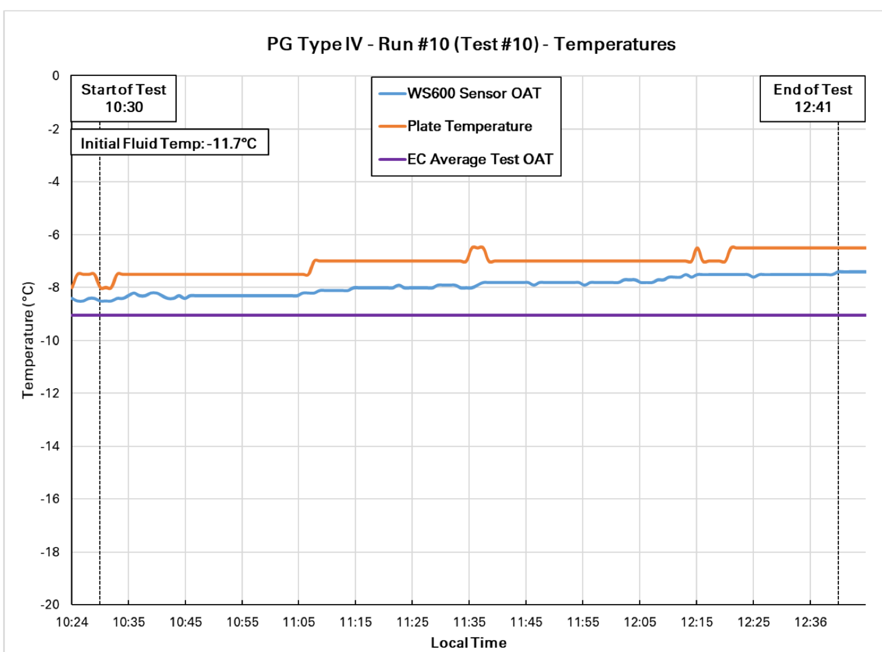
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

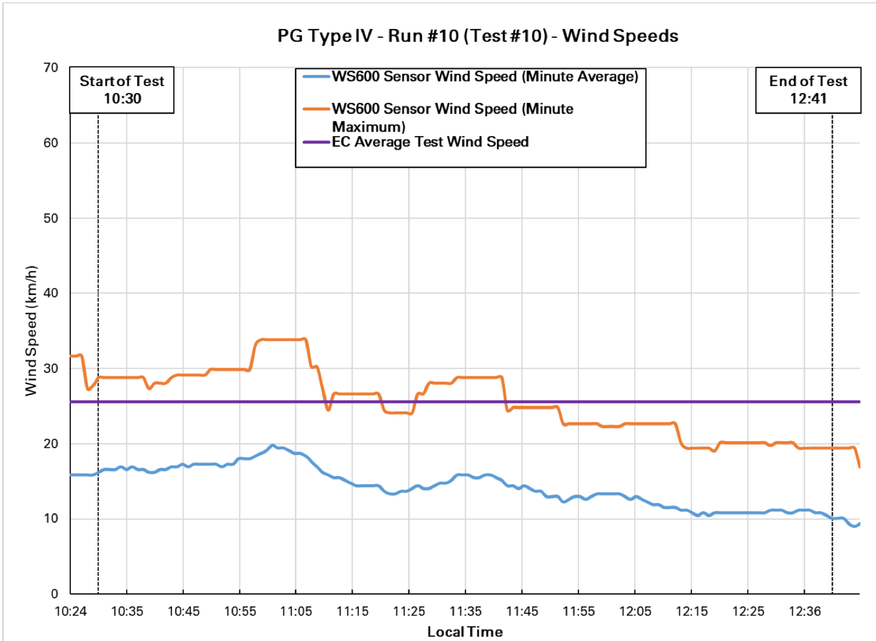
PG TYPE IV
RUN #10 (TEST #10) – PG4-10

PG Type IV – Run #10 (Test #10) – General Test Information

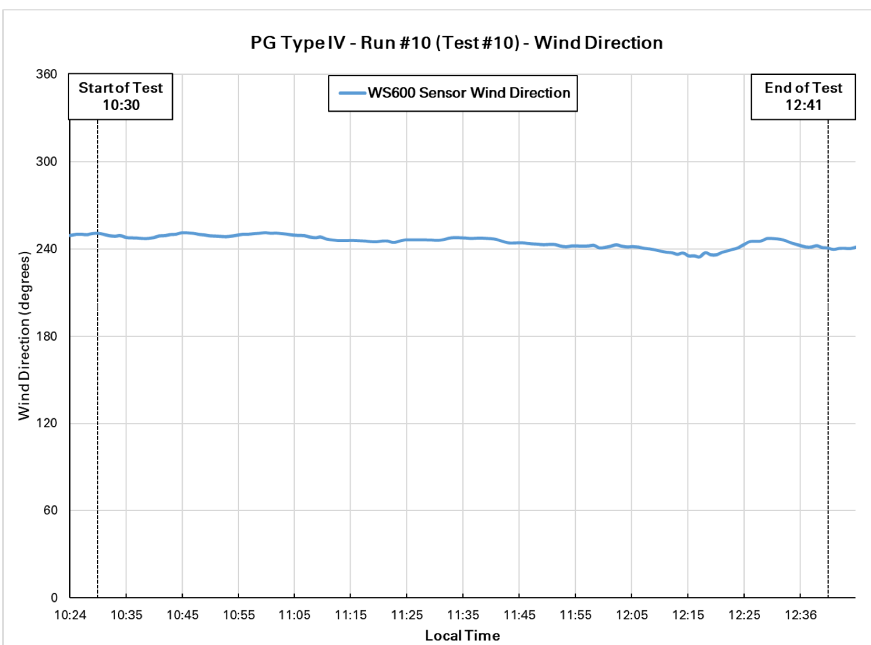
Test Number:	PG4-10
Date of Test:	February 2, 2019
Average OAT:	-9.0
Average Precipitation Rate:	4.6 g/dm²/h
Average Wind Speed:	25.6 km/h
Average Relative Humidity:	80.05%
Pour Time (Local):	10:30:00
Time of Fluid Failure (Local):	12:41:00
Fluid Brix at Failure:	14°
Endurance Time:	131 minutes
Expected Regression-Derived Endurance Time:	120.4 minutes
Difference (ET vs. Reg ET):	+10.7 minutes (+8.9%)


PG Type IV - Run #10 (Test #10) - Precipitation Rate
Start of Test 10:30
End of Test 12:41
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
30
25
20
15
10
5
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

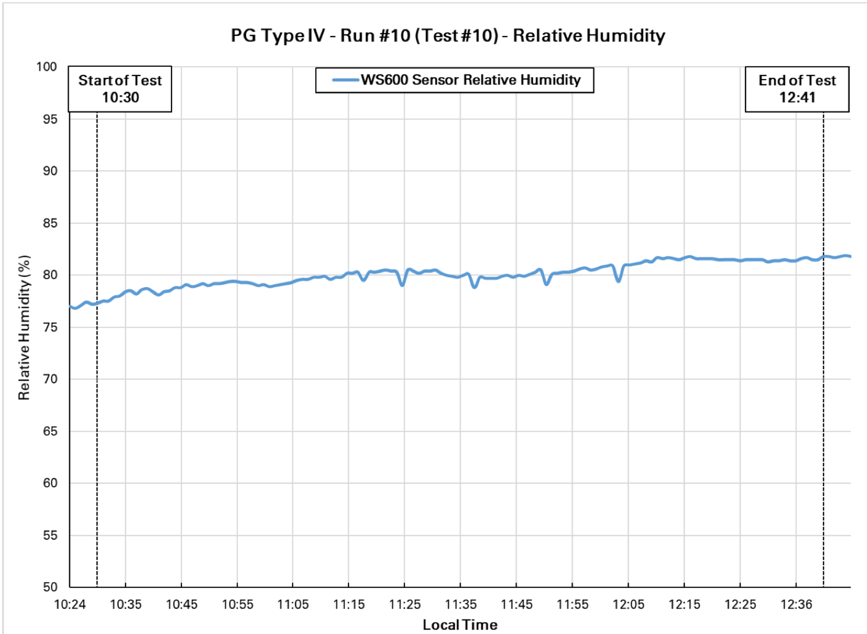

PG Type IV - Run #10 (Test #10) - Temperatures
Start of Test 10:30
Initial Fluid Temp: -11.7°C
End of Test 12:41
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

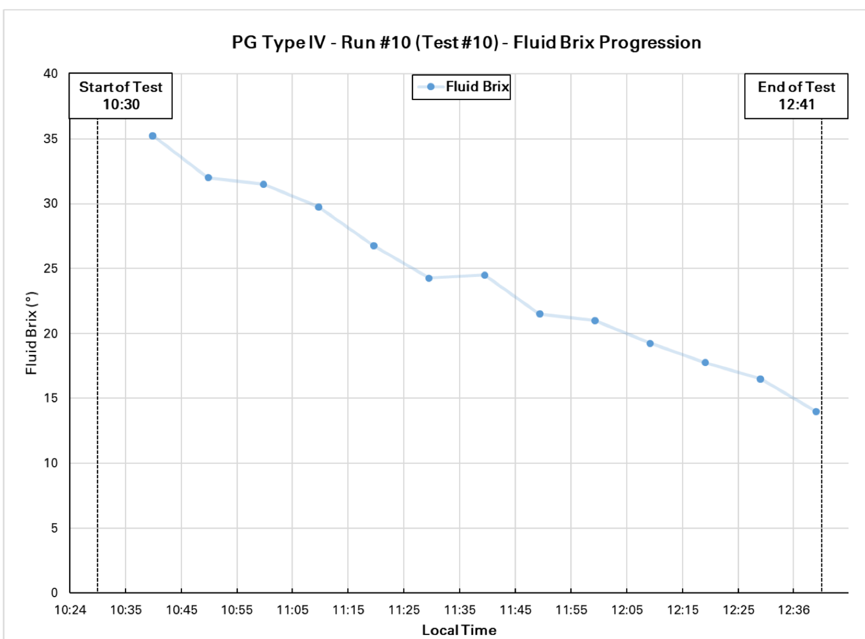


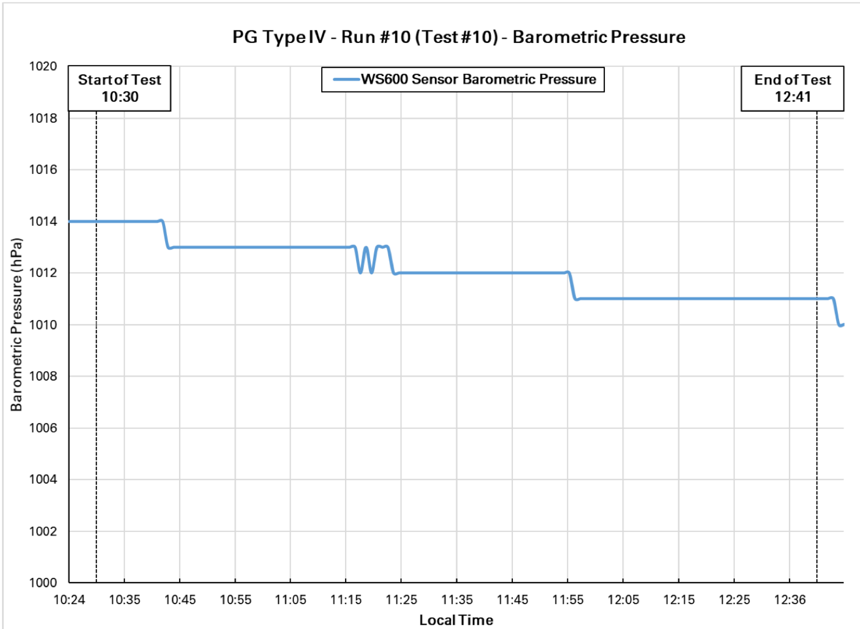
PG Type IV - Run #10 (Test #10) - Wind Speeds
Start of Test 10:30
End of Test 12:41
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time



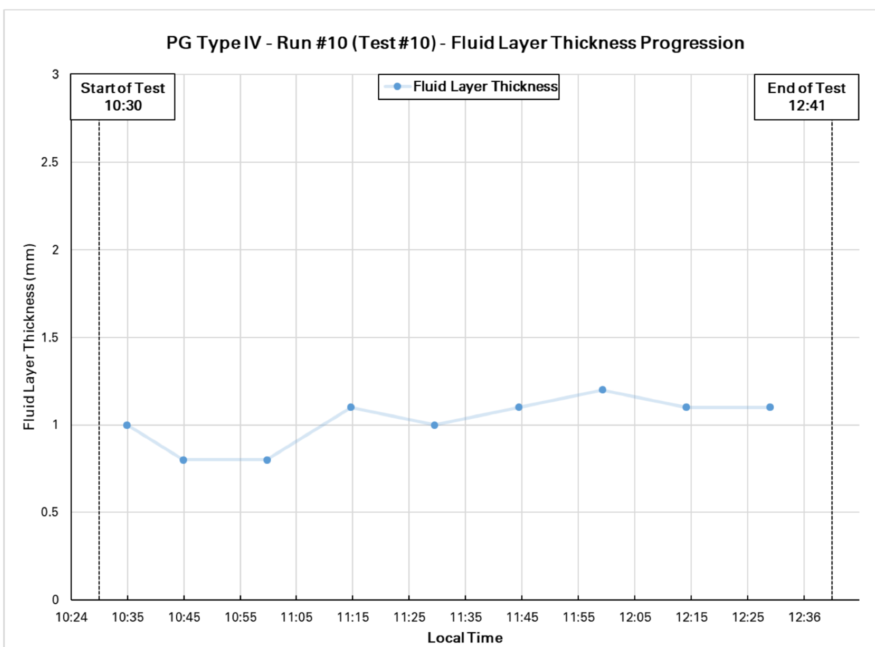
PG Type IV - Run #10 (Test #10) - Wind Direction
Start of Test 10:30
End of Test 12:41
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time


PG Type IV - Run #10 (Test #10) - Relative Humidity
Start of Test 10:30
WS600 Sensor Relative Humidity
End of Test 12:41
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time

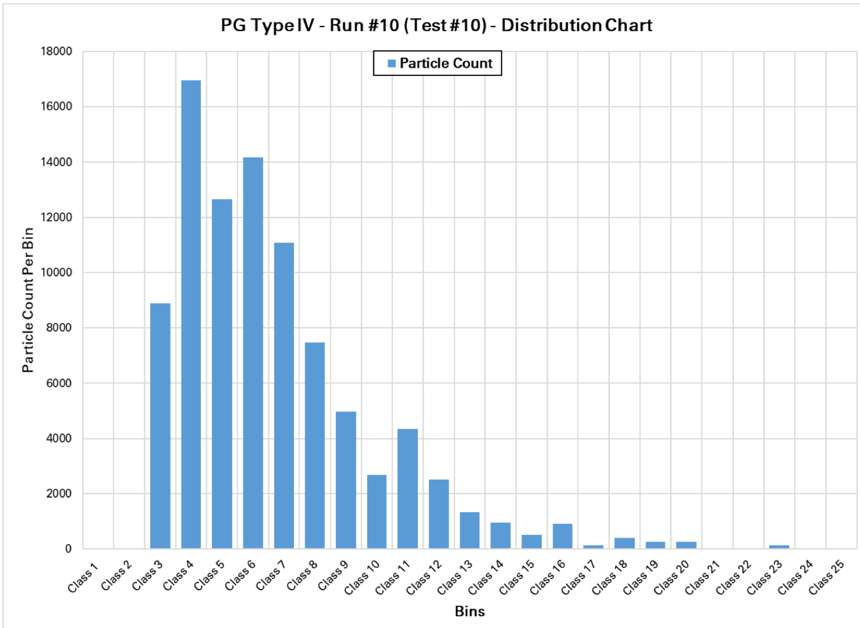

PG Type IV - Run #10 (Test #10) - Fluid Brix Progression
Start of Test 10:30
Fluid Brix
End of Test 12:41
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time



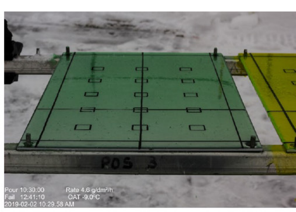
PG Type IV - Run #10 (Test #10) - Barometric Pressure
Start of Test 10:30
WS600 Sensor Barometric Pressure
End of Test 12:41
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time



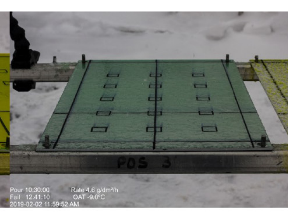
PG Type IV - Run #10 (Test #10) - Fluid Layer Thickness Progression
Start of Test 10:30
Fluid Layer Thickness
End of Test 12:41
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:24
10:35
10:45
10:55
11:05
11:15
11:25
11:35
11:45
11:55
12:05
12:15
12:25
12:36
Local Time



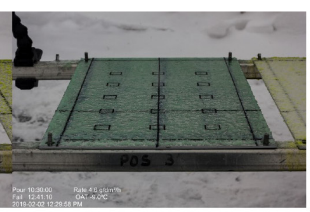
Polar Guard Advance – Run 10 (Test 10) – Failure Progression Photos



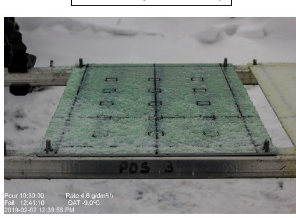
AT POUR (0/131 MIN)



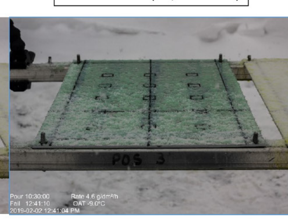
PRE-FAILURE (89/131 MIN)



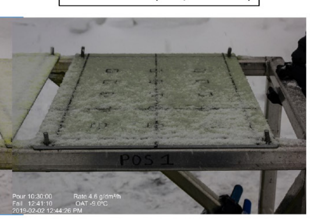
PRE-FAILURE (119/131 MIN)



PRE-FAILURE (129/131 MIN)

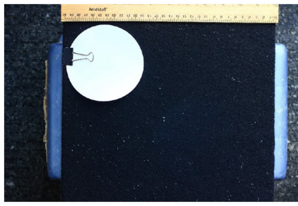


AT FAILURE (131/131 MIN)

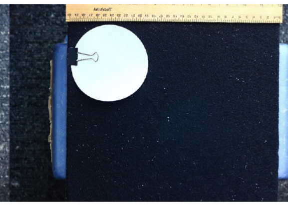


POST-FAILURE (134/131 MIN)

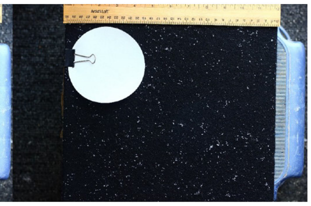
Polar Guard Advance – Run 10 (Test 10) – Snow Characteristics Photos



FELT PAD (0/131 MIN)



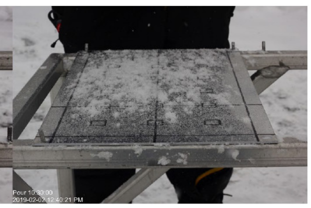
FELT PAD (62/131 MIN)



FELT PAD (135/131 MIN)

BARE PLATE (0/131 MIN)

BARE PLATE (59/131 MIN)



BARE PLATE (130/131 MIN)

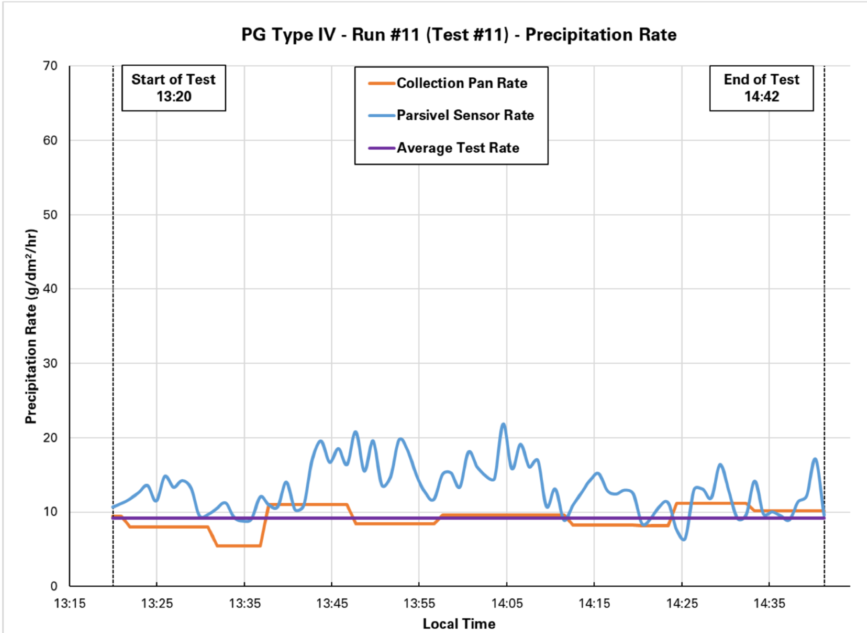
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

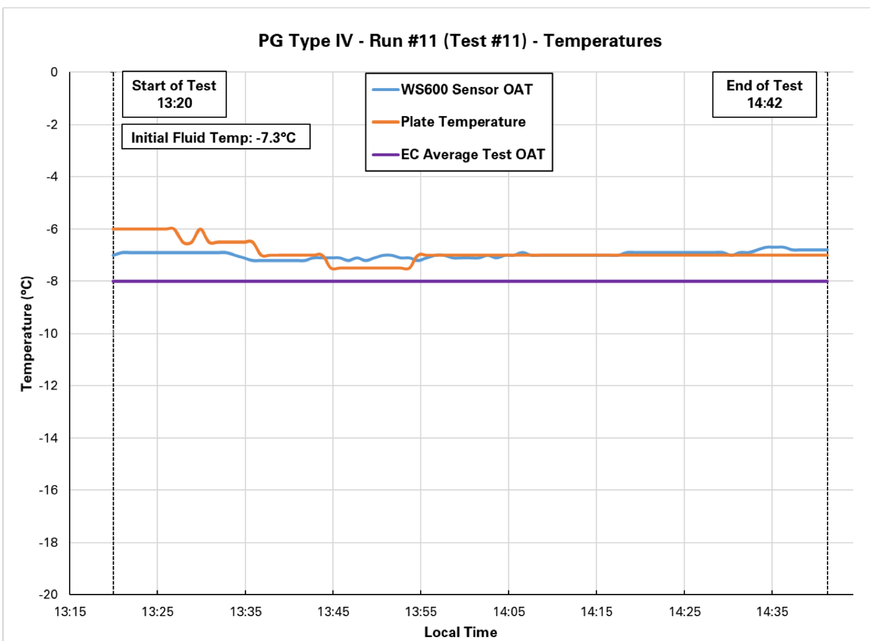
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

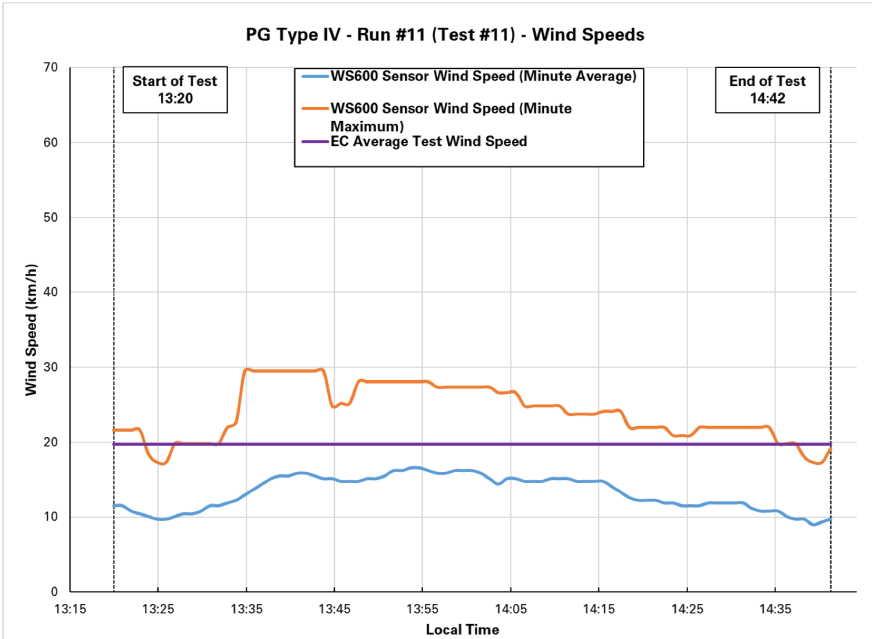
PG TYPE IV
RUN #11 (TEST #11) – PG4-11

PG Type IV – Run #11 (Test #11) – General Test Information

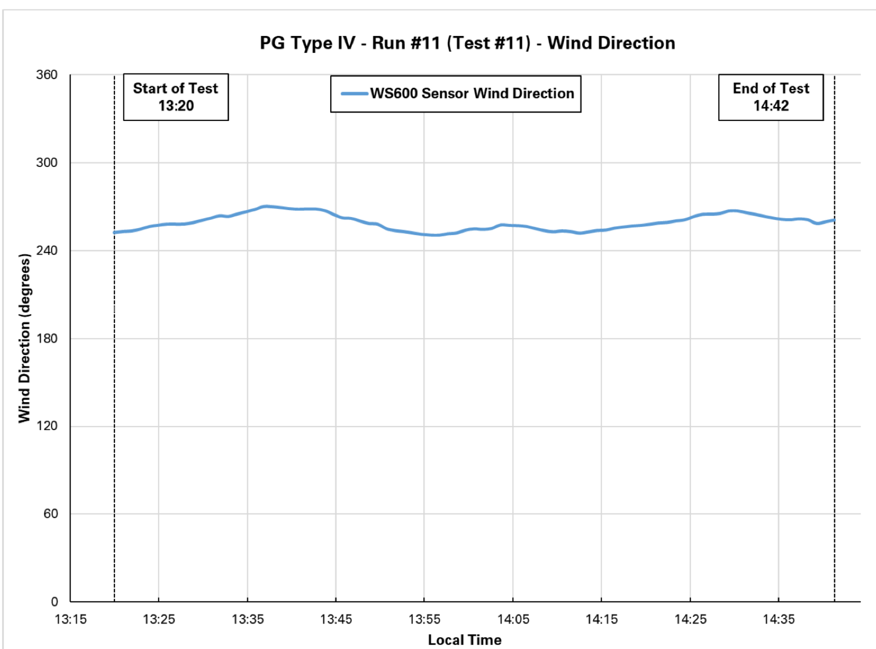
Test Number:	PG4-11
Date of Test:	Feb 2nd, 2019
Average OAT:	-8.0°C
Average Precipitation Rate:	9.2 g/dm²/h
Average Wind Speed:	19.7 km/h
Average Relative Humidity:	82.7%
Pour Time (Local):	13:20:00
Time of Fluid Failure (Local):	14:42:20
Fluid Brix at Failure:	14.75°
Endurance Time:	82.33 minutes
Expected Regression-Derived Endurance Time:	72.1 minutes
Difference (ET vs. Reg ET):	+10.2 minutes (+14.2%)


PG Type IV - Run #11 (Test #11) - Precipitation Rate
Start of Test
13:20
End of Test
14:42
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
13:15
13:25
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time


PG Type IV - Run #11 (Test #11) - Temperatures
Start of Test
13:20
Initial Fluid Temp: -7.3°C
End of Test
14:42
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
13:15
13:25
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

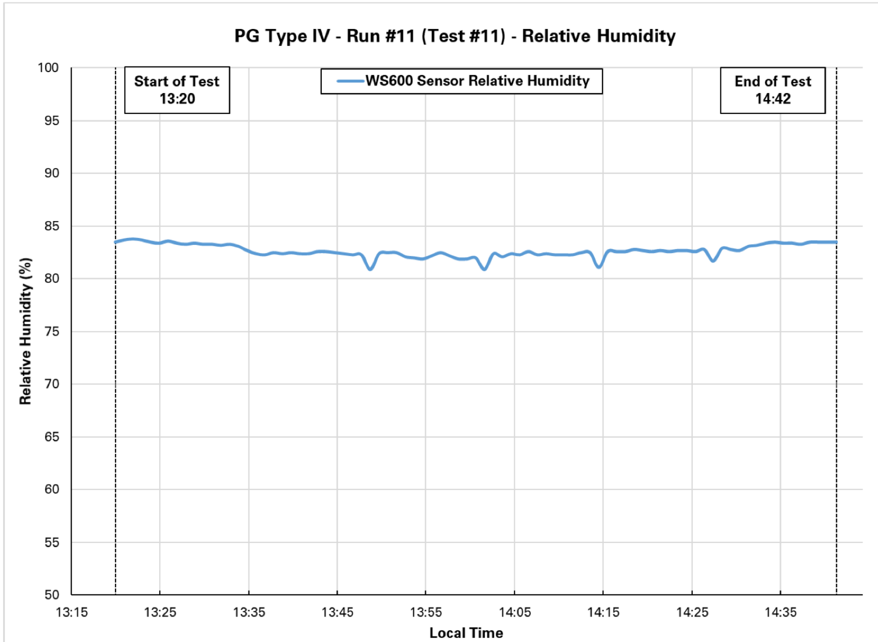


PG Type IV - Run #11 (Test #11) - Wind Speeds
Start of Test 13:20
End of Test 14:42
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
13:15
13:25
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time



PG Type IV - Run #11 (Test #11) - Wind Direction
Start of Test 13:20
End of Test 14:42
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
13:15
13:25
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN 11 (TEST 11)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 11 - Test 11/Data Package - PG Type IV - Run 11 - Test 11.docx
Final Version 1.0, February 2021

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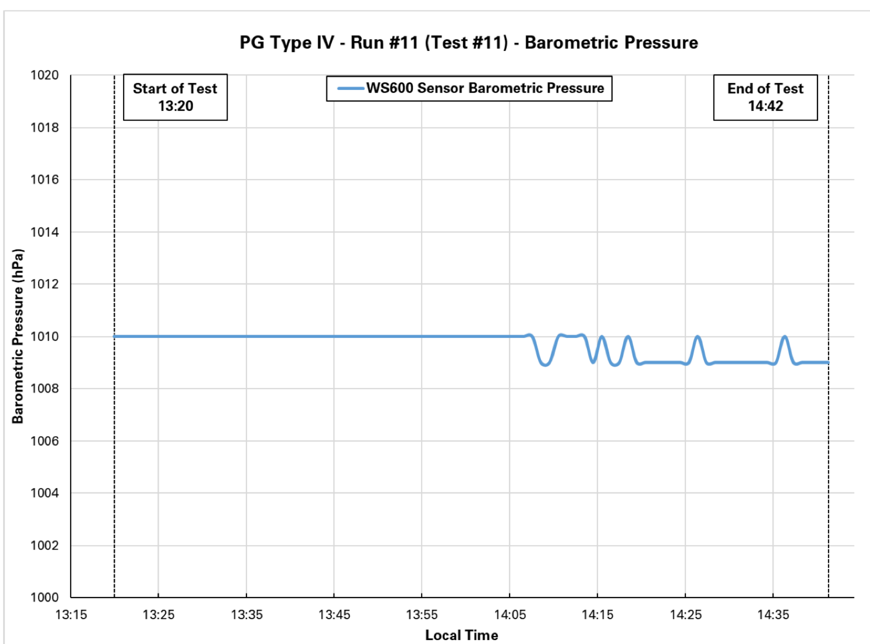
DATA PACKAGE – PG TYPE IV – RUN 11 (TEST 11)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 11 - Test 11/Data Package - PG Type IV - Run 11 - Test 11.docx
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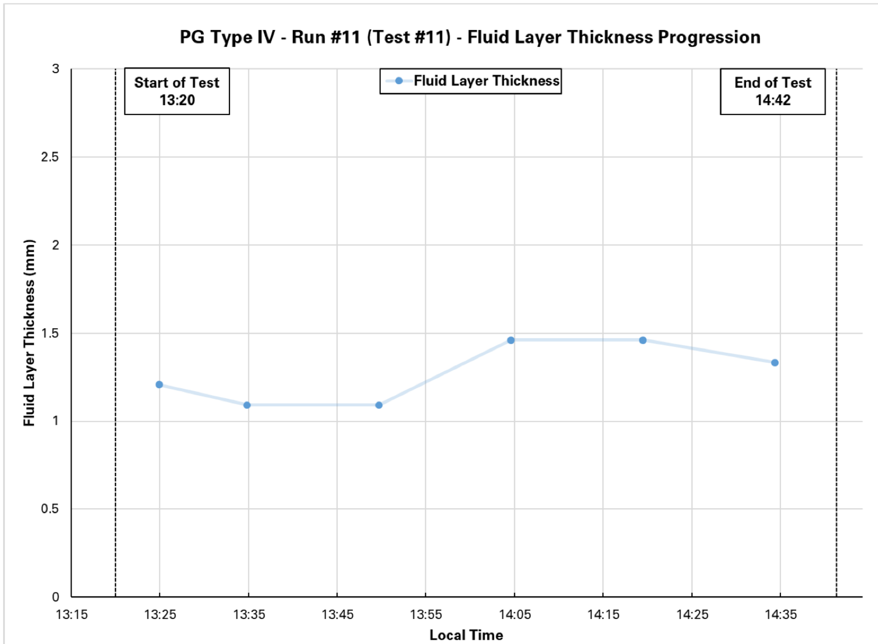
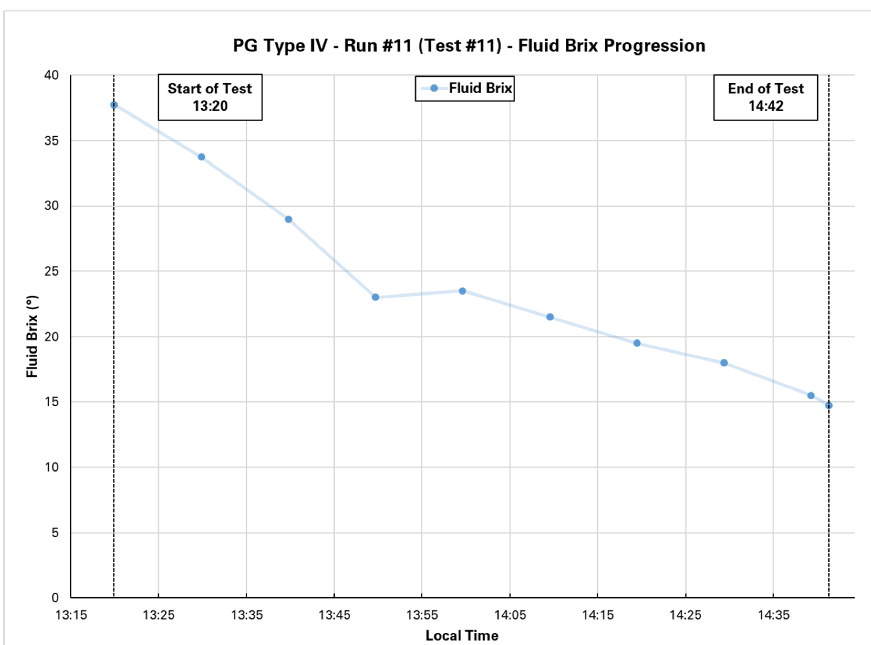
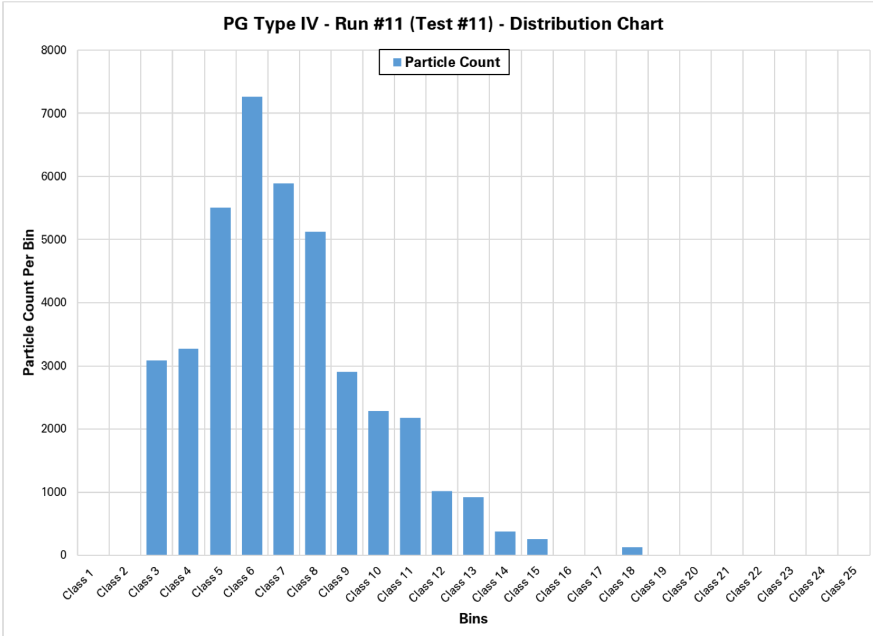
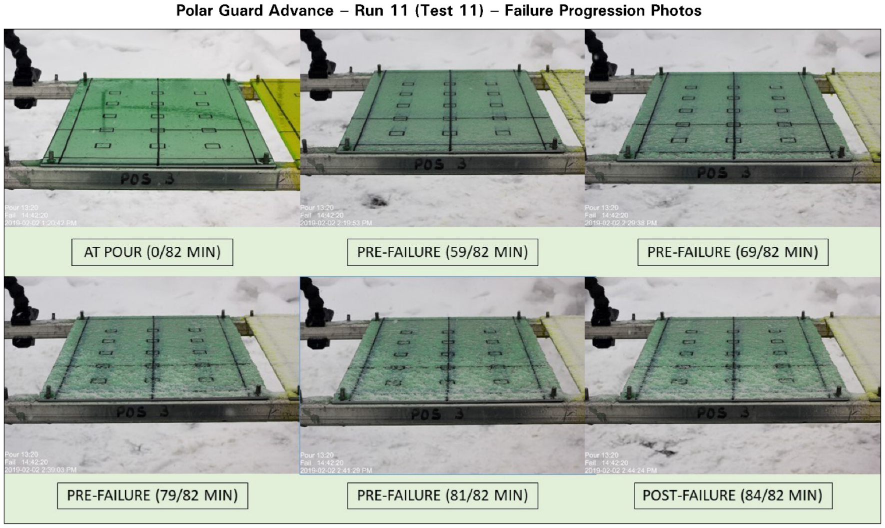

PG Type IV - Run #11 (Test #11) - Fluid Layer Thickness Progression
Start of Test
13:20
Fluid Layer Thickness
End of Test
14:42
Fluid Layer Thickness (mm)
0
0.5
1
1.5
2
2.5
3
13:15
13:25
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

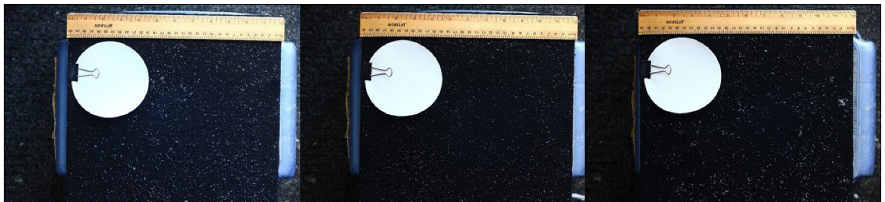

PG Type IV - Run #11 (Test #11) - Fluid Brix Progression
Start of Test
13:20
Fluid Brix
End of Test
14:42
Fluid Brix (°)
0
5
10
15
20
25
30
35
40
13:15
13:25
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time



Polar Guard Advance – Run 11 (Test 11) – Failure Progression Photos



Polar Guard Advance – Run 11 (Test 11) – Snow Characteristics Photos



FELT PAD (3/82 MIN)	FELT PAD (42/82 MIN)	FELT PAD (72/82 MIN)

BARE PLATE (1/82 MIN)	BARE PLATE (49/82 MIN)	BARE PLATE (74/82 MIN)

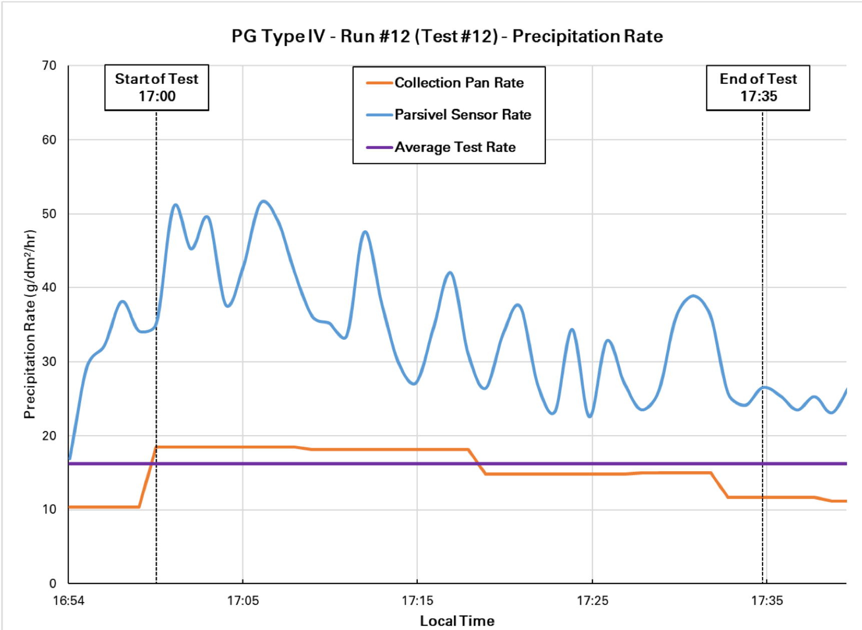
Final Bare Plate Contamination Thickness: **Nil (0.0 cm)**

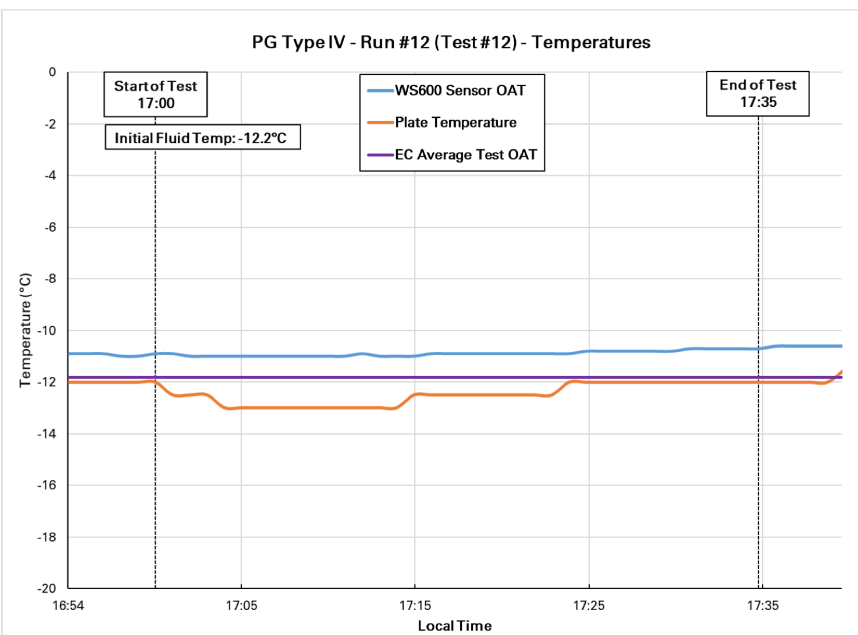
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

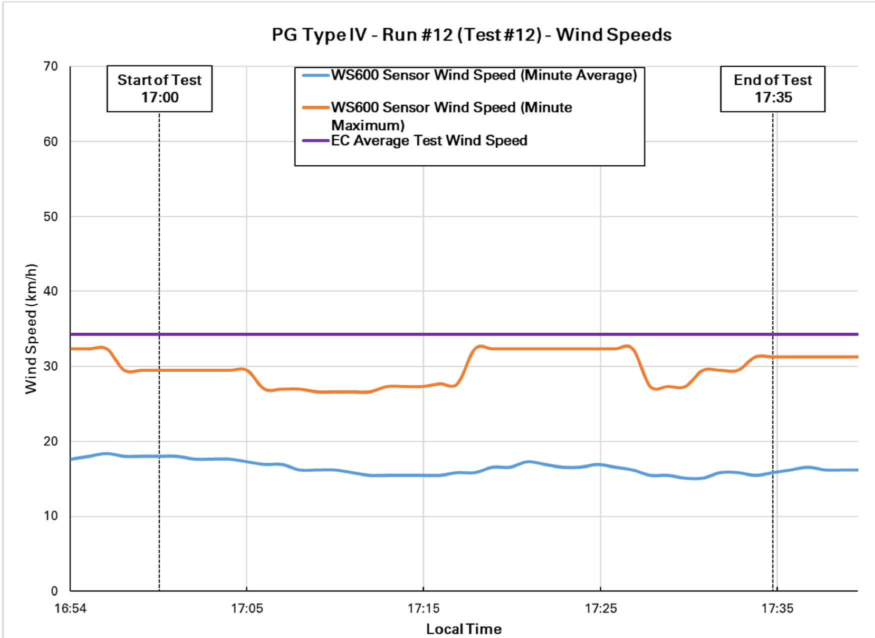
PG TYPE IV
RUN #12 (TEST #12) – PG4-12

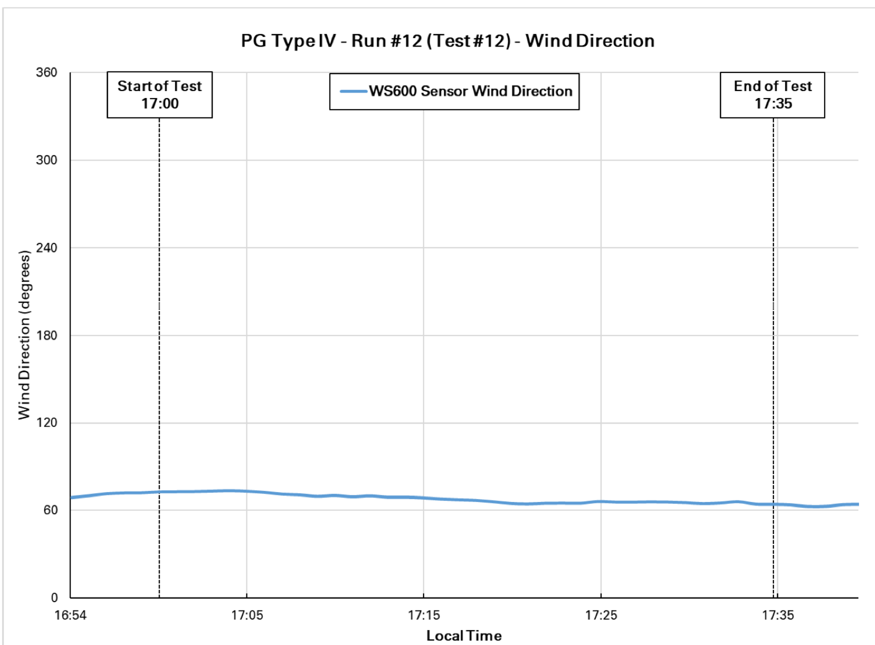
PG Type IV – Run #12 (Test #12) – General Test Information

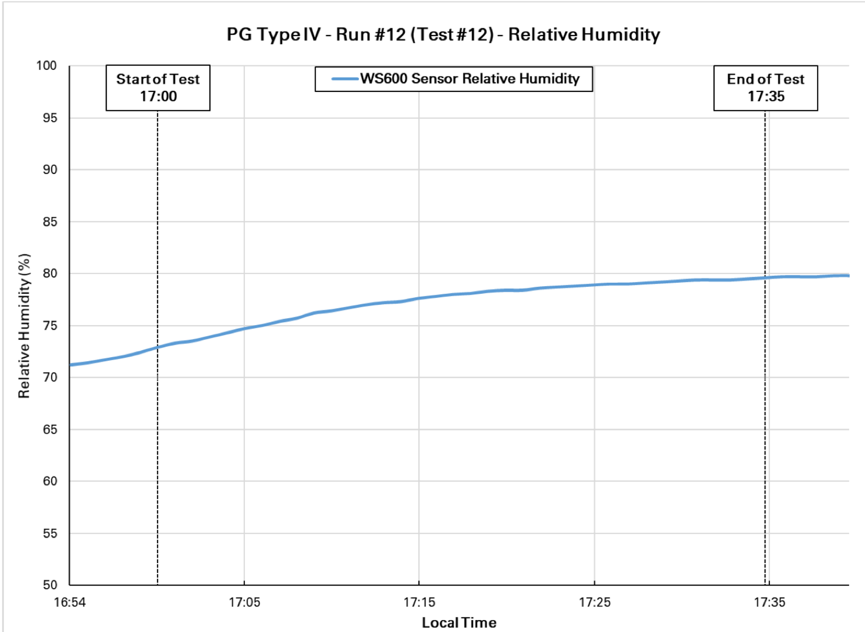
Test Number:	PG4-12
Date of Test:	February 12, 2019
Average OAT:	-11.8
Average Precipitation Rate:	16.2 g/dm²/h
Average Wind Speed:	34.3 km/h
Average Relative Humidity:	76.98%
Pour Time (Local):	17:00:00
Time of Fluid Failure (Local):	17:35:00
Fluid Brix at Failure:	20.25°
Endurance Time:	35 minutes
Expected Regression-Derived Endurance Time:	37.5 minutes
Difference (ET vs. Reg ET):	-2 minutes (-5.2%)


PG Type IV - Run #12 (Test #12) - Precipitation Rate
Start of Test 17:00
End of Test 17:35
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
16:54
17:05
17:15
17:25
17:35
Local Time

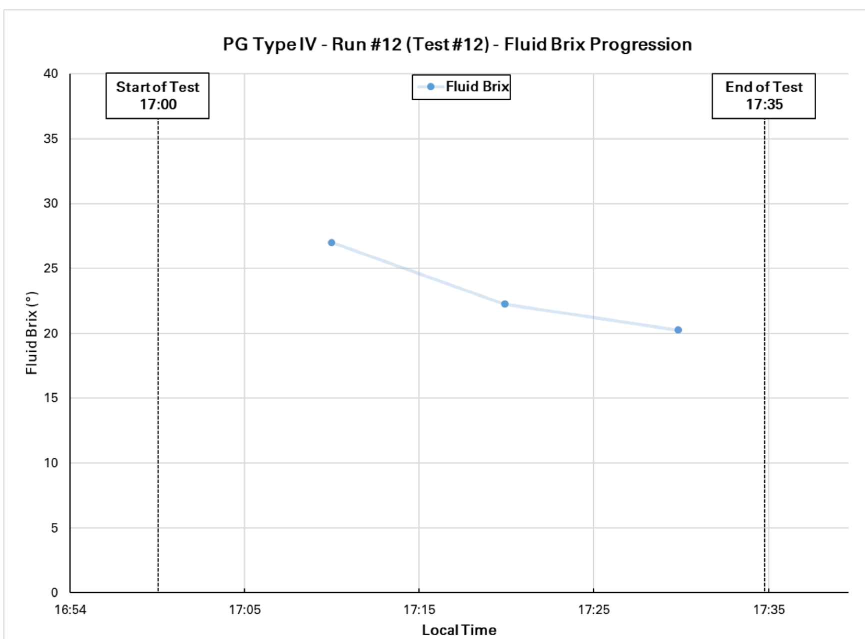

PG Type IV - Run #12 (Test #12) - Temperatures
Start of Test 17:00
Initial Fluid Temp: -12.2°C
End of Test 17:35
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:54
17:05
17:15
17:25
17:35
Local Time


PG Type IV - Run #12 (Test #12) - Wind Speeds
Start of Test 17:00
End of Test 17:35
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
16:54
17:05
17:15
17:25
17:35
Local Time

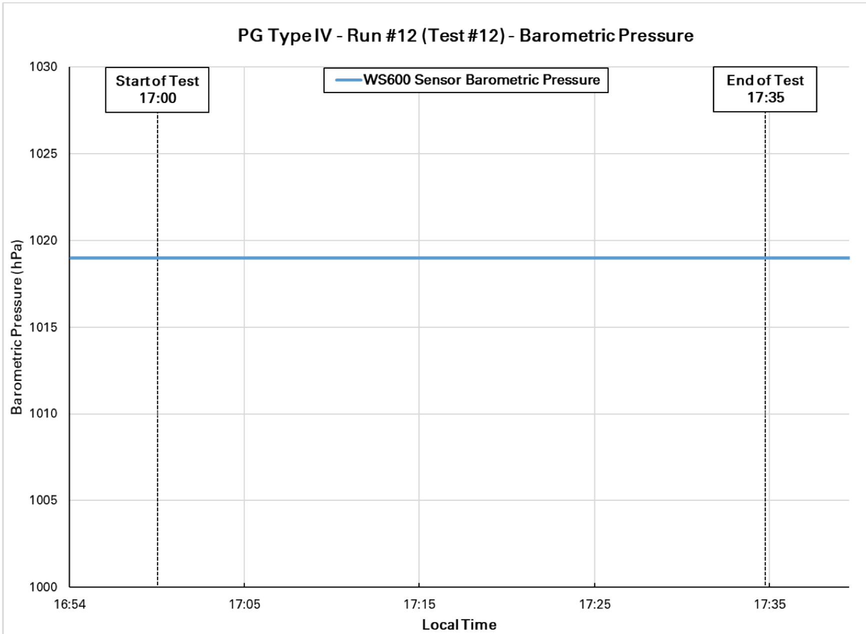

PG Type IV - Run #12 (Test #12) - Wind Direction
Start of Test 17:00
End of Test 17:35
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
16:54
17:05
17:15
17:25
17:35
Local Time

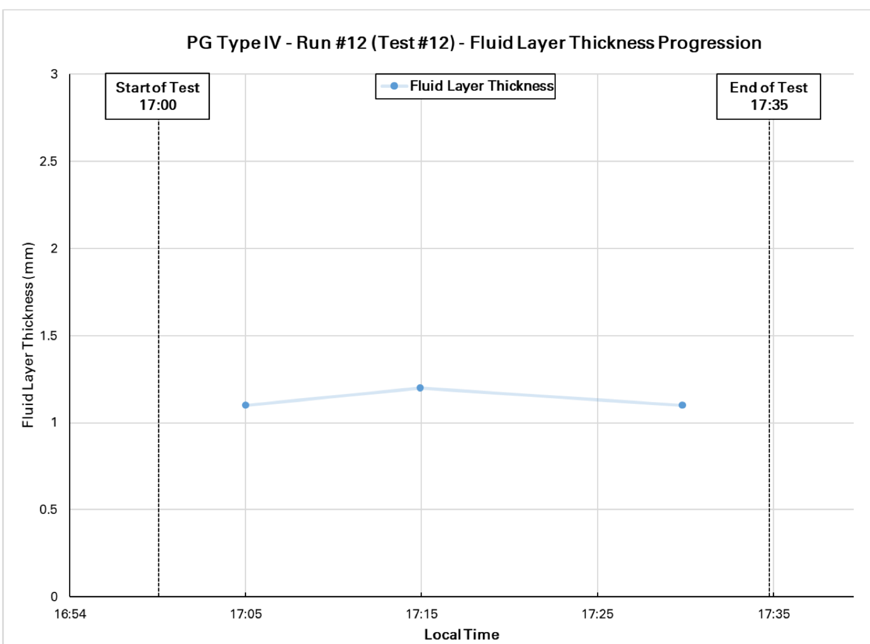


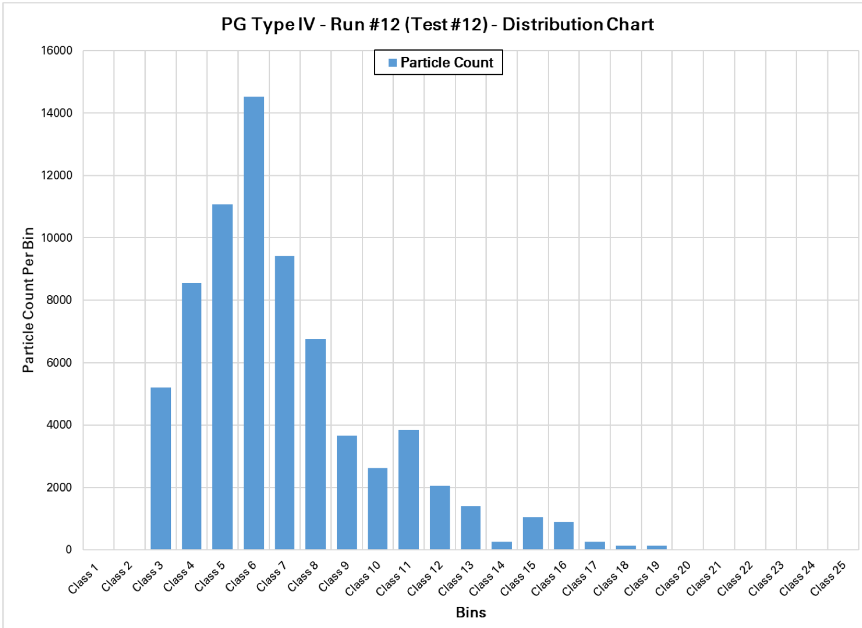
PG Type IV - Run #12 (Test #12) - Relative Humidity
Start of Test 17:00
WS600 Sensor Relative Humidity
End of Test 17:35
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
16:54
17:05
17:15
17:25
17:35
Local Time



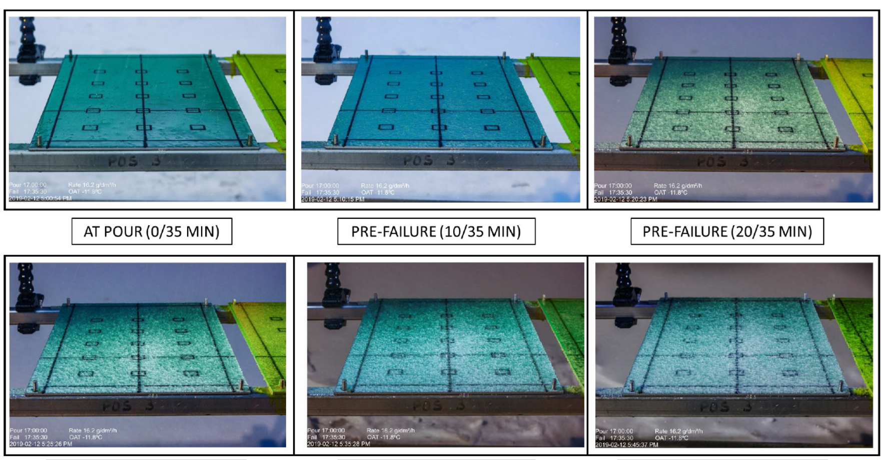
PG Type IV - Run #12 (Test #12) - Fluid Brix Progression
Start of Test 17:00
Fluid Brix
End of Test 17:35
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
16:54
17:05
17:15
17:25
17:35
Local Time


PG Type IV - Run #12 (Test #12) - Barometric Pressure
Start of Test 17:00
WS600 Sensor Barometric Pressure
End of Test 17:35
Barometric Pressure (hPa)
1030
1025
1020
1015
1010
1005
1000
16:54
17:05
17:15
17:25
17:35
Local Time


PG Type IV - Run #12 (Test #12) - Fluid Layer Thickness Progression
Start of Test 17:00
Fluid Layer Thickness
End of Test 17:35
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:54
17:05
17:15
17:25
17:35
Local Time



Polar Guard Advance – Run 12 (Test 12) – Failure Progression Photos

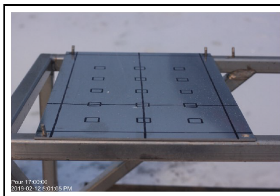


AT POUR (0/35 MIN) | PRE-FAILURE (10/35 MIN) | PRE-FAILURE (20/35 MIN)

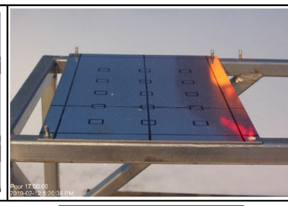
PRE-FAILURE (25/35 MIN) | AT FAILURE (35/35 MIN) | POST-FAILURE (45/35 MIN)

Polar Guard Advance – Run 12 (Test 12) – Snow Characteristics Photos

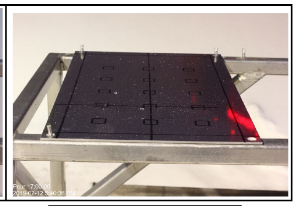
Felt Pad Photos Unavailable	Felt Pad Photos Unavailable	Felt Pad Photos Unavailable
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)



BARE PLATE (0/35 MIN)



BARE PLATE 20/35 MIN)



BARE PLATE (40/35 MIN)

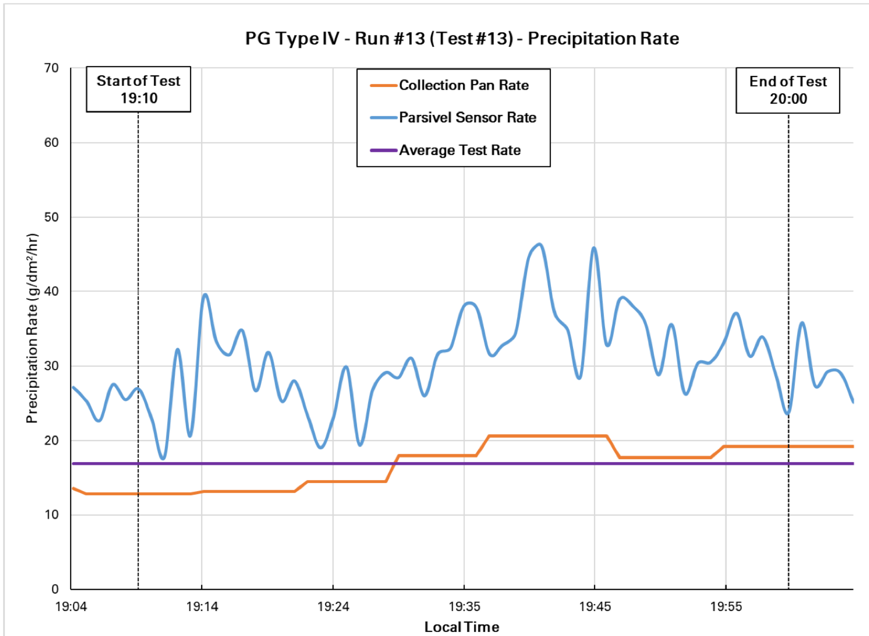
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

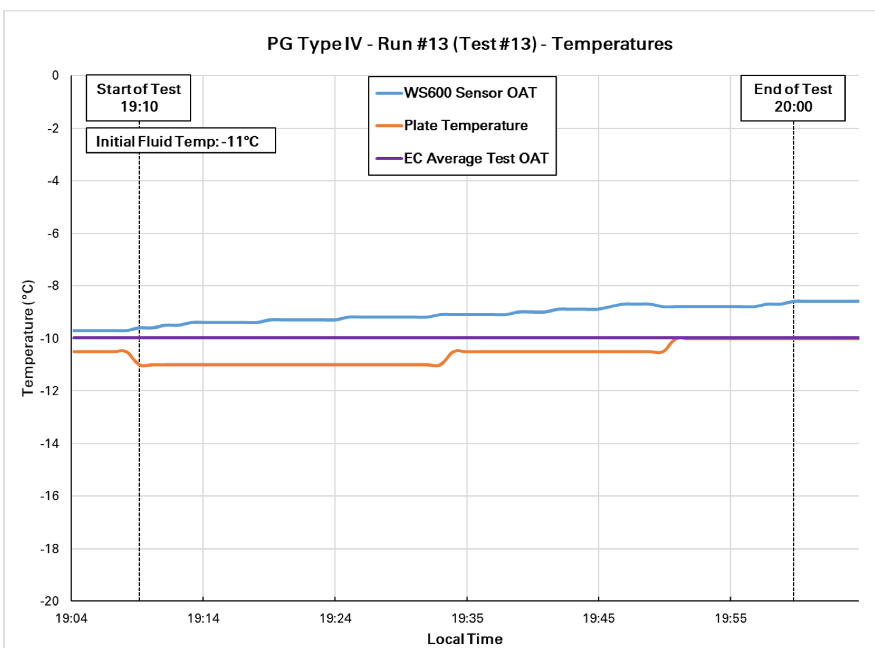
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

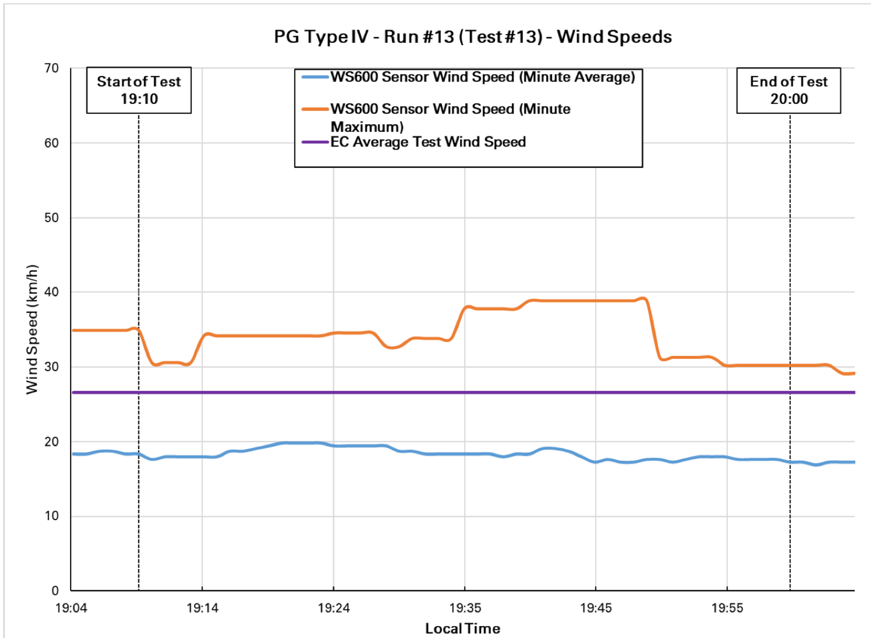
PG TYPE IV
RUN #13 (TEST #13) – PG4-13

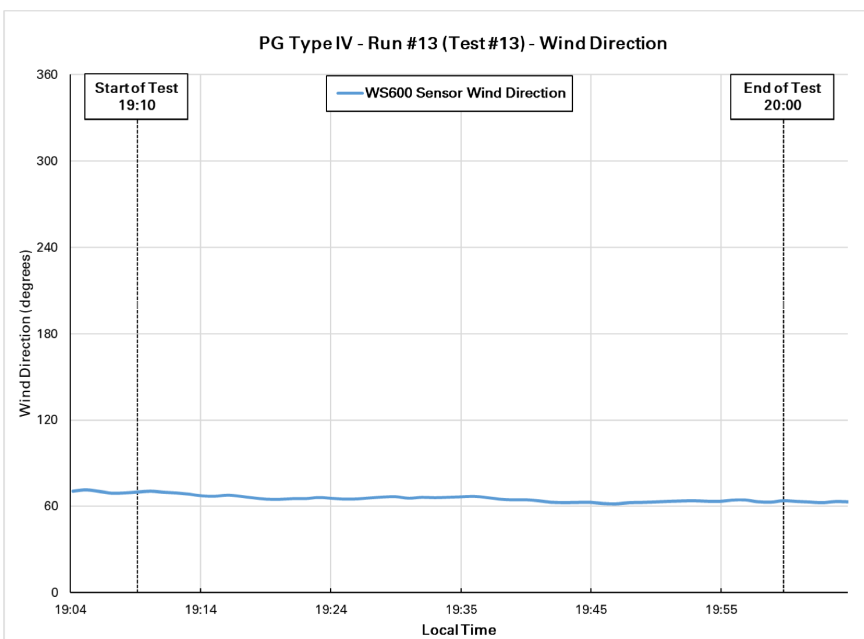
PG Type IV – Run #13 (Test #13) – General Test Information

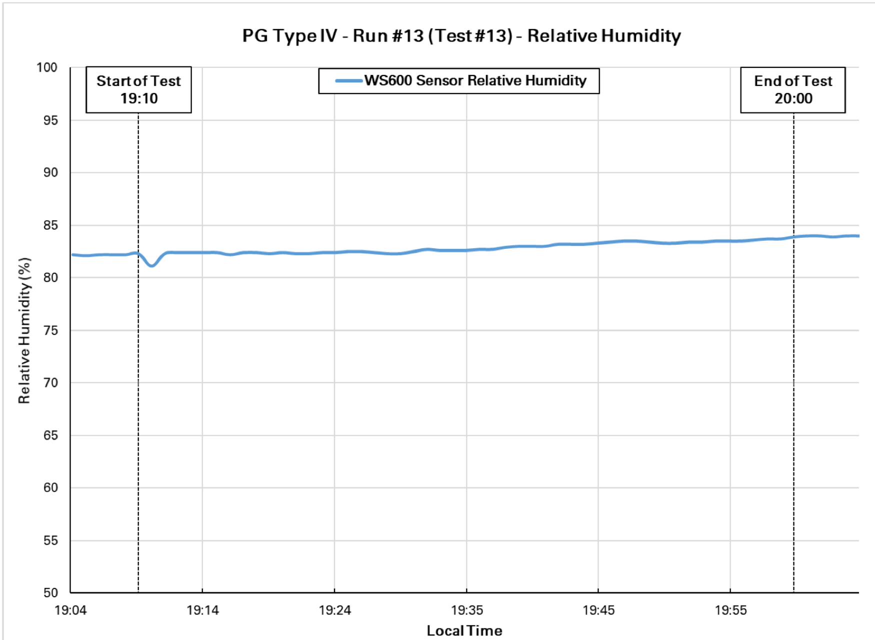
Test Number:	PG4-13
Date of Test:	February 12, 2019
Average OAT:	-10.0
Average Precipitation Rate:	16.9 g/dm²/h
Average Wind Speed:	26.6 km/h
Average Relative Humidity:	82.86%
Pour Time (Local):	19:10:00
Time of Fluid Failure (Local):	20:00:00
Fluid Brix at Failure:	17.5°
Endurance Time:	50 minutes
Expected Regression-Derived Endurance Time:	39.4 minutes
Difference (ET vs. Reg ET):	+10.6 minutes (+26.8%)

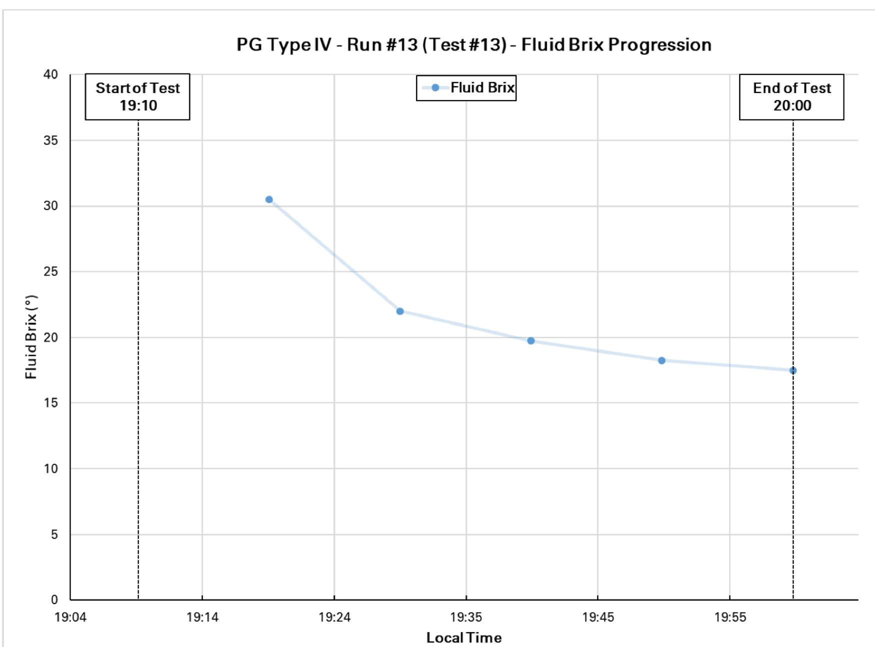

PG Type IV - Run #13 (Test #13) - Precipitation Rate
Start of Test 19:10
End of Test 20:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
19:04
19:14
19:24
19:35
19:45
19:55
Local Time

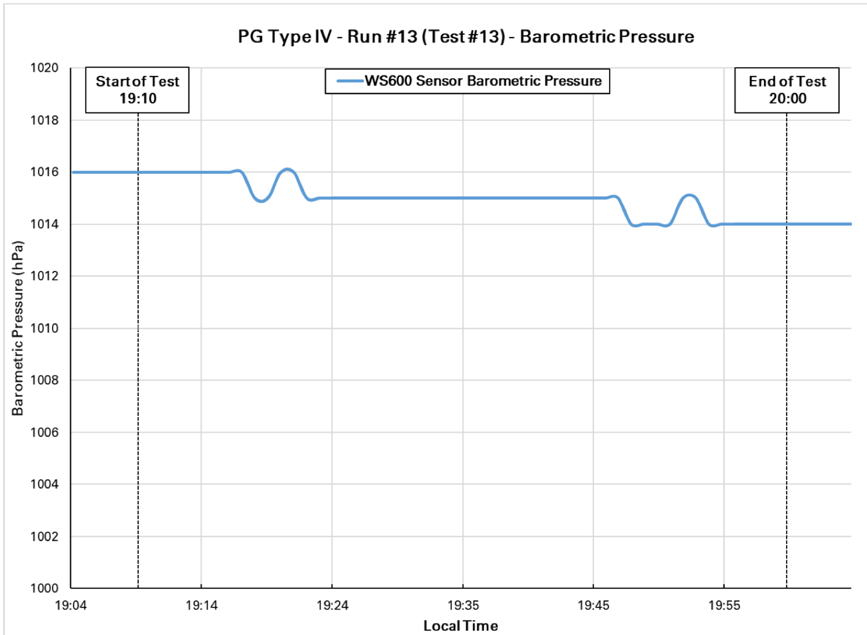

PG Type IV - Run #13 (Test #13) - Temperatures
Start of Test 19:10
Initial Fluid Temp: -11°C
End of Test 20:00
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
19:04
19:14
19:24
19:35
19:45
19:55
Local Time

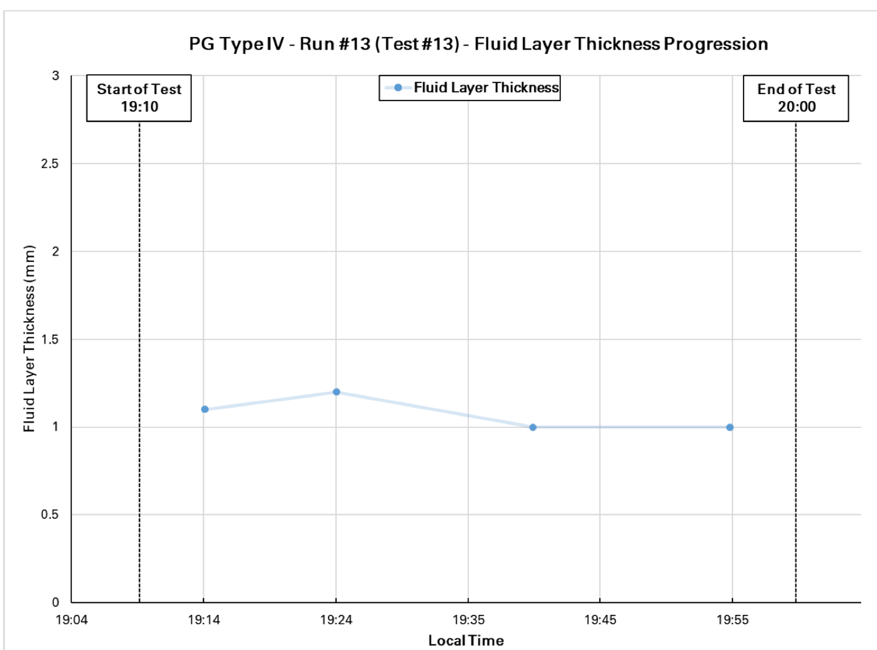

PG Type IV - Run #13 (Test #13) - Wind Speeds
Start of Test 19:10
End of Test 20:00
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
19:04
19:14
19:24
19:35
19:45
19:55
Local Time

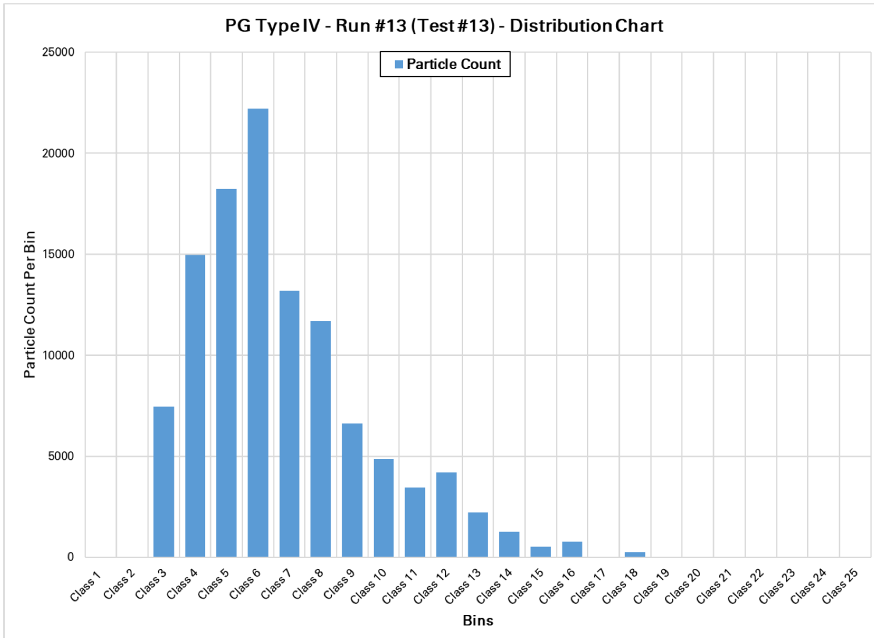

PG Type IV - Run #13 (Test #13) - Wind Direction
Start of Test 19:10
WS600 Sensor Wind Direction
End of Test 20:00
Wind Direction (degrees)
360
300
240
180
120
60
0
19:04
19:14
19:24
19:35
19:45
19:55
Local Time


PG Type IV - Run #13 (Test #13) - Relative Humidity
Start of Test 19:10
WS600 Sensor Relative Humidity
End of Test 20:00
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
19:04
19:14
19:24
19:35
19:45
19:55
Local Time

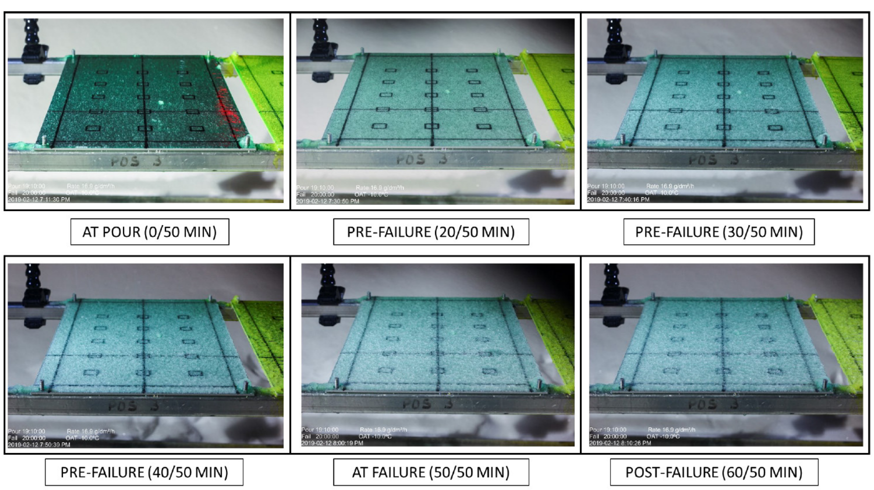

PG Type IV - Run #13 (Test #13) - Fluid Brix Progression
Start of Test 19:10
Fluid Brix
End of Test 20:00
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
19:04
19:14
19:24
19:35
19:45
19:55
Local Time


PG Type IV - Run #13 (Test #13) - Barometric Pressure
Start of Test 19:10
WS600 Sensor Barometric Pressure
End of Test 20:00
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
19:04
19:14
19:24
19:35
19:45
19:55
Local Time


PG Type IV - Run #13 (Test #13) - Fluid Layer Thickness Progression
Start of Test 19:10
Fluid Layer Thickness
End of Test 20:00
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
19:04
19:14
19:24
19:35
19:45
19:55
Local Time

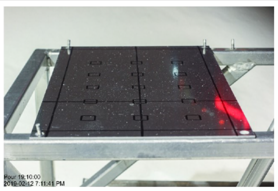


Polar Guard Advance – Run 13 (Test 13) – Failure Progression Photos

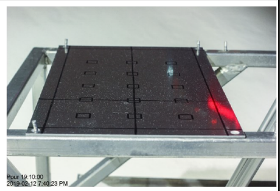


Polar Guard Advance – Run 13 (Test 13) – Snow Characteristics Photos

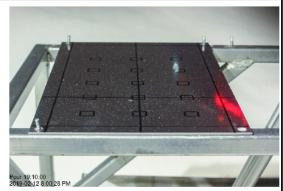
Felt Pad Photos Unavailable	Felt Pad Photos Unavailable	Felt Pad Photos Unavailable
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)



BARE PLATE (1/50 MIN)



BARE PLATE 30/50 MIN)



BARE PLATE (50/50 MIN)

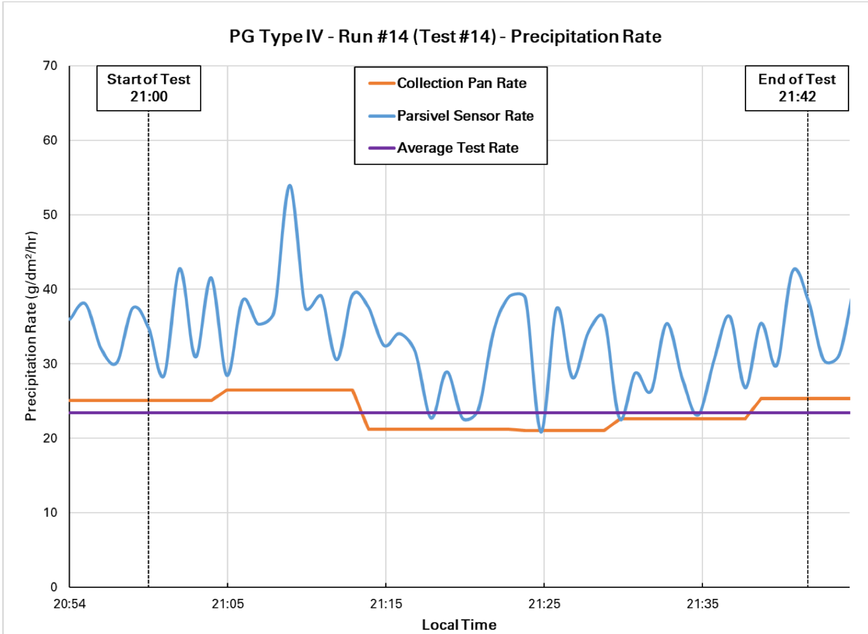
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

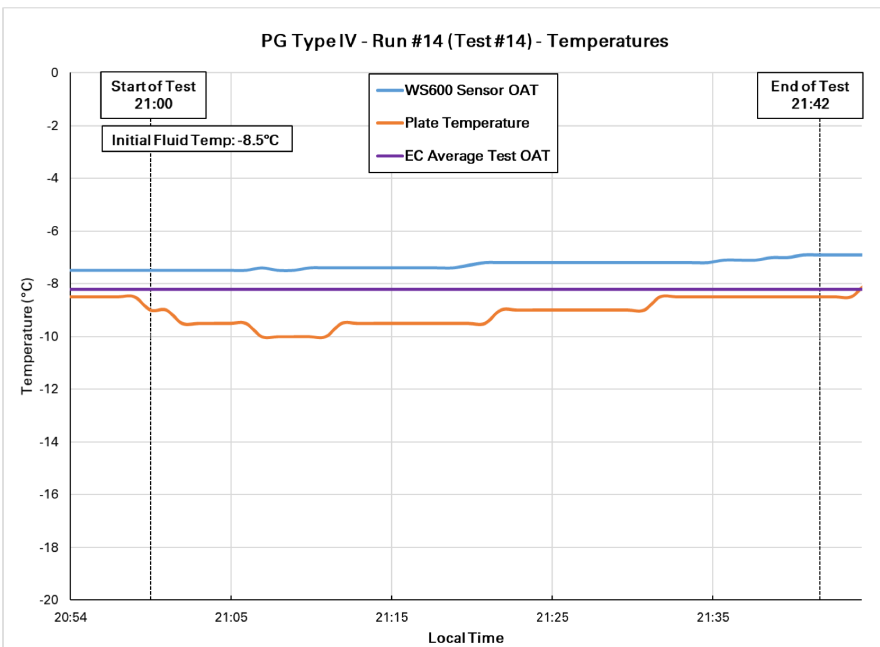
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

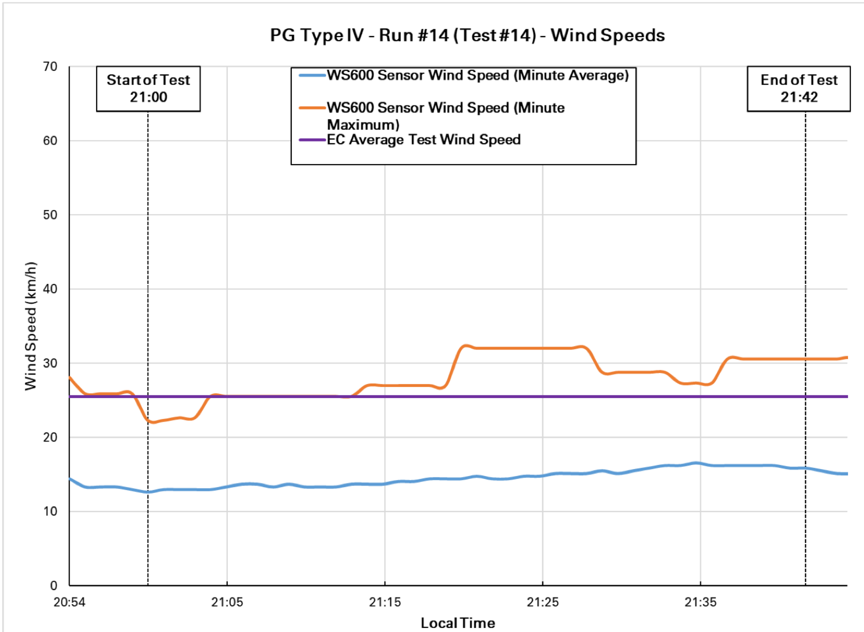
PG TYPE IV
RUN #14 (TEST #14) – PG4-14

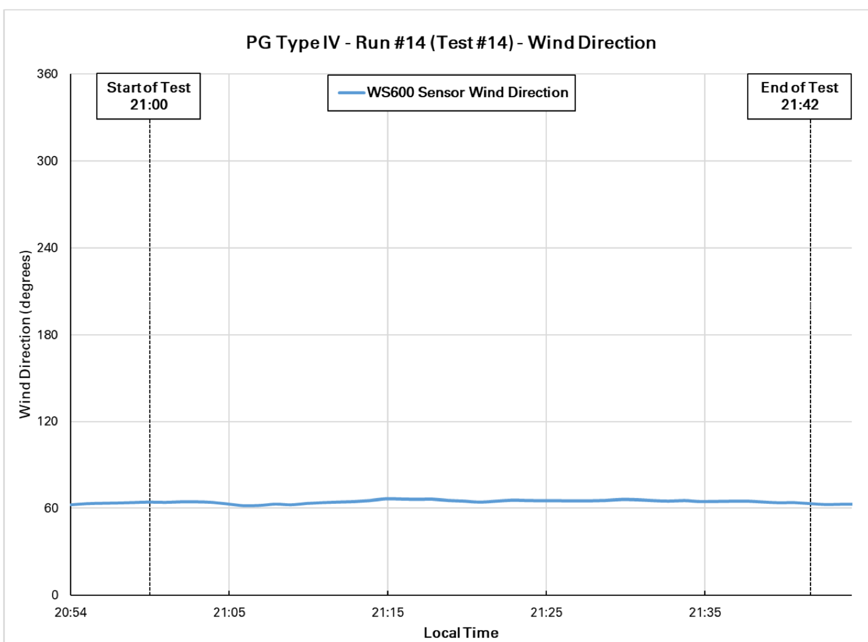
PG Type IV – Run #14 (Test #14) – General Test Information

Test Number:	PG4-14
Date of Test:	February 12, 2019
Average OAT:	-8.2
Average Precipitation Rate:	23.5 g/dm²/h
Average Wind Speed:	25.5 km/h
Average Relative Humidity:	86.40%
Pour Time (Local):	21:00:00
Time of Fluid Failure (Local):	21:42:00
Fluid Brix at Failure:	14°
Endurance Time:	42.5 minutes
Expected Regression-Derived Endurance Time:	33 minutes
Difference (ET vs. Reg ET):	+9.5 minutes (+28.8%)

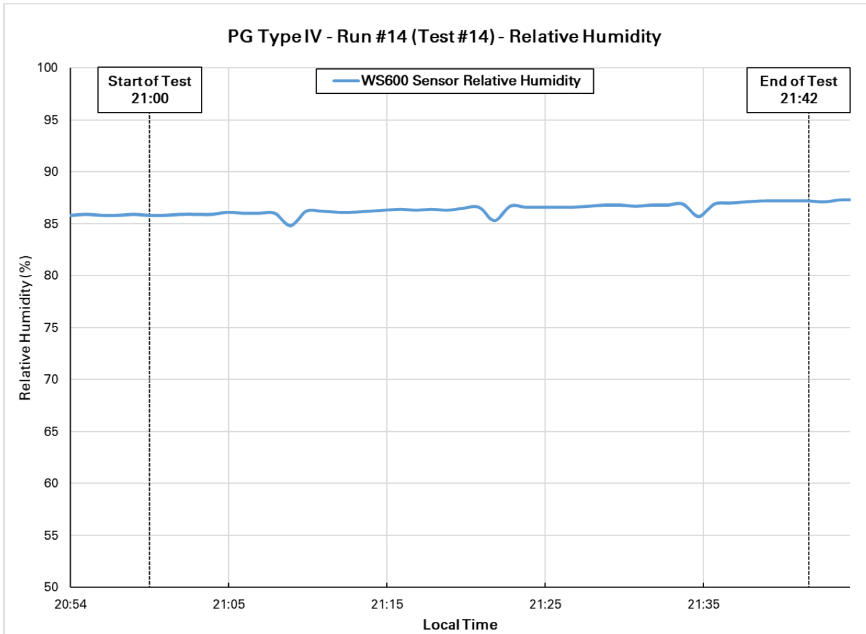

PG Type IV - Run #14 (Test #14) - Precipitation Rate
Start of Test 21:00
End of Test 21:42
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
20:54
21:05
21:15
21:25
21:35
Local Time


PG Type IV - Run #14 (Test #14) - Temperatures
Start of Test 21:00
Initial Fluid Temp: -8.5°C
End of Test 21:42
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
20:54
21:05
21:15
21:25
21:35
Local Time


PG Type IV - Run #14 (Test #14) - Wind Speeds
Start of Test 21:00
End of Test 21:42
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
20:54
21:05
21:15
21:25
21:35
Local Time


PG Type IV - Run #14 (Test #14) - Wind Direction
Start of Test 21:00
WS600 Sensor Wind Direction
End of Test 21:42
Wind Direction (degrees)
360
300
240
180
120
60
0
20:54
21:05
21:15
21:25
21:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN 14 (TEST 14)



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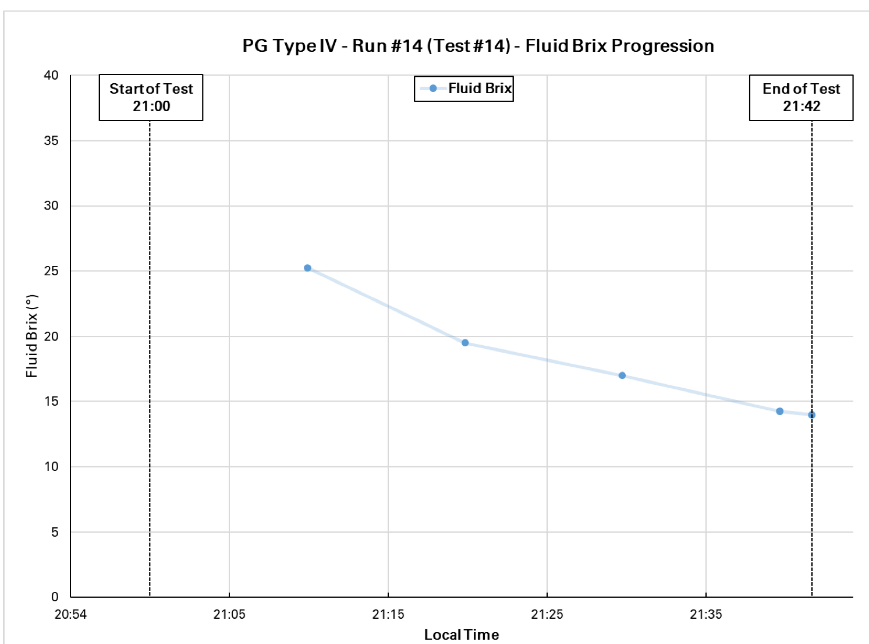
DATA PACKAGE – PG TYPE IV – RUN 14 (TEST 14)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 14 - Test 14/Data Package - PG Type IV - Run 14 - Test 14.docx
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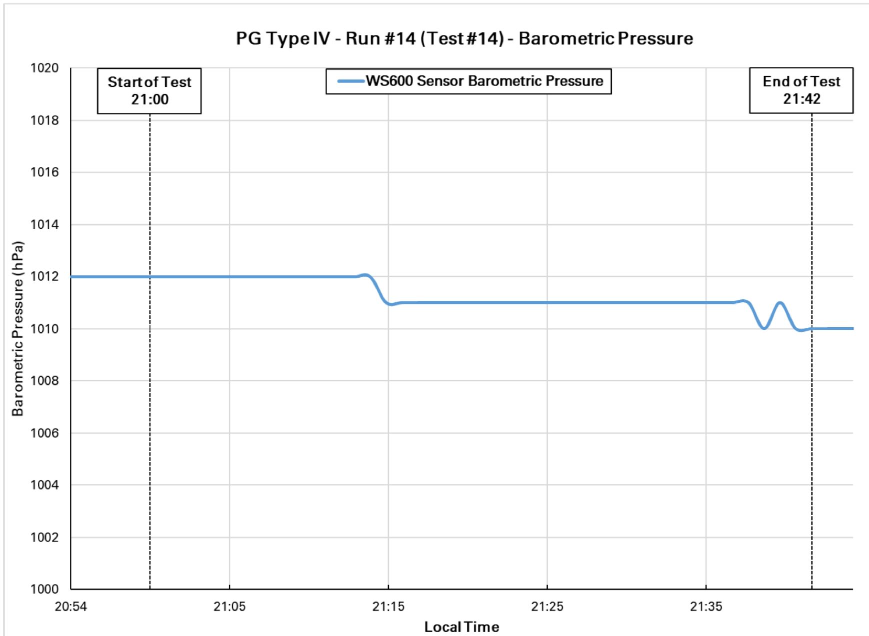
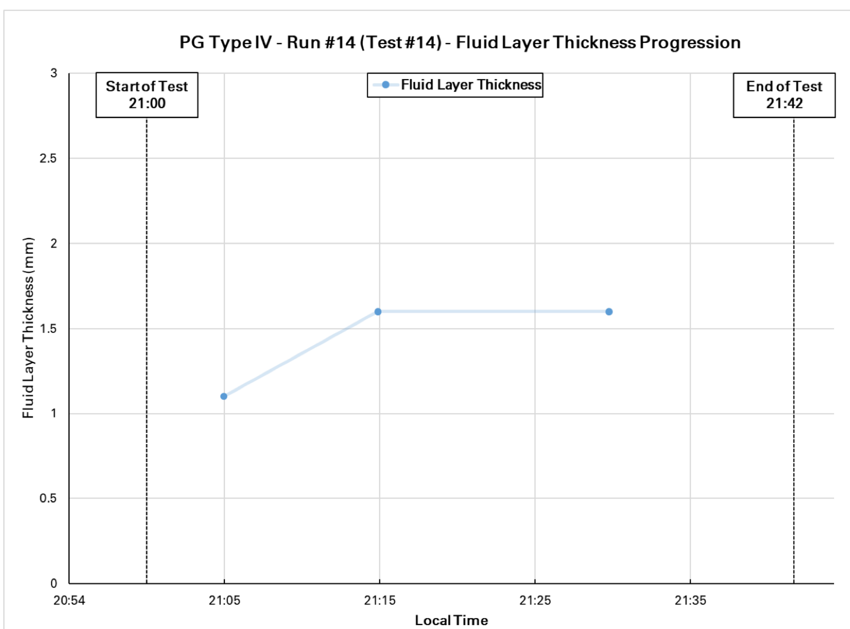
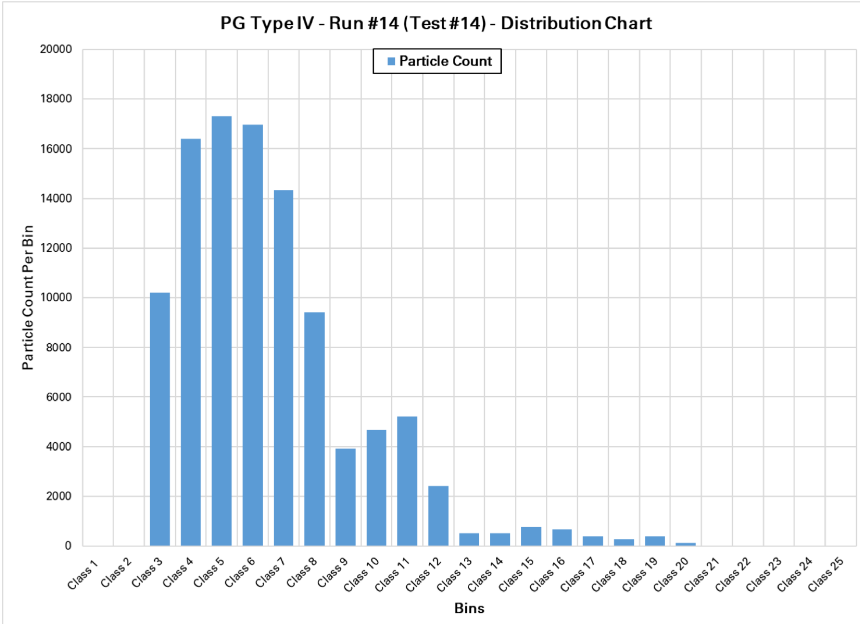
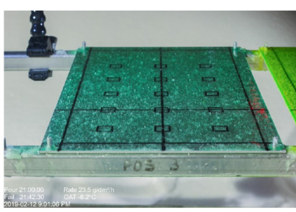
8


PG Type IV - Run #14 (Test #14) - Barometric Pressure
Start of Test 21:00
WS600 Sensor Barometric Pressure
End of Test 21:42
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
20:54
21:05
21:15
21:25
21:35
Local Time

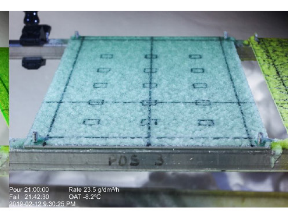

PG Type IV - Run #14 (Test #14) - Fluid Layer Thickness Progression
Start of Test 21:00
Fluid Layer Thickness
End of Test 21:42
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
20:54
21:05
21:15
21:25
21:35
Local Time



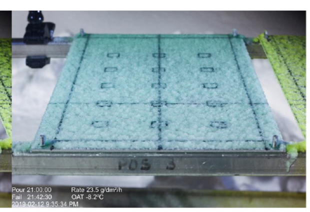
Polar Guard Advance – Run 14 (Test 14) – Failure Progression Photos



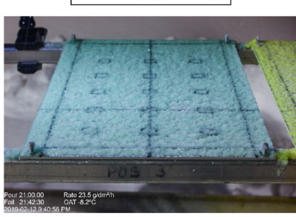
AT POUR (1/42 MIN)



PRE-FAILURE (30/42 MIN)

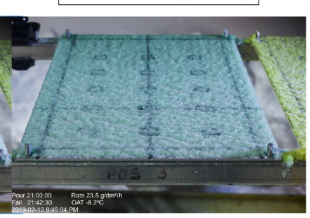


PRE-FAILURE (35/42 MIN)



PRE-FAILURE (40/42 MIN)

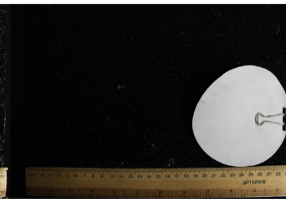
POST-FAILURE (43/42 MIN)



POST-FAILURE (45/42 MIN)

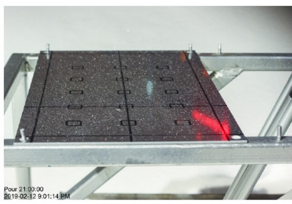
Polar Guard Advance – Run 14 (Test 14) – Snow Characteristics Photos

FELT PAD (1/42 MIN)

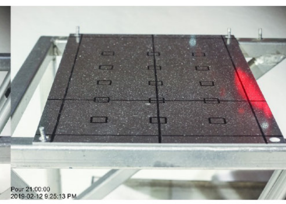


FELT PAD (20/42 MIN)

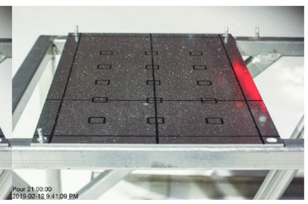
FELT PAD (40/42 MIN)



BARE PLATE (1/42 MIN)



BARE PLATE (25/42 MIN)



BARE PLATE (41/42 MIN)

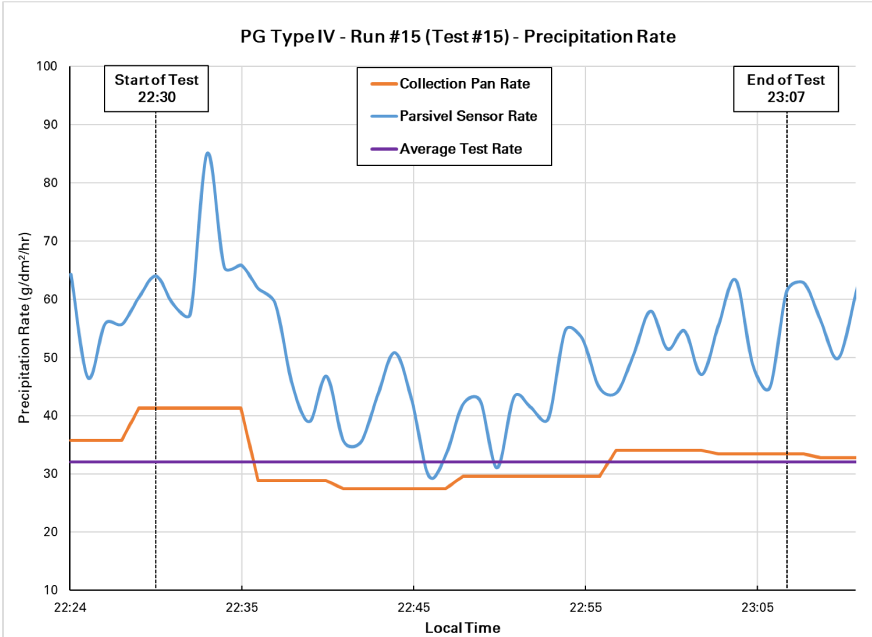
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

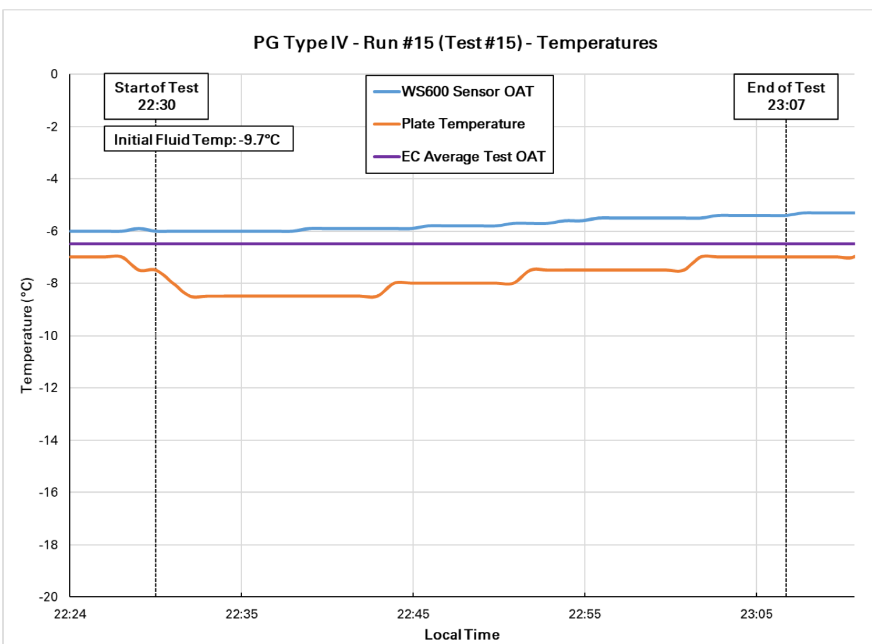
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

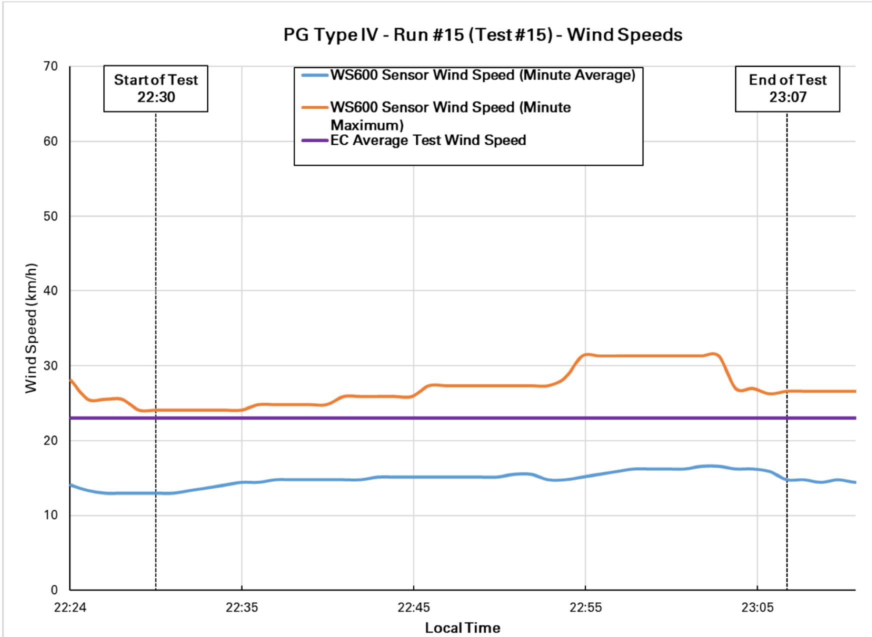
PG TYPE IV
RUN #15 (TEST #15) – PG4-15

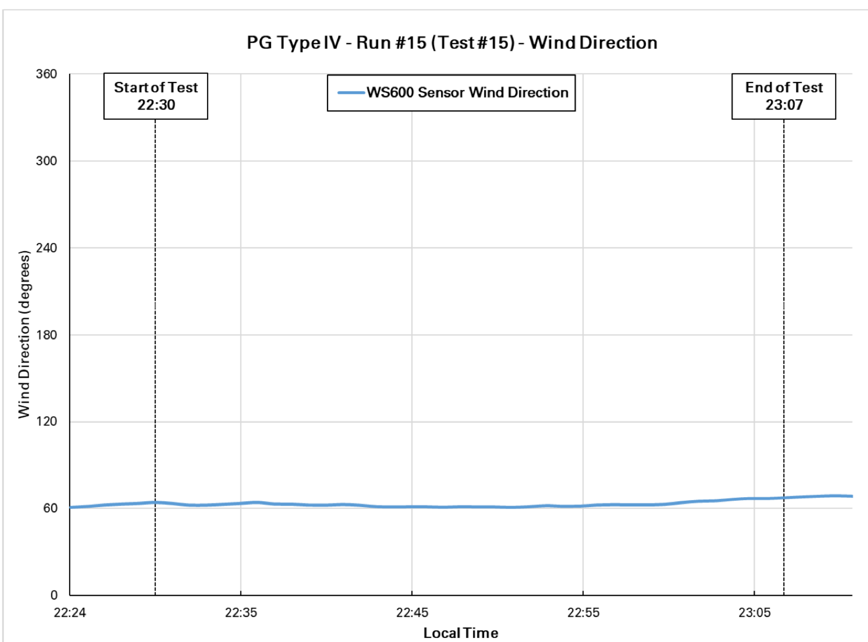
PG Type IV – Run #15 (Test #15) – General Test Information

Test Number:	**PG4-15**
Date of Test:	**February 12, 2019**
Average OAT:	**-6.5**
Average Precipitation Rate:	**32 g/dm²/h**
Average Wind Speed:	**23 km/h**
Average Relative Humidity:	**88.84%**
Pour Time (Local):	**22:30:00**
Time of Fluid Failure (Local):	**23:07:00**
Fluid Brix at Failure:	**12°**
Endurance Time:	**37 minutes**
Expected Regression-Derived Endurance Time:	**28.4 minutes**
Difference (ET vs. Reg ET):	**+8.6 minutes (+30.1%)**

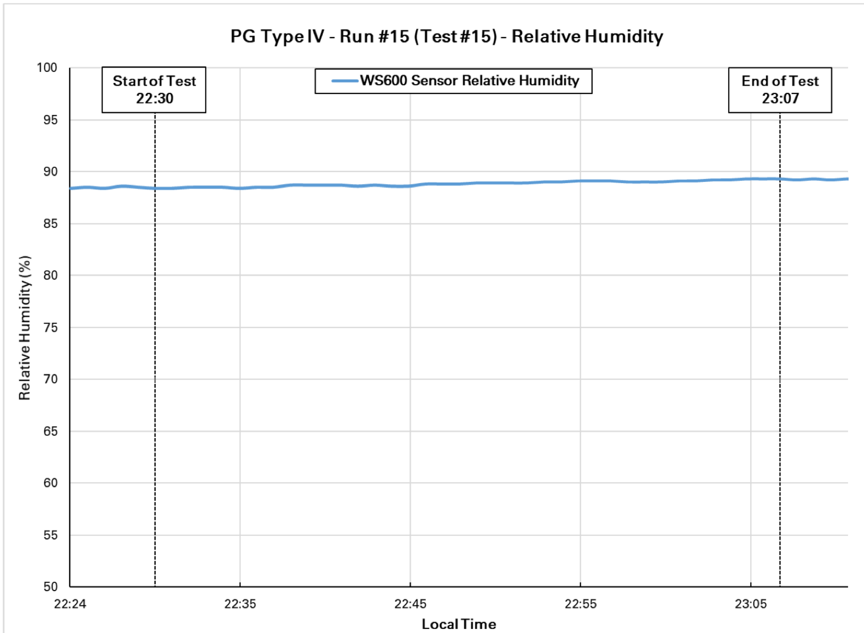

PG Type IV - Run #15 (Test #15) - Precipitation Rate
Start of Test 22:30
End of Test 23:07
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
100
90
80
70
60
50
40
30
20
10
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type IV - Run #15 (Test #15) - Temperatures
Start of Test 22:30
Initial Fluid Temp: -9.7°C
End of Test 23:07
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type IV - Run #15 (Test #15) - Wind Speeds
Start of Test 22:30
End of Test 23:07
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type IV - Run #15 (Test #15) - Wind Direction
Start of Test 22:30
WS600 Sensor Wind Direction
End of Test 23:07
Wind Direction (degrees)
0
60
120
180
240
300
360
22:24
22:35
22:45
22:55
23:05
Local Time

DATA PACKAGE – PG TYPE IV – RUN 15 (TEST 15)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 15 - Test 15/Data Package - PG Type IV - Run 15 - Test 15.docx
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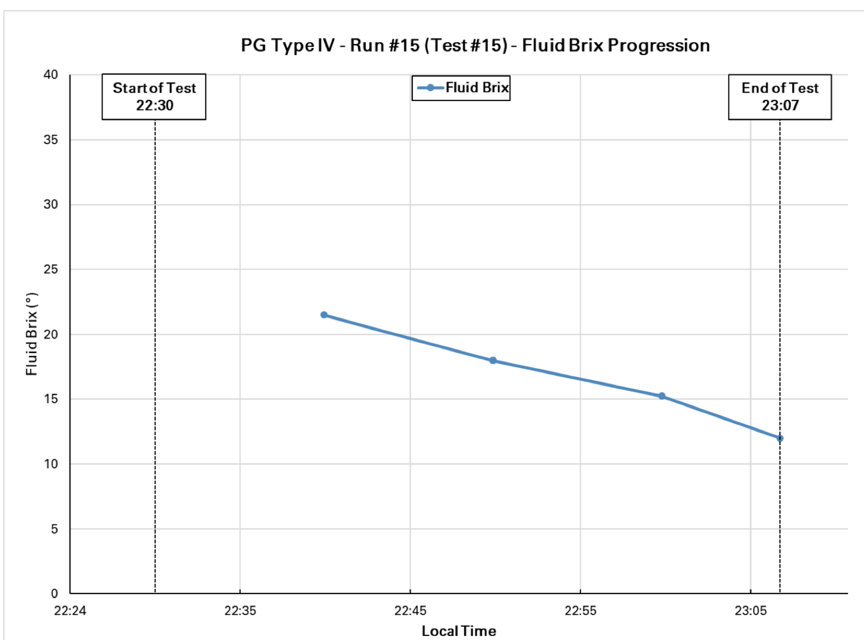
DATA PACKAGE – PG TYPE IV – RUN 15 (TEST 15)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 15 - Test 15/Data Package - PG Type IV - Run 15 - Test 15.docx
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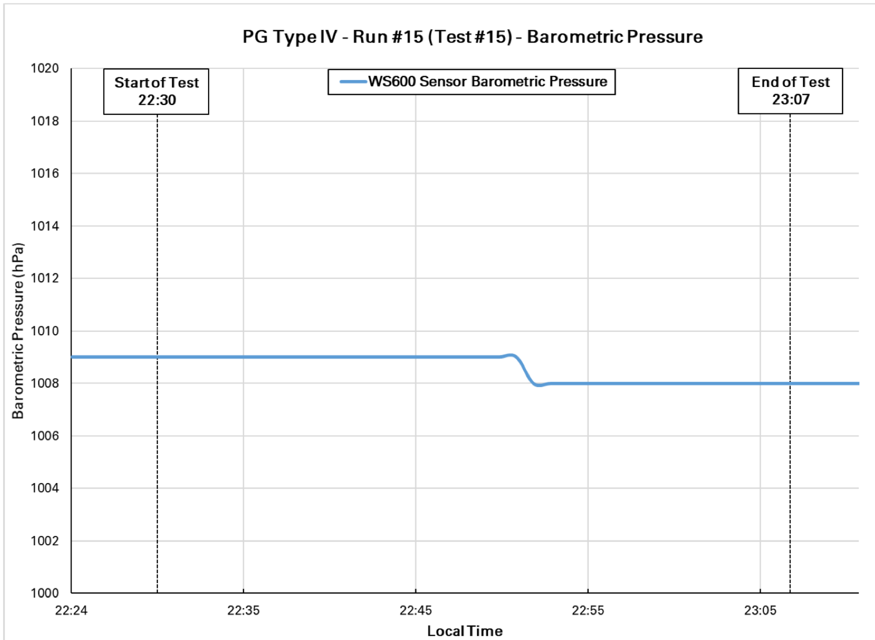
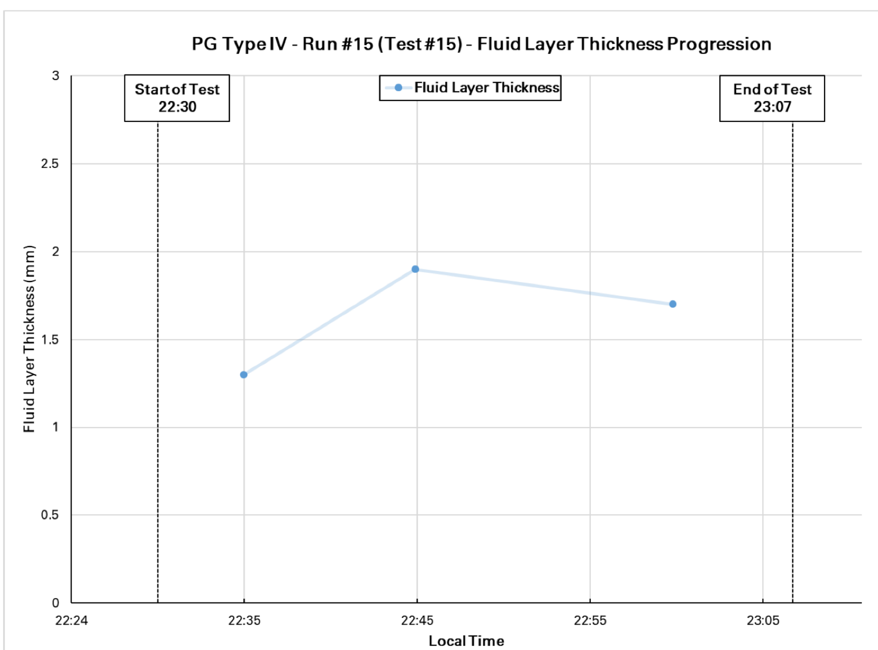
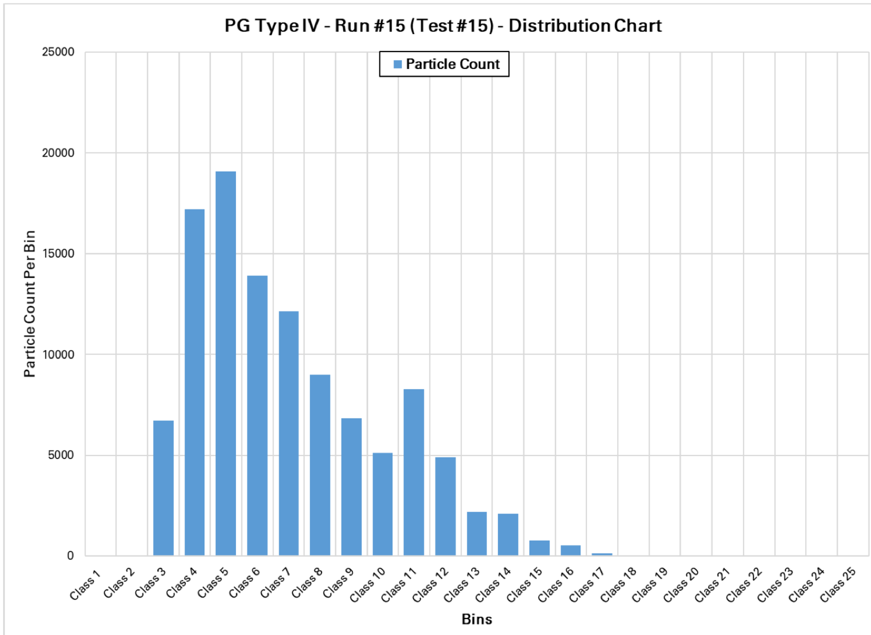
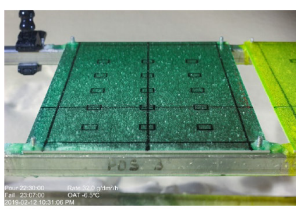
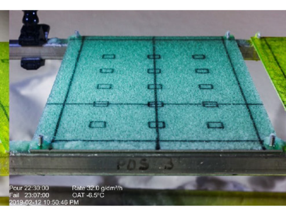

PG Type IV - Run #15 (Test #15) - Barometric Pressure
Start of Test 22:30
WS600 Sensor Barometric Pressure
End of Test 23:07
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
22:24
22:35
22:45
22:55
23:05
Local Time

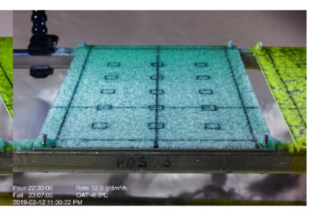

PG Type IV - Run #15 (Test #15) - Fluid Layer Thickness Progression
Start of Test 22:30
Fluid Layer Thickness
End of Test 23:07
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
22:24
22:35
22:45
22:55
23:05
Local Time

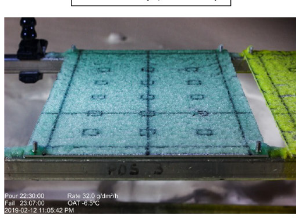


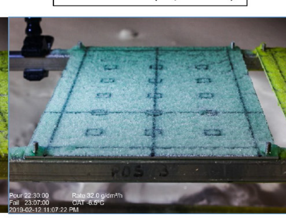
Polar Guard Advance – Run 15 (Test 15) – Failure Progression Photos


AT POUR (1/37 MIN)


PRE-FAILURE (20/37 MIN)

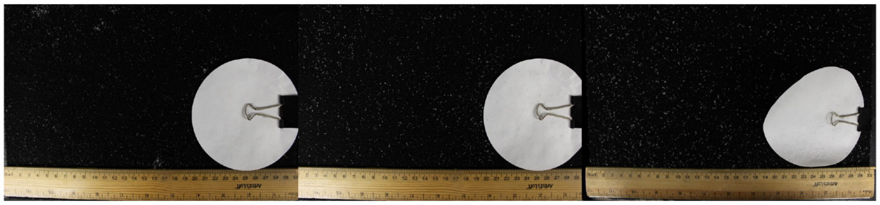

PRE-FAILURE (30/37 MIN)


PRE-FAILURE (35/37 MIN)

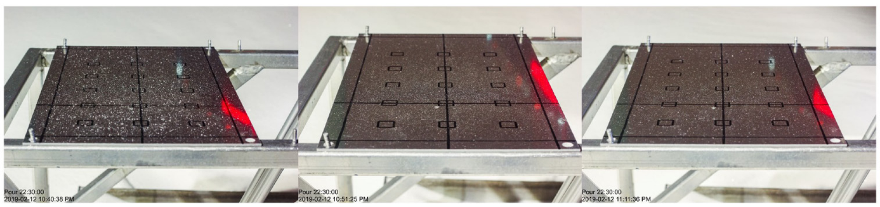

AT FAILURE (37/37 MIN)


POST-FAILURE (41/37 MIN)

Polar Guard Advance – Run 15 (Test 15) – Snow Characteristics Photos



FELT PAD (0/37 MIN) FELT PAD (20/37 MIN) FELT PAD (40/37 MIN)



BARE PLATE (10/37 MIN) BARE PLATE (21/37 MIN) BARE PLATE (41/37 MIN)

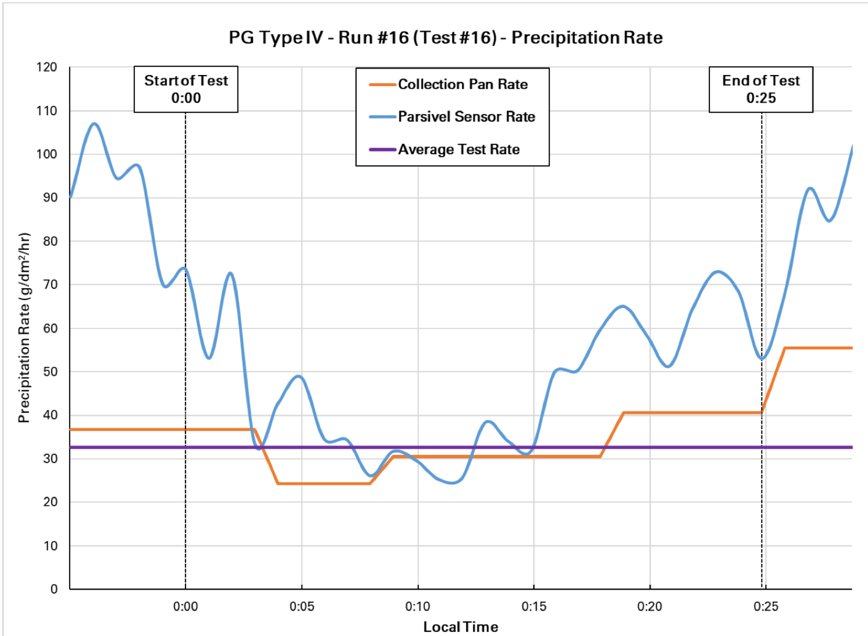
Final Bare Plate Contamination Thickness: **Not taken**

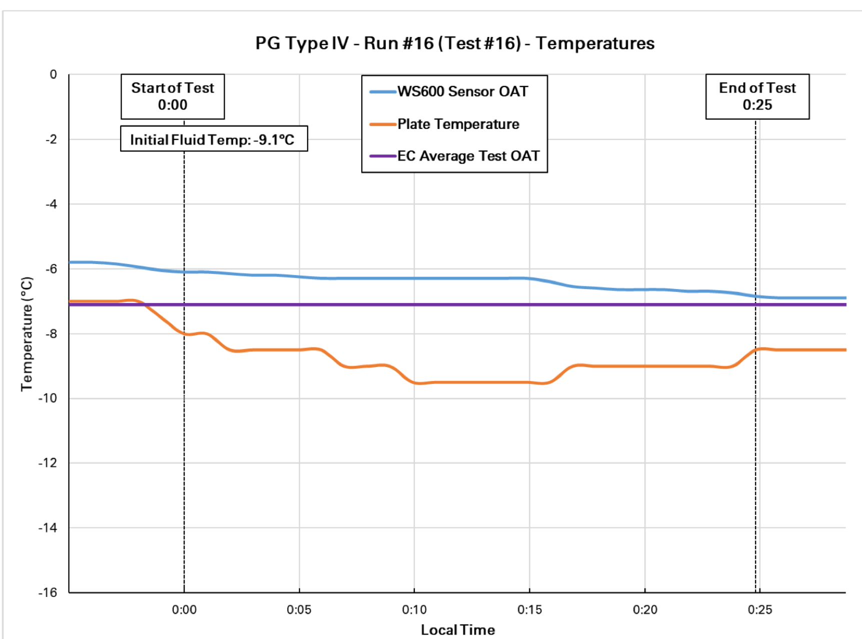
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

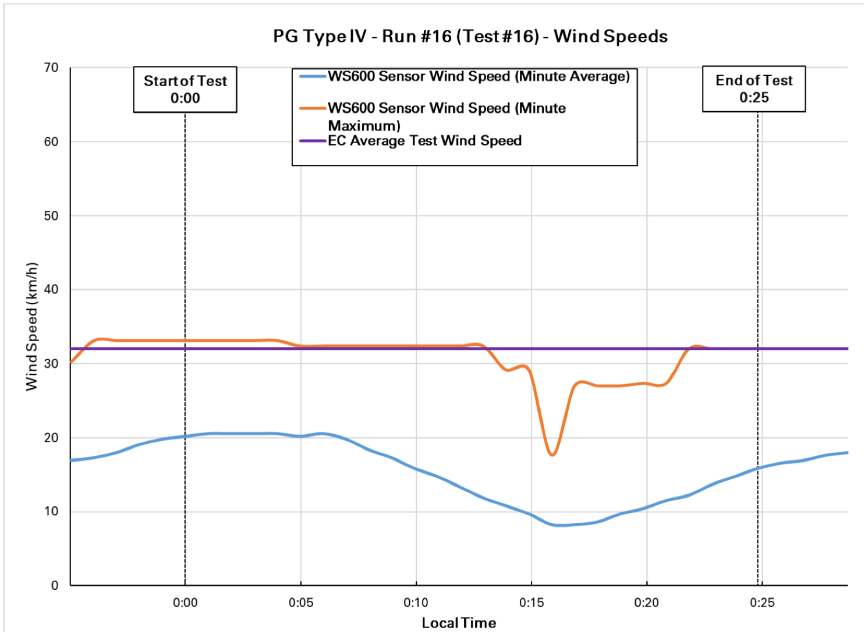
PG TYPE IV
RUN #16 (TEST #16) – PG4-16

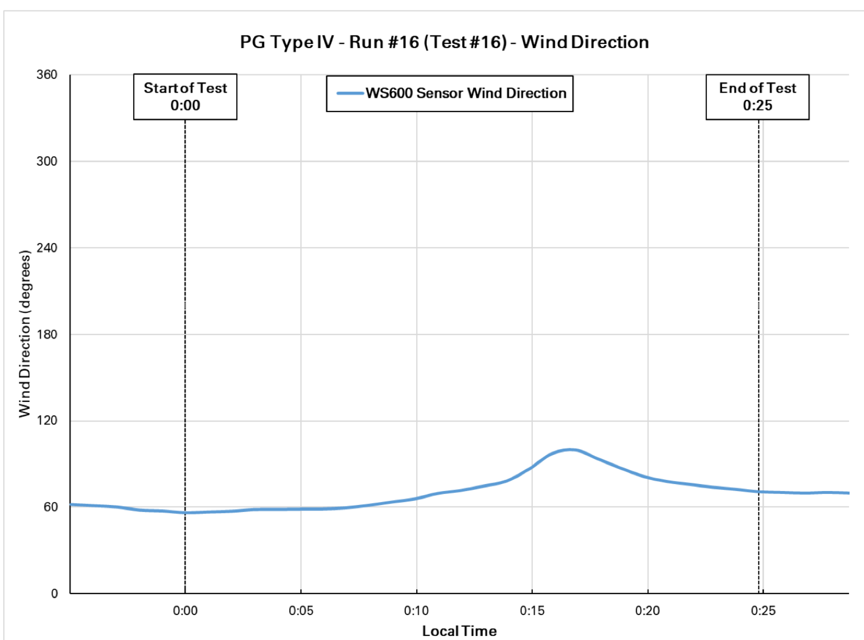
PG Type IV – Run #16 (Test #16) – General Test Information

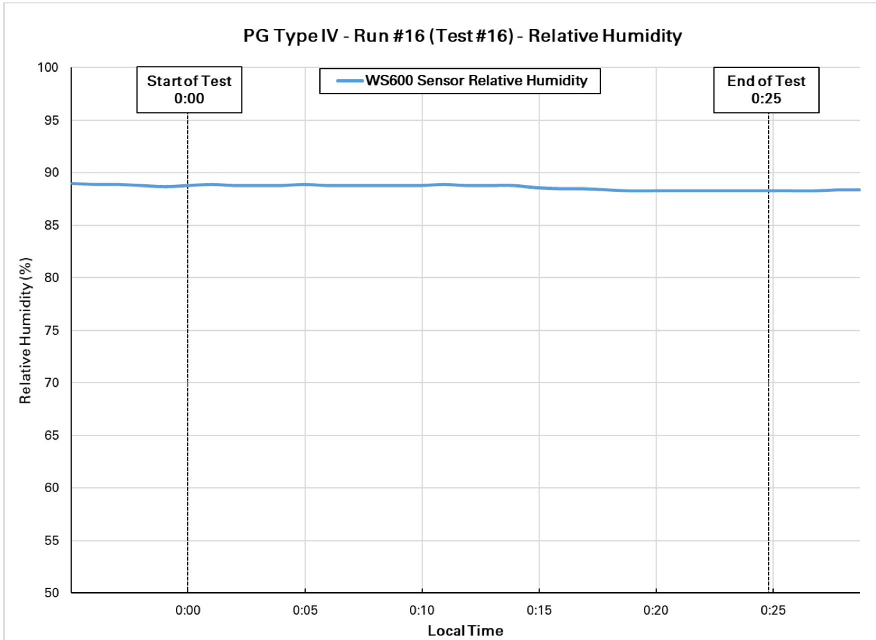
Test Number:	**PG4-16**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.1**
Average Precipitation Rate:	**32.6 g/dm²/h**
Average Wind Speed:	**32.0 km/h**
Average Relative Humidity:	**88.63%**
Pour Time (Local):	**0:00:00**
Time of Fluid Failure (Local):	**0:25:00**
Fluid Brix at Failure:	**16°**
Endurance Time:	**25 minutes**
Expected Regression-Derived Endurance Time:	**26.9 minutes**
Difference (ET vs. Reg ET):	**-2.4 minutes (-8.9%)**

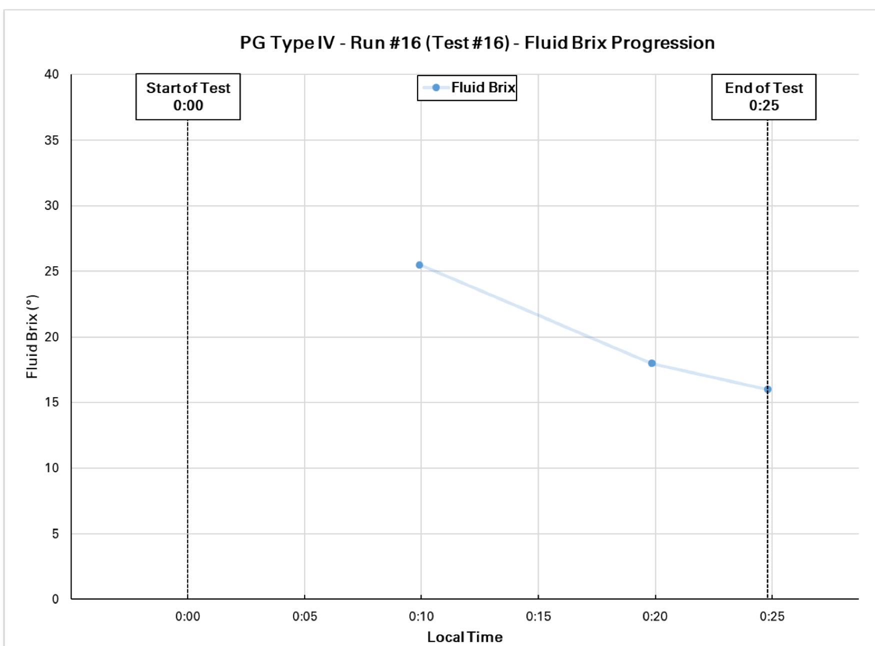

PG Type IV - Run #16 (Test #16) - Precipitation Rate
Start of Test 0:00
End of Test 0:25
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
Local Time
0:00
0:05
0:10
0:15
0:20
0:25

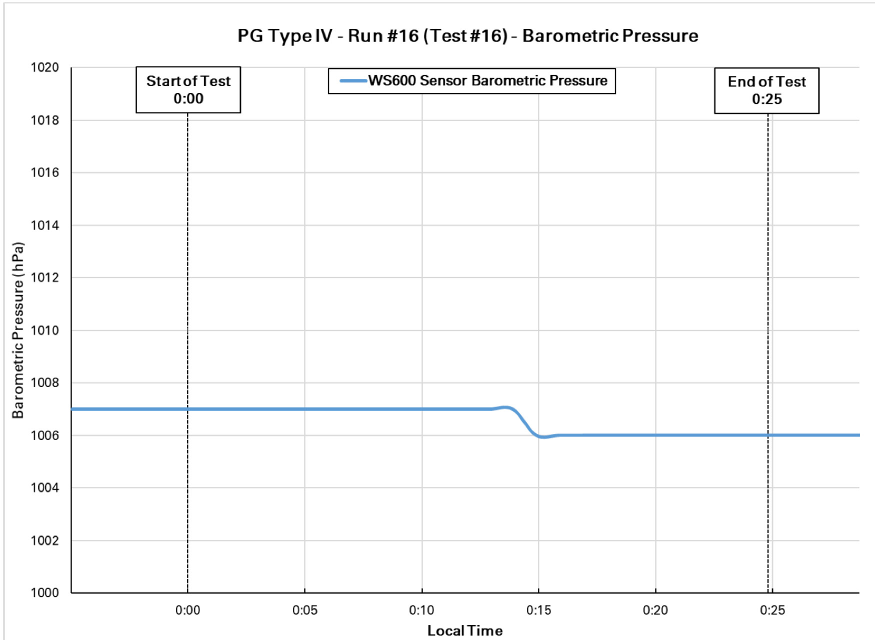

PG Type IV - Run #16 (Test #16) - Temperatures
Start of Test 0:00
Initial Fluid Temp: -9.1°C
End of Test 0:25
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
Local Time
0:00
0:05
0:10
0:15
0:20
0:25

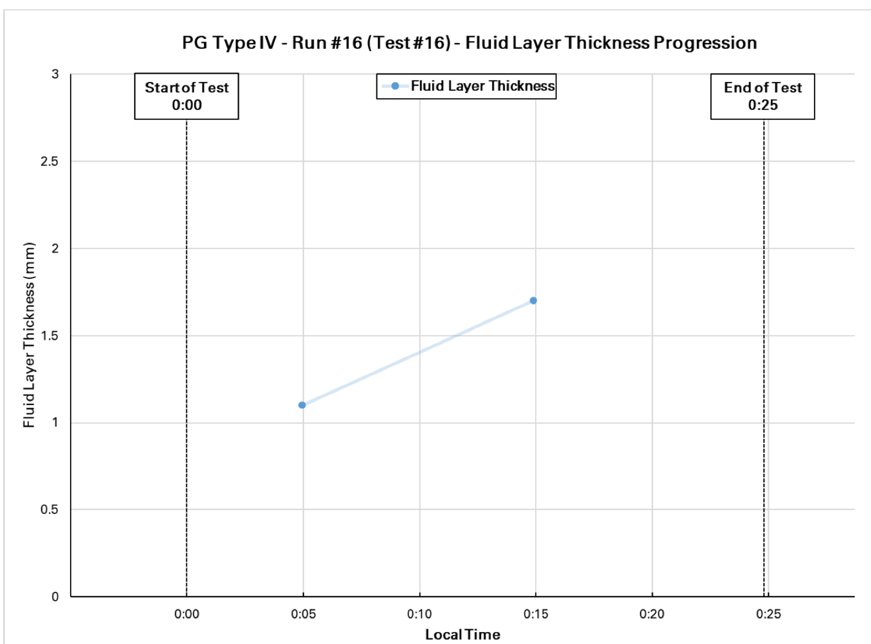

PG Type IV - Run #16 (Test #16) - Wind Speeds
Start of Test
0:00
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
End of Test
0:25
Wind Speed (km/h)
70
60
50
40
30
20
10
0
0:00
0:05
0:10
0:15
0:20
0:25
Local Time

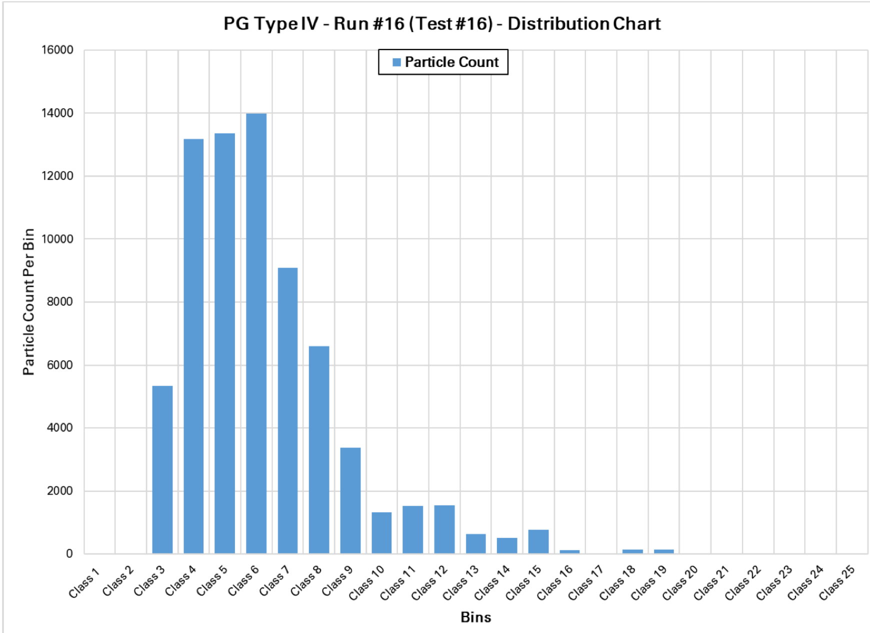

PG Type IV - Run #16 (Test #16) - Wind Direction
Start of Test
0:00
WS600 Sensor Wind Direction
End of Test
0:25
Wind Direction (degrees)
360
300
240
180
120
60
0
0:00
0:05
0:10
0:15
0:20
0:25
Local Time


PG Type IV - Run #16 (Test #16) - Relative Humidity
Start of Test 0:00
WS600 Sensor Relative Humidity
End of Test 0:25
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
0:00
0:05
0:10
0:15
0:20
0:25
Local Time

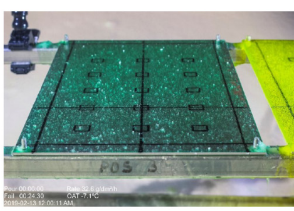

PG Type IV - Run #16 (Test #16) - Fluid Brix Progression
Start of Test 0:00
Fluid Brix
End of Test 0:25
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
0:00
0:05
0:10
0:15
0:20
0:25
Local Time


PG Type IV - Run #16 (Test #16) - Barometric Pressure
Start of Test 0:00
WS600 Sensor Barometric Pressure
End of Test 0:25
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
0:00
0:05
0:10
0:15
0:20
0:25
Local Time

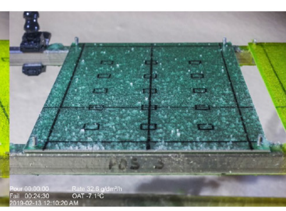

PG Type IV - Run #16 (Test #16) - Fluid Layer Thickness Progression
Start of Test 0:00
Fluid Layer Thickness
End of Test 0:25
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
0:00
0:05
0:10
0:15
0:20
0:25
Local Time



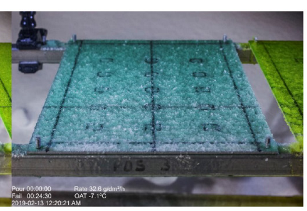
Polar Guard Advance – Run 16 (Test 16) – Failure Progression Photos



AT POUR (0/24 MIN)

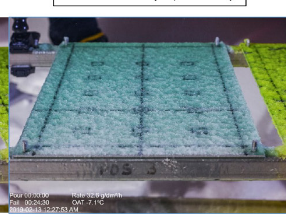


PRE-FAILURE (10/24 MIN)

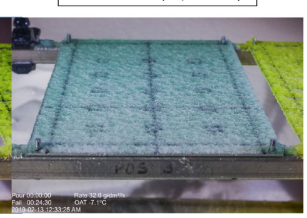


PRE-FAILURE (20/24 MIN)

AT FAILURE (24/24 MIN)



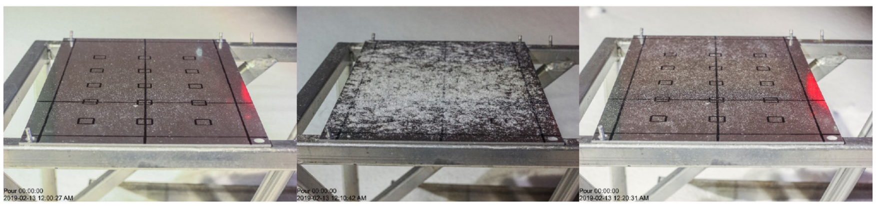
POST-FAILURE (27/24 MIN)



POST-FAILURE (33/24 MIN)

Polar Guard Advance – Run 16 (Test 16) – Snow Characteristics Photos

FELT PAD (0/24 MIN) | FELT PAD (10/24 MIN) | FELT PAD (19/24 MIN)



BARE PLATE (0/24 MIN) | BARE PLATE (10/24 MIN) | BARE PLATE (20/24 MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

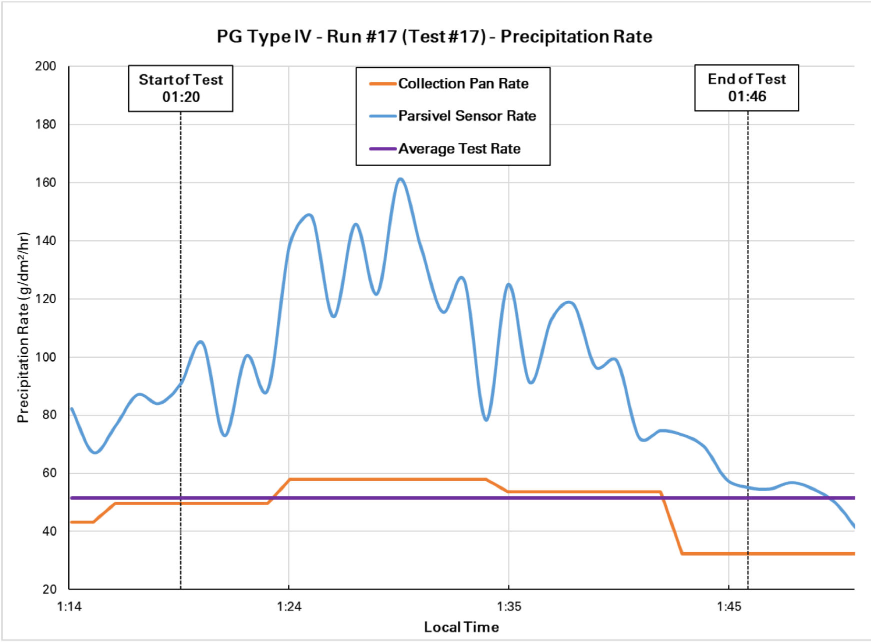
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #17 (TEST #17) – PG4-17

PG Type IV – Run #17 (Test #17) – General Test Information

Test Number:	**PG4-17**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.3**
Average Precipitation Rate:	**51.4 g/dm²/h**
Average Wind Speed:	**30.1 km/h**
Average Relative Humidity:	**88.82%**
Pour Time (Local):	**01:20:00**
Time of Fluid Failure (Local):	**01:46:00**
Fluid Brix at Failure:	**14.25°**
Endurance Time:	**26 minutes**
Expected Regression-Derived Endurance Time:	**18.3 minutes**
Difference (ET vs. Reg ET):	**+7.8 minutes (+42.9%)**

DATA PACKAGE – PG TYPE IV – RUN 17 (TEST 17)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 17 - Test 17/Data Package - PG Type IV - Run 17 - Test 17.docx
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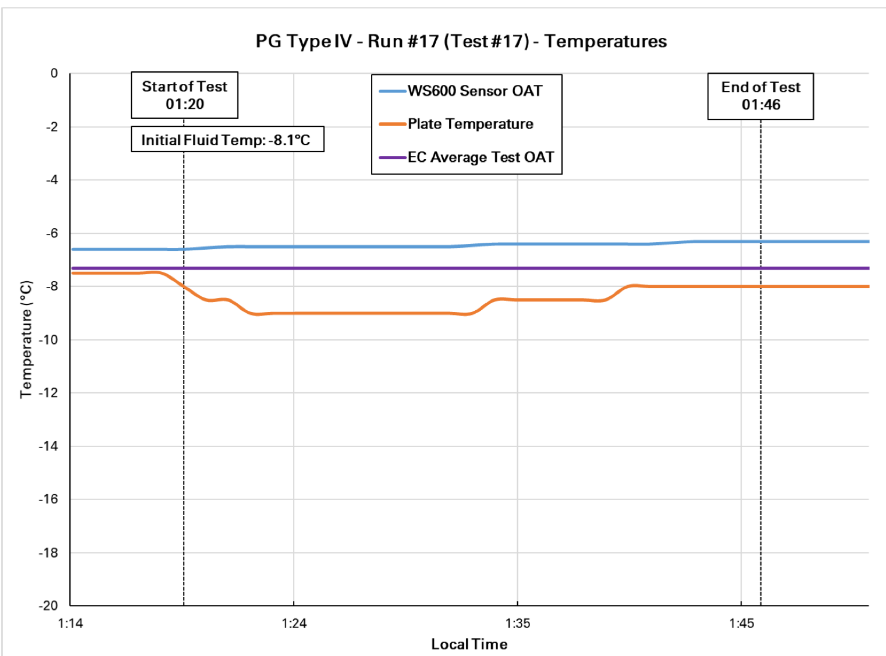
DATA PACKAGE – PG TYPE IV – RUN 17 (TEST 17)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 17 - Test 17/Data Package - PG Type IV - Run 17 - Test 17.docx
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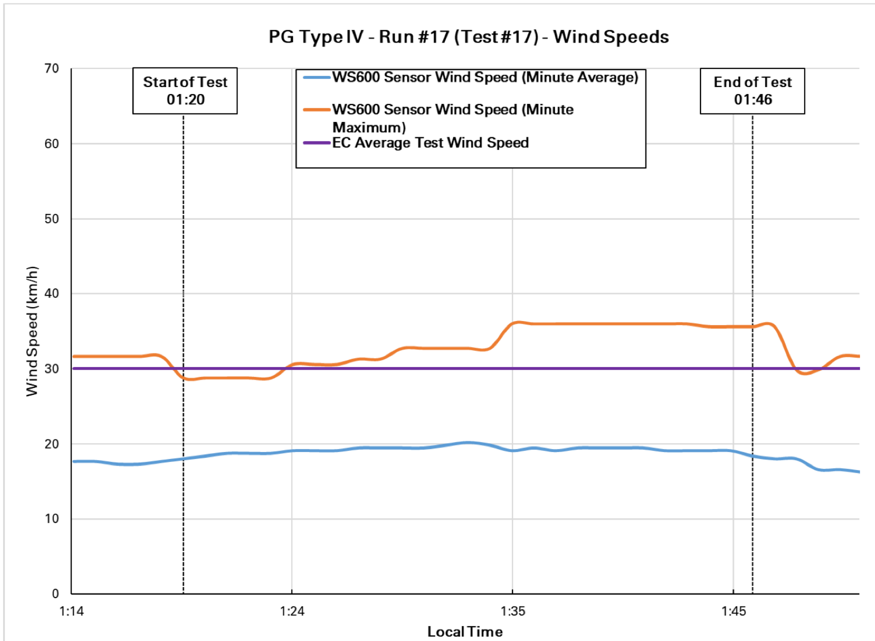
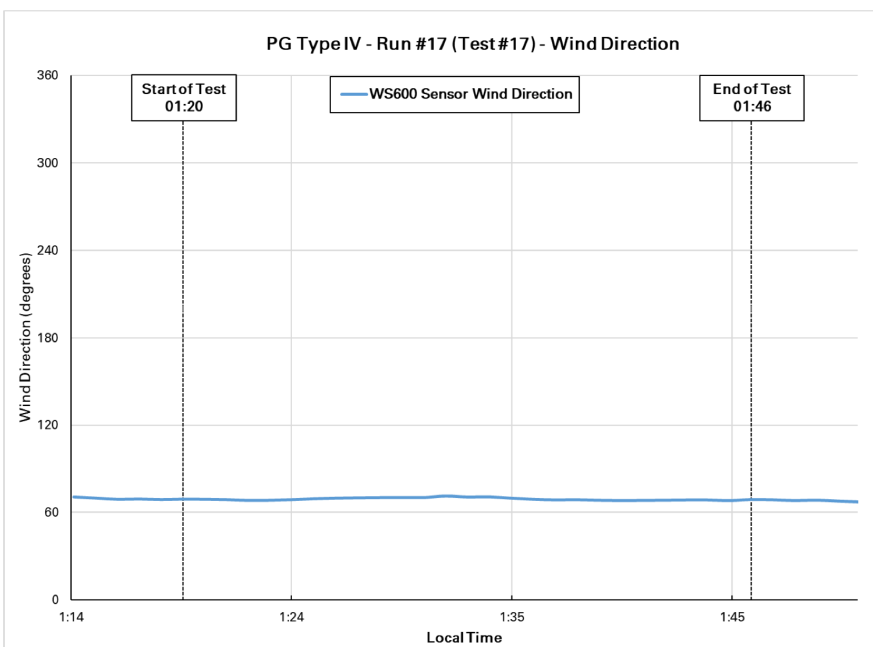
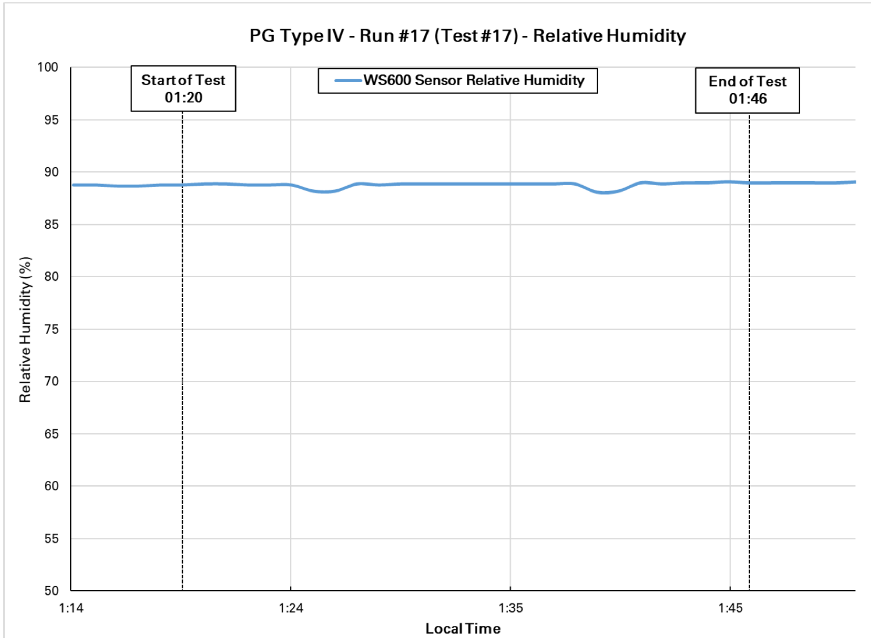
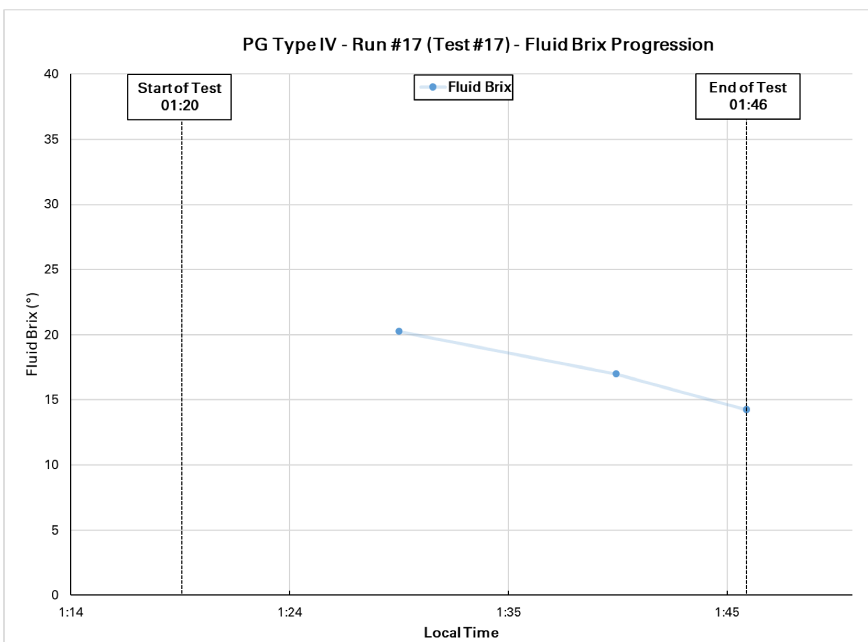
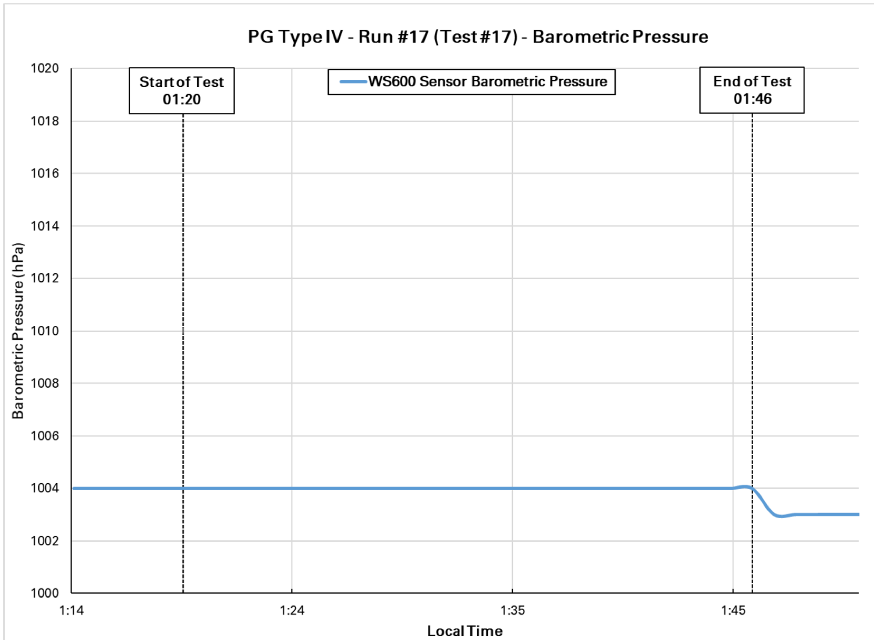

PG Type IV - Run #17 (Test #17) - Wind Speeds
Start of Test 01:20
End of Test 01:46
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
1:14
1:24
1:35
1:45
Local Time

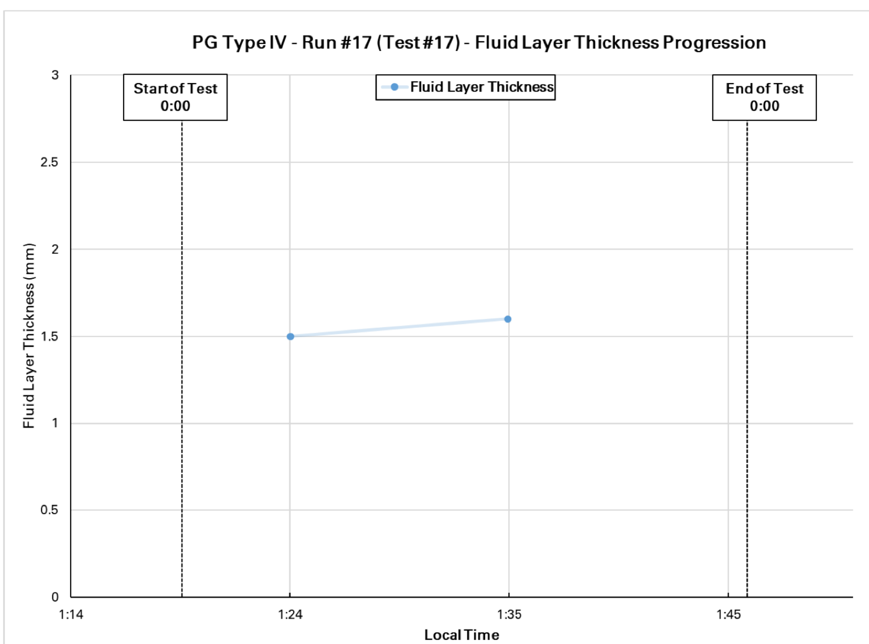

PG Type IV - Run #17 (Test #17) - Wind Direction
Start of Test 01:20
End of Test 01:46
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
1:14
1:24
1:35
1:45
Local Time

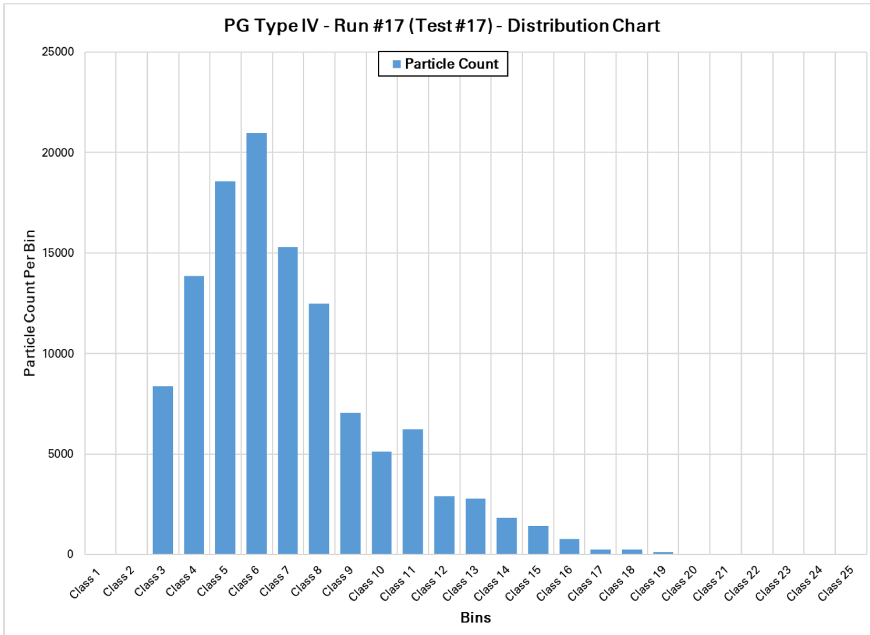


DATA PACKAGE – PG TYPE IV – RUN 17 (TEST 17)



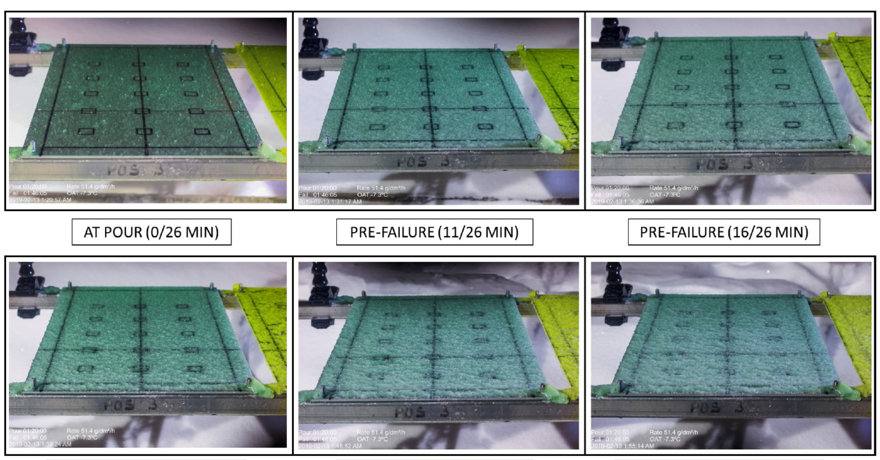

PG Type IV - Run #17 (Test #17) - Barometric Pressure
Start of Test 01:20
WS600 Sensor Barometric Pressure
End of Test 01:46
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
1:14
1:24
1:35
1:45
Local Time


PG Type IV - Run #17 (Test #17) - Fluid Layer Thickness Progression
Start of Test 0:00
Fluid Layer Thickness
End of Test 0:00
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
1:14
1:24
1:35
1:45
Local Time



DATA PACKAGE – PG TYPE IV – RUN 17 (TEST 17)

Polar Guard Advance – Run 17 (Test 17) – Failure Progression Photos



AT POUR (0/26 MIN) | PRE-FAILURE (11/26 MIN) | PRE-FAILURE (16/26 MIN)

PRE-FAILURE (19/26 MIN) | AT FAILURE (26/26 MIN) | POST-FAILURE (35/26 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 17 - Test 17/Data Package - PG Type IV - Run 17 - Test 17.docx
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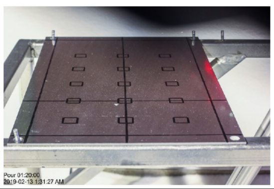
Polar Guard Advance – Run 17 (Test 17) – Snow Characteristics Photos

Felt Pad Photos Unavailable	Felt Pad Photos Unavailable	Felt Pad Photos Unavailable
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
	Bare Plate Photos Unavailable	Bare Plate Photos Unavailable
BARE PLATE (10/26 MIN)	BARE PLATE XX/XX MIN)	BARE PLATE (XX/XX MIN)

Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

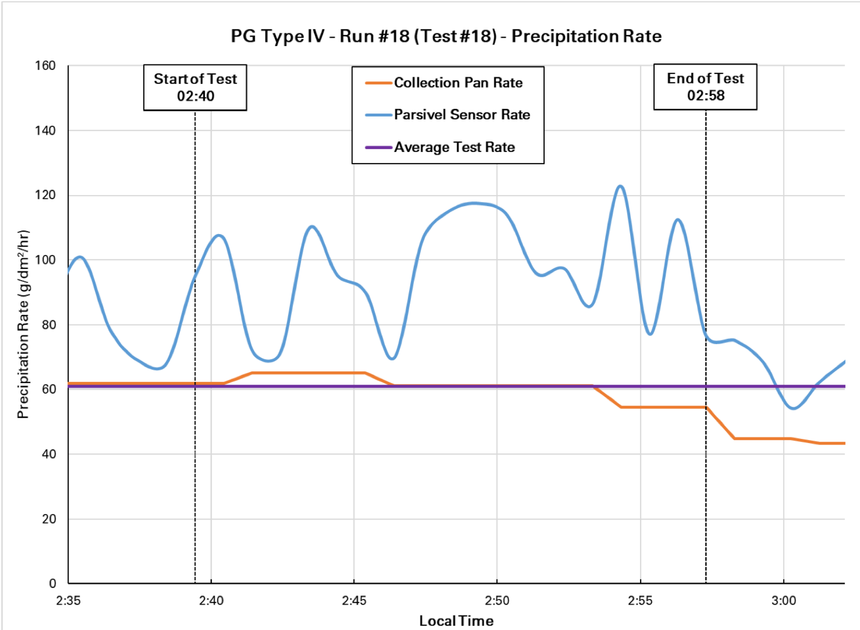
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #18 (TEST #18) – PG4-18

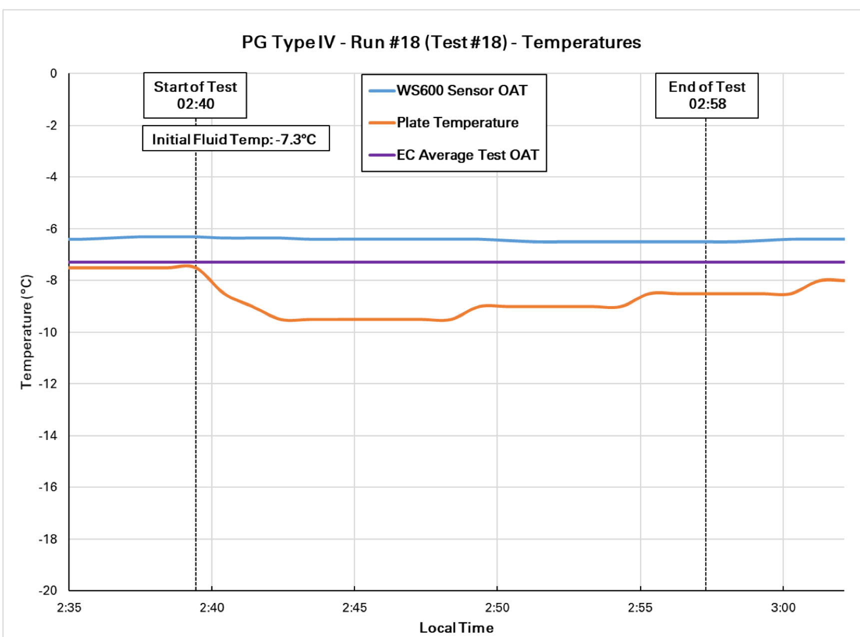
DATA PACKAGE – PG TYPE IV – RUN 18 (TEST 18)

PG Type IV – Run #18 (Test #18) – General Test Information

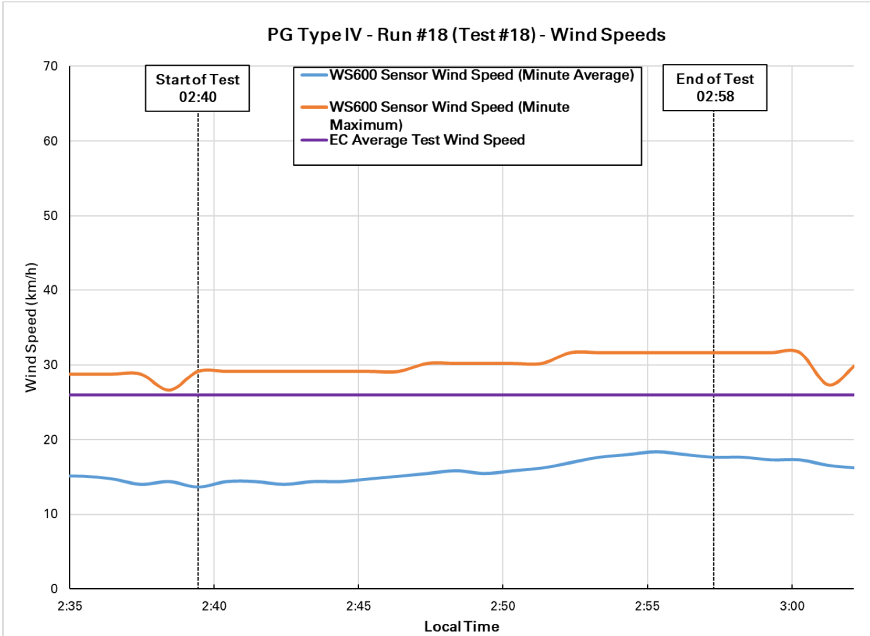
Test Number:	PG4-18
Date of Test:	February 13, 2019
Average OAT:	-7.3
Average Precipitation Rate:	60.9 g/dm²/h
Average Wind Speed:	26.0 km/h
Average Relative Humidity:	89.05%
Pour Time (Local):	02:40:00
Time of Fluid Failure (Local):	02:58:00
Fluid Brix at Failure:	16.25°
Endurance Time:	18 minutes
Expected Regression-Derived Endurance Time:	15.9 minutes
Difference (ET vs. Reg ET):	+2.1 minutes (+13.1%)

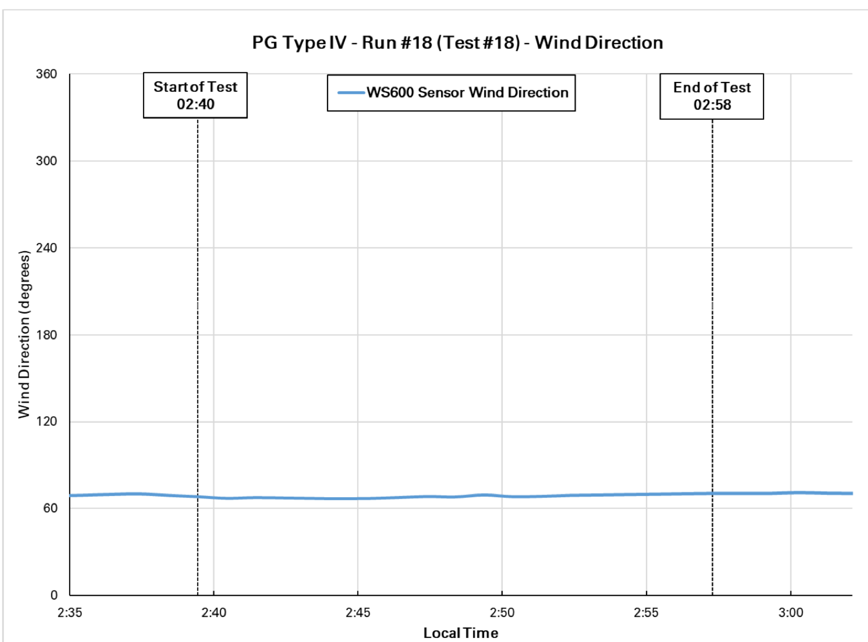


PG Type IV - Run #18 (Test #18) - Precipitation Rate
Start of Test 02:40
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 02:58
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
120
140
160
2:35
2:40
2:45
2:50
2:55
3:00
Local Time

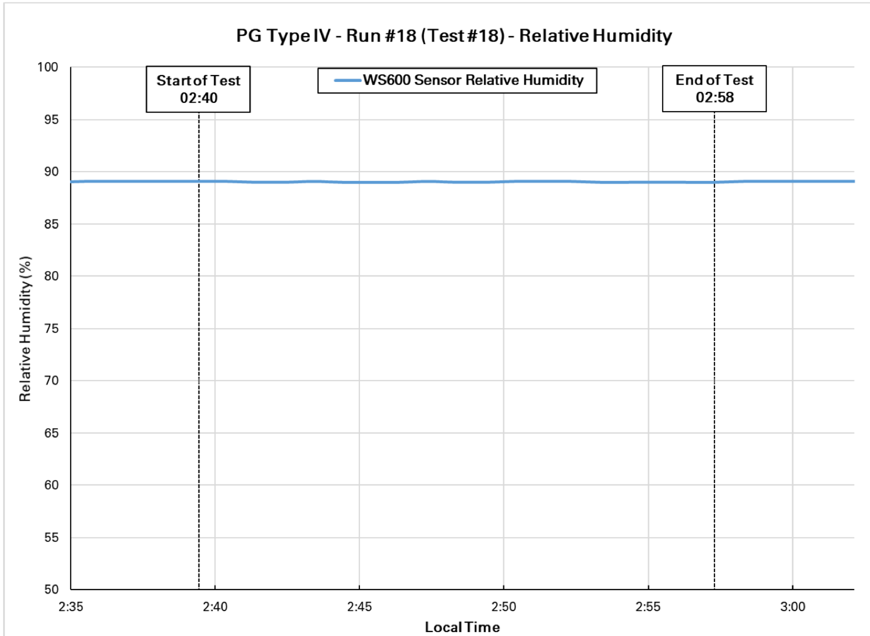


PG Type IV - Run #18 (Test #18) - Temperatures
Start of Test 02:40
Initial Fluid Temp: -7.3°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 02:58
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
2:35
2:40
2:45
2:50
2:55
3:00
Local Time


PG Type IV - Run #18 (Test #18) - Wind Speeds
Start of Test 02:40
End of Test 02:58
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
2:35
2:40
2:45
2:50
2:55
3:00
Local Time


PG Type IV - Run #18 (Test #18) - Wind Direction
Start of Test 02:40
WS600 Sensor Wind Direction
End of Test 02:58
Wind Direction (degrees)
0
60
120
180
240
300
360
2:35
2:40
2:45
2:50
2:55
3:00
Local Time

DATA PACKAGE – PG TYPE IV – RUN 18 (TEST 18)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 18 - Test 18/Data Package - PG Type IV - Run 18 - Test 18.docx
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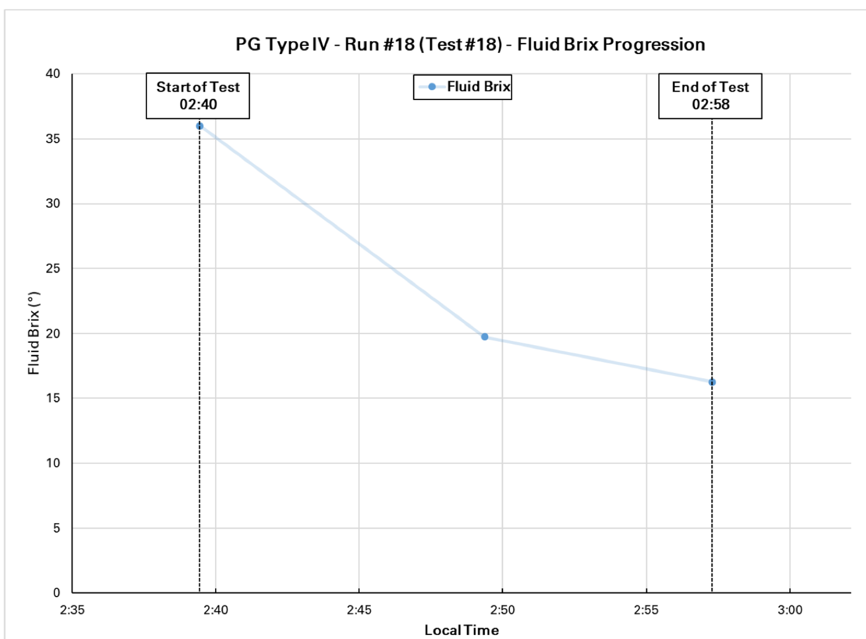
DATA PACKAGE – PG TYPE IV – RUN 18 (TEST 18)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 18 - Test 18/Data Package - PG Type IV - Run 18 - Test 18.docx
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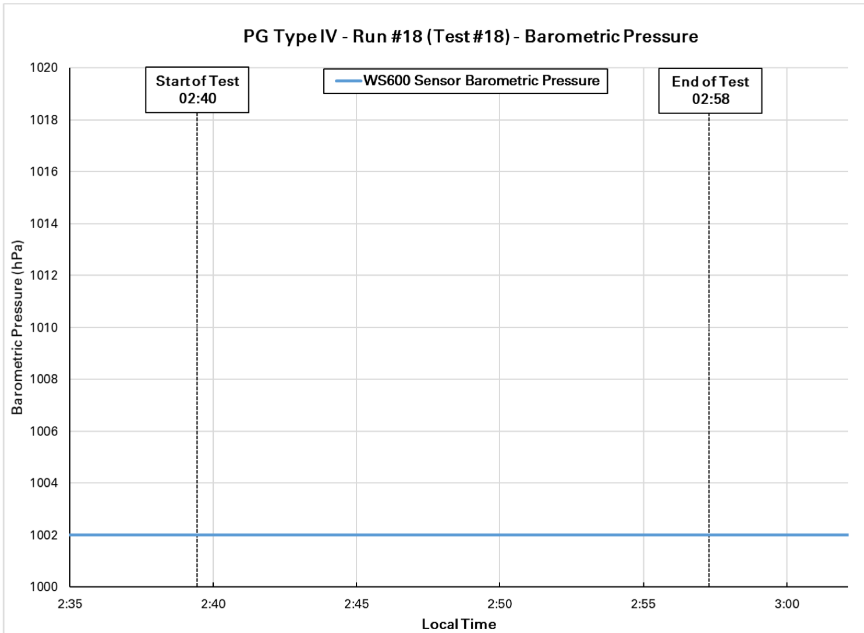
DATA PACKAGE – PG TYPE IV – RUN 18 (TEST 18)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 18 - Test 18/Data Package - PG Type IV - Run 18 - Test 18.docx
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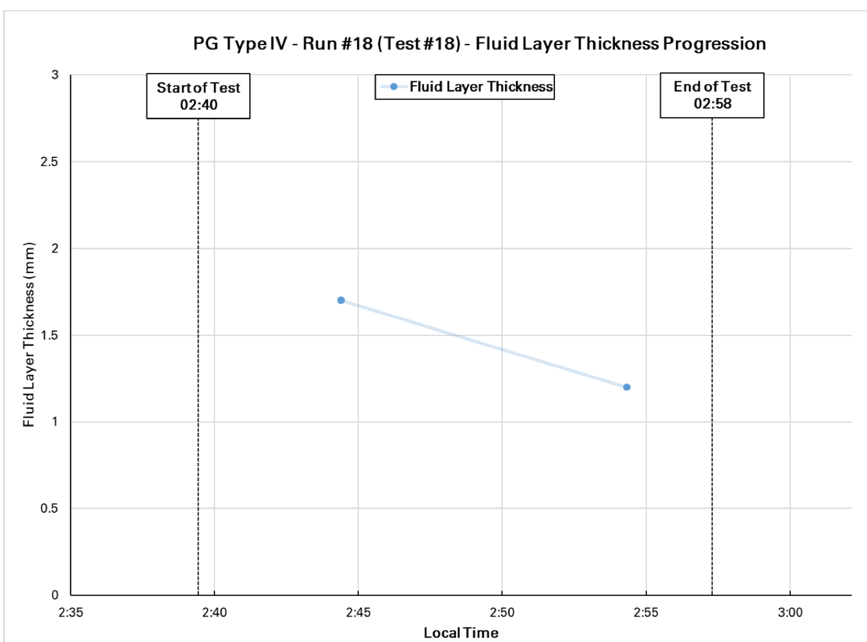
DATA PACKAGE – PG TYPE IV – RUN 18 (TEST 18)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 18 - Test 18/Data Package - PG Type IV - Run 18 - Test 18.docx
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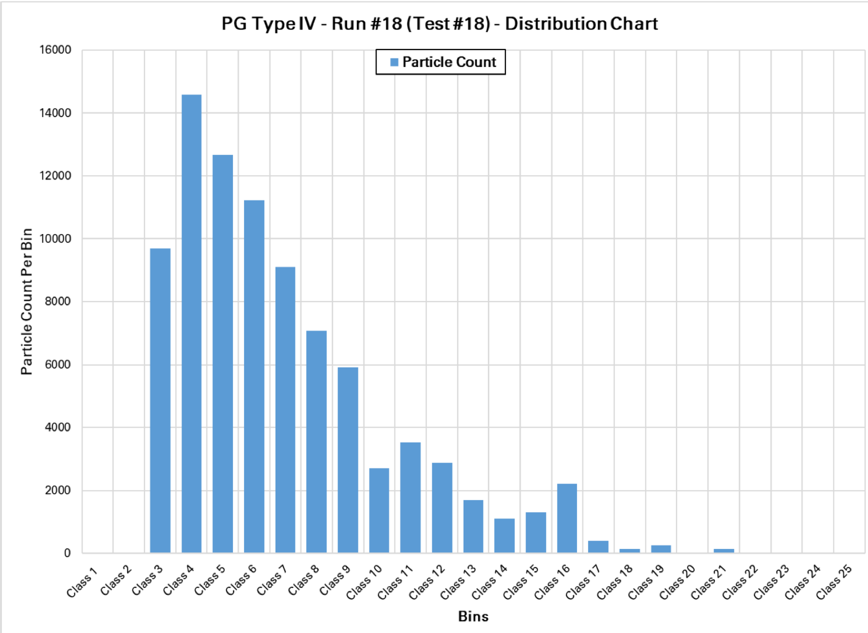
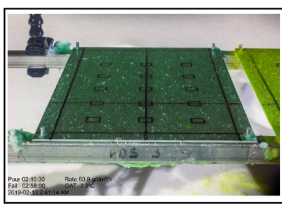
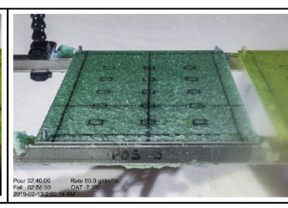


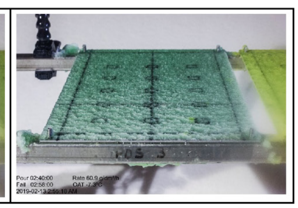
Polar Guard Advance – Run 18 (Test 18) – Failure Progression Photos



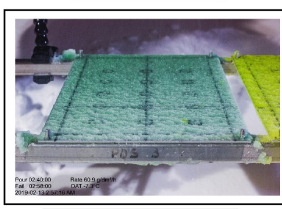
AT POUR (0/18 MIN)



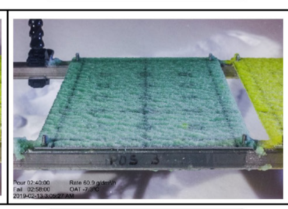
PRE-FAILURE (10/18 MIN)



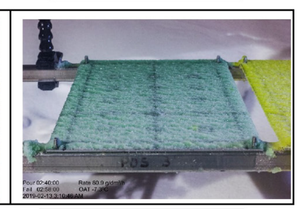
PRE-FAILURE (15/18 MIN)



AT FAILURE (17/18 MIN)

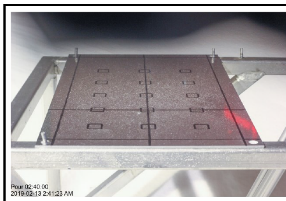
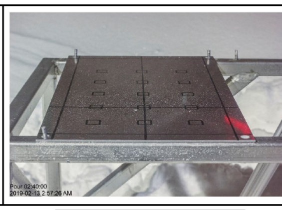
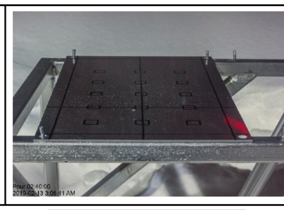


POST-FAILURE (25/18 MIN)



POST-FAILURE (30/18 MIN)

Polar Guard Advance – Run 18 (Test 18) – Snow Characteristics Photos

Felt Pad Photos Unavailable	Felt Pad Photos Unavailable	Felt Pad Photos Unavailable
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (1/18 MIN)	BARE PLATE 17/18 MIN)	BARE PLATE (25/18 MIN)

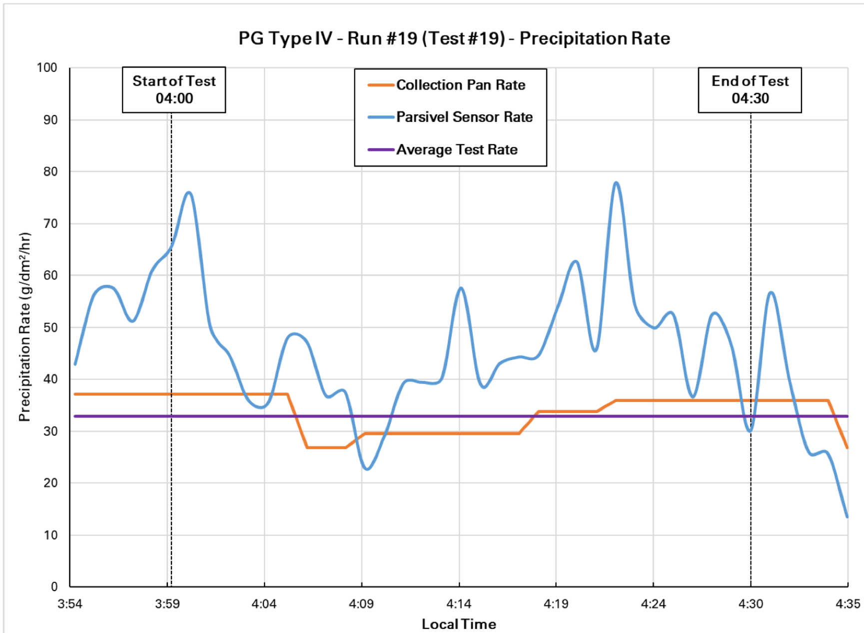
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

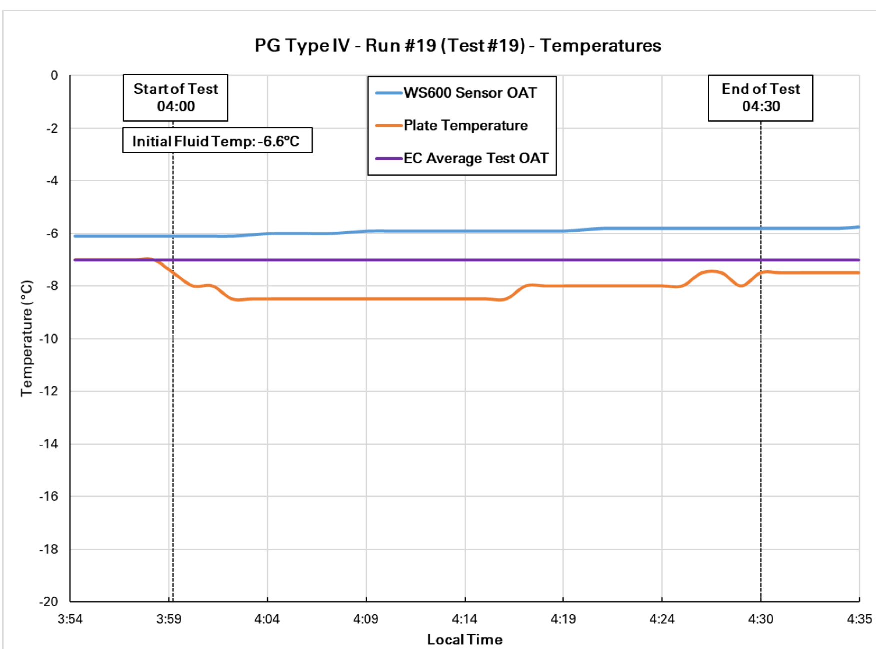
PG TYPE IV
RUN #19 (TEST #19) – PG4-19

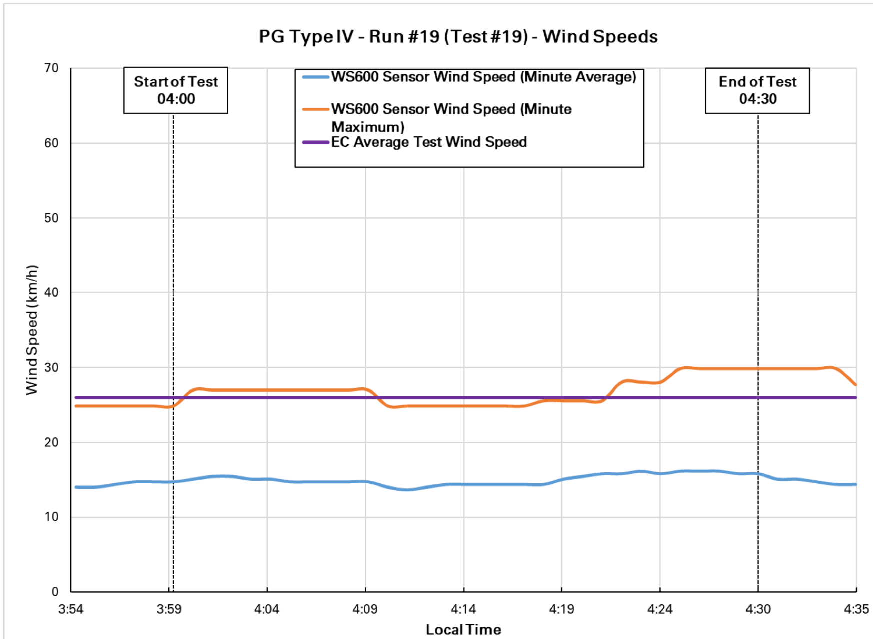
PG Type IV – Run #19 (Test #19) – General Test Information

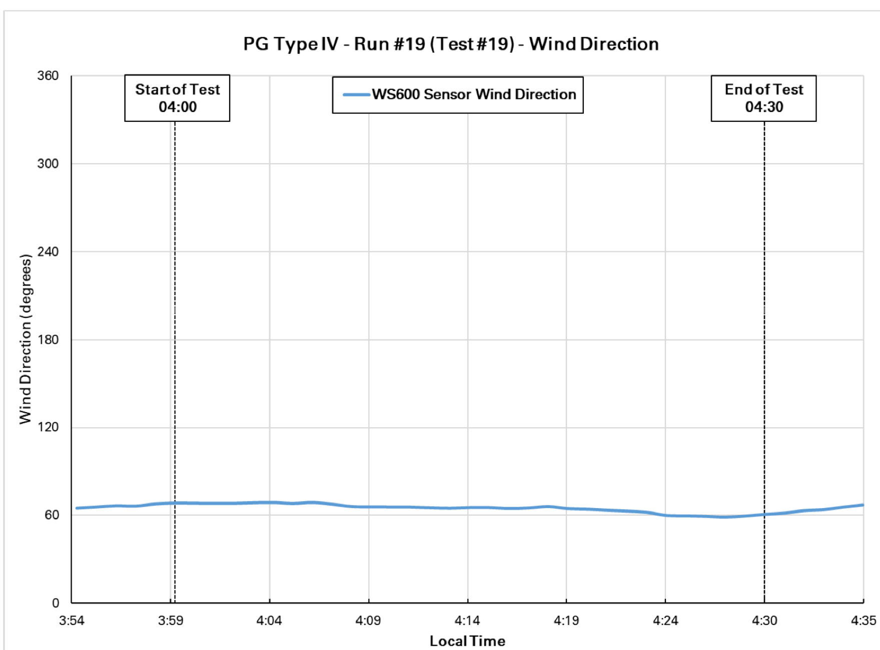
Test Number:	**PG4-19**
Date of Test:	**February 13, 2019**
Average OAT:	**-7.0**
Average Precipitation Rate:	**32.9 g/dm²/h**
Average Wind Speed:	**26.0 km/h**
Average Relative Humidity:	**89.51%**
Pour Time (Local):	**04:00:00**
Time of Fluid Failure (Local):	**04:30:00**
Fluid Brix at Failure:	**16.75°**
Endurance Time:	**30 minutes**
Expected Regression-Derived Endurance Time:	**26.9 minutes**
Difference (ET vs. Reg ET):	**+3.4 minutes (+12.5%)**

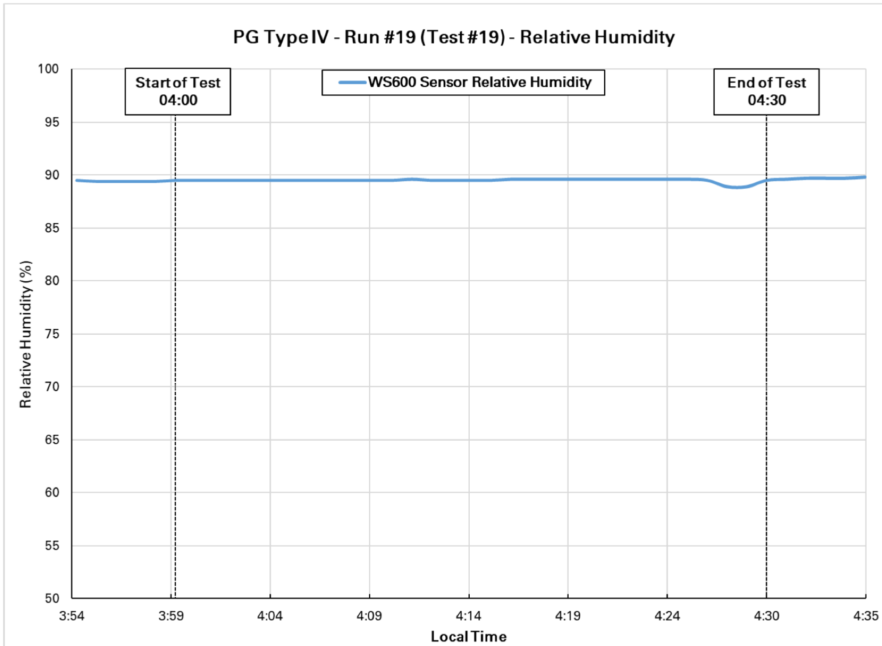


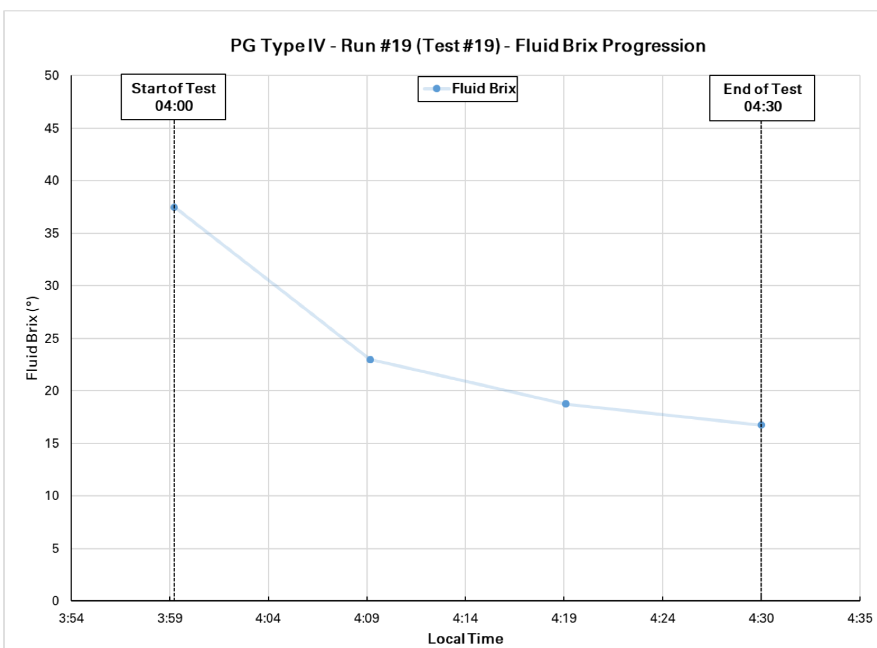
DATA PACKAGE – PG TYPE IV – RUN 19 (TEST 19)

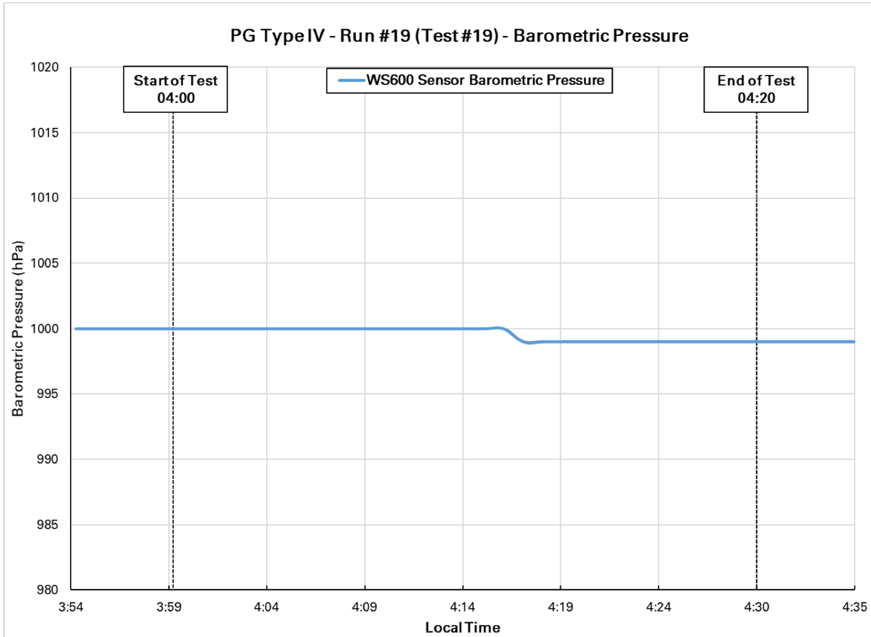


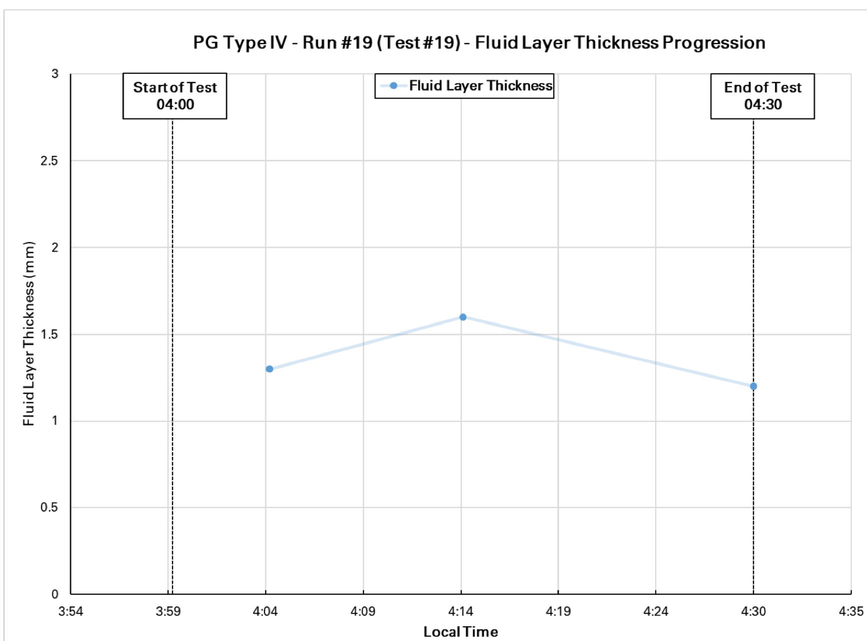

PG Type IV - Run #19 (Test #19) - Wind Speeds
Start of Test 04:00
End of Test 04:30
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
3:54
3:59
4:04
4:09
4:14
4:19
4:24
4:30
4:35
Local Time

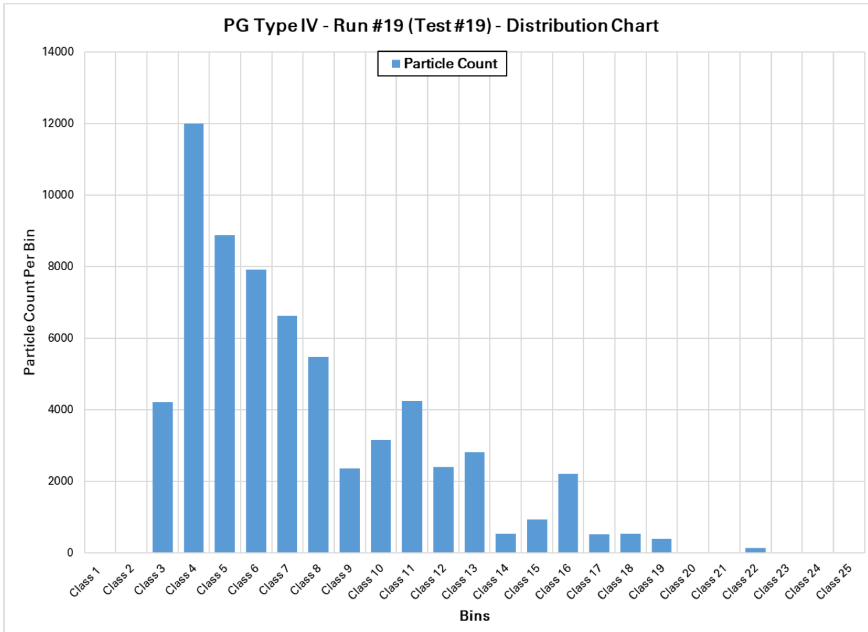

PG Type IV - Run #19 (Test #19) - Wind Direction
Start of Test 04:00
End of Test 04:30
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
3:54
3:59
4:04
4:09
4:14
4:19
4:24
4:30
4:35
Local Time


PG Type IV - Run #19 (Test #19) - Relative Humidity
Start of Test 04:00
WS600 Sensor Relative Humidity
End of Test 04:30
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:54
3:59
4:04
4:09
4:14
4:19
4:24
4:30
4:35
Local Time

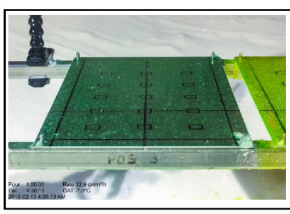

PG Type IV - Run #19 (Test #19) - Fluid Brix Progression
Start of Test 04:00
Fluid Brix
End of Test 04:30
Fluid Brix (°)
50
45
40
35
30
25
20
15
10
5
0
3:54
3:59
4:04
4:09
4:14
4:19
4:24
4:30
4:35
Local Time

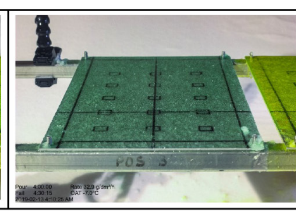

PG Type IV - Run #19 (Test #19) - Barometric Pressure
Start of Test 04:00
WS600 Sensor Barometric Pressure
End of Test 04:20
Barometric Pressure (hPa)
1020
1015
1010
1005
1000
995
990
985
980
3:54
3:59
4:04
4:09
4:14
4:19
4:24
4:30
4:35
Local Time

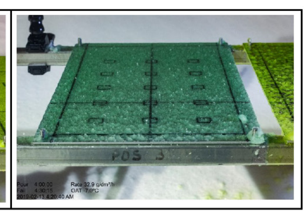

PG Type IV - Run #19 (Test #19) - Fluid Layer Thickness Progression
Start of Test 04:00
Fluid Layer Thickness
End of Test 04:30
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:54
3:59
4:04
4:09
4:14
4:19
4:24
4:30
4:35
Local Time

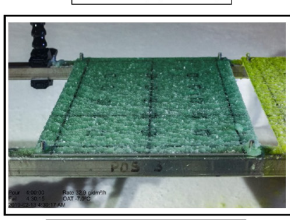


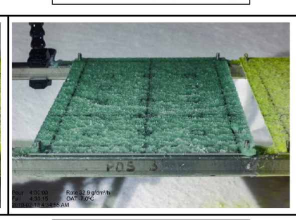
Polar Guard Advance – Run 19 (Test 19) – Failure Progression Photos

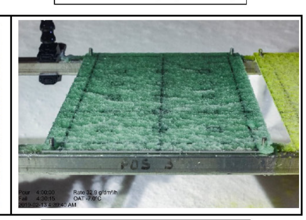

AT POUR (0/30 MIN)


PRE-FAILURE (10/30 MIN)

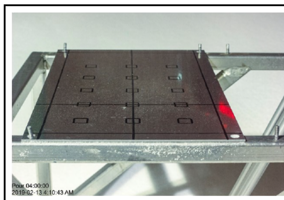
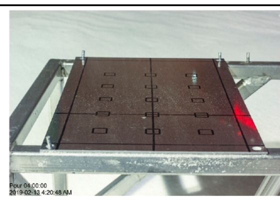
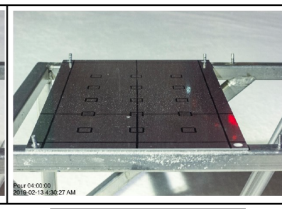

PRE-FAILURE (20/30 MIN)


AT FAILURE (30/30 MIN)


POST-FAILURE (34/30 MIN)


POST-FAILURE (39/30 MIN)

Polar Guard Advance – Run 19 (Test 19) – Snow Characteristics Photos

Felt Pad Photos Unavailable	Felt Pad Photos Unavailable	Felt Pad Photos Unavailable
FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (10/30 MIN)	BARE PLATE 20/30 MIN)	BARE PLATE (30/30 MIN)

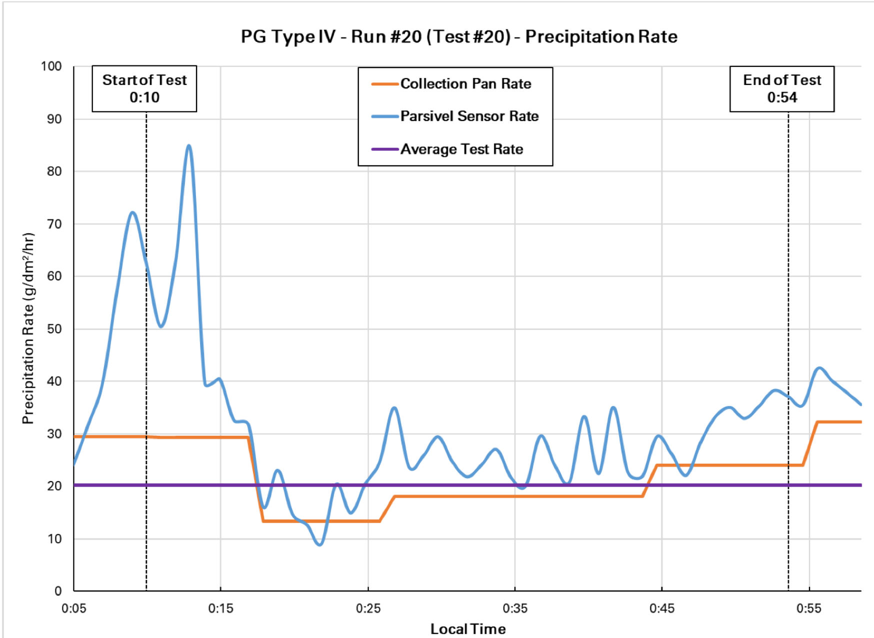
Final Bare Plate Contamination Thickness: **Nil (0.0mm)**

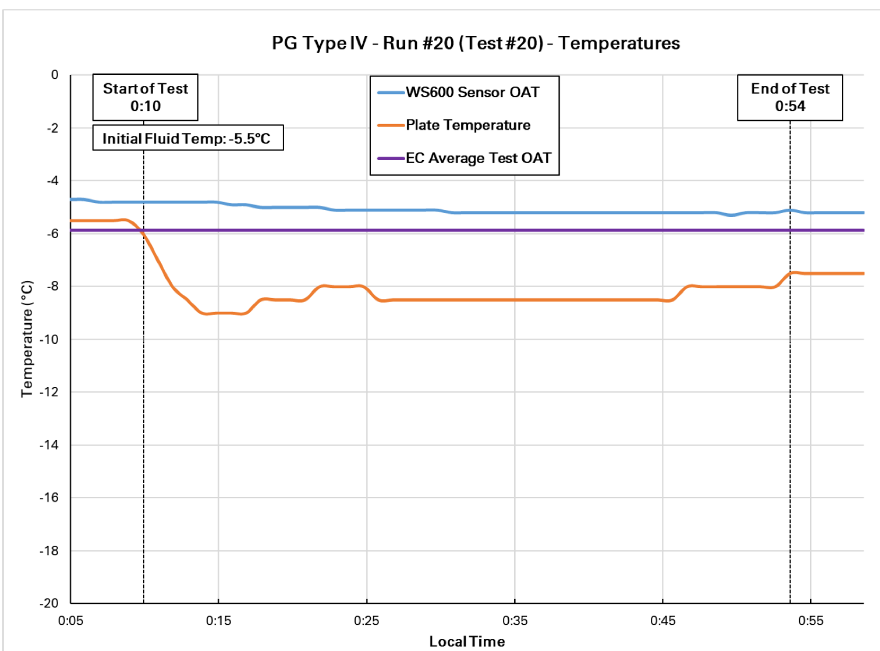
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

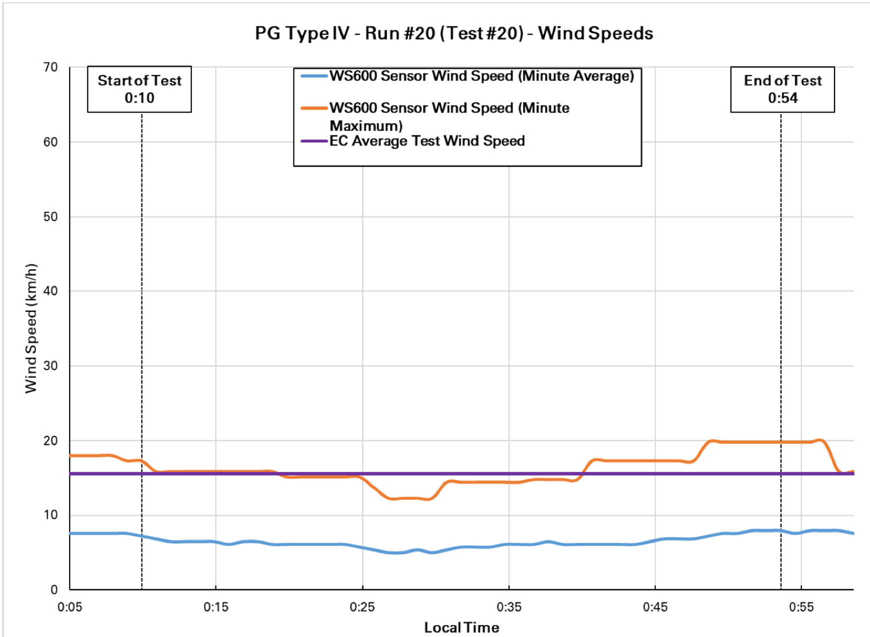
PG TYPE IV
RUN #20 (TEST #20) – PG4-20

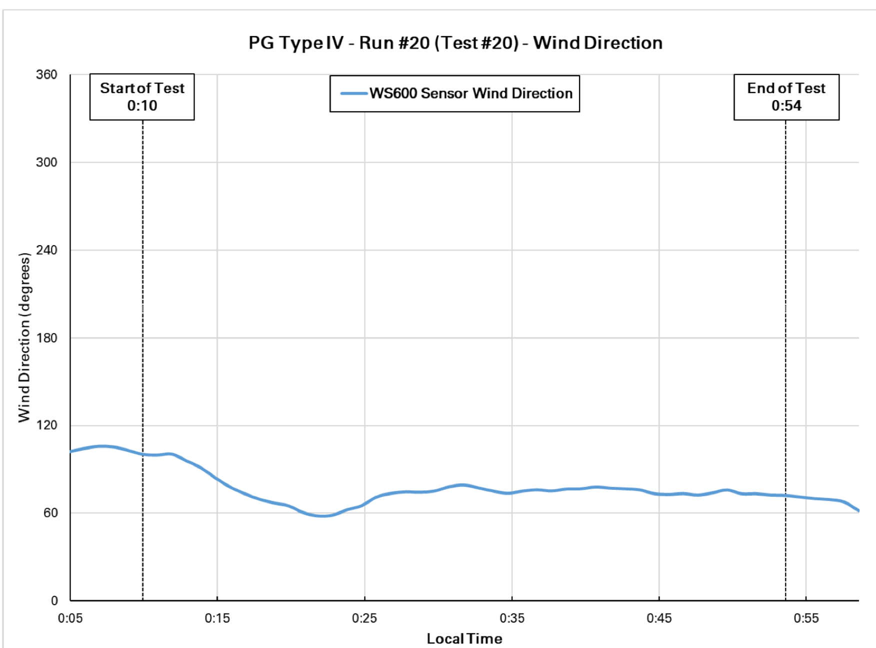
PG Type IV – Run #20 (Test #20) – General Test Information

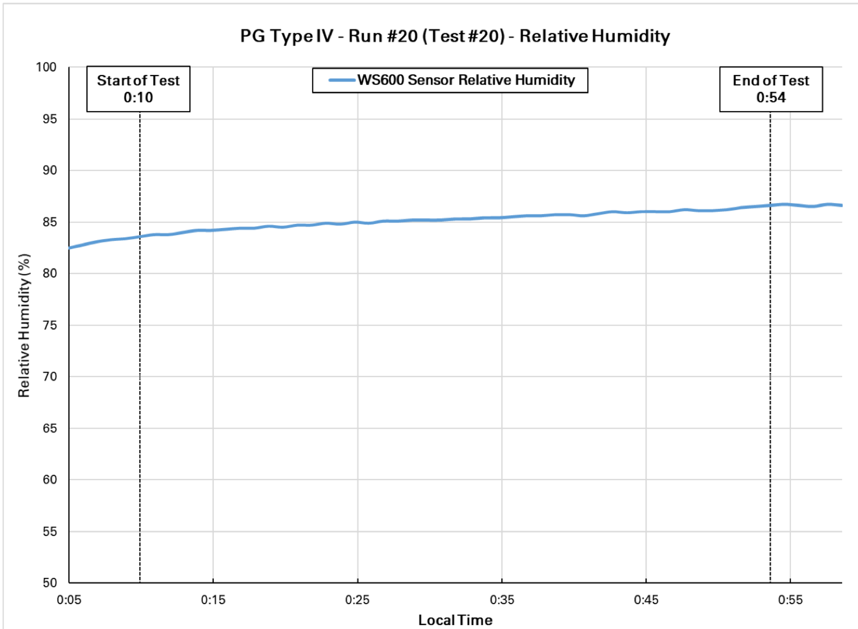
Test Number:	**PG4-20**
Date of Test:	**February 21, 2019**
Average OAT:	**-5.9**
Average Precipitation Rate:	**20.2 g/dm²/h**
Average Wind Speed:	**15.5 km/h**
Average Relative Humidity:	**85.15%**
Pour Time (Local):	**0:10:00**
Time of Fluid Failure (Local):	**0:54:00**
Fluid Brix at Failure:	**15.5°**
Endurance Time:	**44 minutes**
Expected Regression-Derived Endurance Time:	**43.3 minutes**
Difference (ET vs. Reg ET):	**+0.7 minutes (+1.7%)**

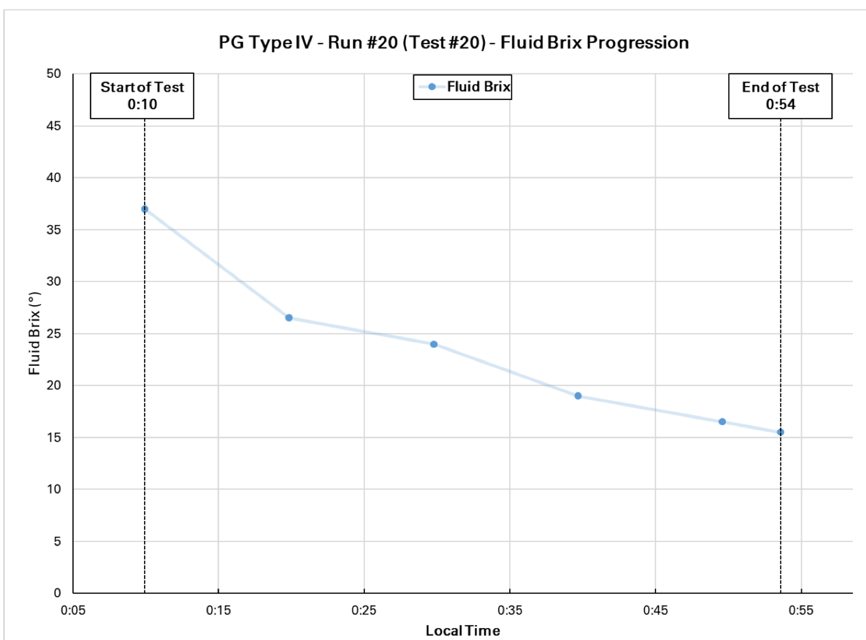

PG Type IV - Run #20 (Test #20) - Precipitation Rate
Start of Test 0:10
End of Test 0:54
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
80
90
100
0:05
0:15
0:25
0:35
0:45
0:55
Local Time

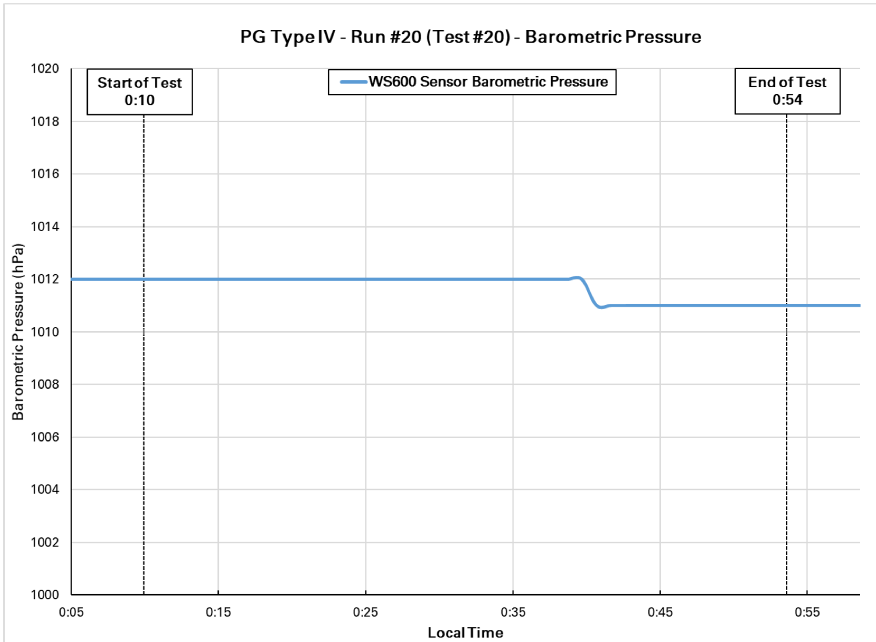

PG Type IV - Run #20 (Test #20) - Temperatures
Start of Test 0:10
Initial Fluid Temp: -5.5°C
End of Test 0:54
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0:05
0:15
0:25
0:35
0:45
0:55
Local Time


PG Type IV - Run #20 (Test #20) - Wind Speeds
Start of Test 0:10
End of Test 0:54
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
0:05
0:15
0:25
0:35
0:45
0:55

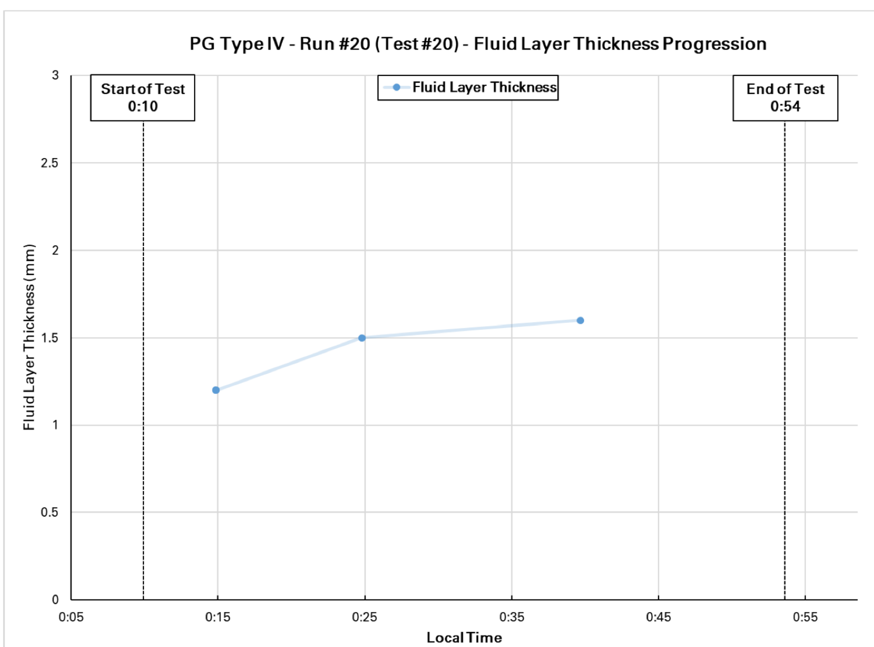

PG Type IV - Run #20 (Test #20) - Wind Direction
Start of Test 0:10
End of Test 0:54
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
0:05
0:15
0:25
0:35
0:45
0:55

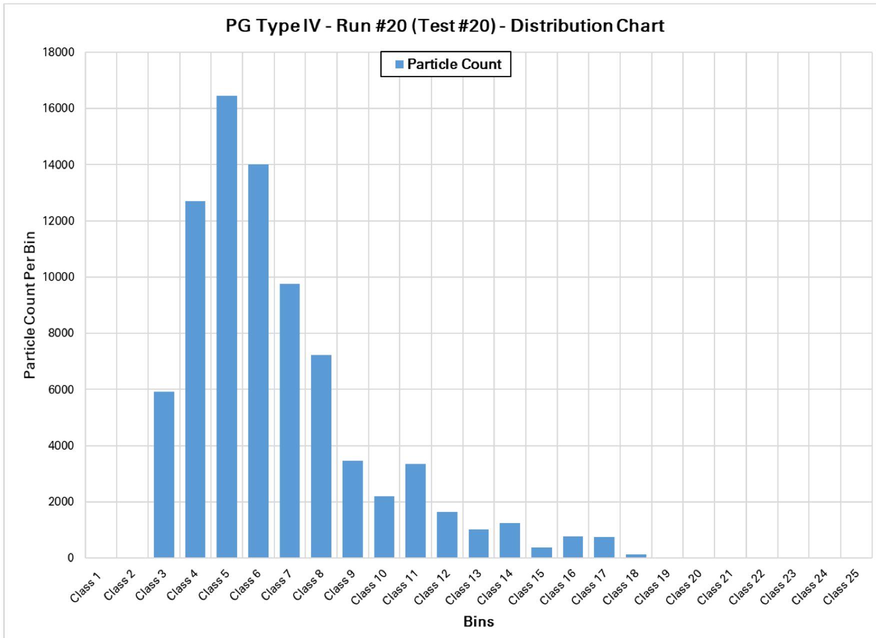

PG Type IV - Run #20 (Test #20) - Relative Humidity
Start of Test 0:10
WS600 Sensor Relative Humidity
End of Test 0:54
Relative Humidity (%)
Local Time
100
95
90
85
80
75
70
65
60
55
50
0:05
0:15
0:25
0:35
0:45
0:55


PG Type IV - Run #20 (Test #20) - Fluid Brix Progression
Start of Test 0:10
Fluid Brix
End of Test 0:54
Fluid Brix (°)
Local Time
50
45
40
35
30
25
20
15
10
5
0
0:05
0:15
0:25
0:35
0:45
0:55

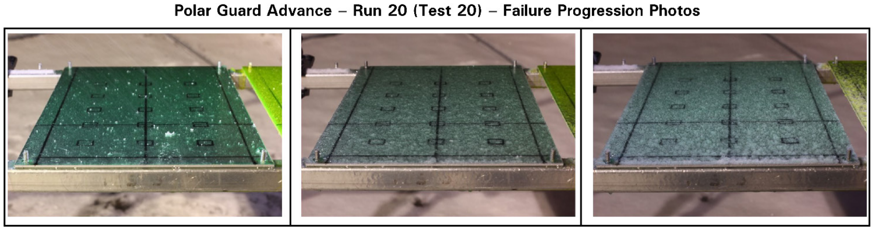


DATA PACKAGE – PG TYPE IV – RUN 20 (TEST 20)

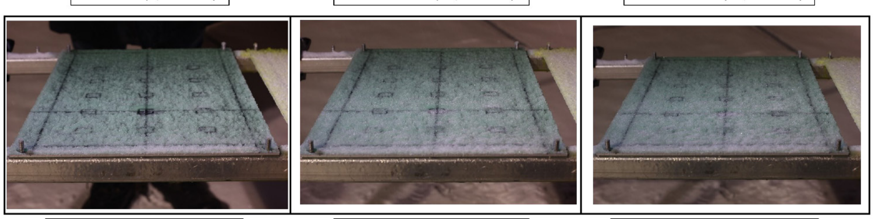




Polar Guard Advance – Run 20 (Test 20) – Failure Progression Photos

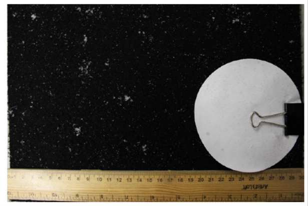


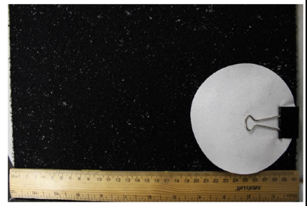
AT POUR (0/44 MIN) | PRE-FAILURE (20/44 MIN) | PRE-FAILURE (30/44 MIN)



PRE-FAILURE (41/44 MIN) | AT FAILURE (44/44 MIN) | POST-FAILURE (46/44 MIN)

Polar Guard Advance – Run 20 (Test 20) – Snow Characteristics Photos

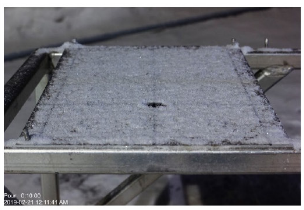


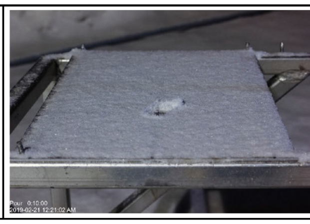


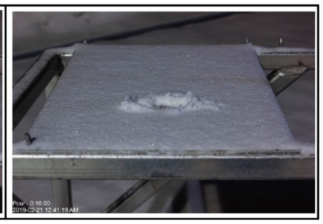
FELT PAD (0/44 MIN)

FELT PAD (19/44 MIN)

FELT PAD (39/44 MIN)







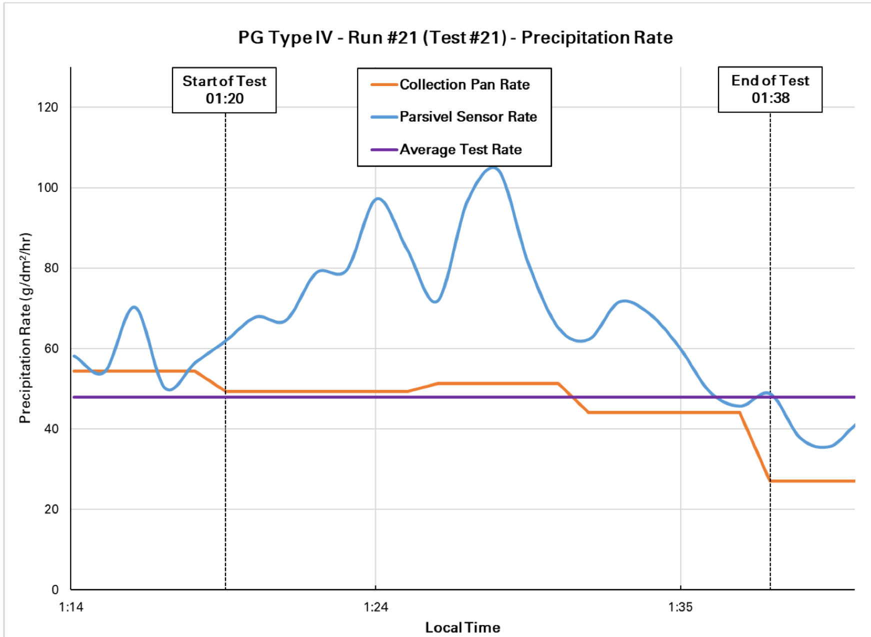
Final Bare Plate Contamination Thickness: **Not taken**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

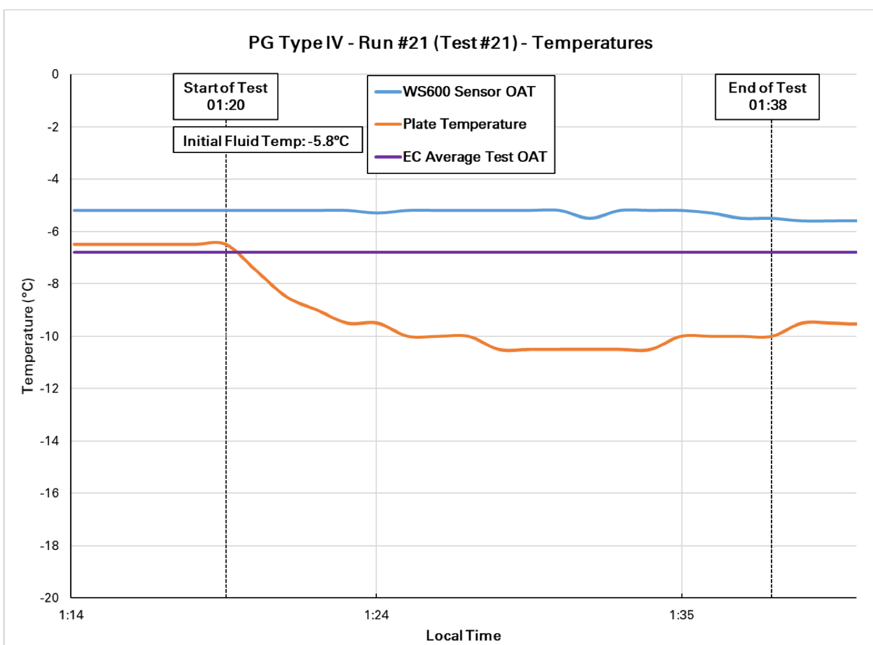
PG TYPE IV
RUN #21 (TEST #21) – PG4-21

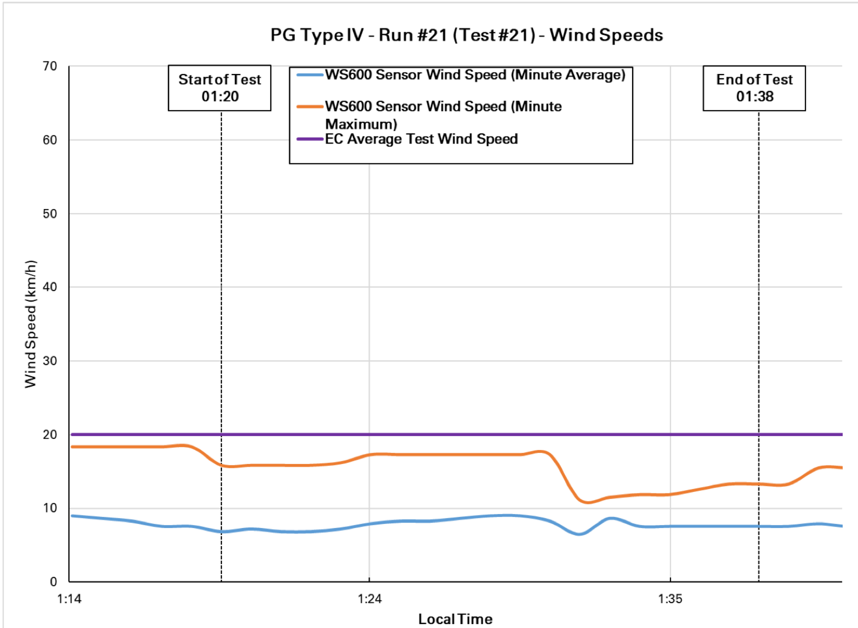
PG Type IV – Run #21 (Test #21) – General Test Information

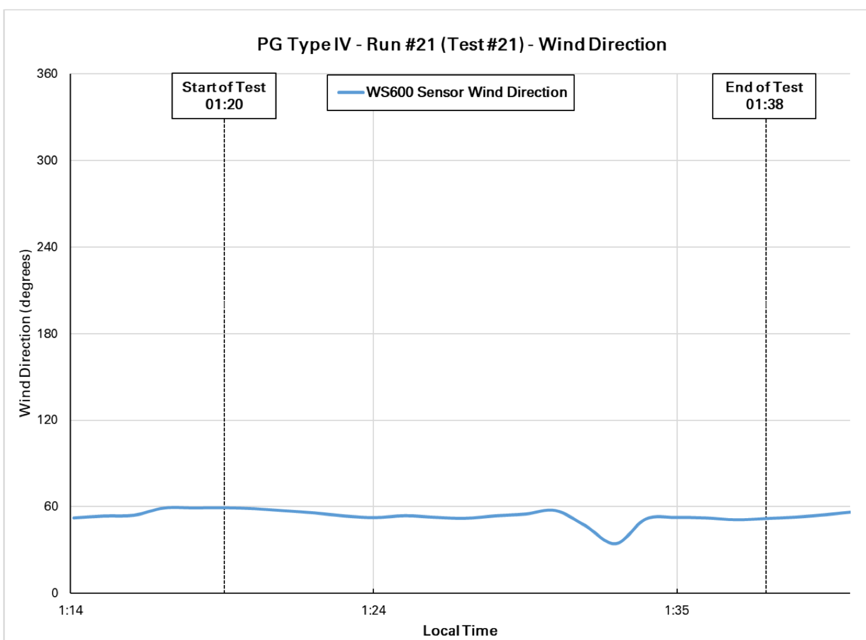
Test Number:	**PG4-21**
Date of Test:	**February 21, 2019**
Average OAT:	**-6.8**
Average Precipitation Rate:	**48 g/dm²/h**
Average Wind Speed:	**20 km/h**
Average Relative Humidity:	**87.7%**
Pour Time (Local):	**01:20:00**
Time of Fluid Failure (Local):	**01:38:00**
Fluid Brix at Failure:	**17.5°**
Endurance Time:	**18 minutes**
Expected Regression-Derived Endurance Time:	**20 minutes**
Difference (ET vs. Reg ET):	**-2 minutes (-10.0%)**

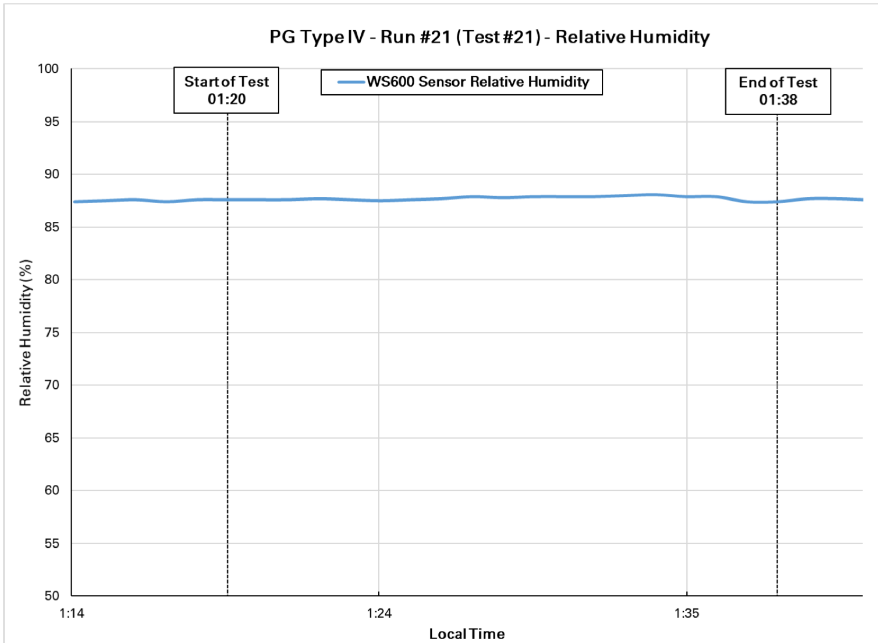


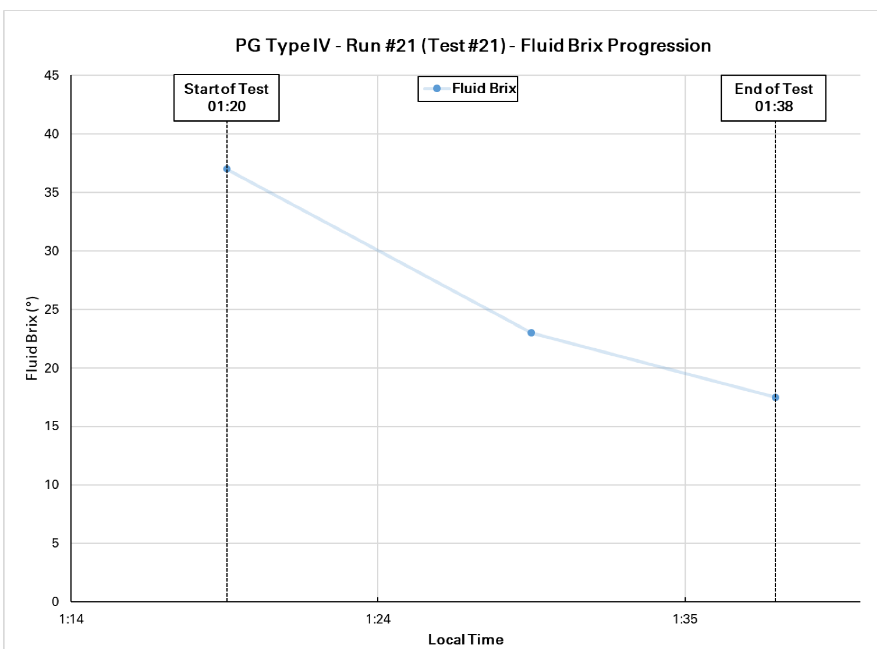
DATA PACKAGE – PG TYPE IV – RUN 21 (TEST 21)



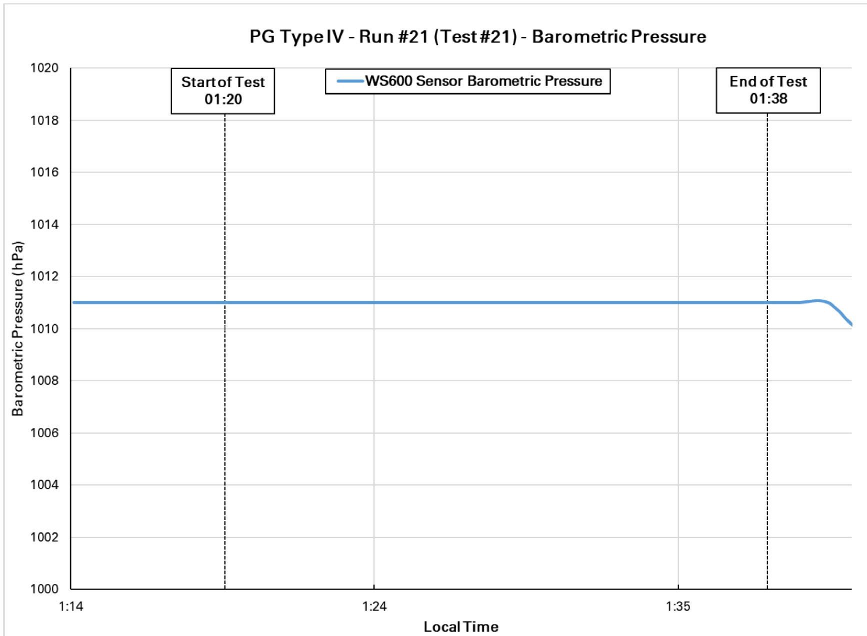

PG Type IV - Run #21 (Test #21) - Wind Speeds
Start of Test 01:20
End of Test 01:38
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
1:14
1:24
1:35
Local Time


PG Type IV - Run #21 (Test #21) - Wind Direction
Start of Test 01:20
WS600 Sensor Wind Direction
End of Test 01:38
Wind Direction (degrees)
360
300
240
180
120
60
0
1:14
1:24
1:35
Local Time


PG Type IV - Run #21 (Test #21) - Relative Humidity
Start of Test 01:20
WS600 Sensor Relative Humidity
End of Test 01:38
100
95
90
85
80
75
70
65
60
55
50
Relative Humidity (%)
1:14
1:24
1:35
Local Time


PG Type IV - Run #21 (Test #21) - Fluid Brix Progression
Start of Test 01:20
Fluid Brix
End of Test 01:38
45
40
35
30
25
20
15
10
5
0
Fluid Brix (°)
1:14
1:24
1:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN 21 (TEST 21)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 21 - Test 21/Data Package - PG Type IV - Run 21 - Test 21.docx
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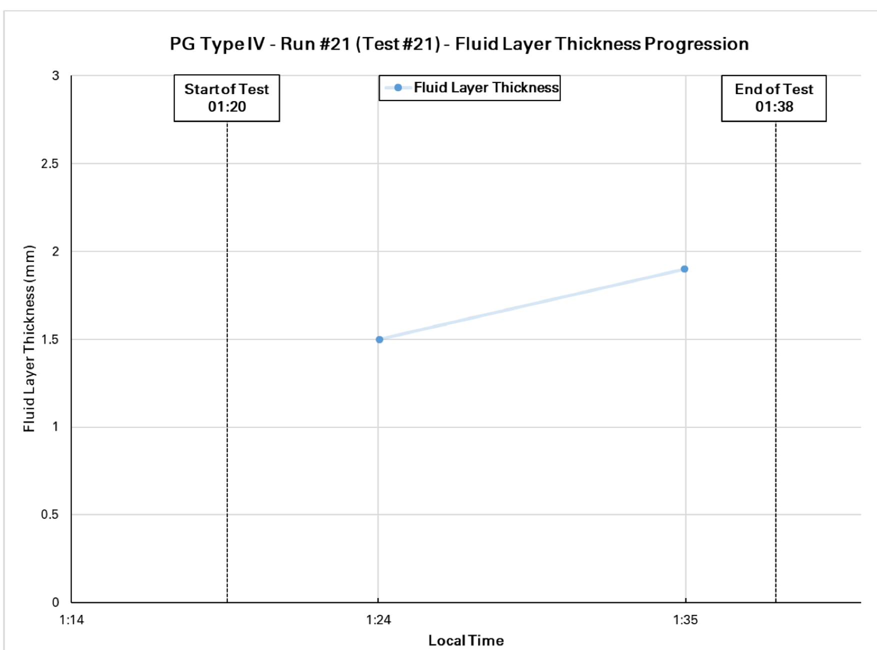
DATA PACKAGE – PG TYPE IV – RUN 21 (TEST 21)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 21 - Test 21/Data Package - PG Type IV - Run 21 - Test 21.docx
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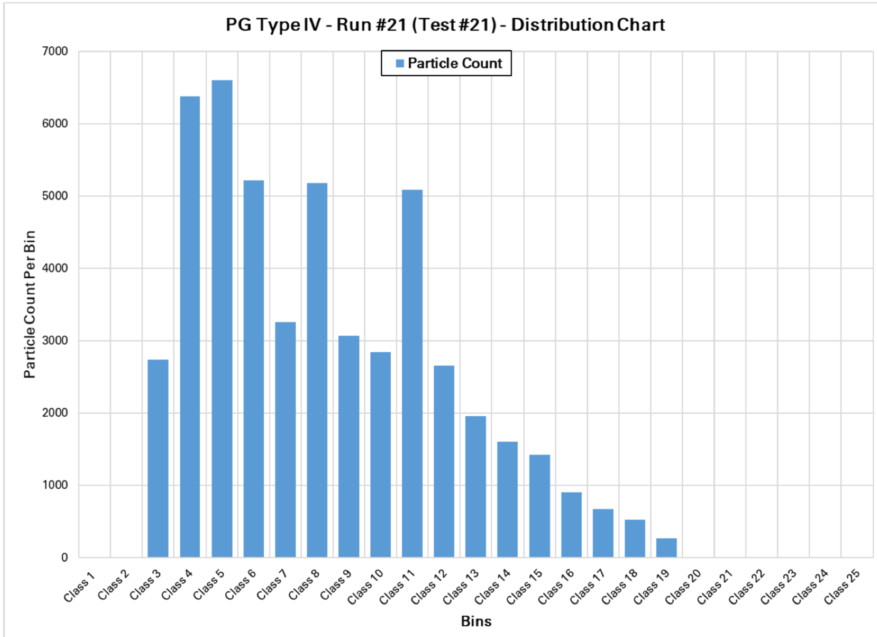
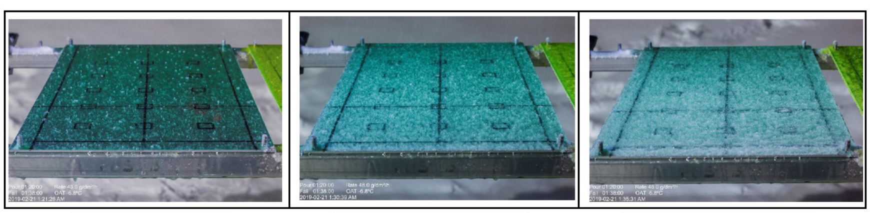
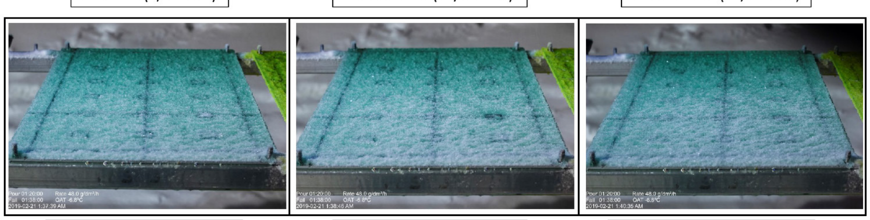


Polar Guard Advance – Run 21 (Test 21) – Failure Progression Photos

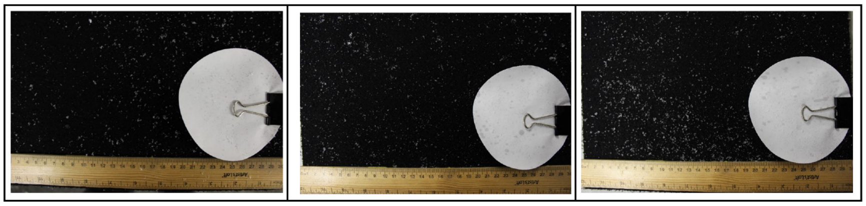


AT POUR (0/18 MIN) | PRE-FAILURE (10/18 MIN) | PRE-FAILURE (15/18 MIN)

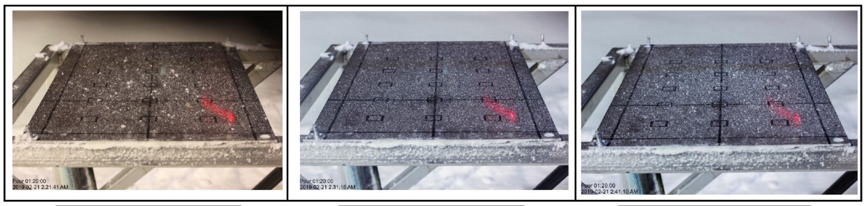


PRE-FAILURE (17/18 MIN) | AT FAILURE (18/18 MIN) | POST-FAILURE (20/18 MIN)

Polar Guard Advance – Run 21 (Test 21) – Snow Characteristics Photos



FELT PAD (-6/18 MIN) | FELT PAD (0/18 MIN) | FELT PAD (10/18 MIN)



BARE PLATE (1/18 MIN) | BARE PLATE 11/18 MIN) | BARE PLATE (21/18 MIN)

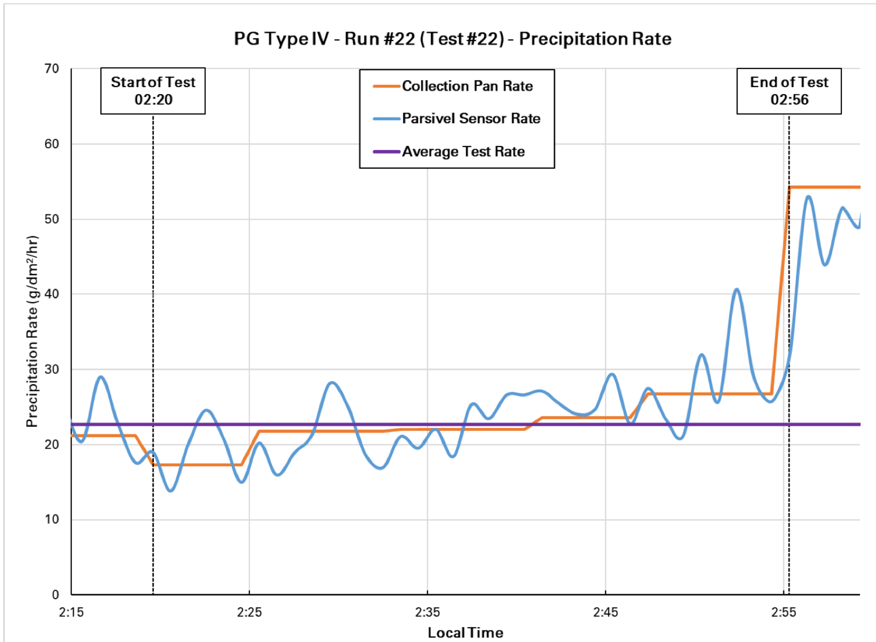
Final Bare Plate Contamination Thickness: **0.6mm**

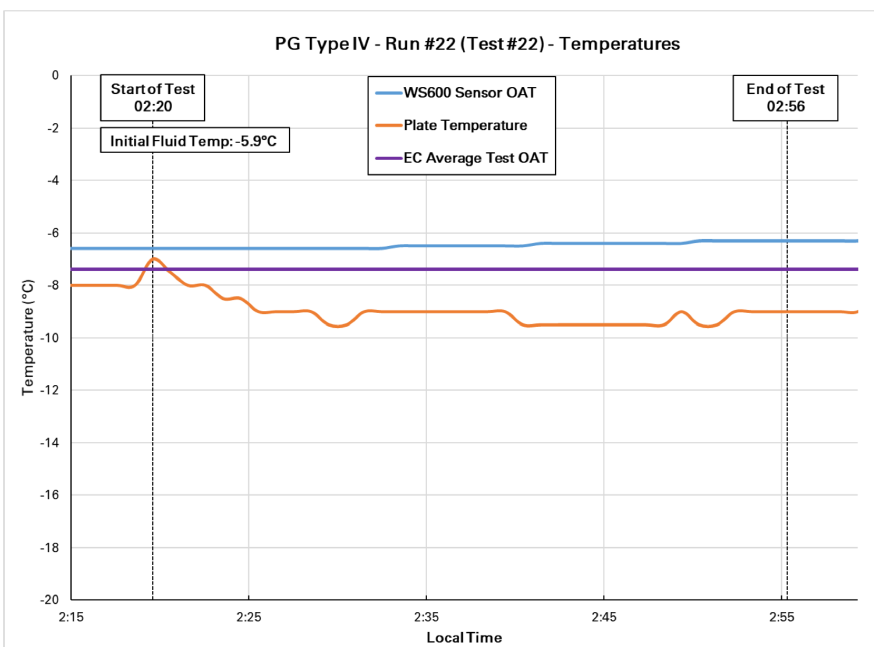
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

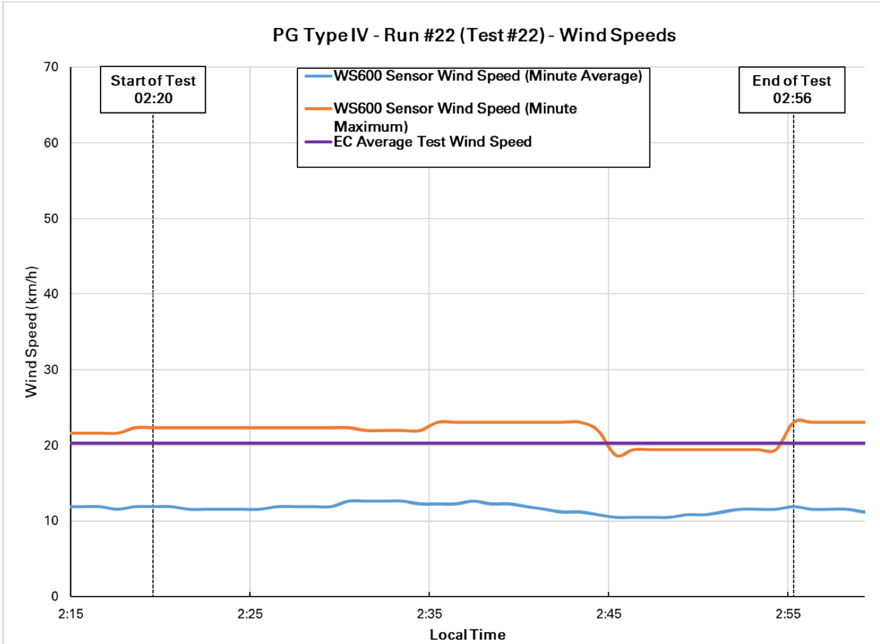
PG TYPE IV
RUN #22 (TEST #22) – PG4-22

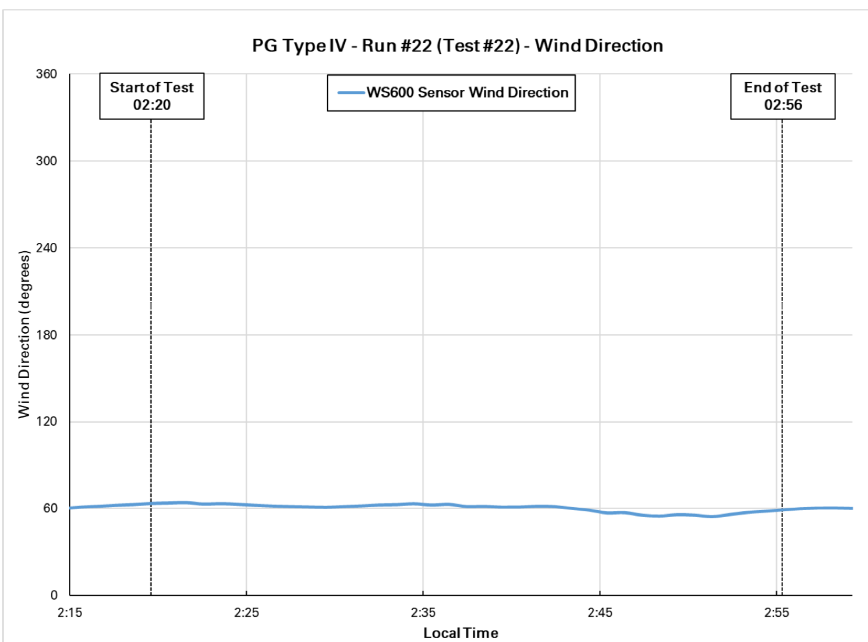
PG Type IV – Run #22 (Test #22) – General Test Information

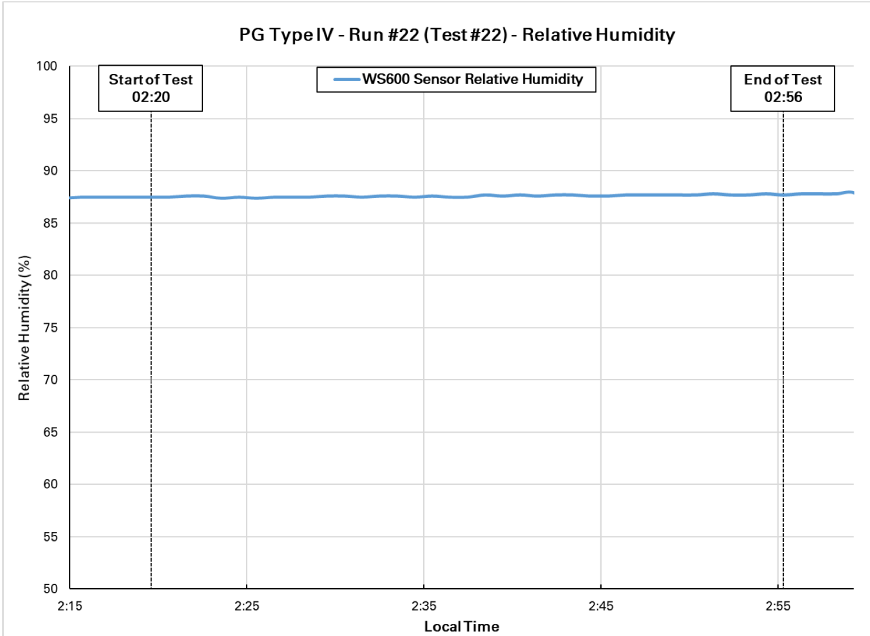
Test Number:	**PG4-22**
Date of Test:	**February 21, 2019**
Average OAT:	**-7.4**
Average Precipitation Rate:	**22.7 g/dm²/h**
Average Wind Speed:	**20.3 km/h**
Average Relative Humidity:	**87.6%**
Pour Time (Local):	**02:20:00**
Time of Fluid Failure (Local):	**02:56:00**
Fluid Brix at Failure:	**16.5°**
Endurance Time:	**36 minutes**
Expected Regression-Derived Endurance Time:	**35.7 minutes**
Difference (ET vs. Reg ET):	**+0.3 minutes (+0.8%)**

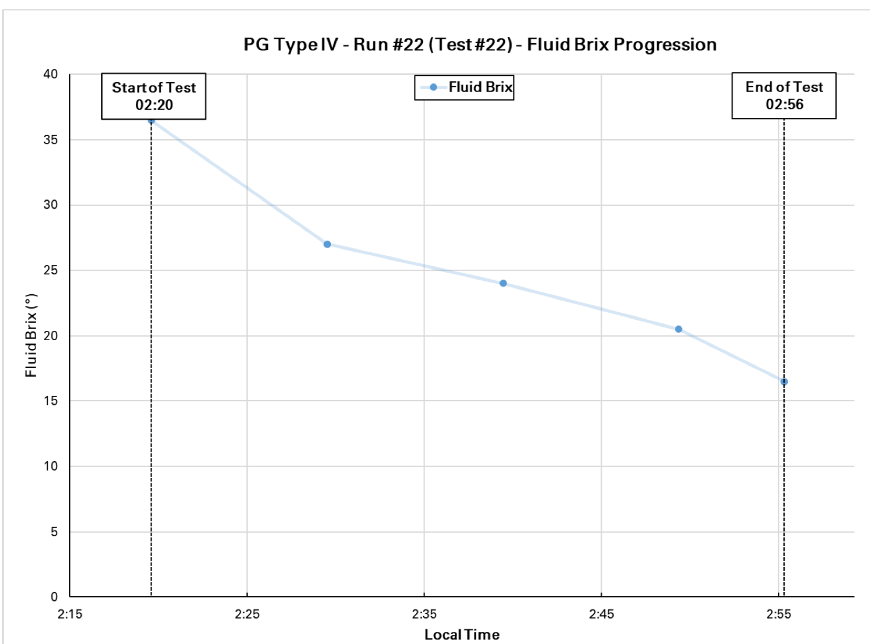

PG Type IV - Run #22 (Test #22) - Precipitation Rate
Start of Test 02:20
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
End of Test 02:56
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type IV - Run #22 (Test #22) - Temperatures
Start of Test 02:20
Initial Fluid Temp: -5.9°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 02:56
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
2:15
2:25
2:35
2:45
2:55
Local Time

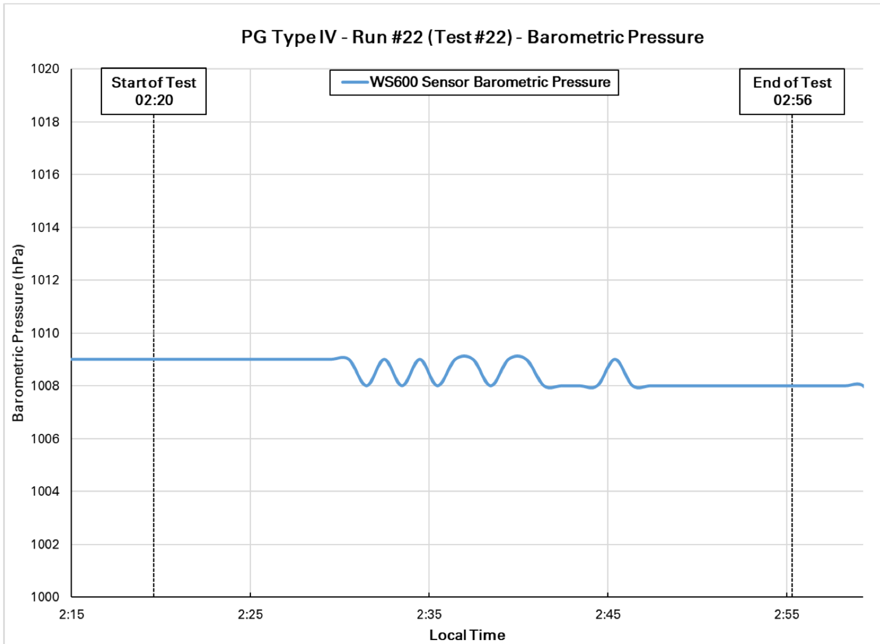

PG Type IV - Run #22 (Test #22) - Wind Speeds
Wind Speed (km/h)
0
10
20
30
40
50
60
70
Start of Test
02:20
End of Test
02:56
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type IV - Run #22 (Test #22) - Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
Start of Test
02:20
End of Test
02:56
WS600 Sensor Wind Direction
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type IV - Run #22 (Test #22) - Relative Humidity
Start of Test 02:20
WS600 Sensor Relative Humidity
End of Test 02:56
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type IV - Run #22 (Test #22) - Fluid Brix Progression
Start of Test 02:20
Fluid Brix
End of Test 02:56
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
2:15
2:25
2:35
2:45
2:55
Local Time

DATA PACKAGE – PG TYPE IV – RUN 22 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 22 - Test 22/Data Package - PG Type IV - Run 22 - Test 22.docx
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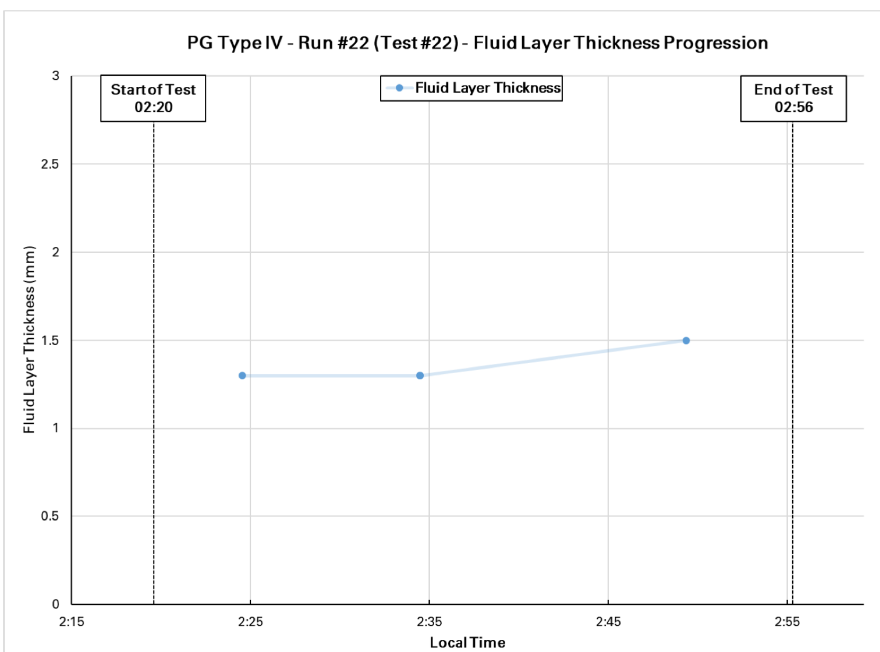
DATA PACKAGE – PG TYPE IV – RUN 22 (TEST 22)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 22 - Test 22/Data Package - PG Type IV - Run 22 - Test 22.docx
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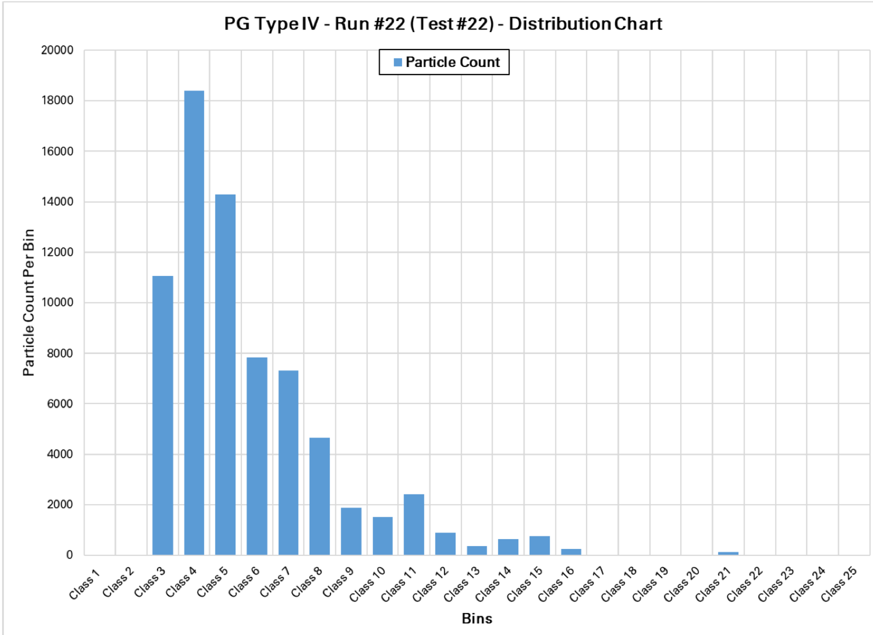
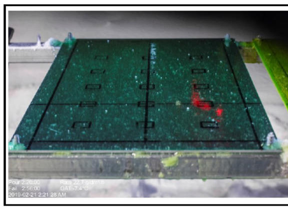
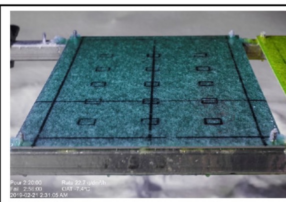


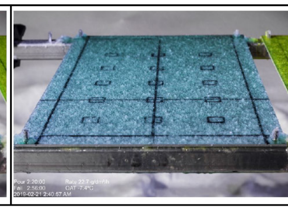
Polar Guard Advance – Run 22 (Test 22) – Failure Progression Photos



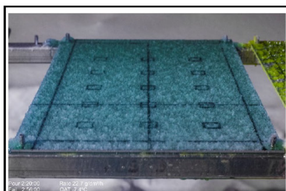
AT POUR (1/36 MIN)



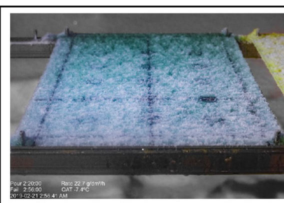
PRE-FAILURE (11/36 MIN)



PRE-FAILURE (20/56 MIN)



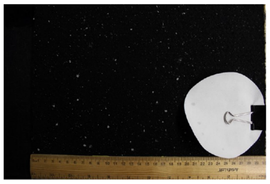
PRE-FAILURE (30/36 MIN)



AT FAILURE (36/36 MIN)

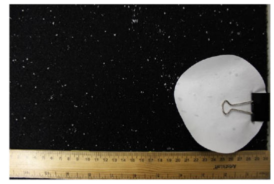
POST-FAILURE (40/36 MIN)

Polar Guard Advance – Run 22 (Test 22) – Snow Characteristics Photos

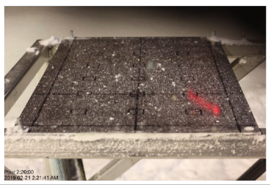


FELT PAD (1/36 MIN)

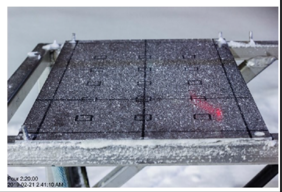
FELT PAD (9/36 MIN)



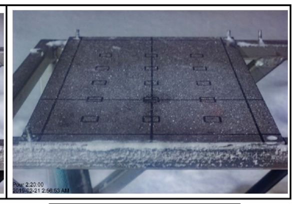
FELT PAD (30/36 MIN)



BARE PLATE (1/36 MIN)



BARE PLATE 21/36 MIN)



BARE PLATE (36/36 MIN)

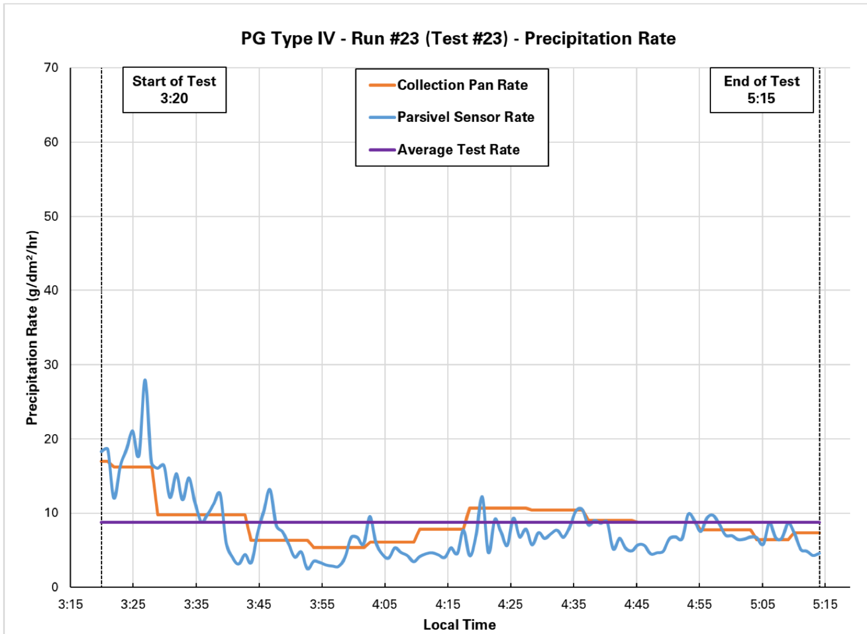
Final Bare Plate Contamination Thickness: **0.4mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

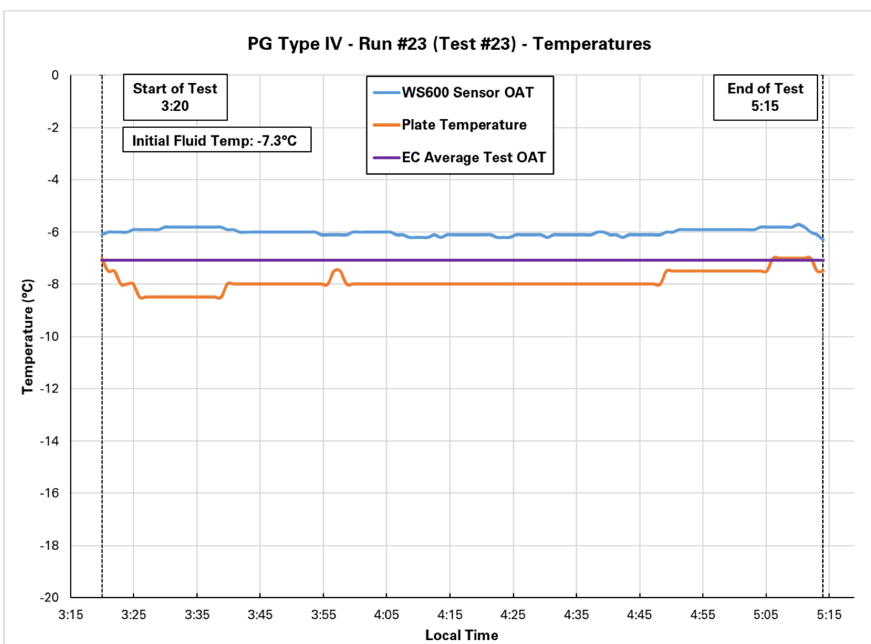
PG TYPE IV
RUN #23 (TEST #23) – PG4-23

PG Type IV – Run #23 (Test #23) – General Test Information

Test Number:	PG4-23
Date of Test:	Feb 21st, 2019
Average OAT:	-7.1°C
Average Precipitation Rate:	8.8 g/dm²/h
Average Wind Speed:	17.7 km/h
Average Relative Humidity:	87.8%
Pour Time (Local):	3:20:00
Time of Fluid Failure (Local):	5:14:40
Fluid Brix at Failure:	13.50°
Endurance Time:	114.67 minutes
Expected Regression-Derived Endurance Time:	79.22 minutes
Difference (ET vs. Reg ET):	+35.44 minutes (+44.7%)

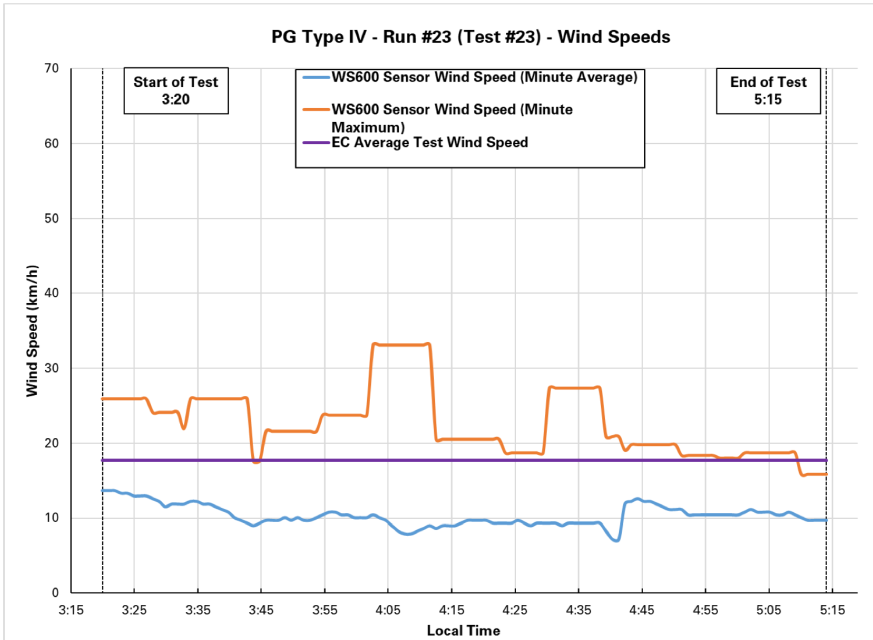


PG Type IV - Run #23 (Test #23) - Precipitation Rate
Start of Test 3:20
End of Test 5:15
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
5:15
Local Time



PG Type IV - Run #23 (Test #23) - Temperatures
Start of Test 3:20
Initial Fluid Temp: -7.3°C
End of Test 5:15
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
5:15
Local Time

DATA PACKAGE – PG TYPE IV – RUN 23 (TEST 23)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 23 - Test 23/Data Package - PG Type IV - Run 23 - Test 23.docx
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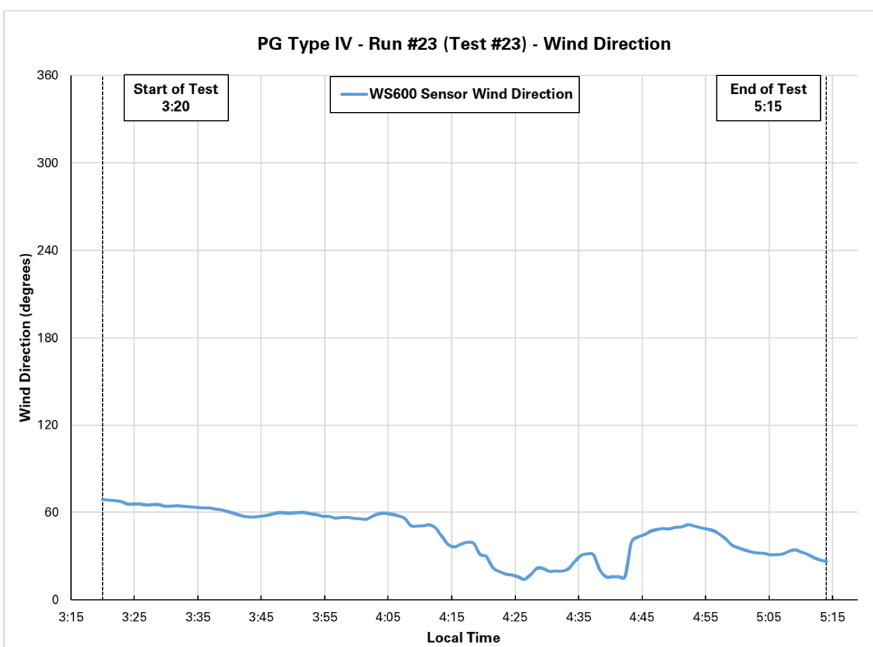
DATA PACKAGE – PG TYPE IV – RUN 23 (TEST 23)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 23 - Test 23/Data Package - PG Type IV - Run 23 - Test 23.docx
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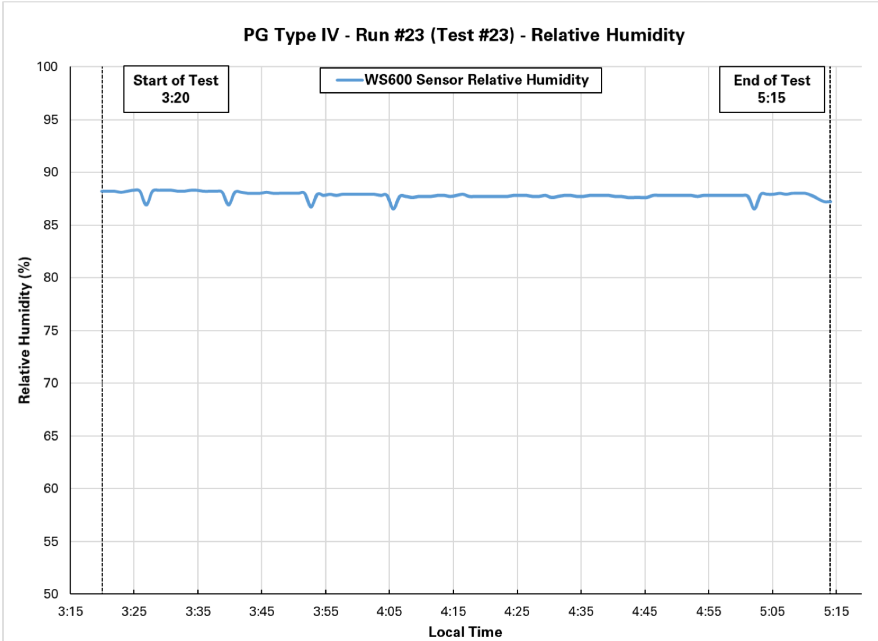
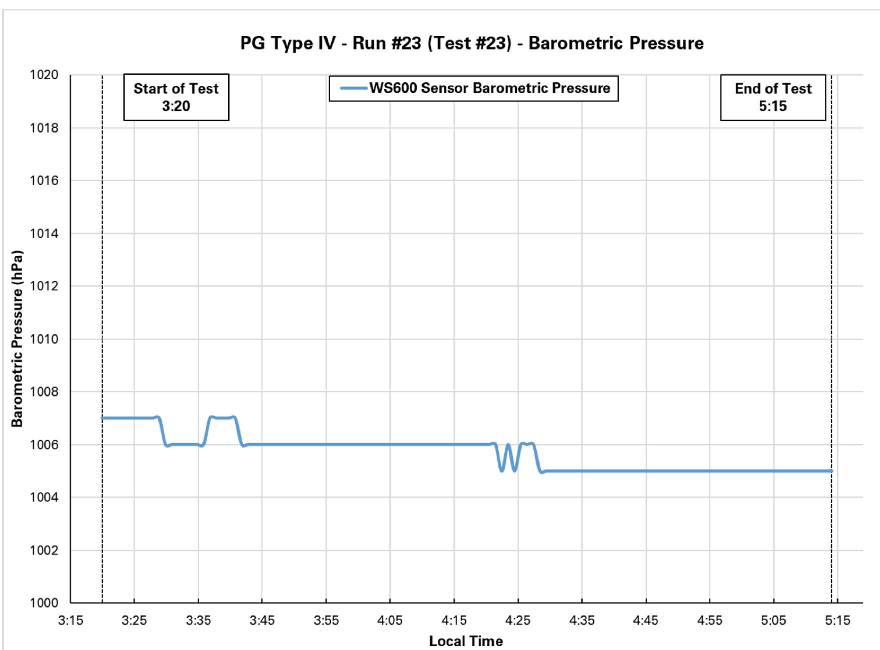
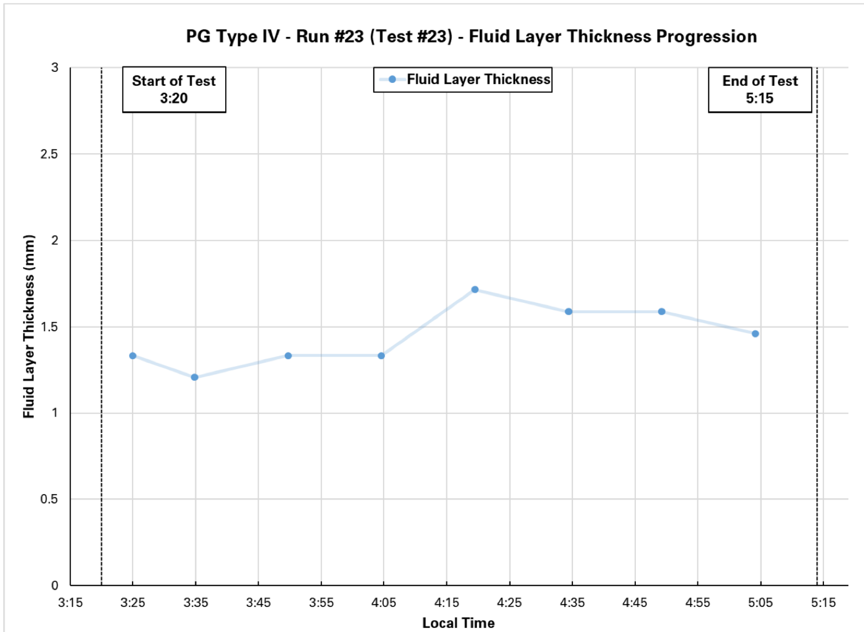
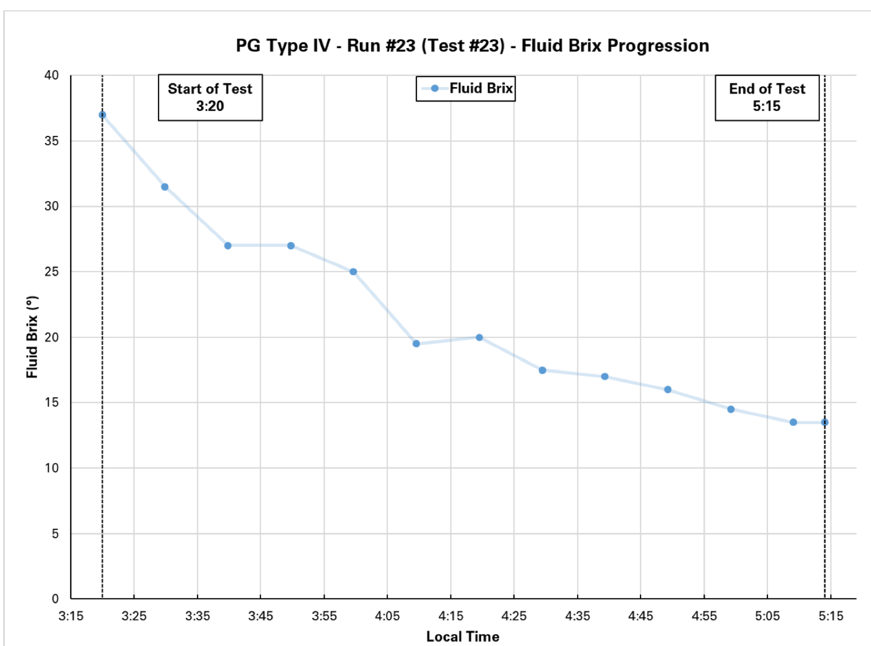
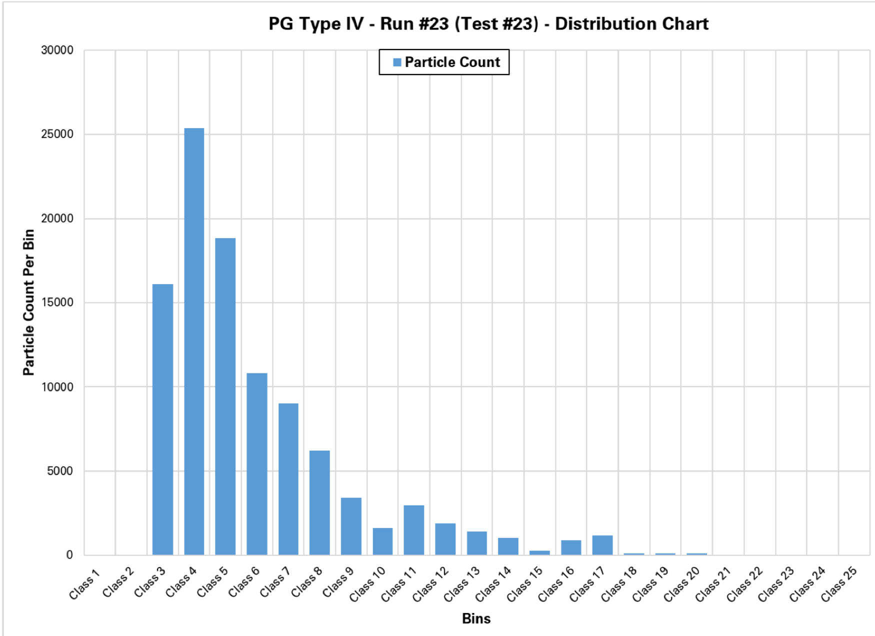

PG Type IV - Run #23 (Test #23) - Relative Humidity
Start of Test 3:20
WS600 Sensor Relative Humidity
End of Test 5:15
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
5:15
Local Time

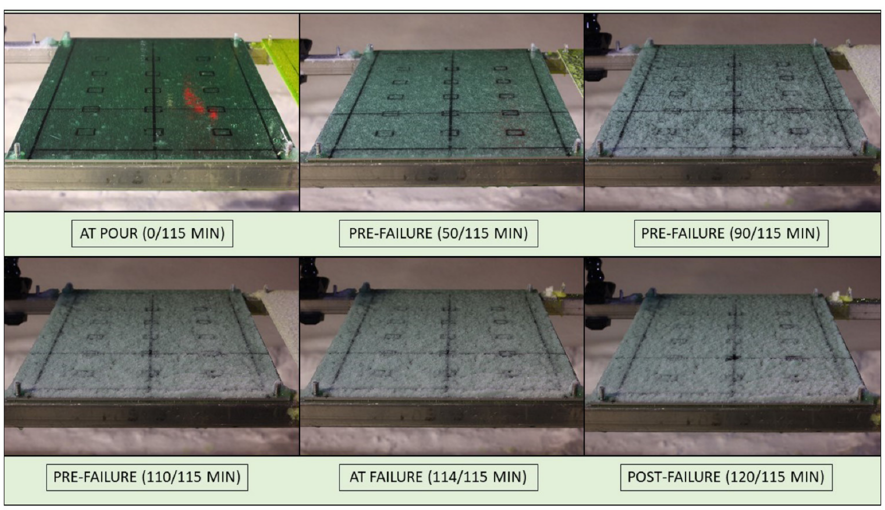

PG Type IV - Run #23 (Test #23) - Barometric Pressure
Start of Test 3:20
WS600 Sensor Barometric Pressure
End of Test 5:15
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
5:15
Local Time


PG Type IV - Run #23 (Test #23) - Fluid Layer Thickness Progression
Start of Test 3:20
Fluid Layer Thickness
End of Test 5:15
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
5:15
Local Time

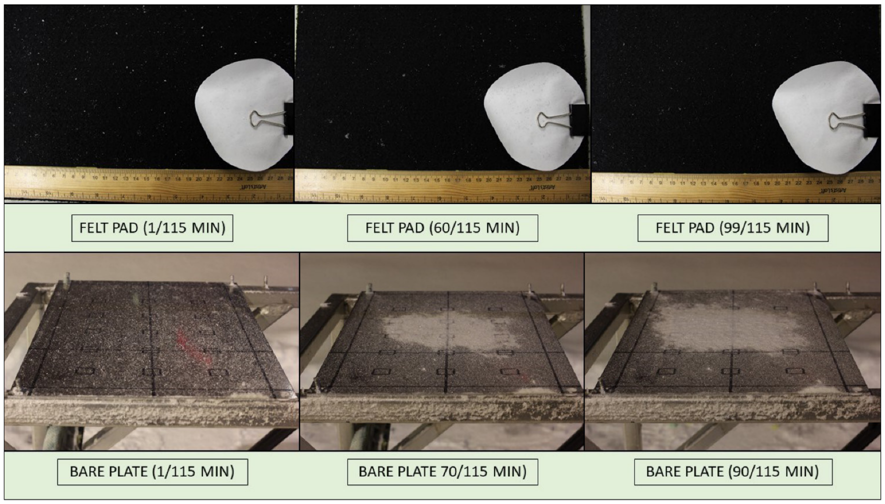

PG Type IV - Run #23 (Test #23) - Fluid Brix Progression
Start of Test 3:20
Fluid Brix
End of Test 5:15
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
3:15
3:25
3:35
3:45
3:55
4:05
4:15
4:25
4:35
4:45
4:55
5:05
5:15
Local Time



Polar Guard Advance – Run 23 (Test 23) – Failure Progression Photos



Polar Guard Advance – Run 23 (Test 23) – Snow Characteristics Photos



Final Bare Plate Contamination Thickness: **0.3 mm**

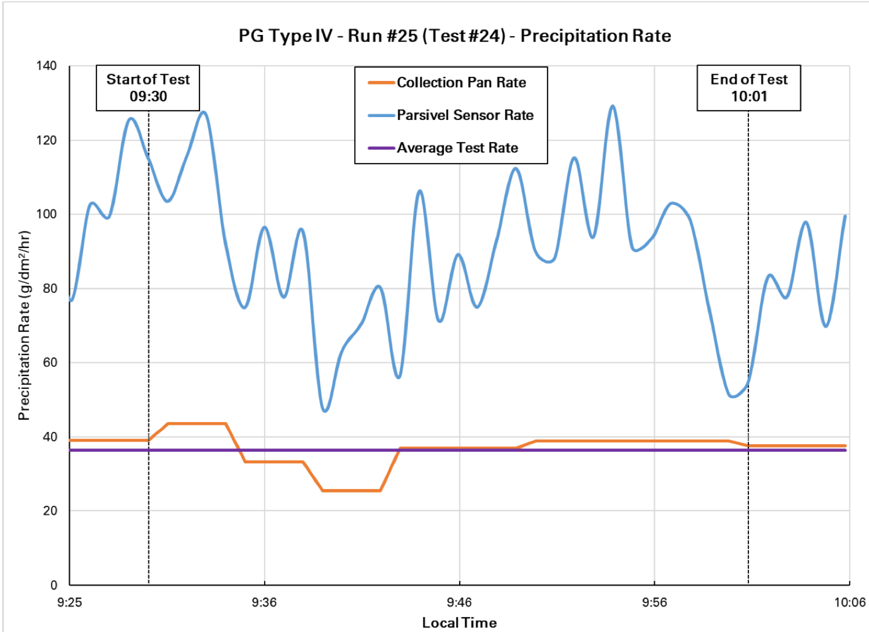
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #25 (TEST #24) – PG4-24

PG Type IV – Run #25 (Test #24) – General Test Information

Test Number:	PG4-24
Date of Test:	March 10, 2019
Average OAT:	-1.8
Average Precipitation Rate:	36.5 g/dm²/h
Average Wind Speed:	24 km/h
Average Relative Humidity:	91.6%
Pour Time (Local):	09:30:00
Time of Fluid Failure (Local):	10:01:00
Fluid Brix at Failure:	6.5°
Endurance Time:	31 minutes
Expected Regression-Derived Endurance Time:	40.8 minutes
Difference (ET vs. Reg ET):	-9.8 minutes (-23.9%)

DATA PACKAGE – PG TYPE IV – RUN 25 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 25 - Test 24/Data Package - PG Type IV - Run 25 - Test 24.docx
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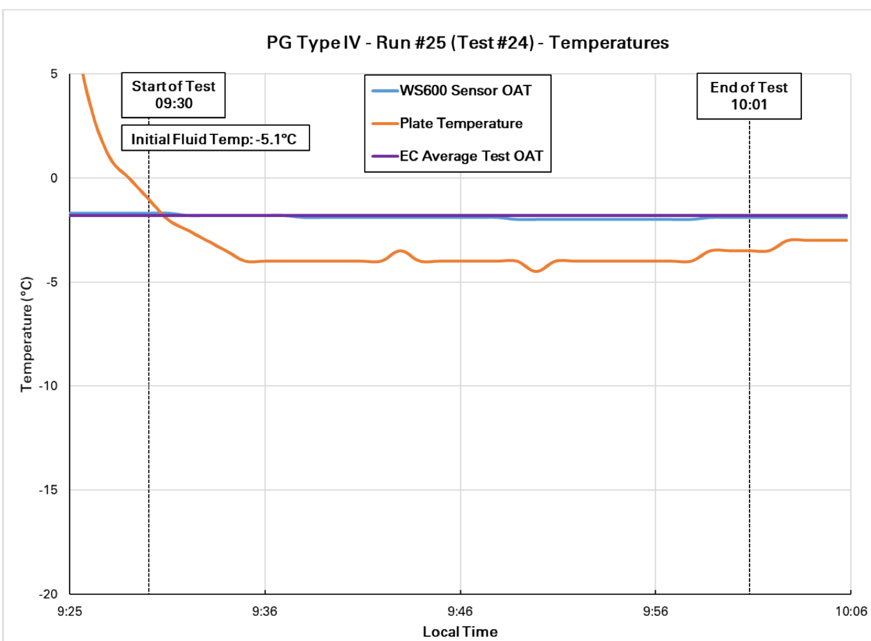
DATA PACKAGE – PG TYPE IV – RUN 25 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 25 - Test 24/Data Package - PG Type IV - Run 25 - Test 24.docx
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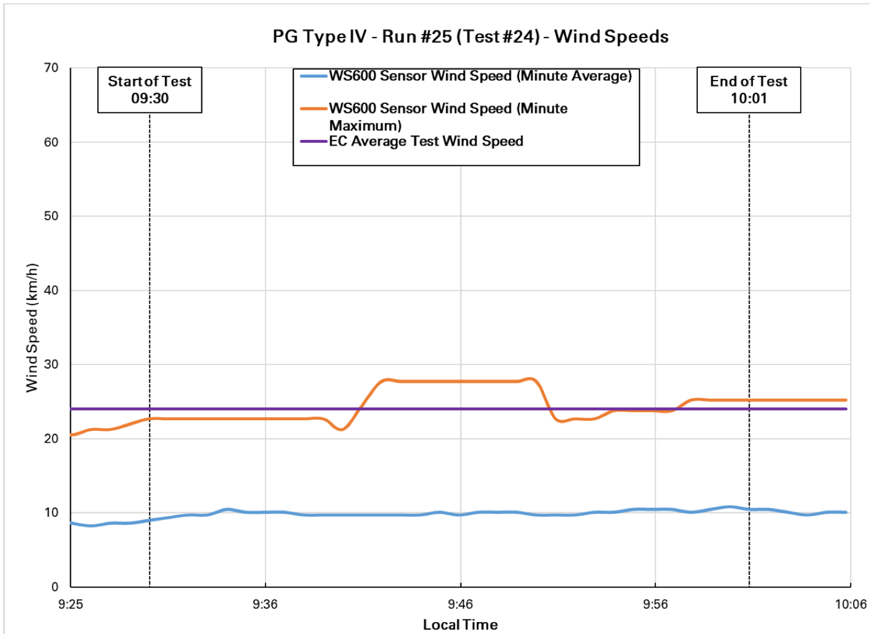
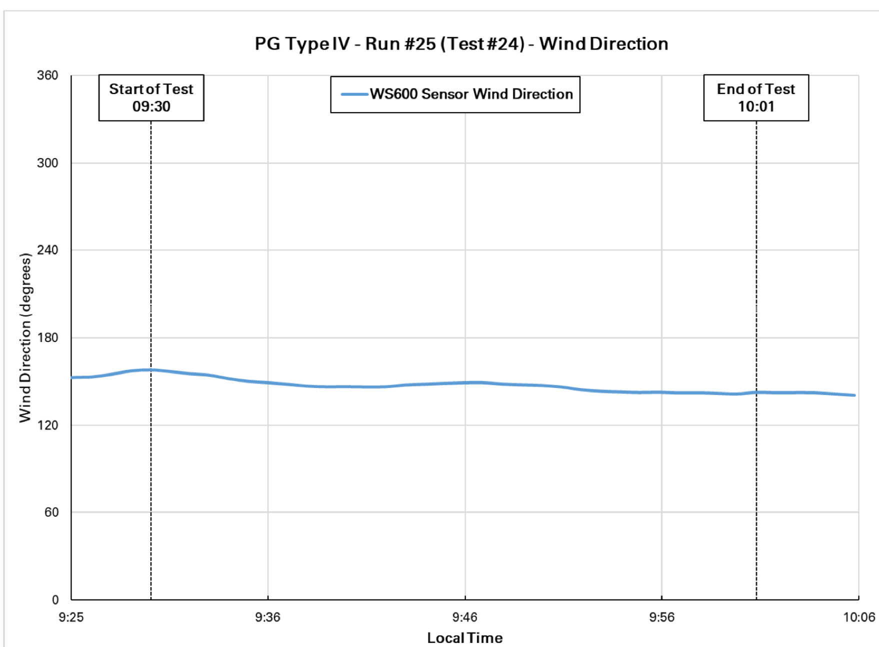
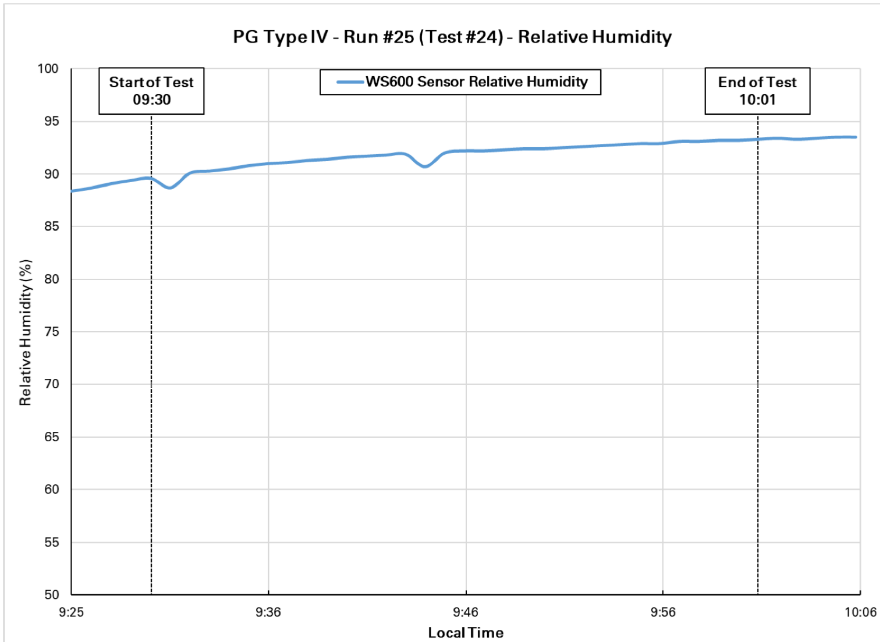
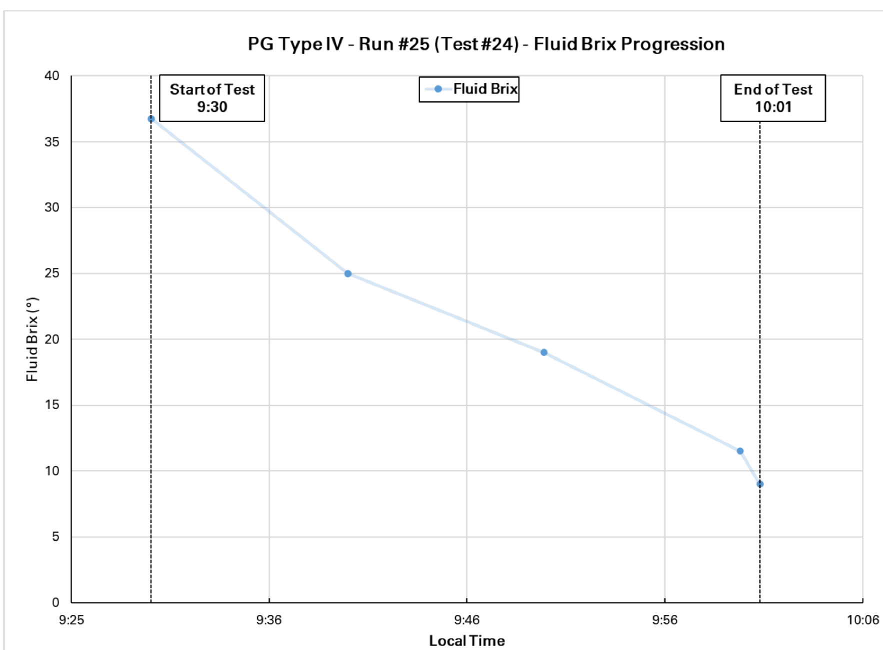
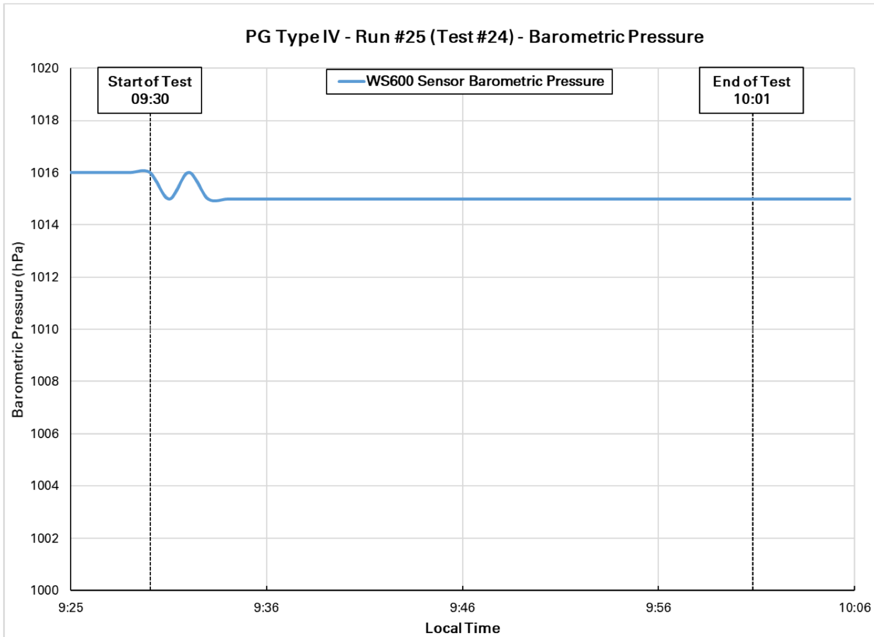

PG Type IV - Run #25 (Test #24) - Wind Speeds
Start of Test 09:30
End of Test 10:01
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
9:25
9:36
9:46
9:56
10:06
Local Time


PG Type IV - Run #25 (Test #24) - Wind Direction
Start of Test 09:30
End of Test 10:01
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
9:25
9:36
9:46
9:56
10:06
Local Time


PG Type IV - Run #25 (Test #24) - Relative Humidity
Start of Test 09:30
WS600 Sensor Relative Humidity
End of Test 10:01
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
9:25
9:36
9:46
9:56
10:06
Local Time


PG Type IV - Run #25 (Test #24) - Fluid Brix Progression
Start of Test 9:30
Fluid Brix
End of Test 10:01
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
9:25
9:36
9:46
9:56
10:06
Local Time

DATA PACKAGE – PG TYPE IV – RUN 25 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 25 - Test 24/Data Package - PG Type IV - Run 25 - Test 24.docx
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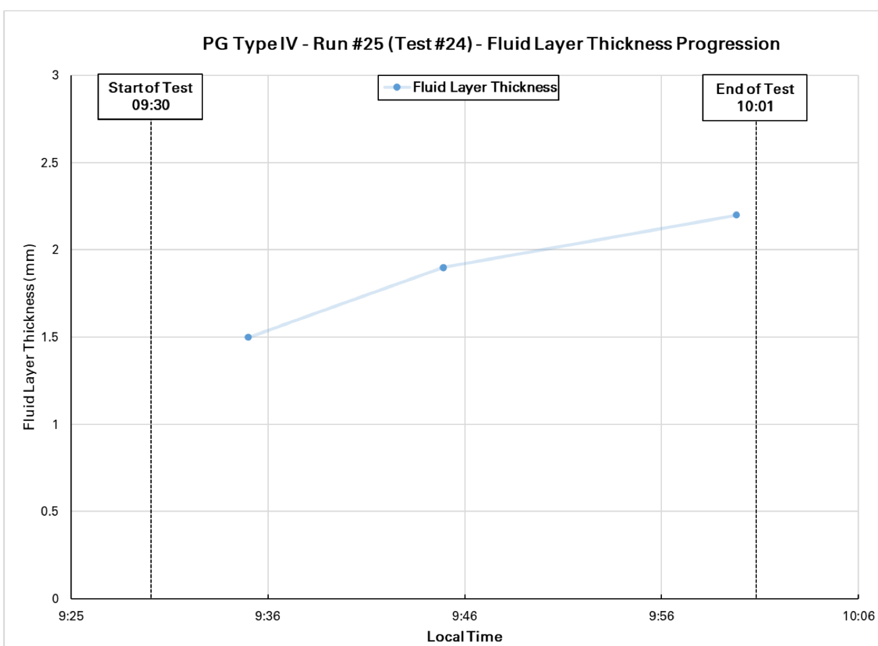
DATA PACKAGE – PG TYPE IV – RUN 25 (TEST 24)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 25 - Test 24/Data Package - PG Type IV - Run 25 - Test 24.docx
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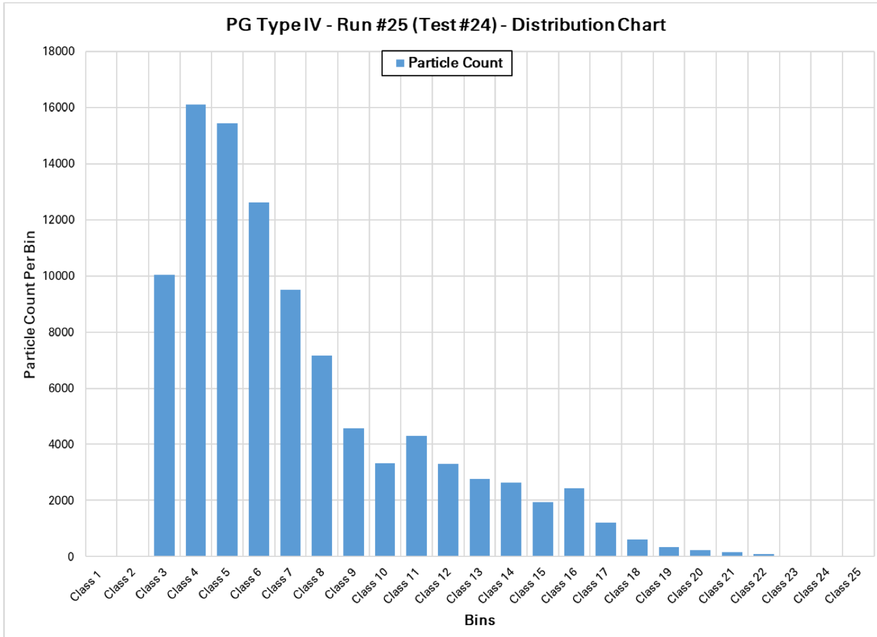
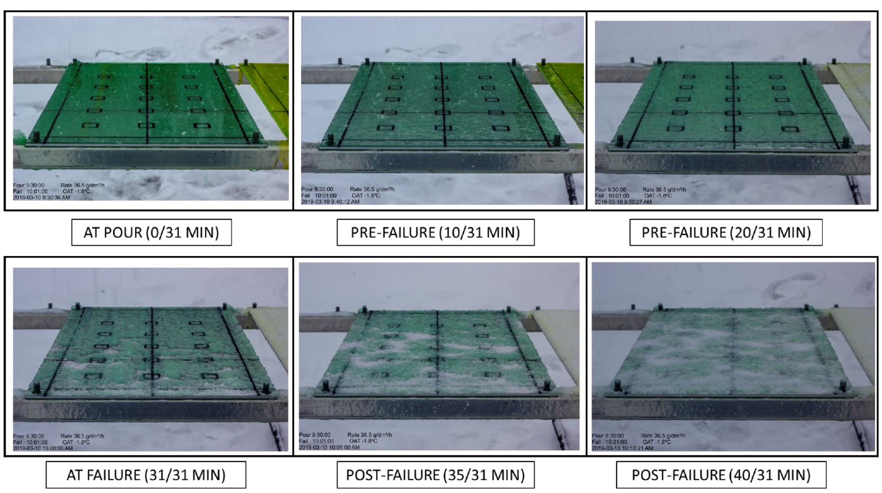
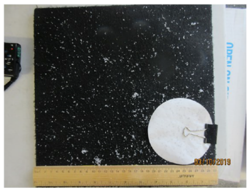
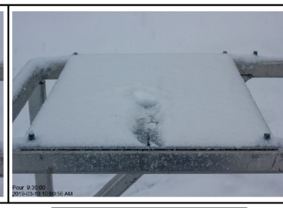


Polar Guard Advance – Run 25 (Test 24) – Failure Progression Photos



Polar Guard Advance – Run 25 (Test 24) – Snow Characteristics Photos

	No Felt Pad photos exist	No Felt Pad photos exist
FELT PAD (1/31 MIN)	FELT PAD (XX/XX MIN)	FELT PAD (XX/XX MIN)
		
BARE PLATE (1/31 MIN)	BARE PLATE 21/31 MIN)	BARE PLATE (30/31 MIN)

Final Bare Plate Contamination Thickness: **Not taken**

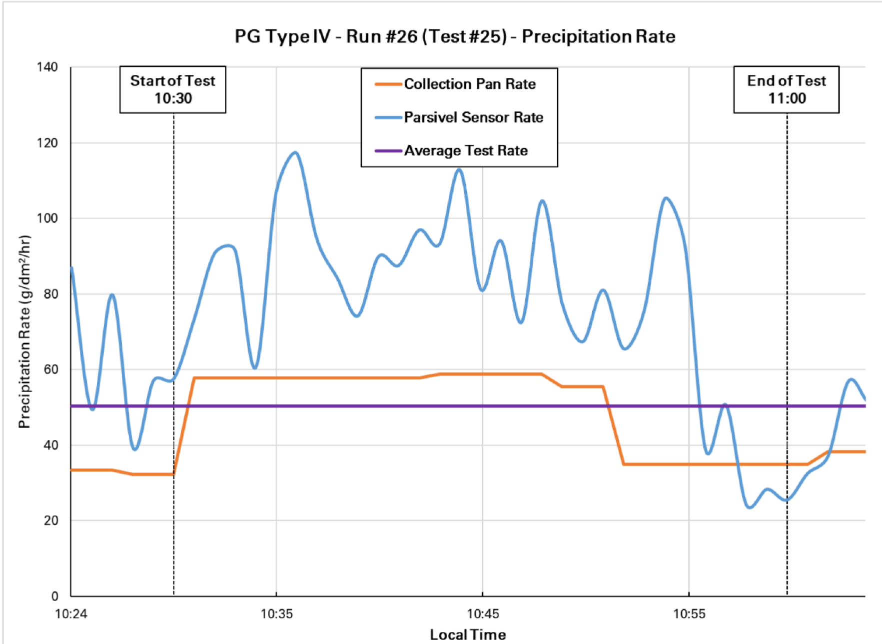
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #26 (TEST #25) – PG4-25

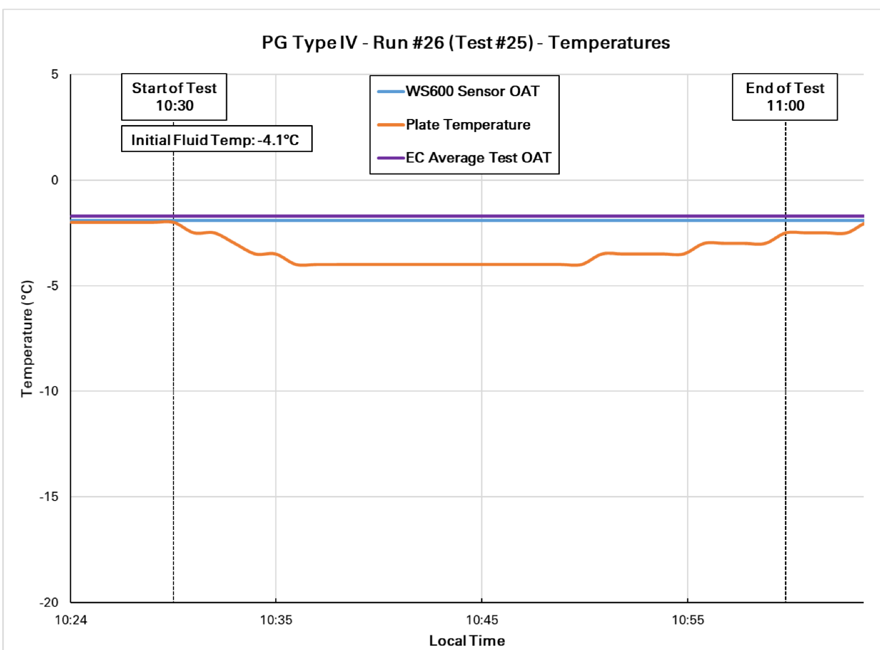
DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)

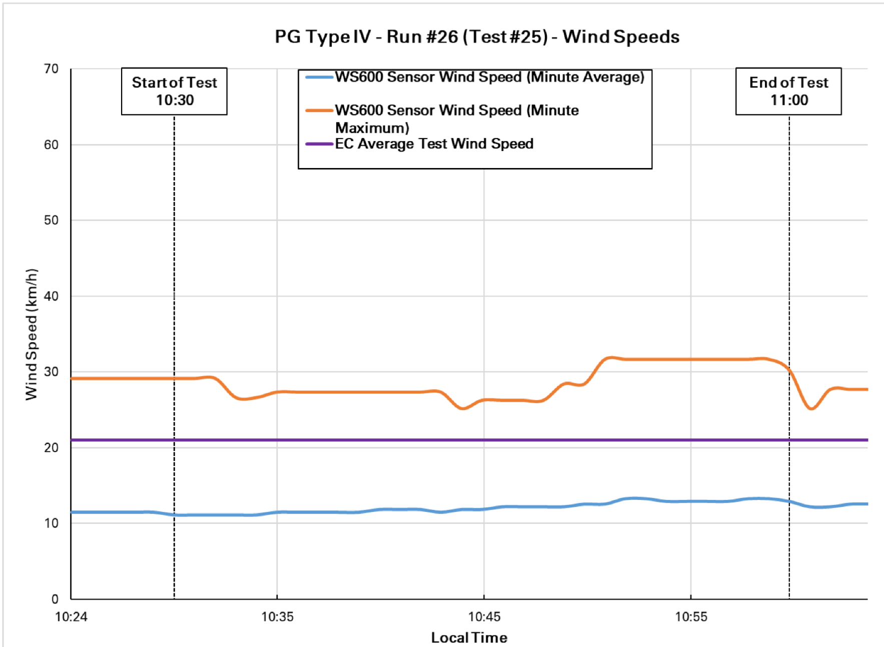
PG Type IV – Run #26 (Test #25) – General Test Information

Test Number:	PG4-25
Date of Test:	March 10, 2019
4Average OAT:	-1.7
Average Precipitation Rate:	50.4 g/dm²/h
Average Wind Speed:	21 km/h
Average Relative Humidity:	94.7%
Pour Time (Local):	10:30:00
Time of Fluid Failure (Local):	11:00:00
Fluid Brix at Failure:	10°
Endurance Time:	30 minutes
Expected Regression-Derived Endurance Time:	31.8 minutes
Difference (ET vs. Reg ET):	-1.3 minutes (-4.0%)

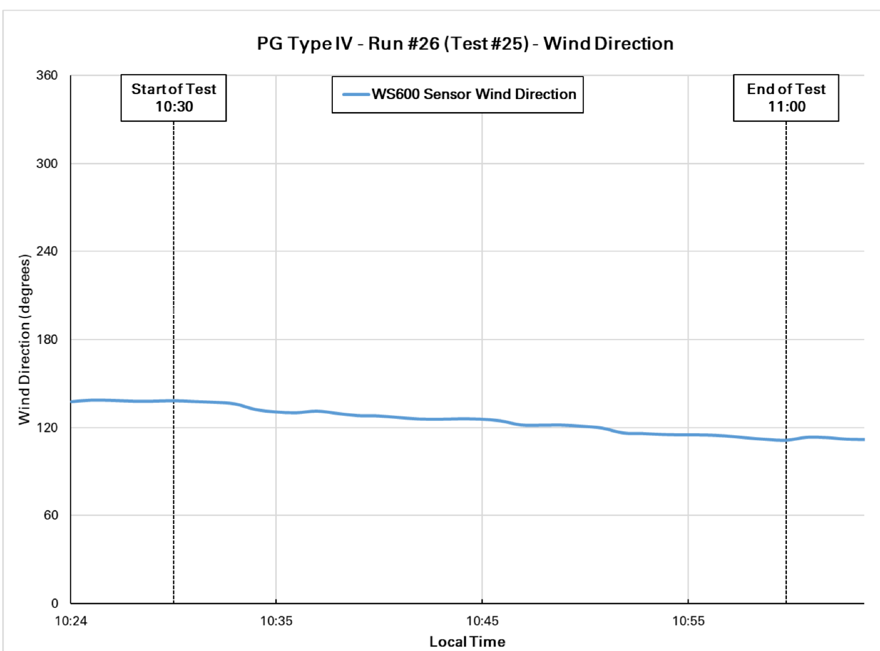


DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)

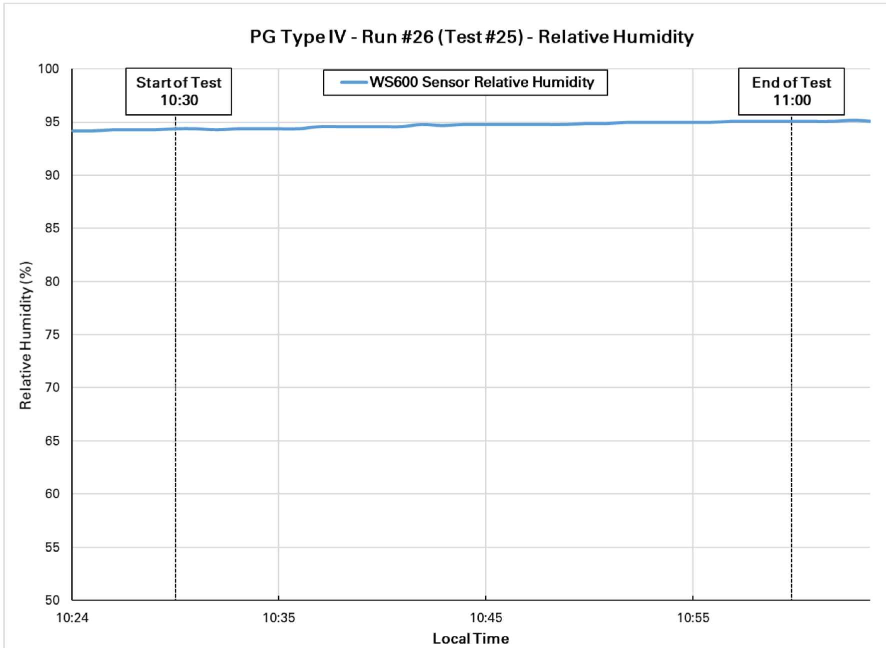




DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)



DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 26 - Test 25/Data Package - PG Type IV - Run 26 - Test 25.docx
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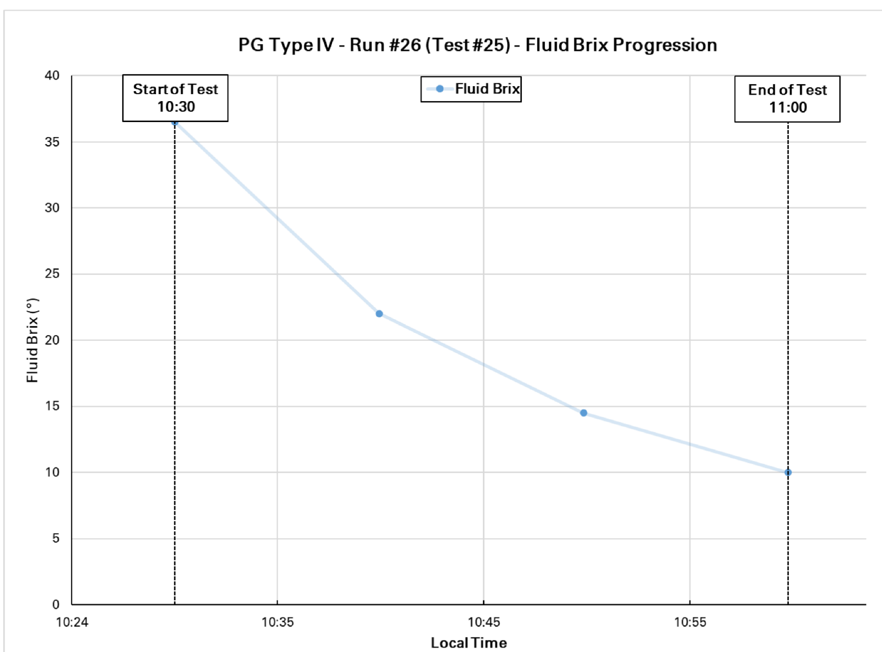
DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 26 - Test 25/Data Package - PG Type IV - Run 26 - Test 25.docx
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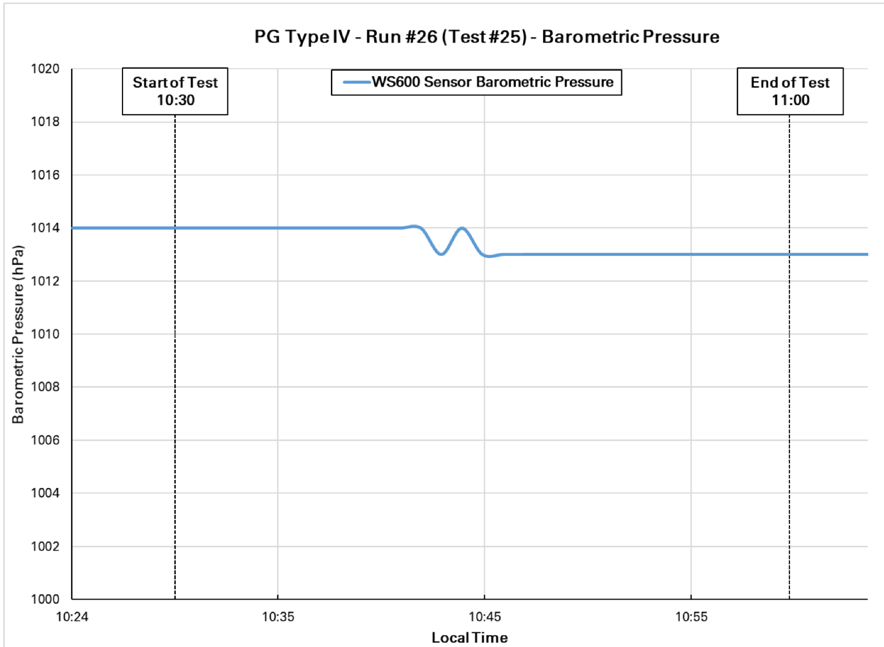
DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 26 - Test 25/Data Package - PG Type IV - Run 26 - Test 25.docx
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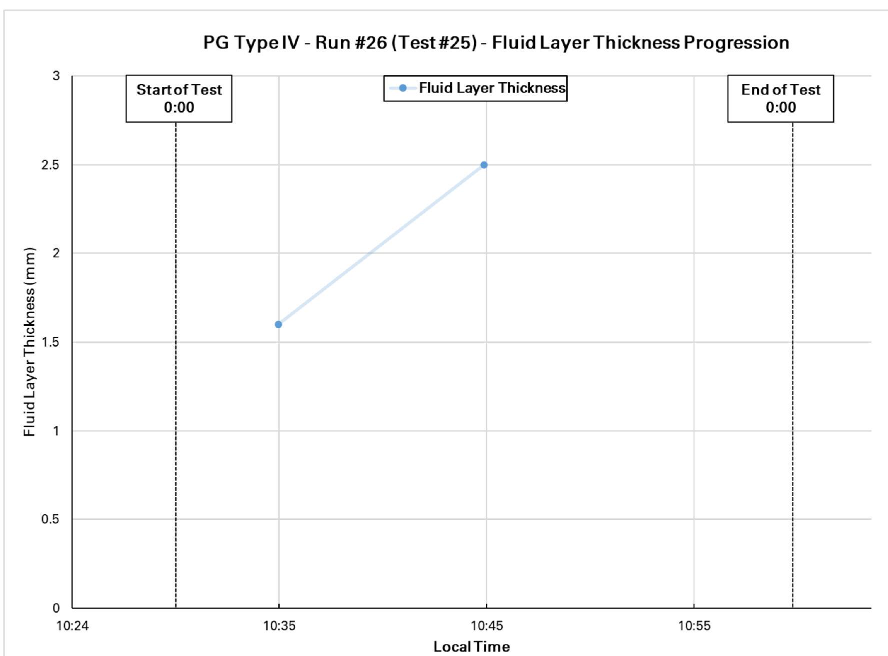
DATA PACKAGE – PG TYPE IV – RUN 26 (TEST 25)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 26 - Test 25/Data Package - PG Type IV - Run 26 - Test 25.docx
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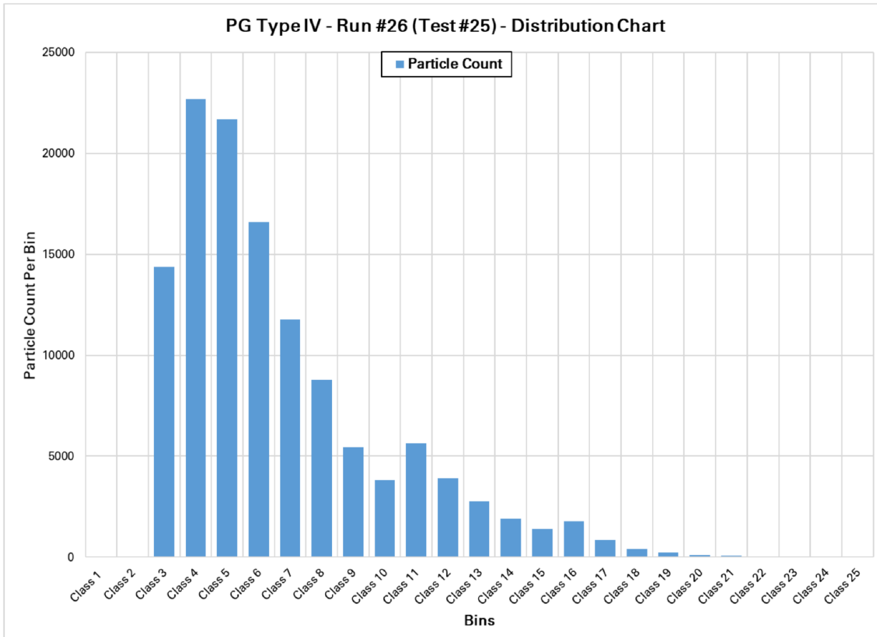
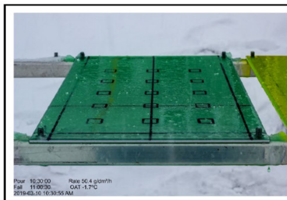
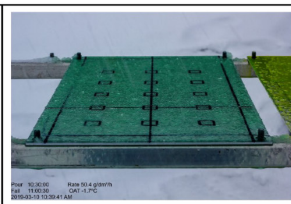


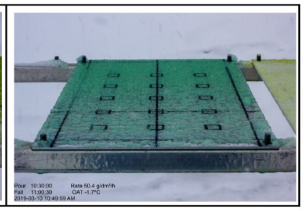
Polar Guard Advance – Run 26 (Test 25) – Failure Progression Photos



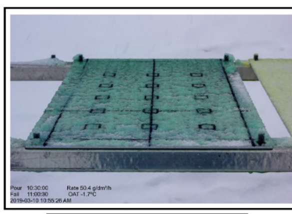
AT POUR (0/30 MIN)



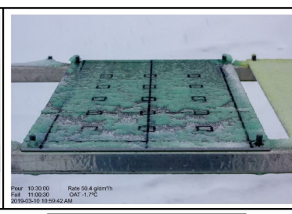
PRE-FAILURE (9/30 MIN)



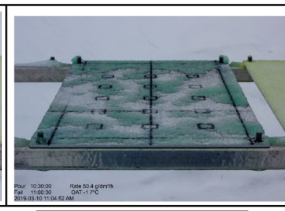
PRE-FAILURE (19/30 MIN)



PRE-FAILURE (25/30 MIN)

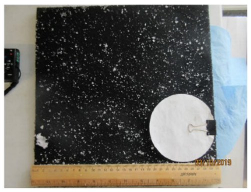


AT FAILURE (30/30 MIN)

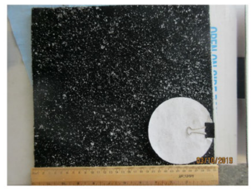


POST-FAILURE (34/30 MIN)

Polar Guard Advance – Run 26 (Test 25) – Snow Characteristics Photos



FELT PAD (1/30 MIN)



FELT PAD (21/30 MIN)

FELT PAD (37/30 MIN)

BARE PLATE (1/30 MIN)

BARE PLATE 20/30 MIN)

BARE PLATE (30/30 MIN)

Final Bare Plate Contamination Thickness: **Not taken**

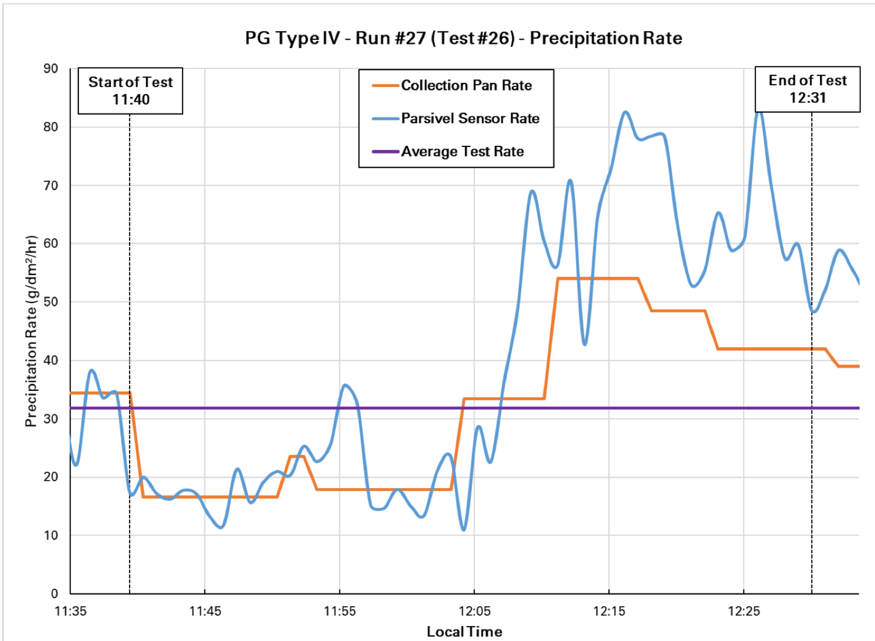
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

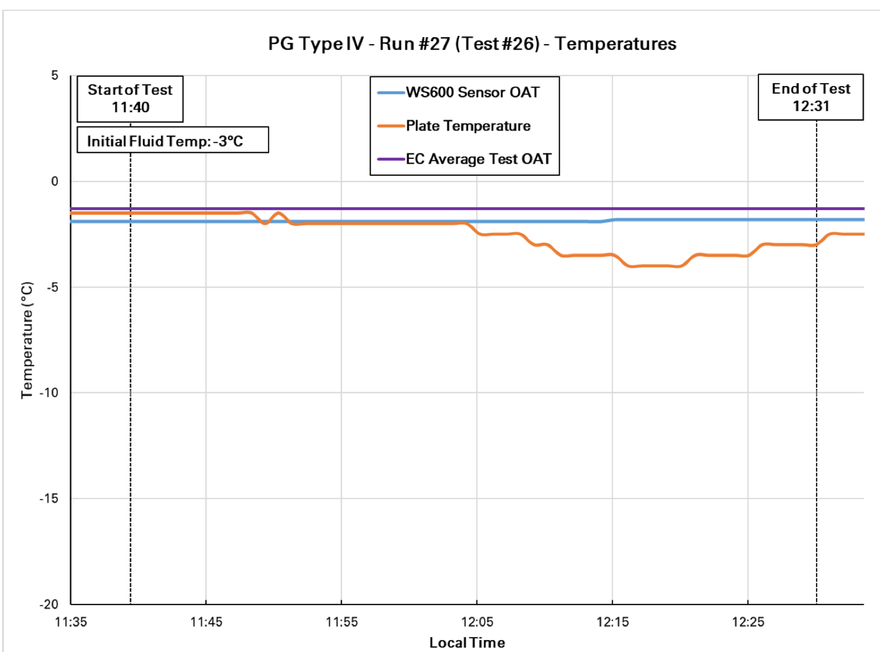
PG TYPE IV
RUN #27 (TEST #26) – PG4-26

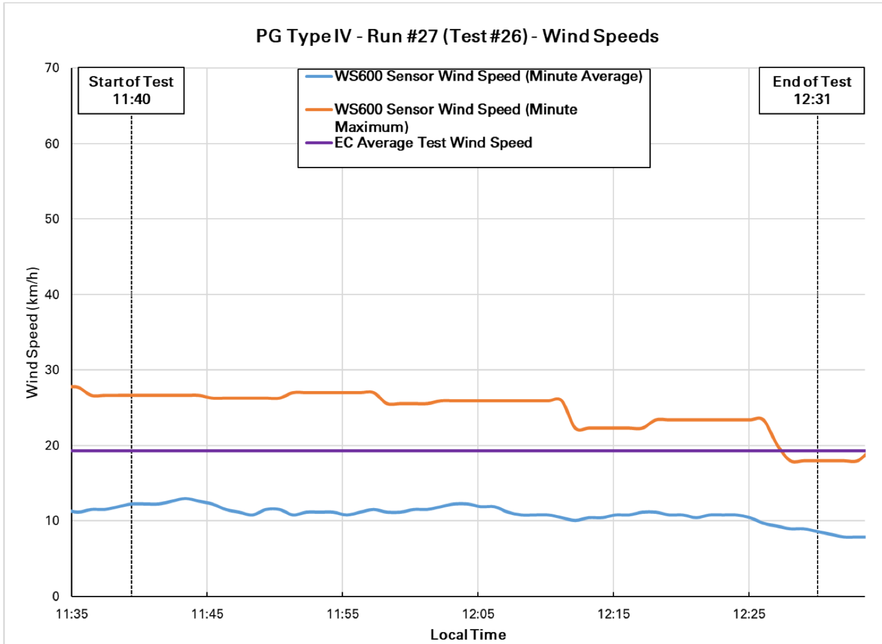
DATA PACKAGE – PG TYPE IV – RUN 27 (TEST 26)

PG Type IV – Run #27 (Test #26) – General Test Information

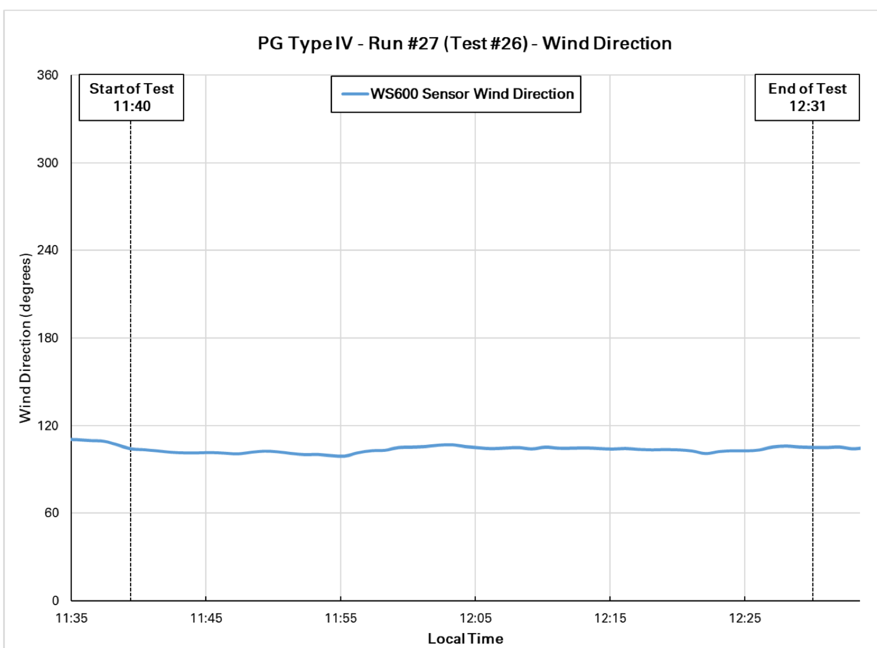
Test Number:	PG4-26
Date of Test:	March 10, 2019
Average OAT:	-1.3
Average Precipitation Rate:	31.8 g/dm²/h
Average Wind Speed:	19.3 km/h
Average Relative Humidity:	95.6%
Pour Time (Local):	11:40:00
Time of Fluid Failure (Local):	12:31:00
Fluid Brix at Failure:	10.75°
Endurance Time:	51 minutes
Expected Regression-Derived Endurance Time:	50 minutes
Difference (ET vs. Reg ET):	+1.8 minutes (+3.5%)


PG Type IV - Run #27 (Test #26) - Precipitation Rate
Start of Test 11:40
End of Test 12:31
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
80
90
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

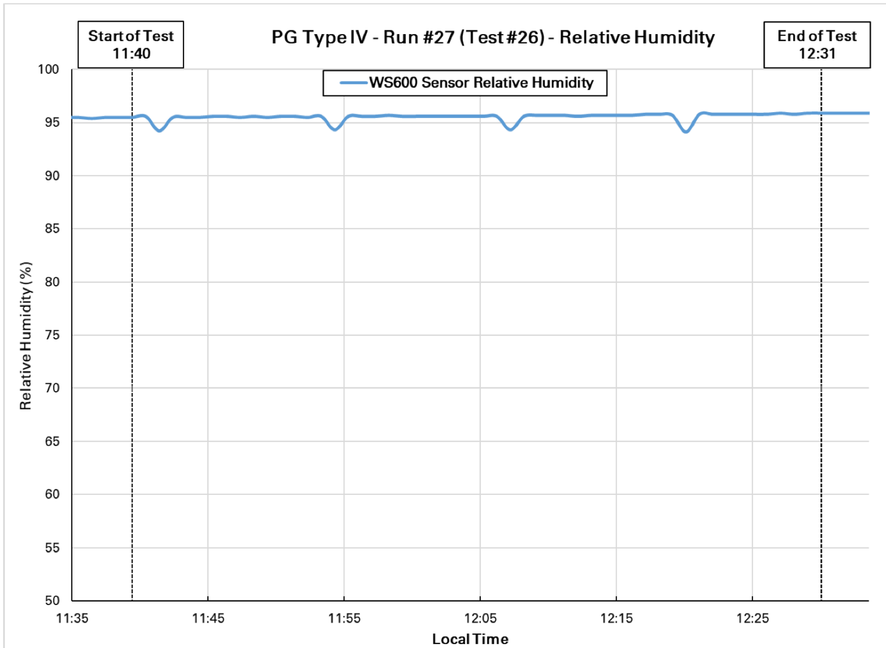

PG Type IV - Run #27 (Test #26) - Temperatures
Start of Test 11:40
Initial Fluid Temp: -3°C
End of Test 12:31
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
0
-5
-10
-15
-20
11:35
11:45
11:55
12:05
12:15
12:25
Local Time



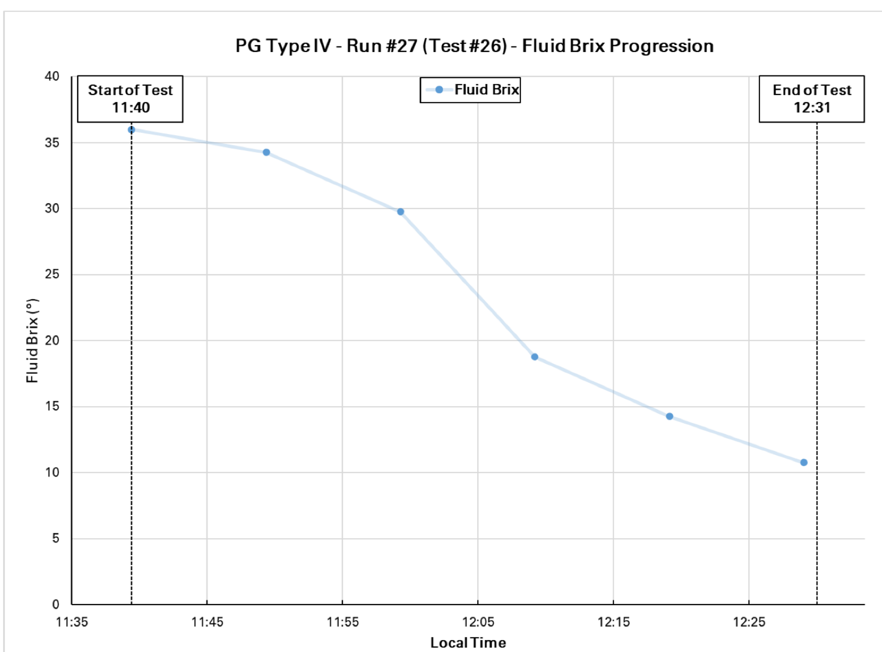
PG Type IV - Run #27 (Test #26) - Wind Speeds
Start of Test 11:40
End of Test 12:31
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
11:35
11:45
11:55
12:05
12:15
12:25
Local Time



PG Type IV - Run #27 (Test #26) - Wind Direction
Start of Test 11:40
End of Test 12:31
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

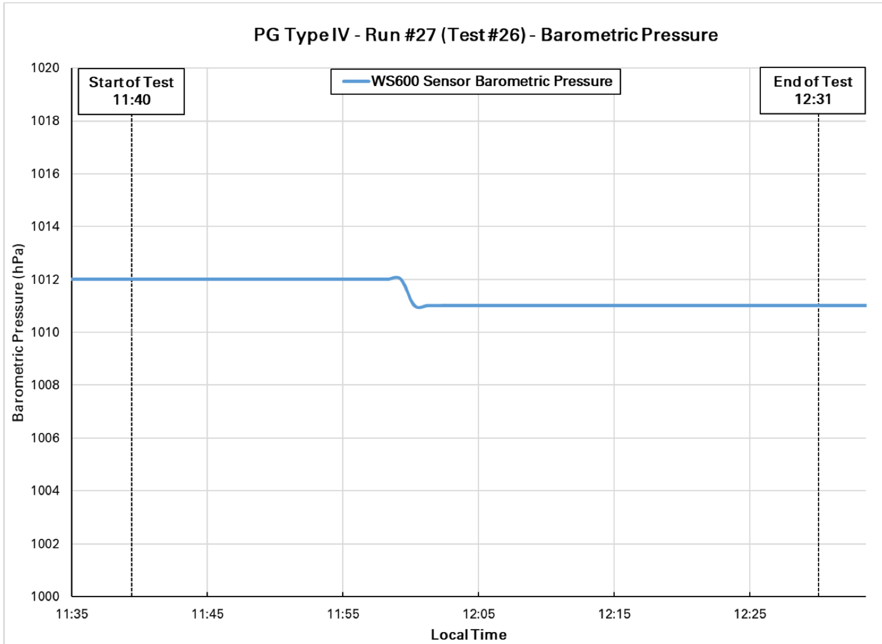


PG Type IV - Run #27 (Test #26) - Relative Humidity
Start of Test 11:40
End of Test 12:31
WS600 Sensor Relative Humidity
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
11:35
11:45
11:55
12:05
12:15
12:25
Local Time



PG Type IV - Run #27 (Test #26) - Fluid Brix Progression
Start of Test 11:40
End of Test 12:31
Fluid Brix
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
11:35
11:45
11:55
12:05
12:15
12:25
Local Time

DATA PACKAGE – PG TYPE IV – RUN 27 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 27 - Test 26/Data Package - PG Type IV - Run 27 - Test 26.docx
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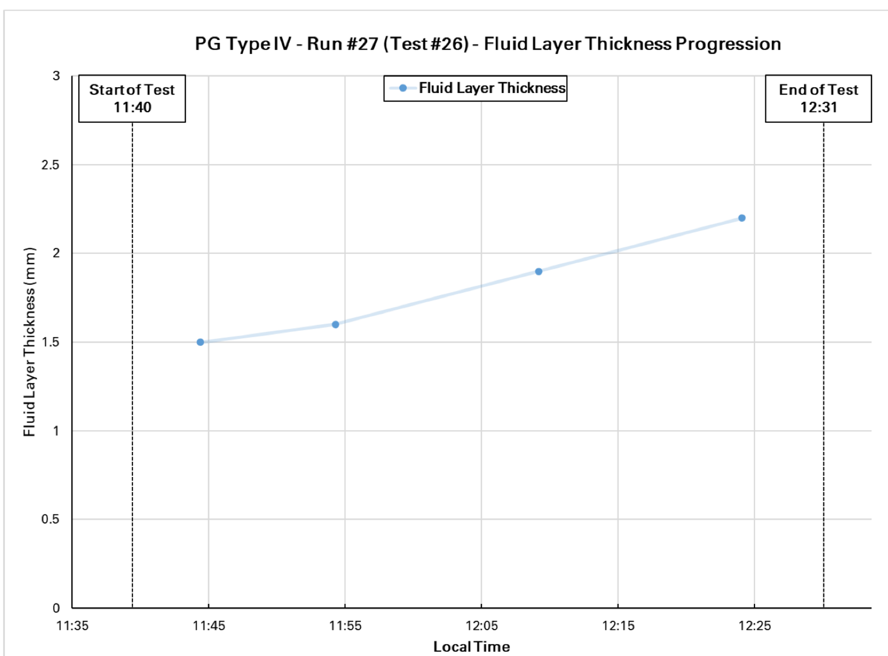
DATA PACKAGE – PG TYPE IV – RUN 27 (TEST 26)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 27 - Test 26/Data Package - PG Type IV - Run 27 - Test 26.docx
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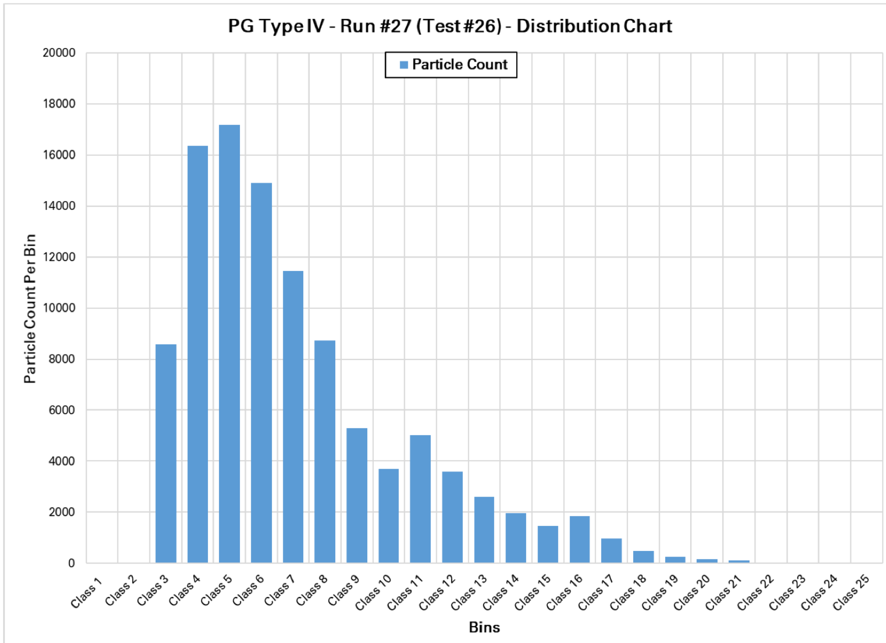
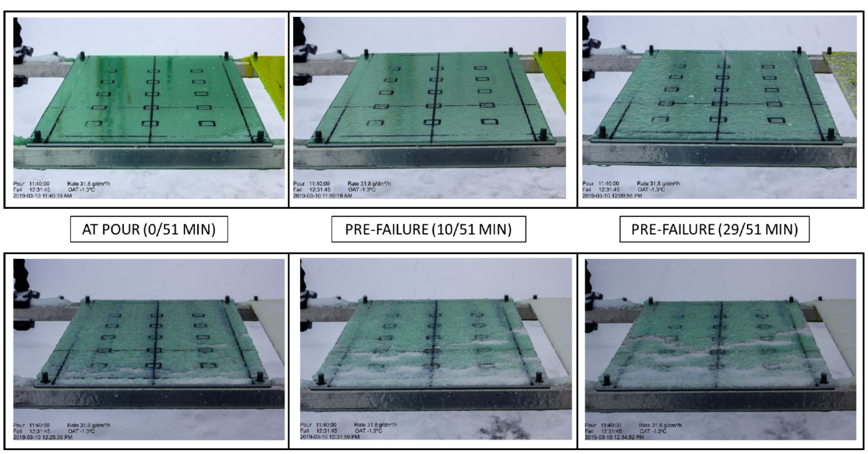


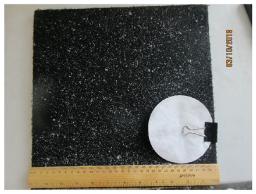
Polar Guard Advance – Run 27 (Test 26) – Failure Progression Photos



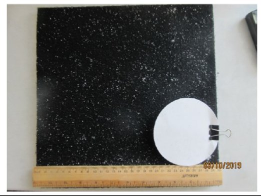
AT POUR (0/51 MIN) | PRE-FAILURE (10/51 MIN) | PRE-FAILURE (29/51 MIN)

PRE-FAILURE (45/51 MIN) | AT FAILURE (51/51 MIN) | POST-FAILURE (54/51 MIN)

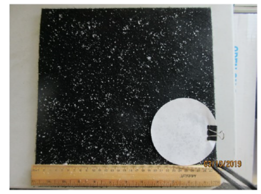
Polar Guard Advance – Run 27 (Test 26) – Snow Characteristics Photos



FELT PAD (1/51 MIN)

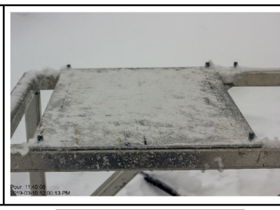


FELT PAD (21/51 MIN)

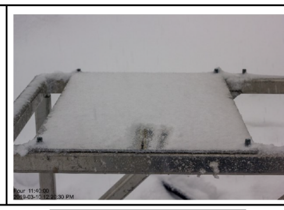


FELT PAD (41/51 MIN)

BARE PLATE (0/51 MIN)



BARE PLATE (20/51 MIN)



BARE PLATE (40/51 MIN)

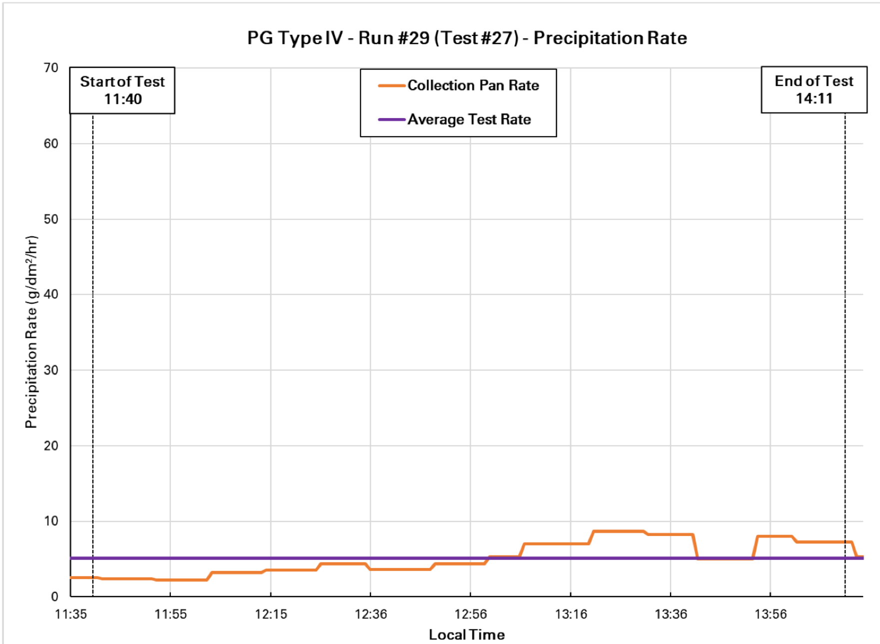
Final Bare Plate Contamination Thickness: **Not taken**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

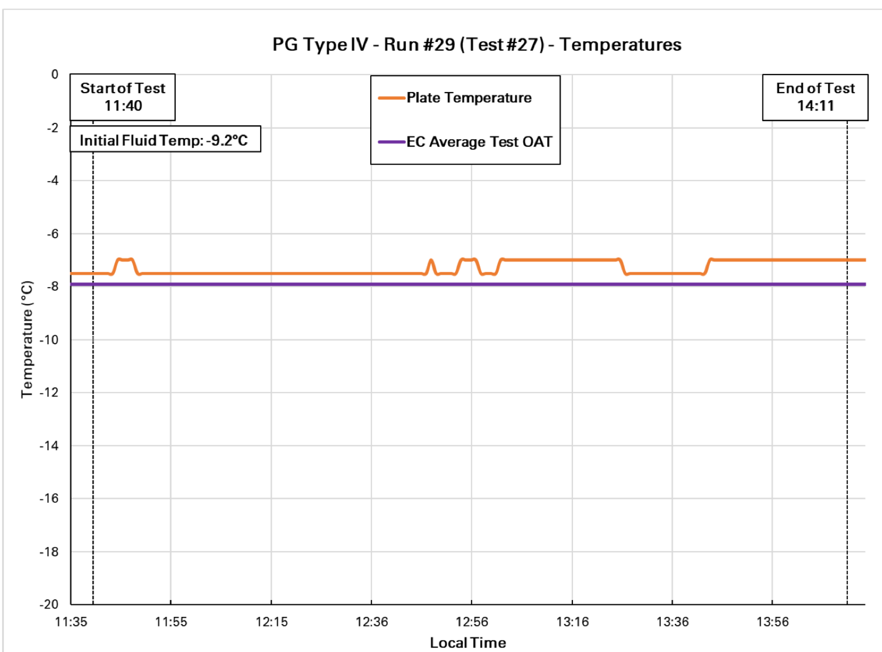
PG TYPE IV
RUN #29 (TEST #27) – TEST PG4-27

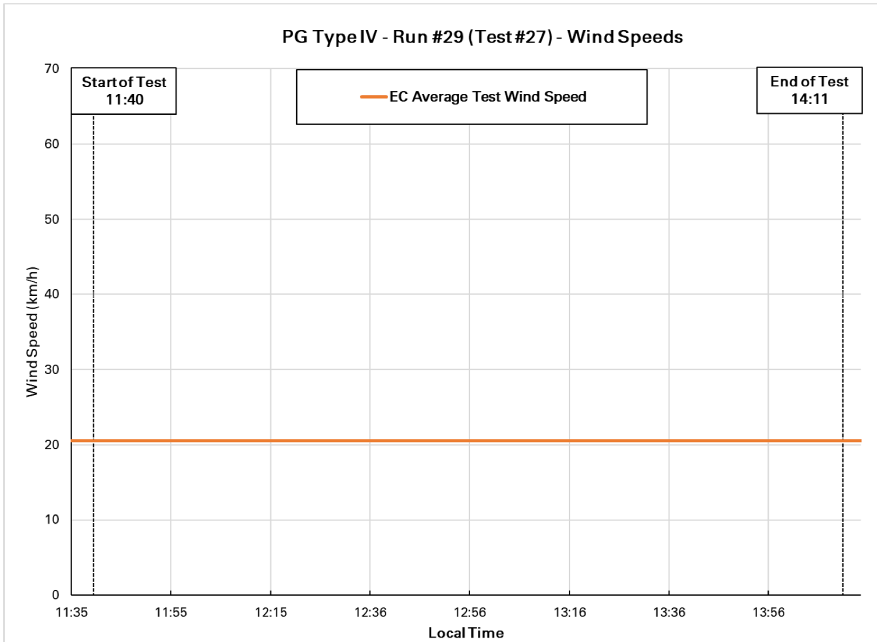
PG Type IV – Run #29 (Test #27) – General Test Information

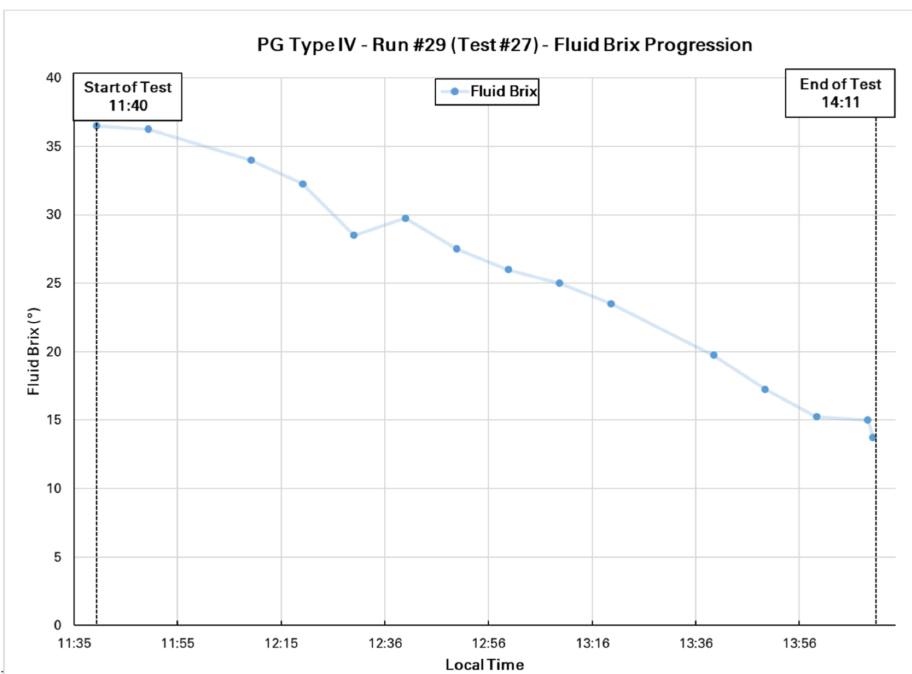
Test Number:	PG4-27
Date of Test:	January 6, 2020
Average OAT:	-7.9
Average Precipitation Rate:	5.1 g/dm²/h
Average Wind Speed:	20.5 km/h
Average Relative Humidity:	Not Available
Pour Time (Local):	11:40:00
Time of Fluid Failure (Local):	14:11:00
Fluid Brix at Failure:	13.75°
Endurance Time:	151 minutes
Expected Regression-Derived Endurance Time:	116.9 minutes
Difference (ET vs. Reg ET):	+34.7 minutes (+29.7%)



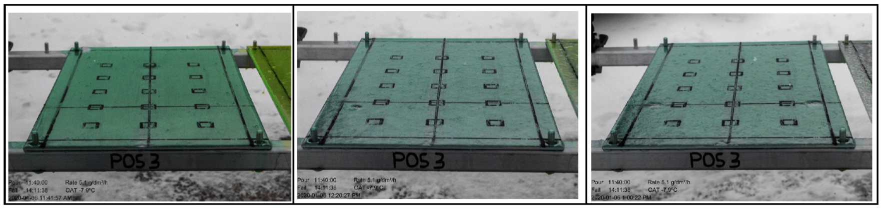
DATA PACKAGE – PG TYPE IV – RUN 29 (TEST 27)



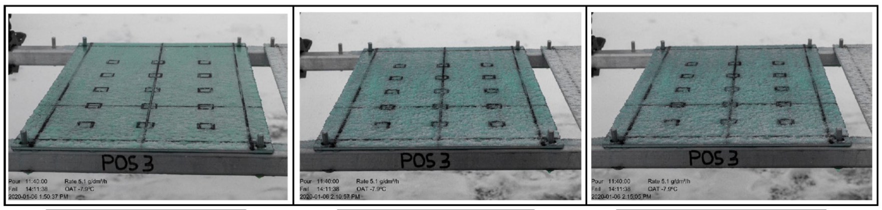

PG Type IV - Run #29 (Test #27) - Wind Speeds
Start of Test 11:40
EC Average Test Wind Speed
End of Test 14:11
Wind Speed (km/h)
0
10
20
30
40
50
60
70
11:35
11:55
12:15
12:36
12:56
13:16
13:36
13:56
Local Time


PG Type IV - Run #29 (Test #27) - Fluid Brix Progression
Start of Test 11:40
Fluid Brix
End of Test 14:11
Fluid Brix (°)
0
5
10
15
20
25
30
35
40
11:35
11:55
12:15
12:36
12:56
13:16
13:36
13:56
Local Time

Polar Guard Advance – Run 29 (Test 27) – Failure Progression Photos

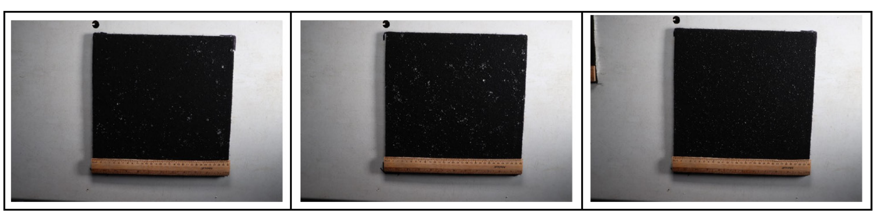


AT POUR (0/151 MIN) | PRE-FAILURE (40/151 MIN) | PRE-FAILURE (80/151 MIN)

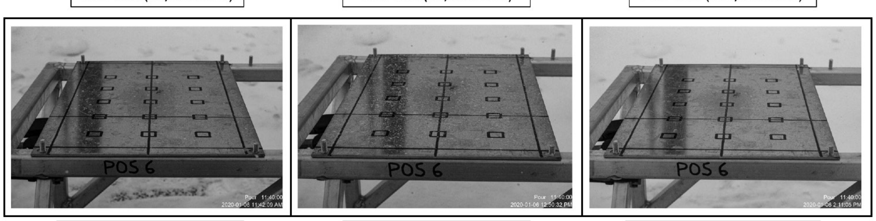


PRE-FAILURE (130/151 MIN) | AT FAILURE (151/151 MIN) | POST-FAILURE (155/151 MIN)

Polar Guard Advance – Run 29 (Test 27) – Snow Characteristics Photos



FELT PAD (10/151 MIN) | FELT PAD (80/151 MIN) | FELT PAD (130/151 MIN)



BARE PLATE (2/151 MIN) | BARE PLATE (70/151 MIN) | BARE PLATE (151/151 MIN)

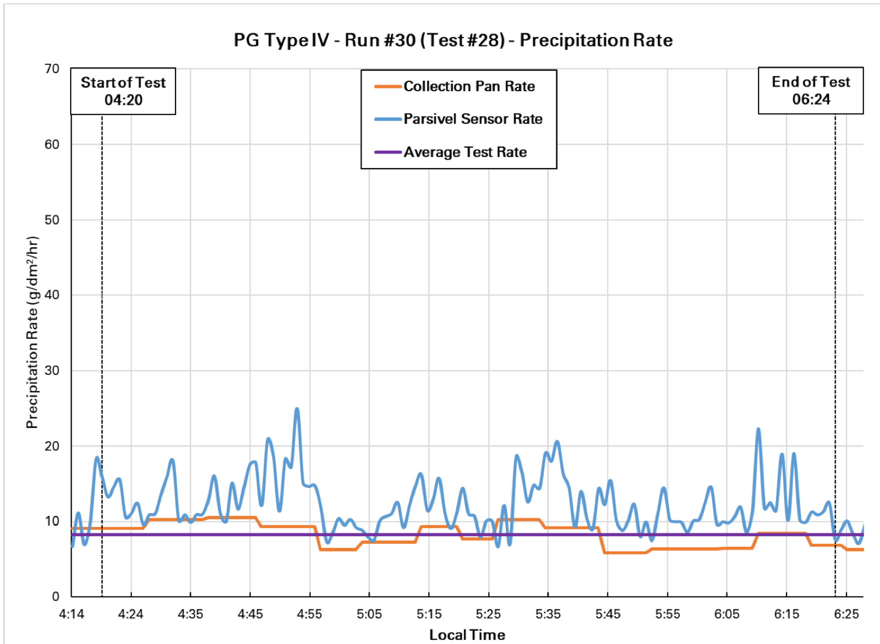
Final Bare Plate Contamination Thickness: **Nil (0mm)**

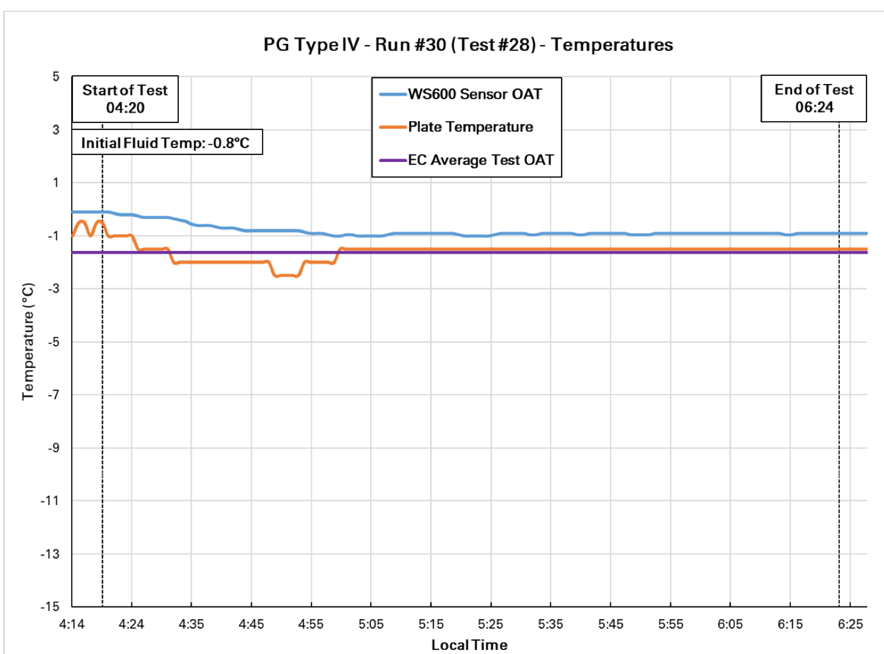
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #30 (TEST #28) PG4-28

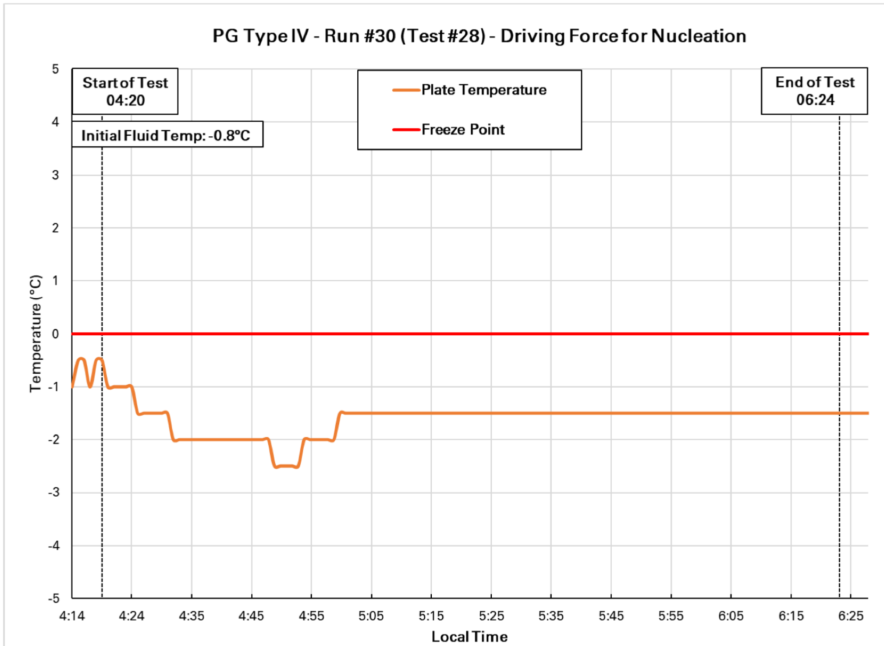
PG Type IV – Run #30 (Test #28) – General Test Information

Test Number:	PG4-28
Date of Test:	January 16, 2020
Average OAT:	-1.6
Average Precipitation Rate:	8.3 g/dm²/h
Average Wind Speed:	13.2 km/h
Average Relative Humidity:	90.7%
Pour Time (Local):	04:20:00
Time of Fluid Failure (Local):	06:24:00
Fluid Brix at Failure:	7.5°
Endurance Time:	124 minutes
Expected Regression-Derived Endurance Time:	140.9 minutes
Difference (ET vs. Reg ET):	- 16.8 minutes (- 11.9%)


PG Type IV - Run #30 (Test #28) - Precipitation Rate
Start of Test 04:20
End of Test 06:24
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
Local Time


PG Type IV - Run #30 (Test #28) - Temperatures
Start of Test 04:20
Initial Fluid Temp: -0.8°C
End of Test 06:24
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
Local Time

DATA PACKAGE – PG TYPE IV – RUN 30 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 30 - Test 28/Data Package - PG Type IV - Run 30 - Test 28.docx
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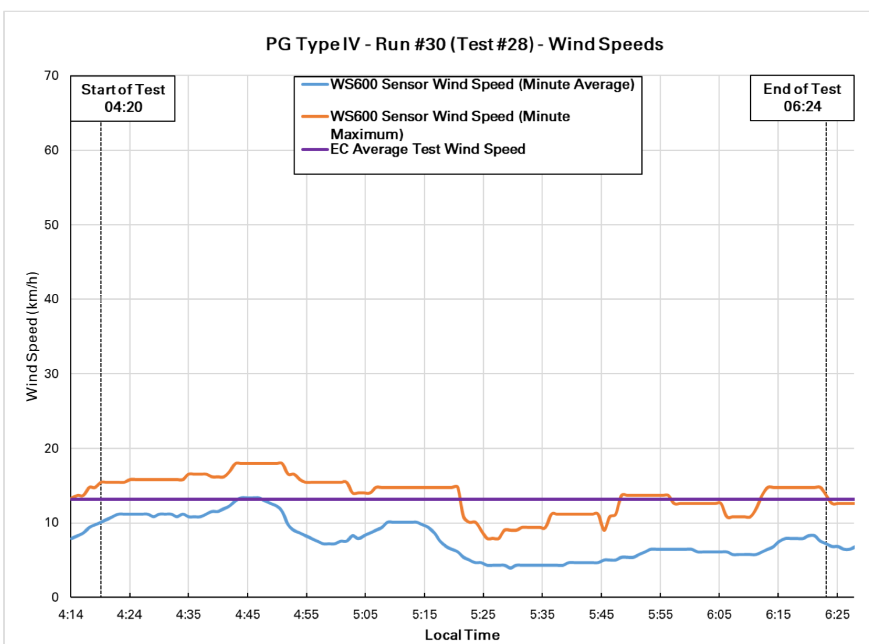
DATA PACKAGE – PG TYPE IV – RUN 30 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 30 - Test 28/Data Package - PG Type IV - Run 30 - Test 28.docx
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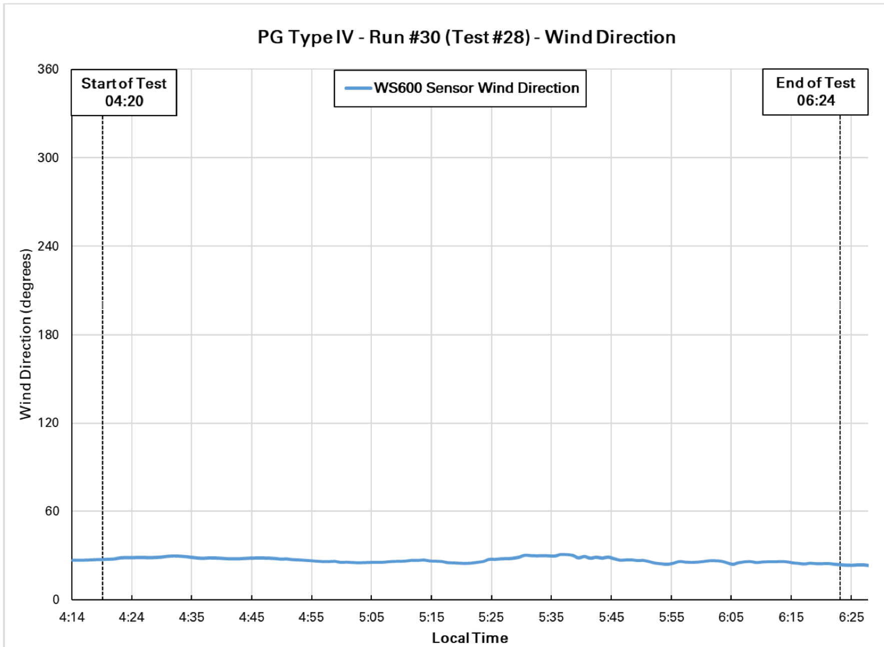
DATA PACKAGE – PG TYPE IV – RUN 30 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 30 - Test 28/Data Package - PG Type IV - Run 30 - Test 28.docx
Final Version 1.0, March 2021

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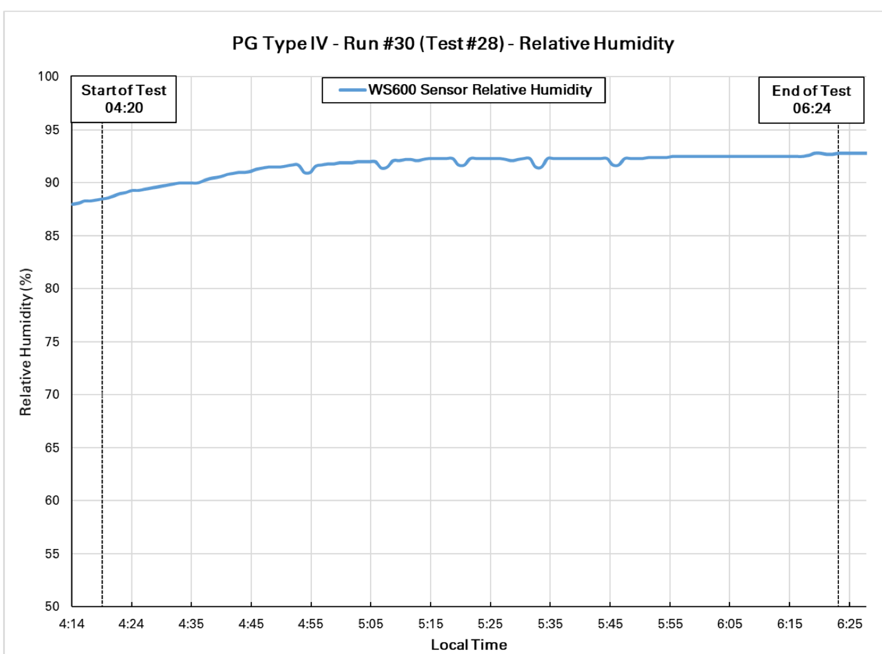
DATA PACKAGE – PG TYPE IV – RUN 30 (TEST 28)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 30 - Test 28/Data Package - PG Type IV - Run 30 - Test 28.docx
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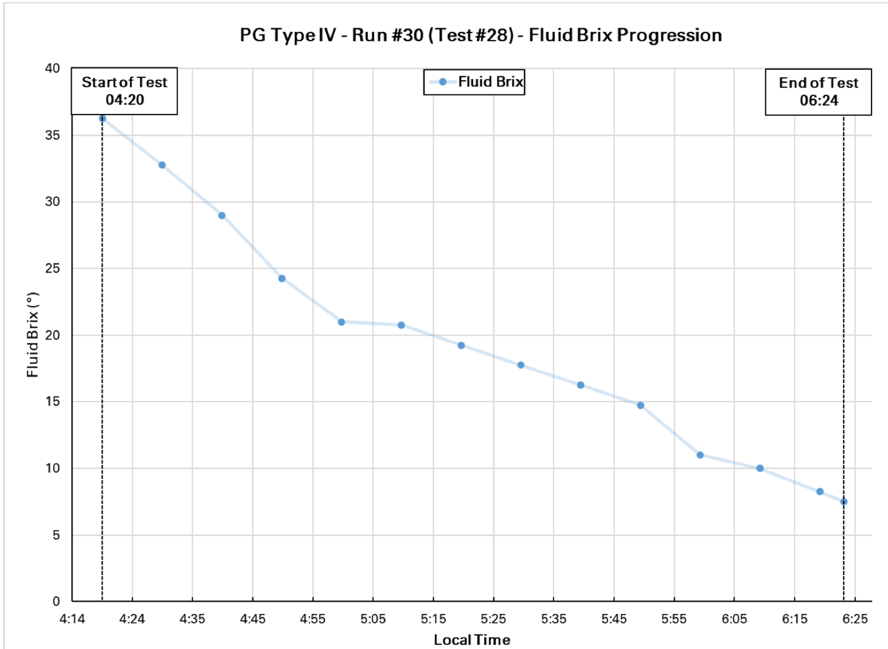
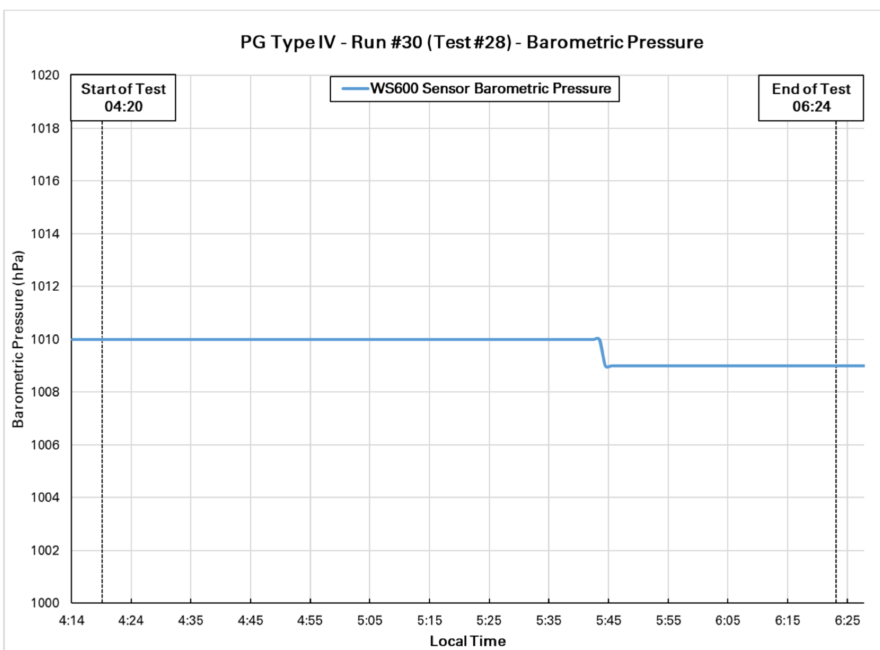
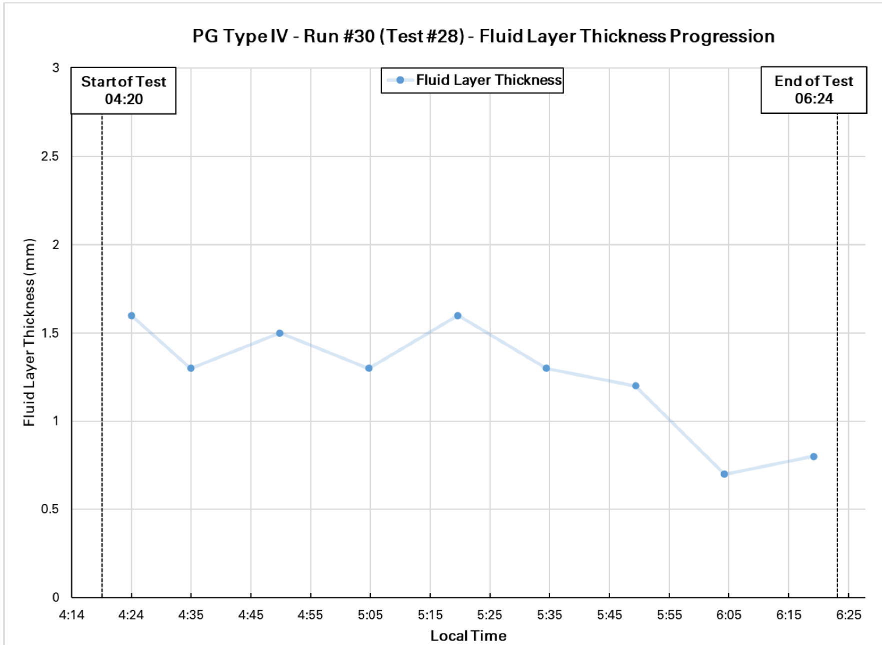
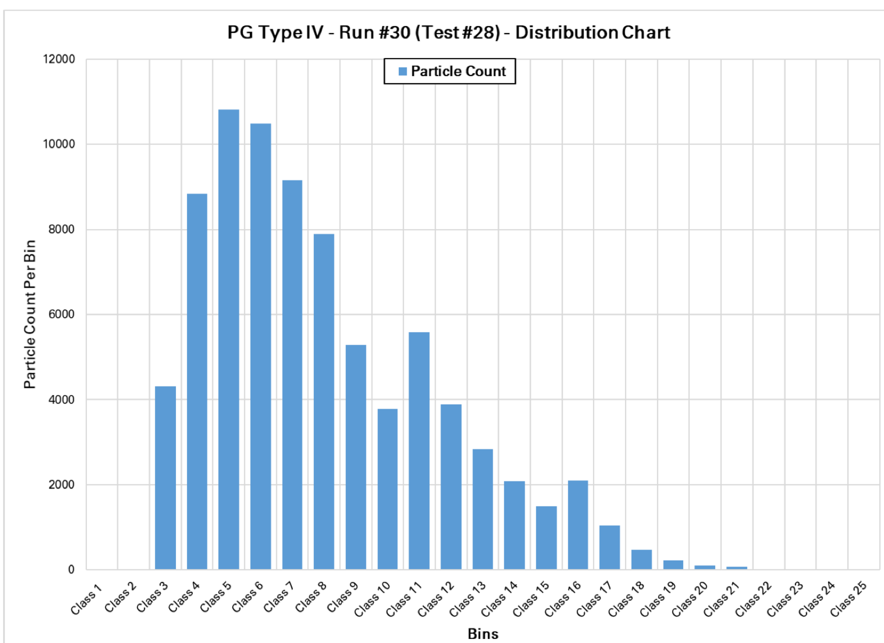


PG Type IV - Run #30 (Test #28) - Fluid Brix Progression
Start of Test
04:20
Fluid Brix
End of Test
06:24
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
Local Time

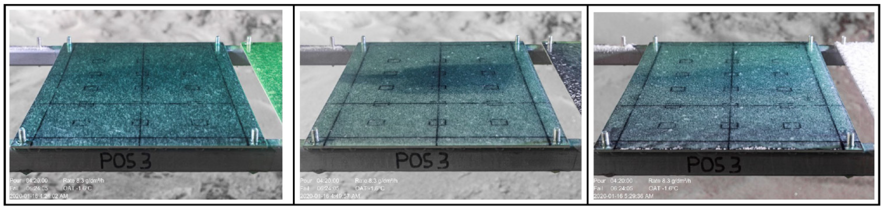


PG Type IV - Run #30 (Test #28) - Barometric Pressure
Start of Test
04:20
WS600 Sensor Barometric Pressure
End of Test
06:24
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25
Local Time

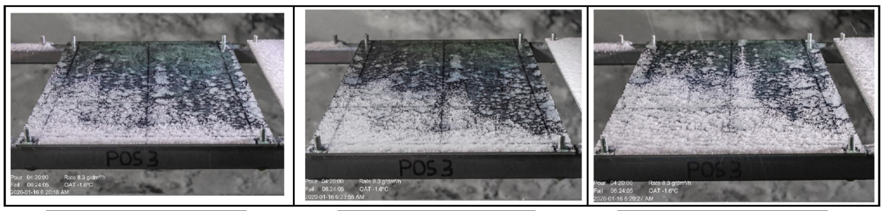

PG Type IV - Run #30 (Test #28) - Fluid Layer Thickness Progression
Start of Test 04:20
Fluid Layer Thickness
End of Test 06:24
Fluid Layer Thickness (mm)
Local Time
3
2.5
2
1.5
1
0.5
0
4:14
4:24
4:35
4:45
4:55
5:05
5:15
5:25
5:35
5:45
5:55
6:05
6:15
6:25


PG Type IV - Run #30 (Test #28) - Distribution Chart
Particle Count
Particle Count Per Bin
Bins
12000
10000
8000
6000
4000
2000
0
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
Class 9
Class 10
Class 11
Class 12
Class 13
Class 14
Class 15
Class 16
Class 17
Class 18
Class 19
Class 20
Class 21
Class 22
Class 23
Class 24
Class 25

Polar Guard Advance - Run 30 (Test 28) – Failure Progression Photos

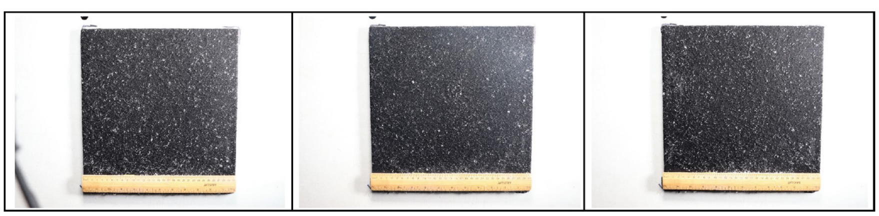


AT POUR (4/124 MIN) | PRE-FAILURE (29/124 MIN) | PRE-FAILURE (69/124 MIN)

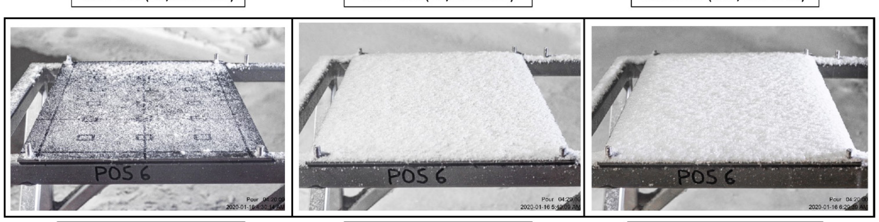


PRE-FAILURE (120/124 MIN) | AT FAILURE (123/124 MIN) | POST-FAILURE (129/124 MIN)

Polar Guard Advance - Run 30 (Test 28) – Snow Characteristics Photos



FELT PAD (20/124 MIN) | FELT PAD (50/124 MIN) | FELT PAD (101/124 MIN)



BARE PLATE (10/124 MIN) | BARE PLATE (80/124 MIN) | BARE PLATE (129/124 MIN)

Final Bare Plate Contamination Thickness: **1.25 mm**

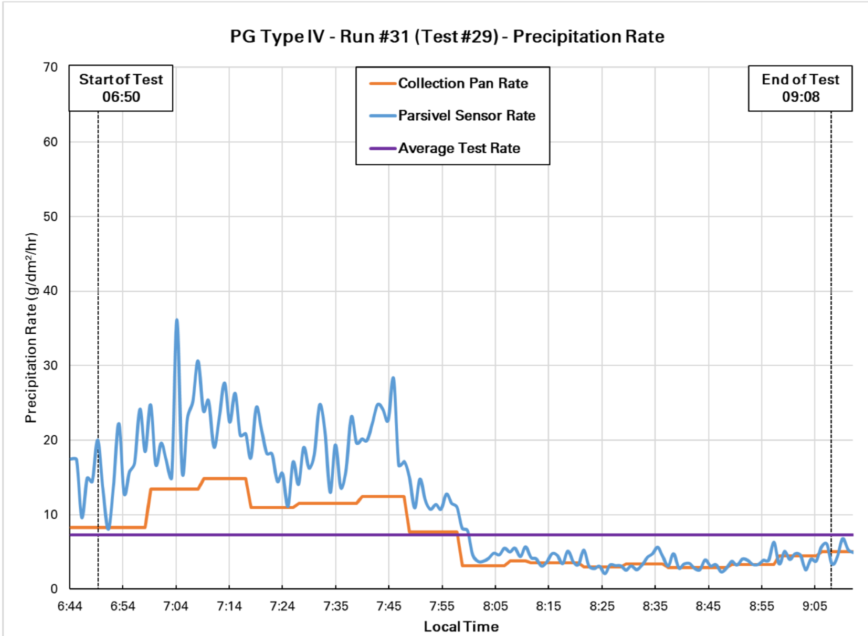
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #31 (TEST #29) – TEST PG4-29

PG Type IV – Run #31 (Test #29) – General Test Information

Test Number:	**PG4-29**
Date of Test:	**January 16, 2020**
Average OAT:	**-1.9**
Average Precipitation Rate:	**7.3 g/dm²/h**
Average Wind Speed:	**12.7 km/h**
Average Relative Humidity:	**92.9%**
Pour Time (Local):	**06:50:00**
Time of Fluid Failure (Local):	**09:08:00**
Fluid Brix at Failure:	**7°**
Endurance Time:	**138 minutes**
Expected Regression-Derived Endurance Time:	**149.7 minutes**
Difference (ET vs. Reg ET):	**- 10.8 minutes (- 7.2%)**

DATA PACKAGE – PG TYPE IV – RUN 31 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 31 - Test 29/Data Package - PG Type IV - Run 31 - Test 29.docx
Final Version 1.0, March 2021

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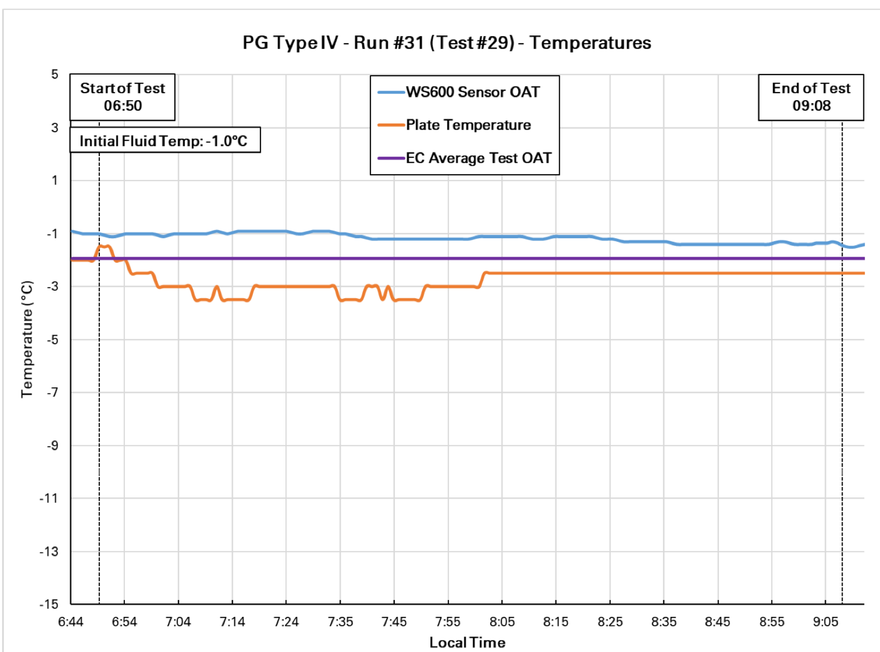
DATA PACKAGE – PG TYPE IV – RUN 31 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 31 - Test 29/Data Package - PG Type IV - Run 31 - Test 29.docx
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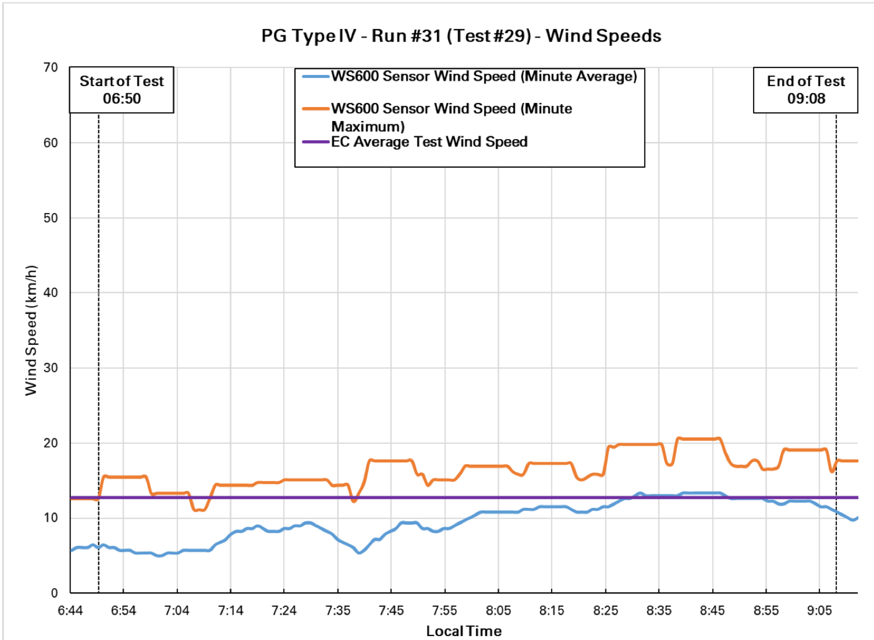
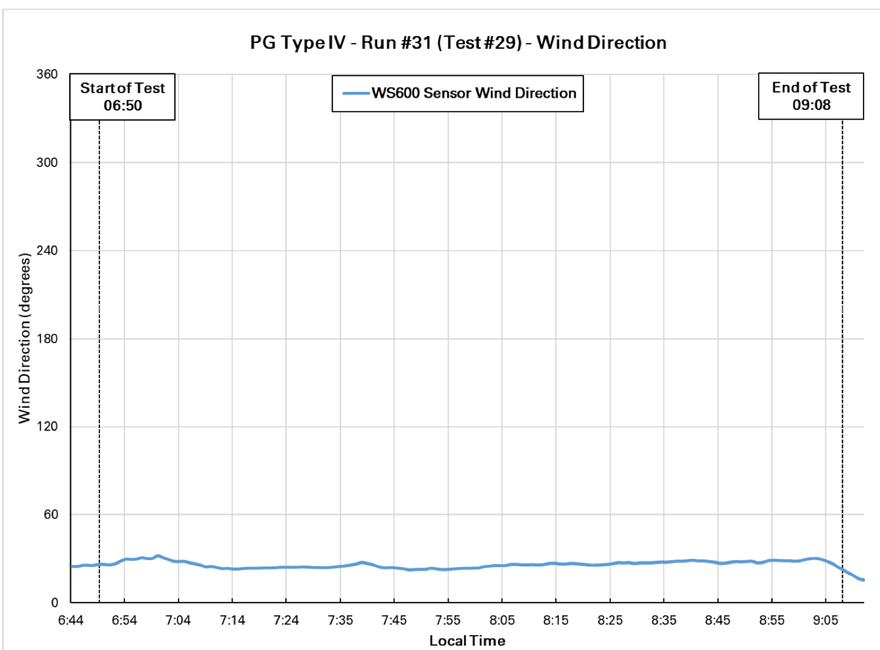
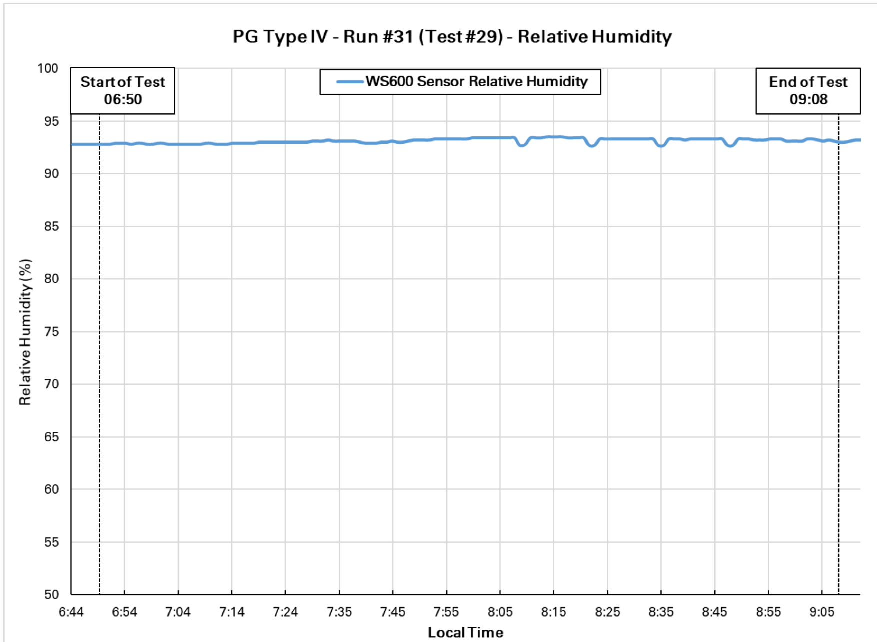


DATA PACKAGE – PG TYPE IV – RUN 31 (TEST 29)



DATA PACKAGE – PG TYPE IV – RUN 31 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 31 - Test 29/Data Package - PG Type IV - Run 31 - Test 29.docx
Final Version 1.0, March 2021

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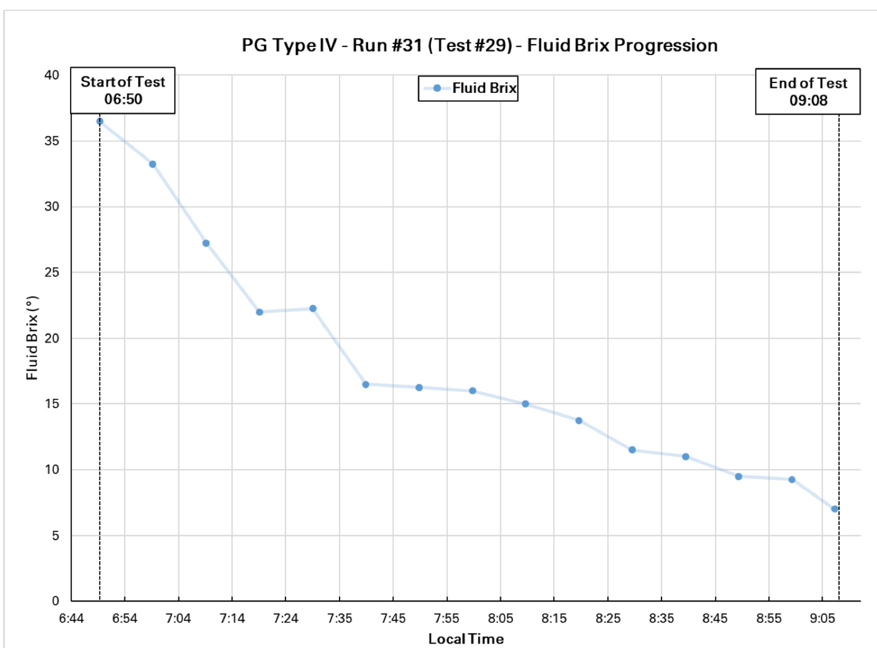
DATA PACKAGE – PG TYPE IV – RUN 31 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 31 - Test 29/Data Package - PG Type IV - Run 31 - Test 29.docx
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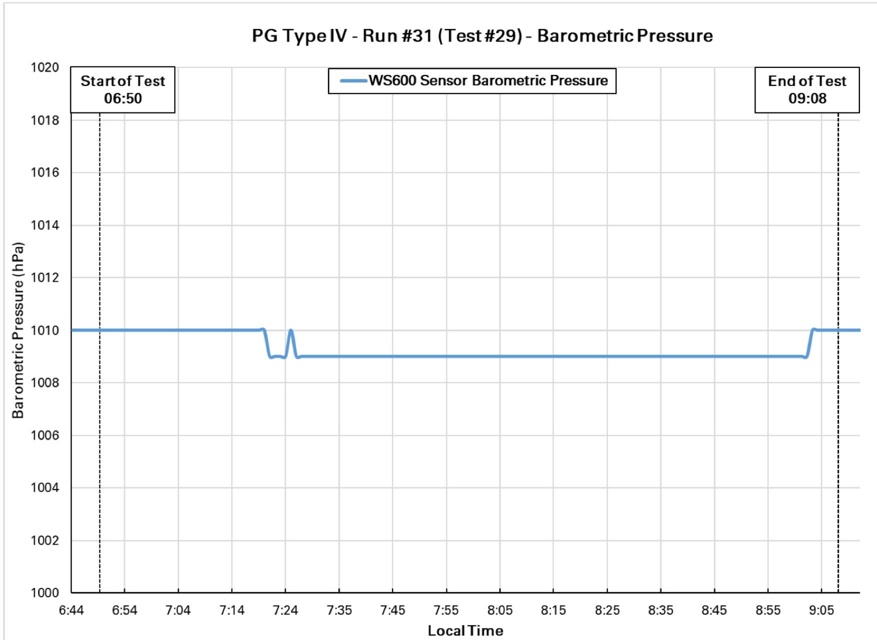

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 31 - Test 29/Data Package - PG Type IV - Run 31 - Test 29.docx
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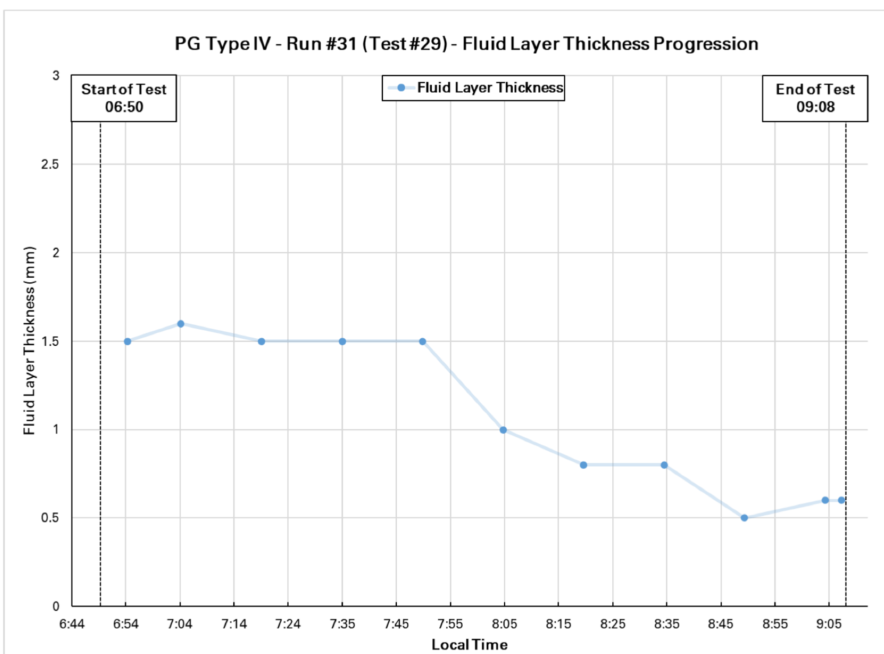
DATA PACKAGE – PG TYPE IV – RUN 31 (TEST 29)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 31 - Test 29/Data Package - PG Type IV - Run 31 - Test 29.docx
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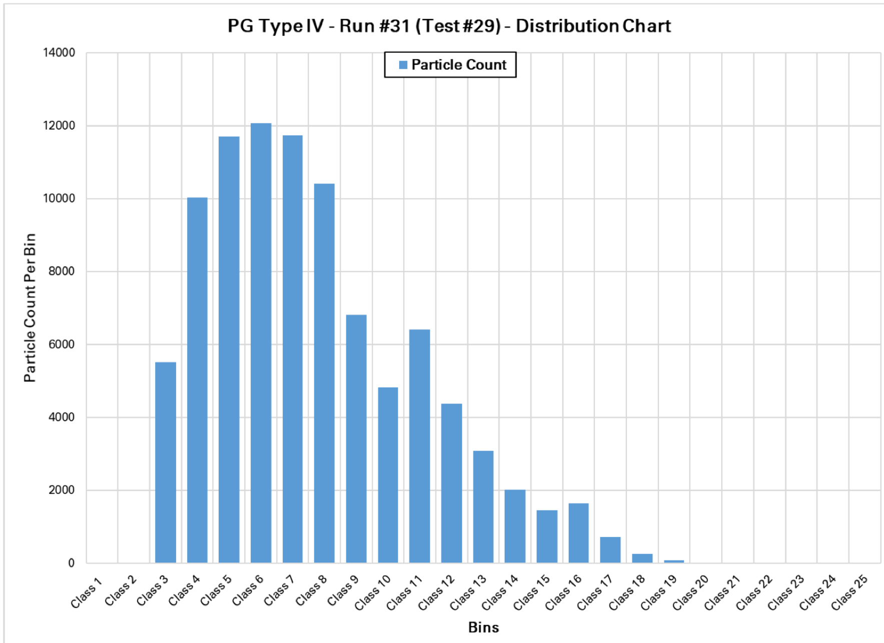
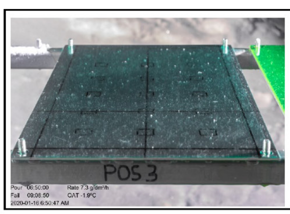
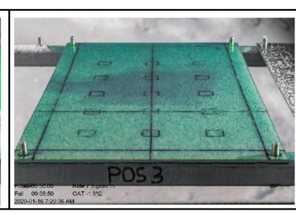


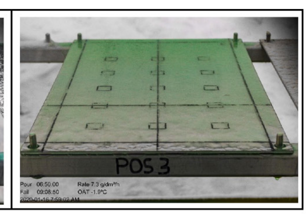
Polar Guard Advance – Run 31 (Test 29) – Failure Progression Photos



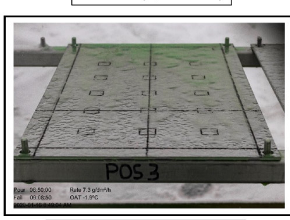
AT POUR (0/138 MIN)



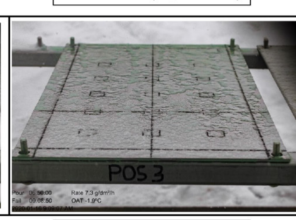
PRE-FAILURE (30/138 MIN)



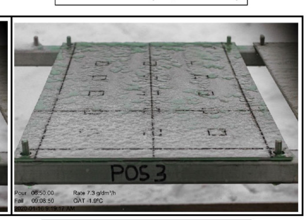
PRE-FAILURE (69/138 MIN)



PRE-FAILURE (119/138 MIN)

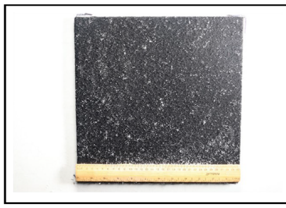


AT FAILURE (138/138 MIN)

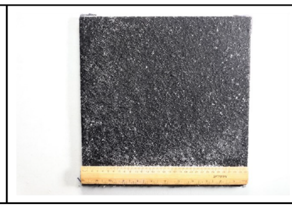


POST-FAILURE (149/138 MIN)

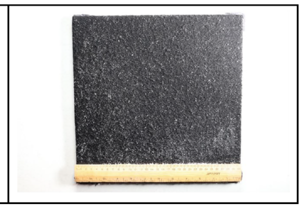
Polar Guard Advance – Run 31 (Test 29) – Snow Characteristics Photos



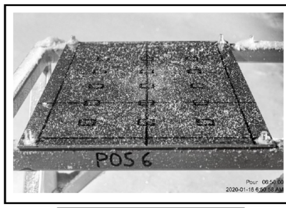
FELT PAD (2/138 MIN)



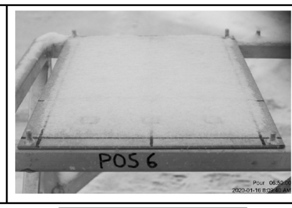
FELT PAD (60/138 MIN)



FELT PAD (120/138 MIN)



BARE PLATE (0/138 MIN)



BARE PLATE (79/138 MIN)

BARE PLATE (139/138 MIN)

Final Bare Plate Contamination Thickness: **0.3mm**

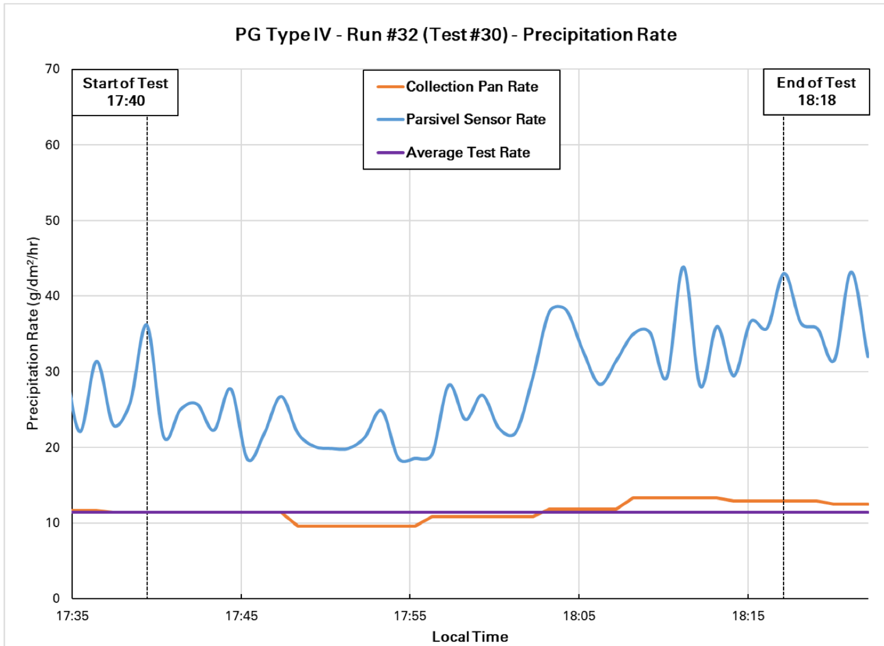
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #32 (TEST #30) – PG4-30

PG Type IV – Run #32 (Test #30) – General Test Information

Test Number:	PG4-30
Date of Test:	January 18, 2020
Average OAT:	-15.1
Average Precipitation Rate:	11.4 g/dm²/h
Average Wind Speed:	29.0 km/h
Average Relative Humidity:	75.2%
Pour Time (Local):	17:40:00
Time of Fluid Failure (Local):	18:18:00
Fluid Brix at Failure:	24.5°
Endurance Time:	38 minutes
Expected Regression-Derived Endurance Time:	44.1 minutes
Difference (ET vs. Reg ET):	- 6.1 minutes (- 13.9%)

DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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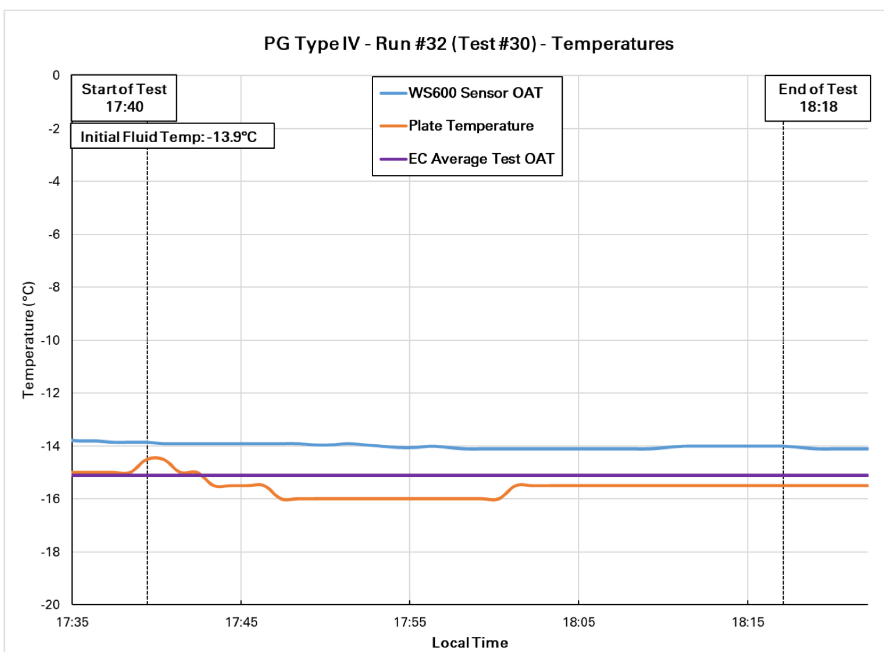
DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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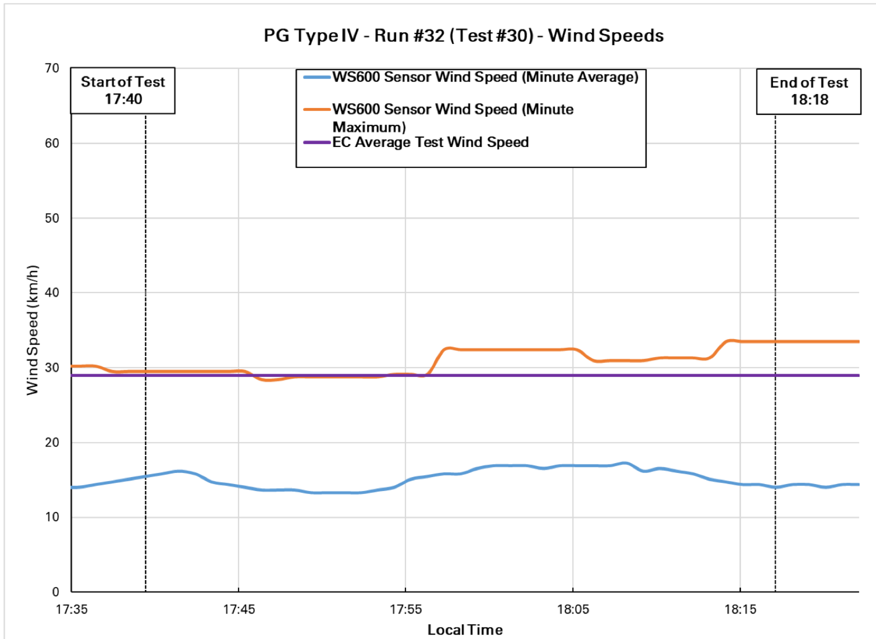
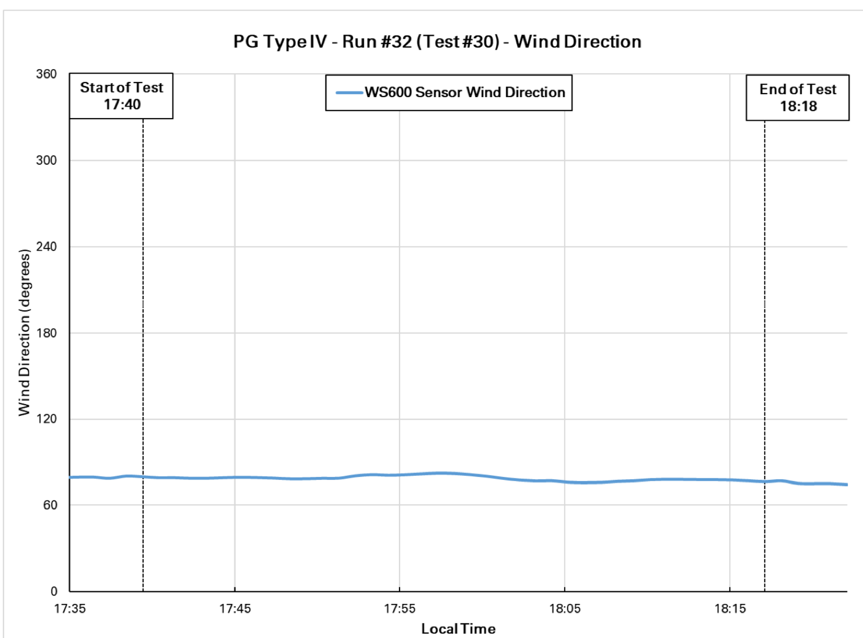
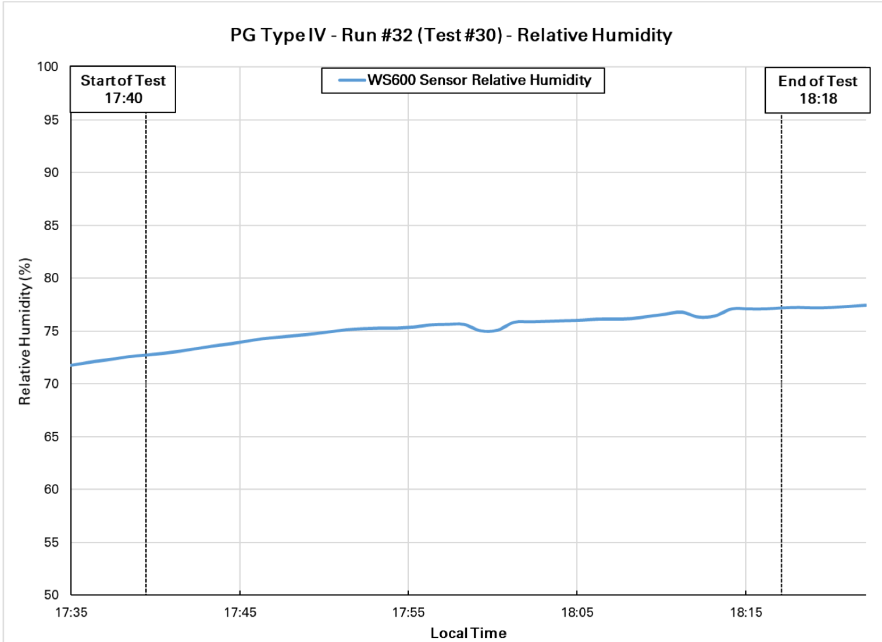

PG Type IV - Run #32 (Test #30) - Wind Speeds
Start of Test 17:40
End of Test 18:18
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
17:35
17:45
17:55
18:05
18:15


PG Type IV - Run #32 (Test #30) - Wind Direction
Start of Test 17:40
End of Test 18:18
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
17:35
17:45
17:55
18:05
18:15

DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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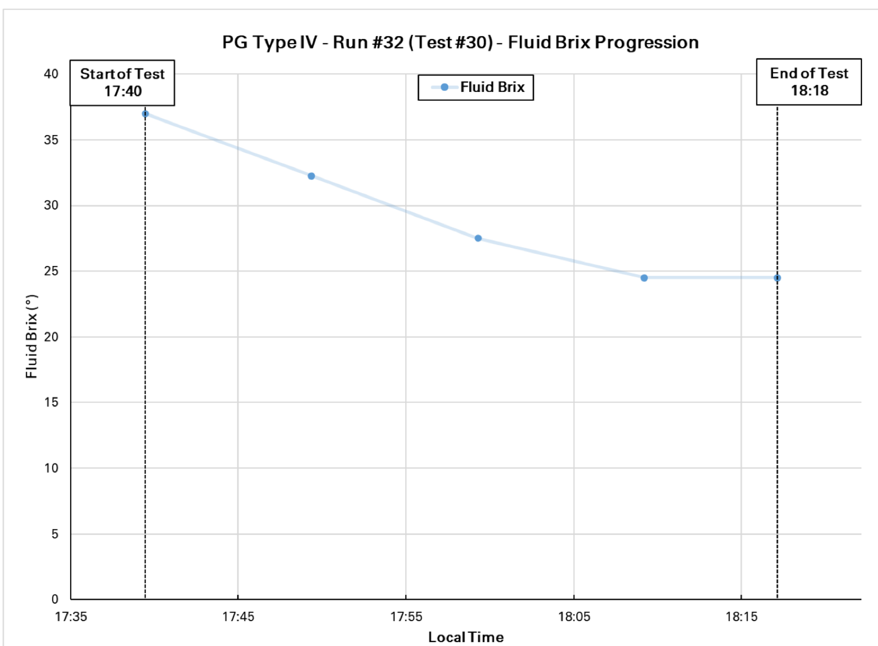
DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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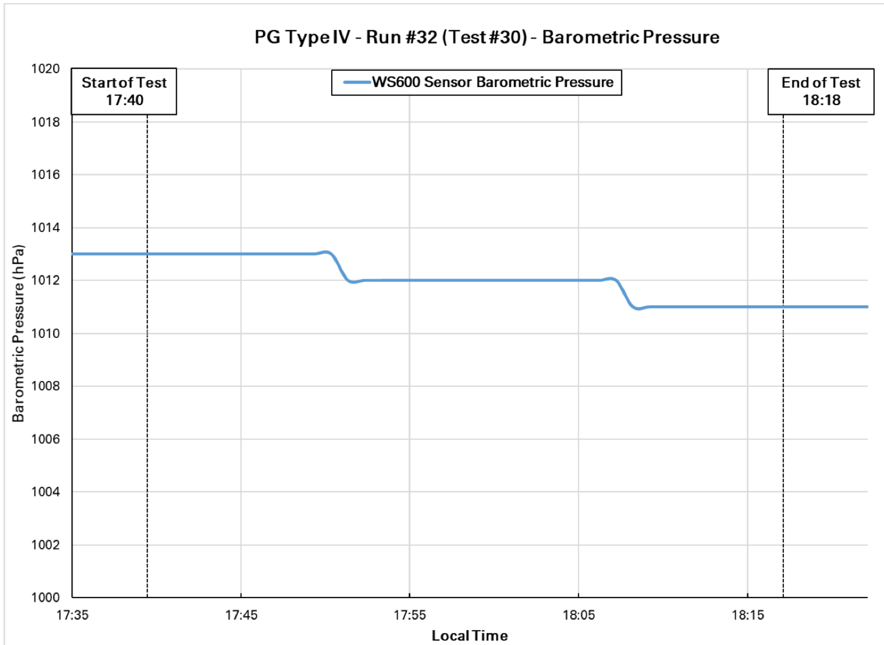
DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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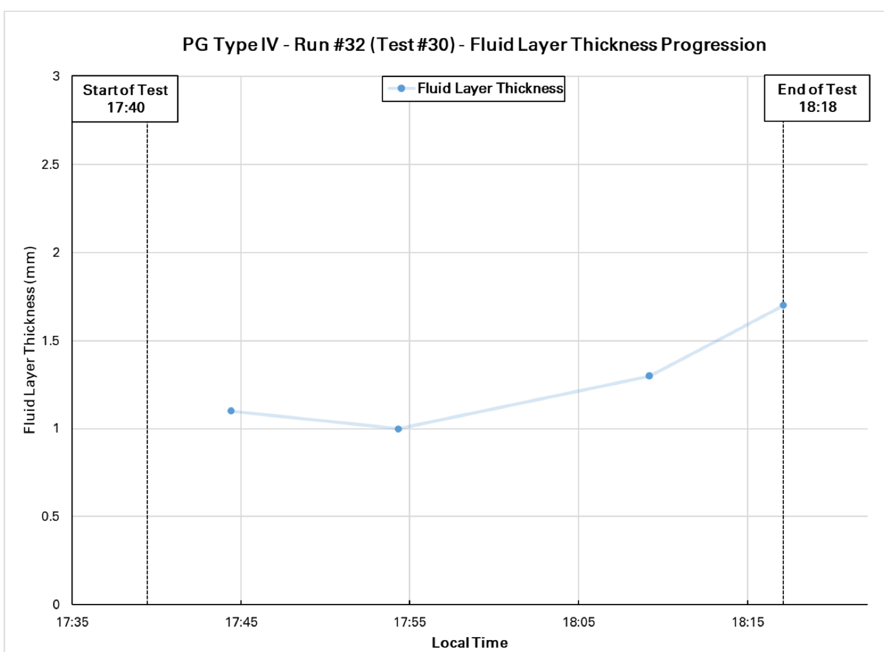
DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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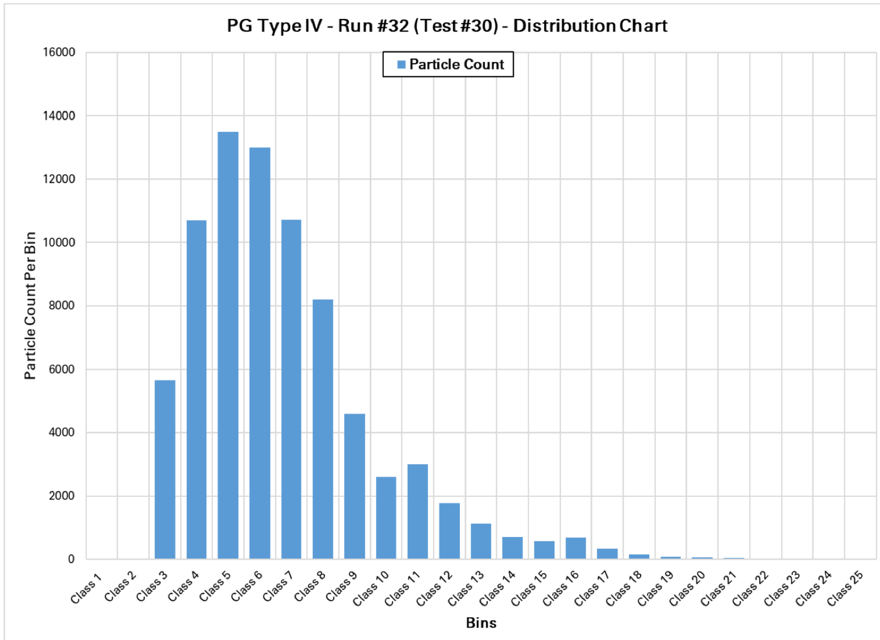
DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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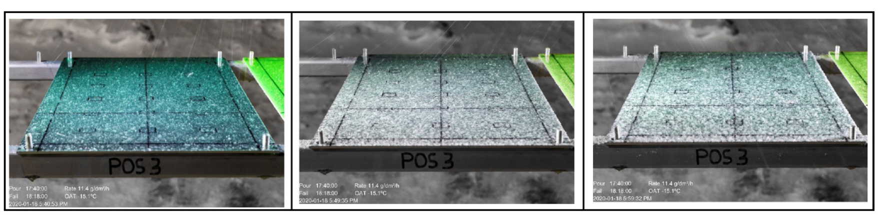
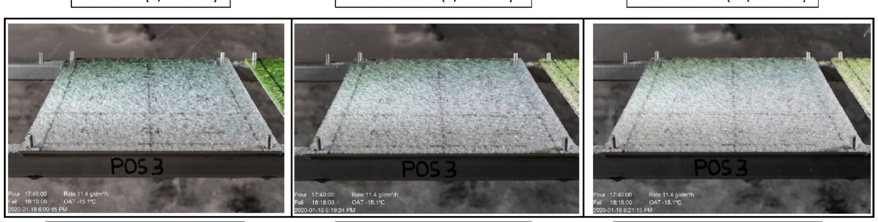
DATA PACKAGE – PG TYPE IV – RUN 32 (TEST 30)

Polar Guard Advance – Run 32 (Test 30) – Failure Progression Photos



AT POUR (0/38 MIN) | PRE-FAILURE (9/38 MIN) | PRE-FAILURE (19/38 MIN)



PRE-FAILURE (29/38 MIN) | AT FAILURE (39/38 MIN) | POST-FAILURE (41/38 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 32 - Test 30/Data Package - PG Type IV - Run 32 - Test 30.docx
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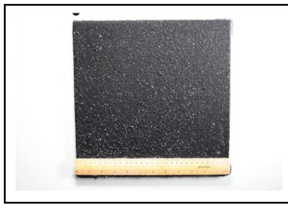
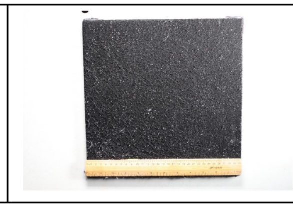
Polar Guard Advance – Run 32 (Test 30) – Snow Characteristics Photos

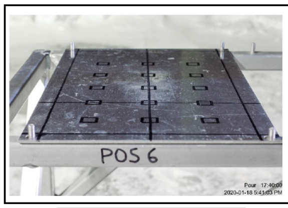


FELT PAD (2/38 MIN)

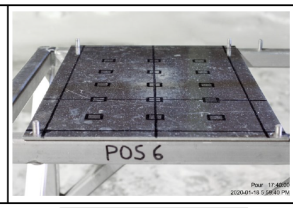


FELT PAD (21/38 MIN)

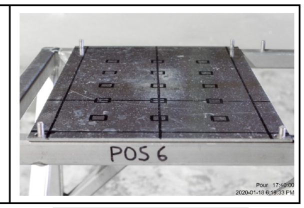
FELT PAD (41/38 MIN)



BARE PLATE (1/38 MIN)



BARE PLATE (19/38 MIN)



BARE PLATE (39/38 MIN)

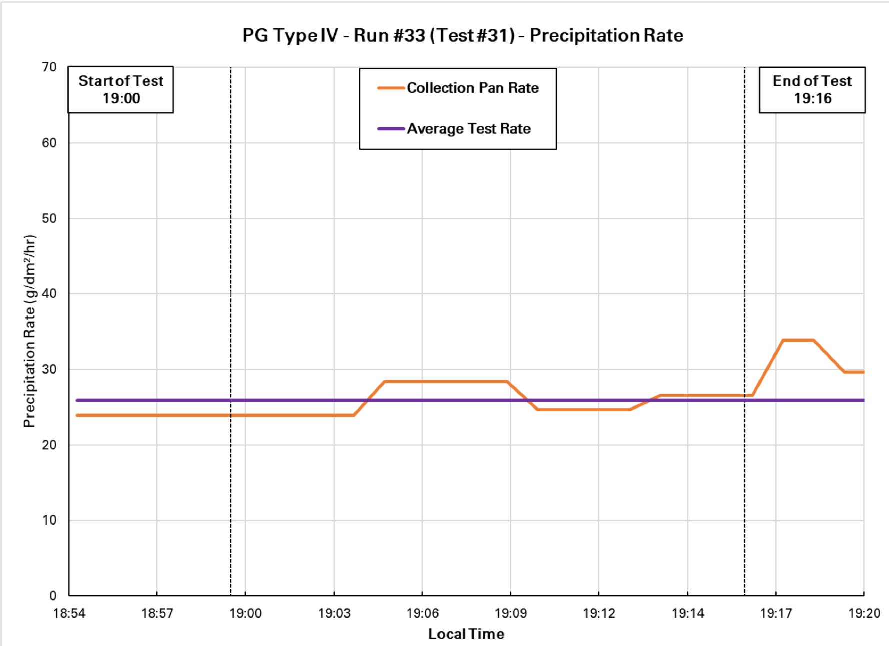
Final Bare Plate Contamination Thickness: **Nil (0mm)**

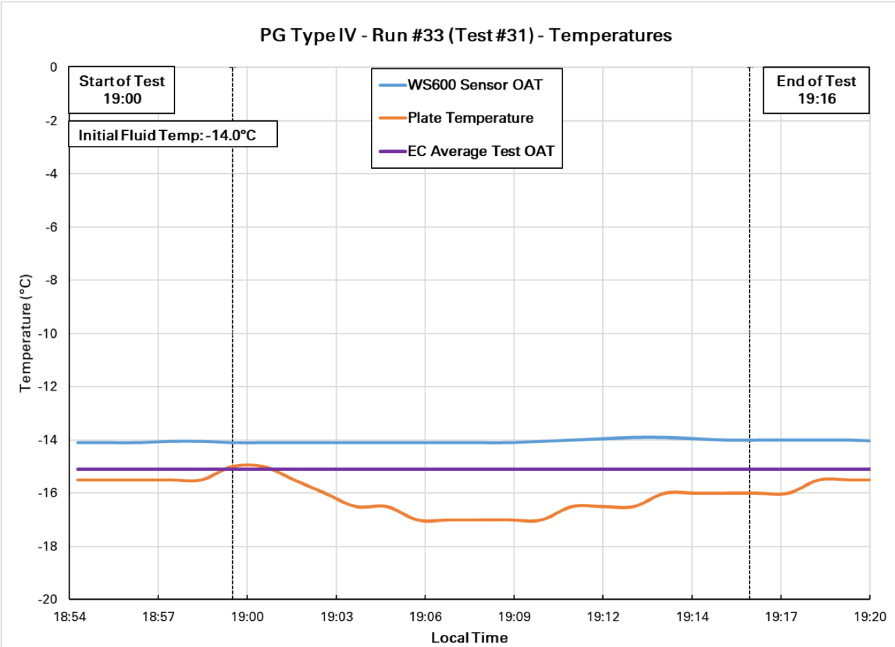
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

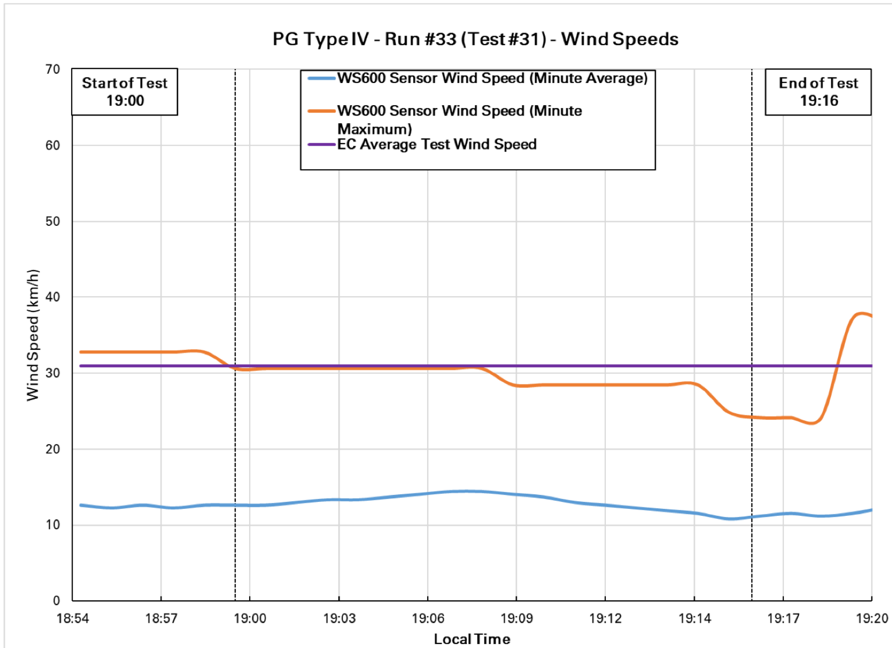
PG TYPE IV
RUN #33 (TEST #31) - PG4-31

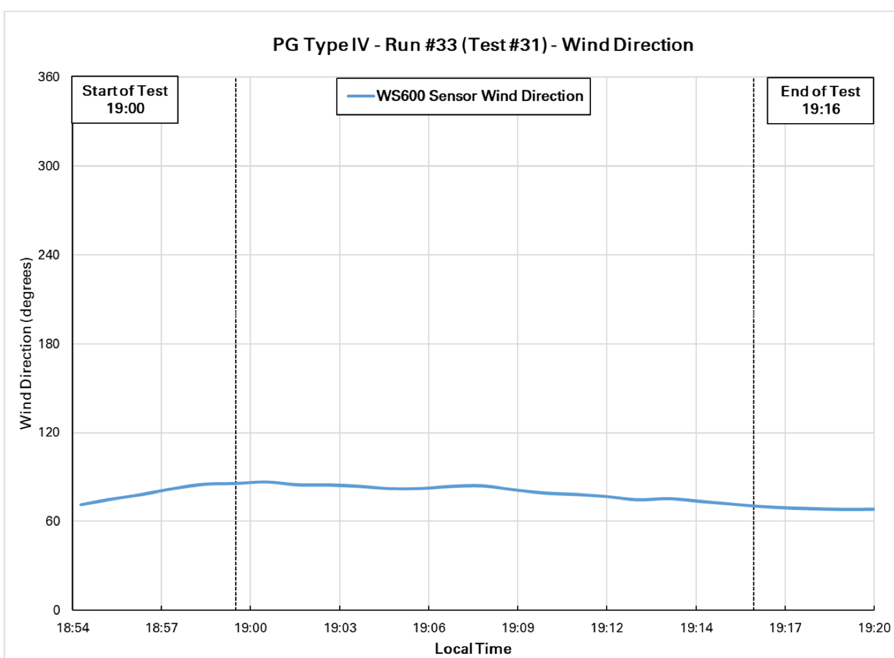
PG Type IV – Run #33 (Test #31) – General Test Information

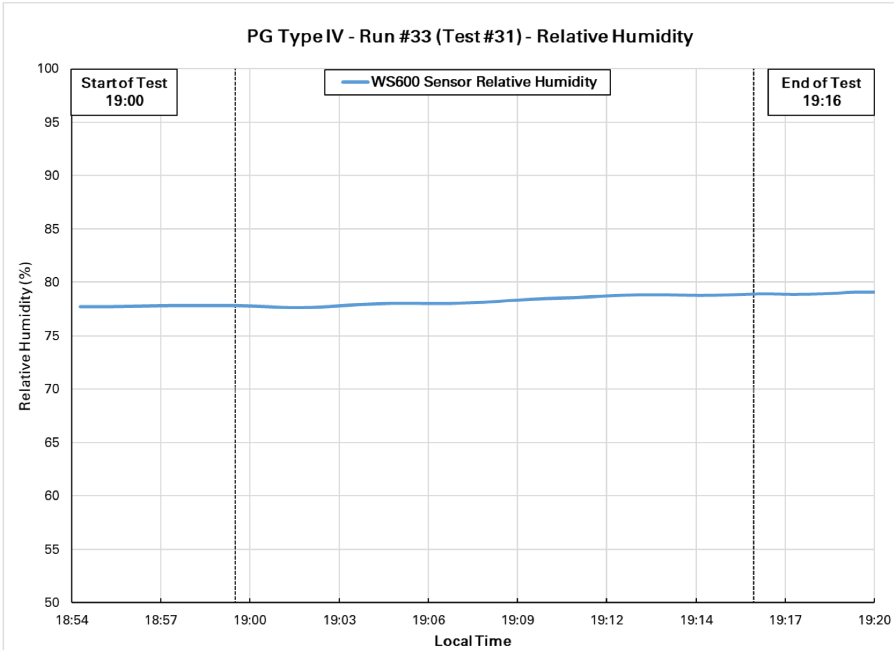
Test Number:	PG4-31
Date of Test:	January 18, 2020
Average OAT:	-15.1
Average Precipitation Rate:	25.9 g/dm²/h
Average Wind Speed:	31.0 km/h
Average Relative Humidity:	78.2%
Pour Time (Local):	19:00:00
Time of Fluid Failure (Local):	19:16:00
Fluid Brix at Failure:	24°
Endurance Time:	16 minutes
Expected Regression-Derived Endurance Time:	22.5 minutes
Difference (ET vs. Reg ET):	- 5.7 minutes (- 25.5%)

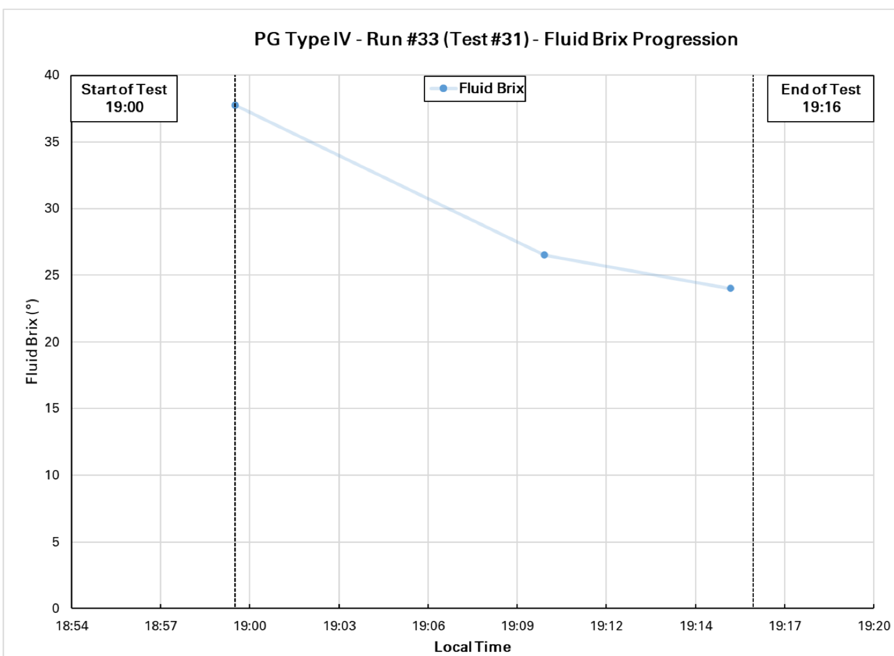

PG Type IV - Run #33 (Test #31) - Precipitation Rate
Start of Test 19:00
End of Test 19:16
Collection Pan Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

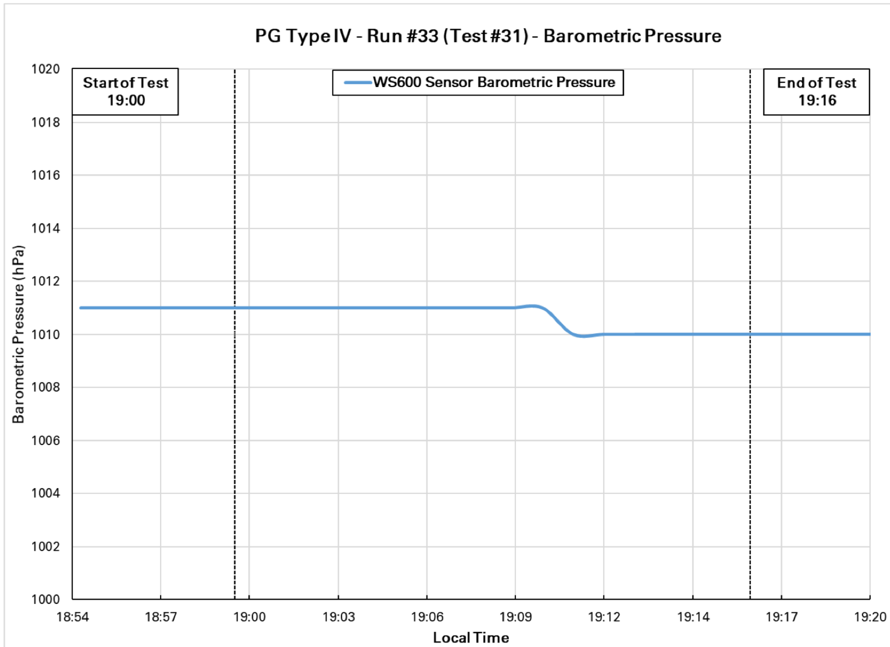

PG Type IV - Run #33 (Test #31) - Temperatures
Start of Test 19:00
Initial Fluid Temp: -14.0°C
End of Test 19:16
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

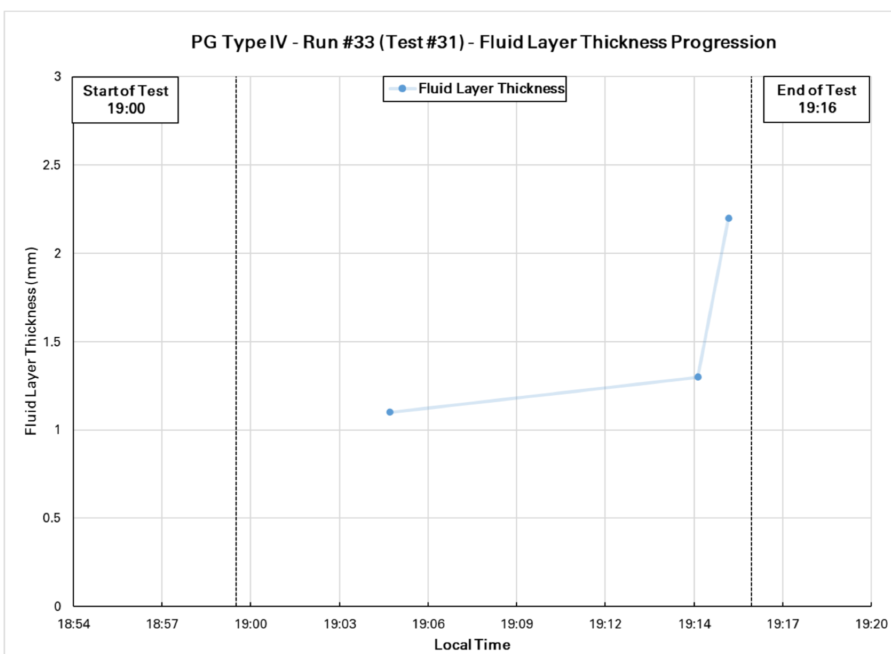

PG Type IV - Run #33 (Test #31) - Wind Speeds
Start of Test 19:00
End of Test 19:16
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

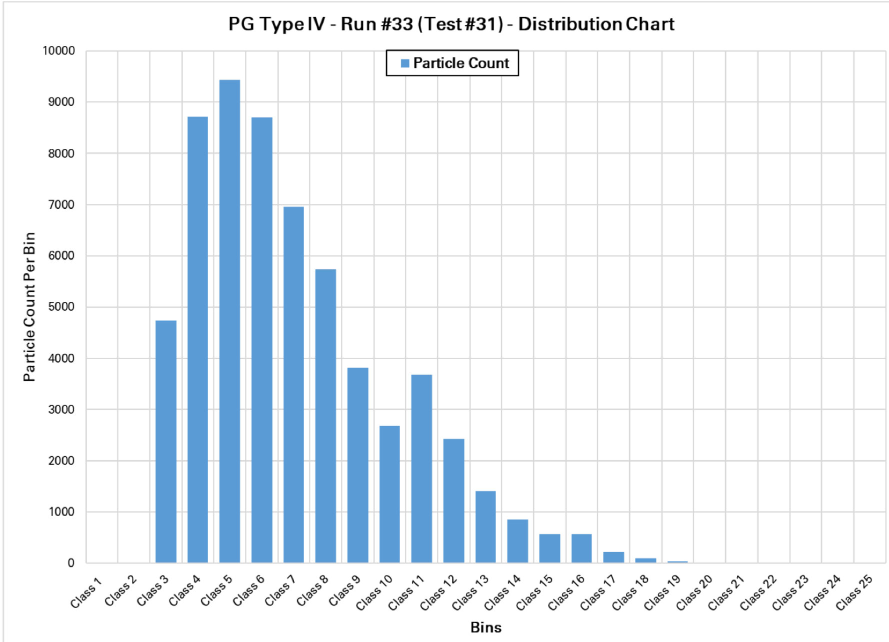

PG Type IV - Run #33 (Test #31) - Wind Direction
Start of Test 19:00
End of Test 19:16
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time


PG Type IV - Run #33 (Test #31) - Relative Humidity
Start of Test 19:00
WS600 Sensor Relative Humidity
End of Test 19:16
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

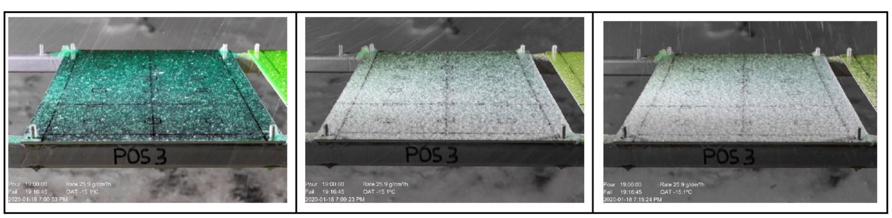

PG Type IV - Run #33 (Test #31) - Fluid Brix Progression
Start of Test 19:00
Fluid Brix
End of Test 19:16
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time


PG Type IV - Run #33 (Test #31) - Barometric Pressure
Start of Test 19:00
WS600 Sensor Barometric Pressure
End of Test 19:16
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time

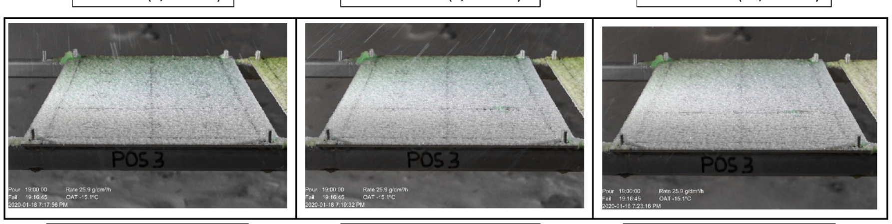

PG Type IV - Run #33 (Test #31) - Fluid Layer Thickness Progression
Start of Test 19:00
Fluid Layer Thickness
End of Test 19:16
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
18:54
18:57
19:00
19:03
19:06
19:09
19:12
19:14
19:17
19:20
Local Time



Polar Guard Advance – Run 33 (Test 31) – Failure Progression Photos



AT POUR (0/16 MIN) | PRE-FAILURE (9/16 MIN) | PRE-FAILURE (15/16 MIN)



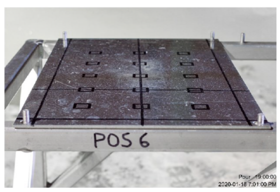
AT FAILURE (17/16 MIN) | POST-FAILURE (19/16 MIN) | POST-FAILURE (23/16 MIN)

Polar Guard Advance – Run 33 (Test #31) – Snow Characteristics Photos

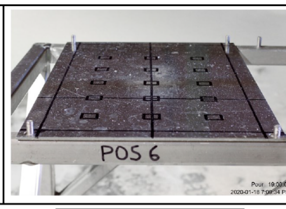
FELT PAD (1/16 MIN)

FELT PAD (10/16 MIN)

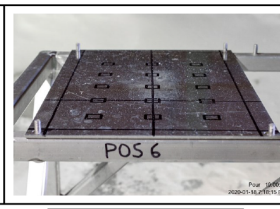
FELT PAD (18/16 MIN)



BARE PLATE (1/16 MIN)



BARE PLATE (9/16 MIN)



BARE PLATE (18/16 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

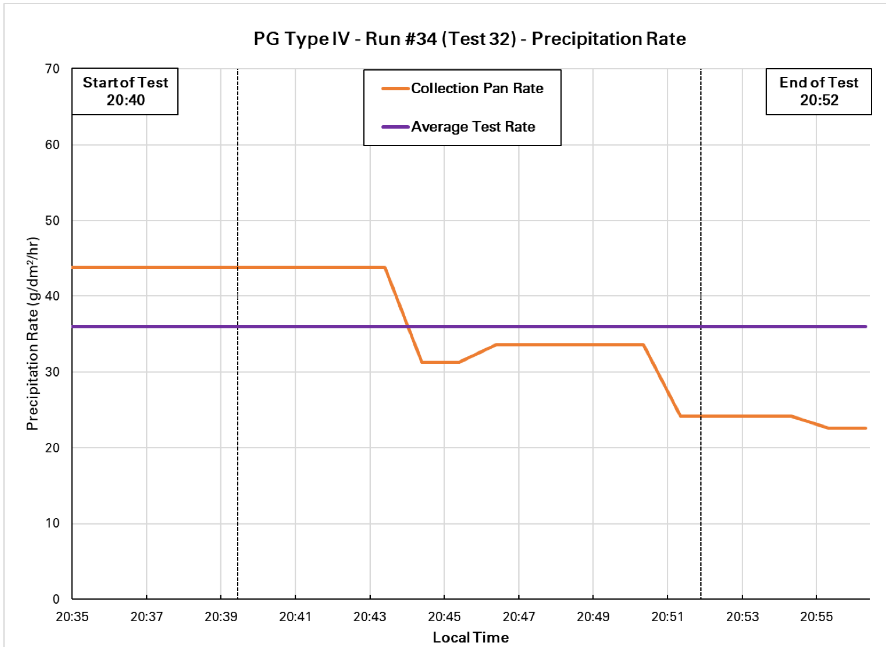
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #34 (TEST #32) – PG4-32

PG Type IV – Run #34 (Test #32) – General Test Information

Test Number:	**PG4-32**
Date of Test:	**January 18, 2020**
Average OAT:	**-15.0**
Average Precipitation Rate:	**36.0 g/dm²/h**
Average Wind Speed:	**32.0 km/h**
Average Relative Humidity:	**80.8%**
Pour Time (Local):	**20:40:00**
Time of Fluid Failure (Local):	**20:52:00**
Fluid Brix at Failure:	**24.5°**
Endurance Time:	**12 minutes**
Expected Regression-Derived Endurance Time:	**17.2 minutes**
Difference (ET vs. Reg ET):	**- 4.7 minutes (- 27.2%)**

DATA PACKAGE – PG TYPE IV – RUN 34 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 34 - Test 32/Data Package - PG Type IV - Run 34 - Test 32.docx
Final Version 1.0, March 2021

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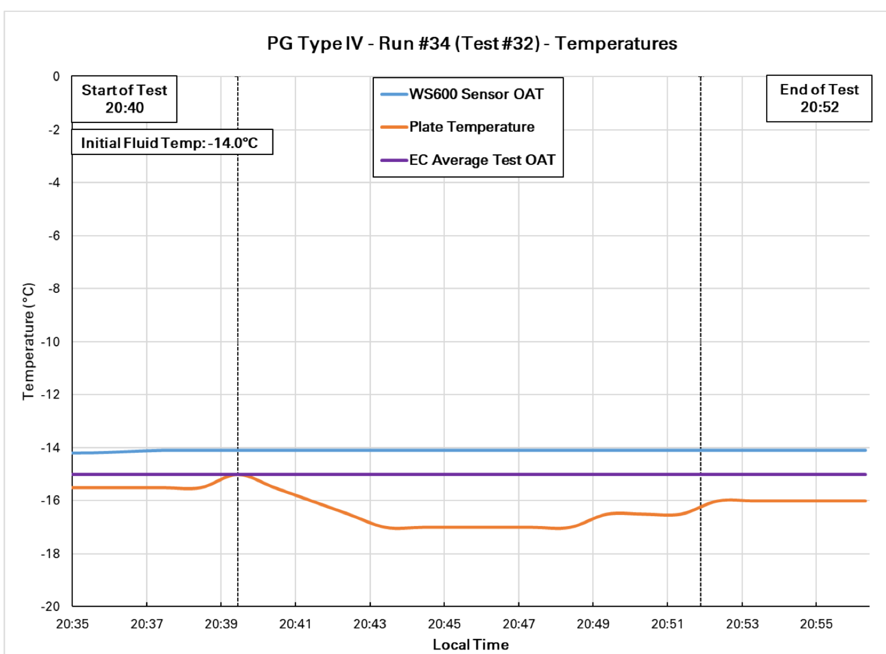
DATA PACKAGE – PG TYPE IV – RUN 34 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 34 - Test 32/Data Package - PG Type IV - Run 34 - Test 32.docx
Final Version 1.0, March 2021

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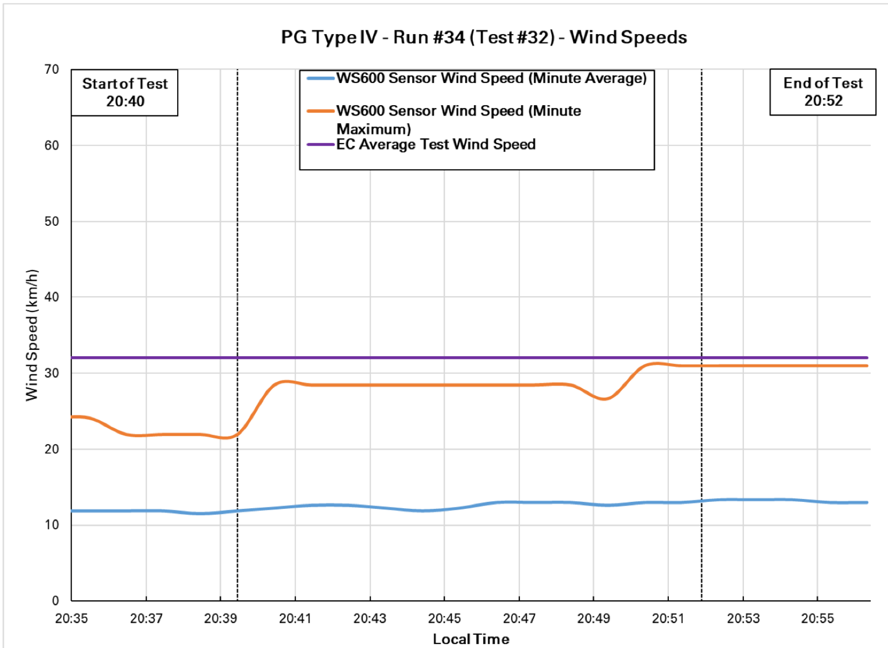
DATA PACKAGE – PG TYPE IV – RUN 34 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 34 - Test 32/Data Package - PG Type IV - Run 34 - Test 32.docx
Final Version 1.0, March 2021

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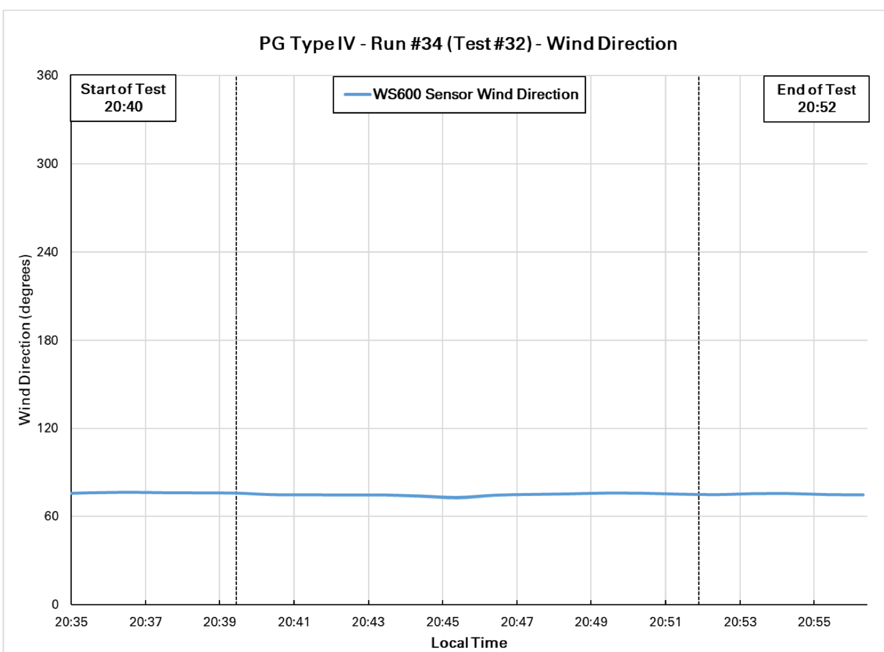
DATA PACKAGE – PG TYPE IV – RUN 34 (TEST 32)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 34 - Test 32/Data Package - PG Type IV - Run 34 - Test 32.docx
Final Version 1.0, March 2021

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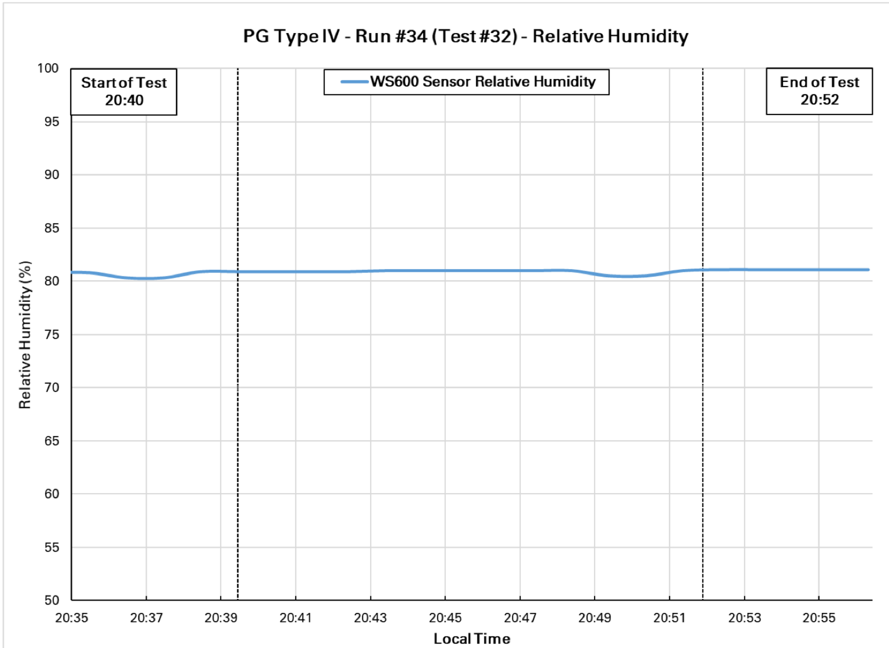
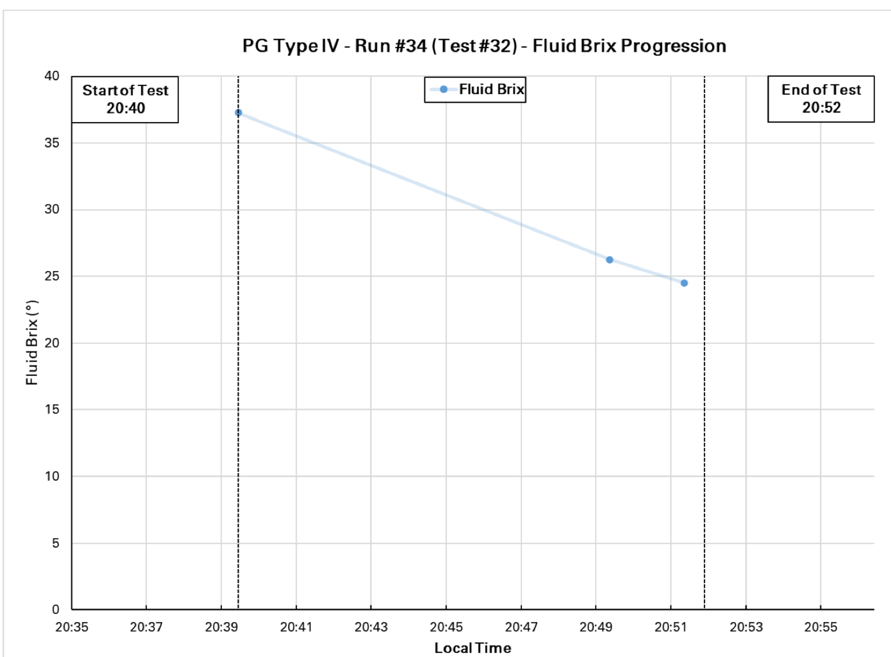
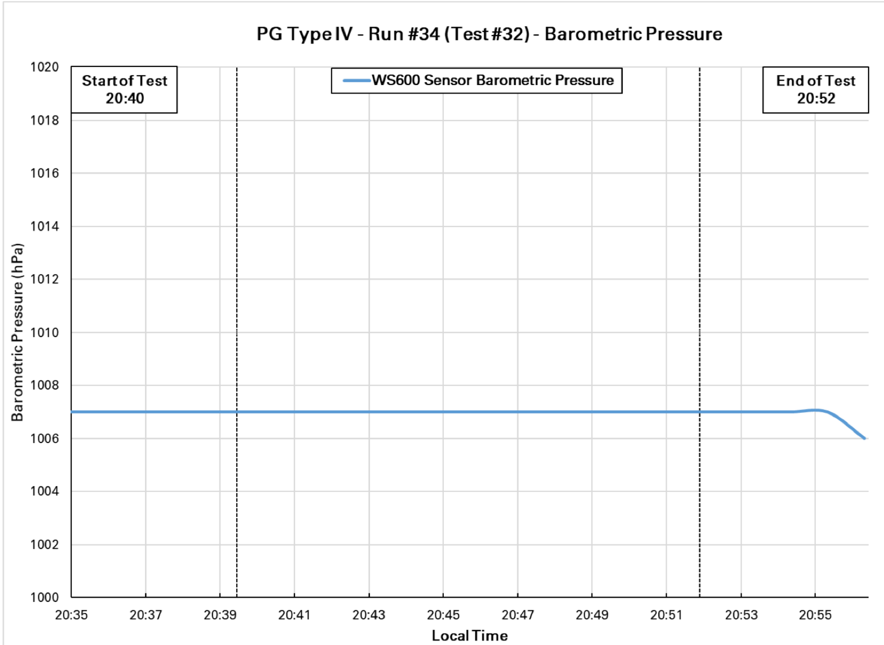
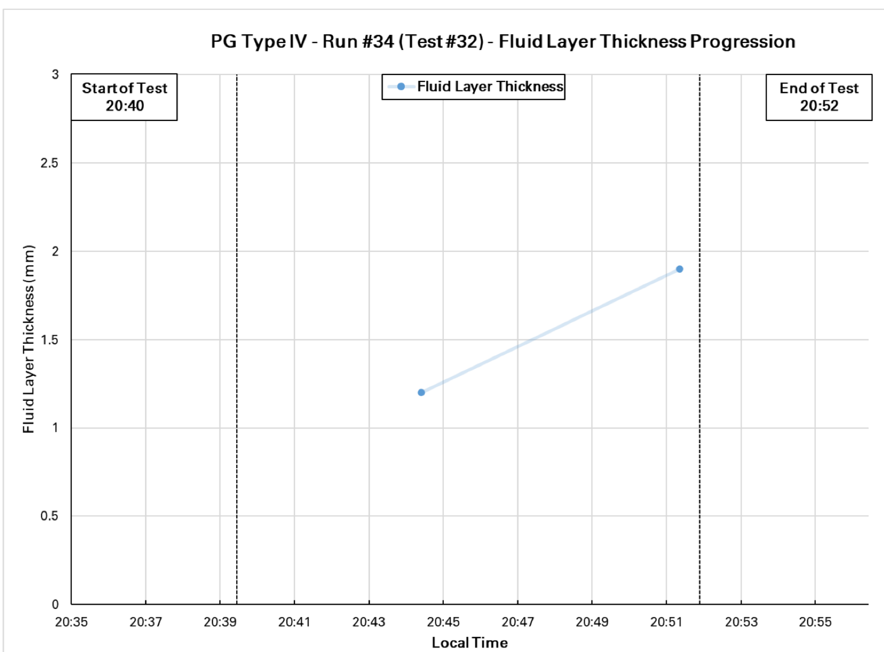
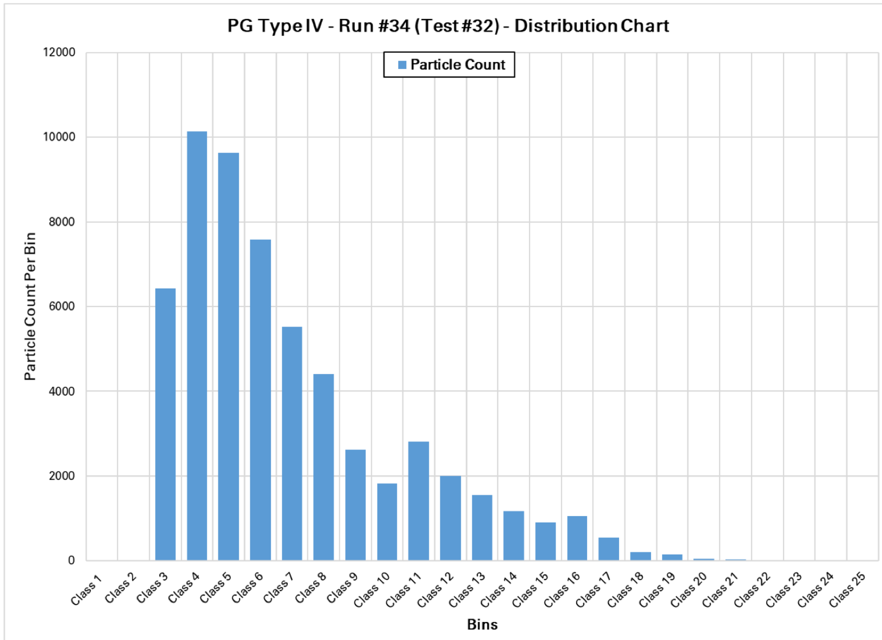

PG Type IV - Run #34 (Test #32) - Relative Humidity
Start of Test 20:40
WS600 Sensor Relative Humidity
End of Test 20:52
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
Local Time

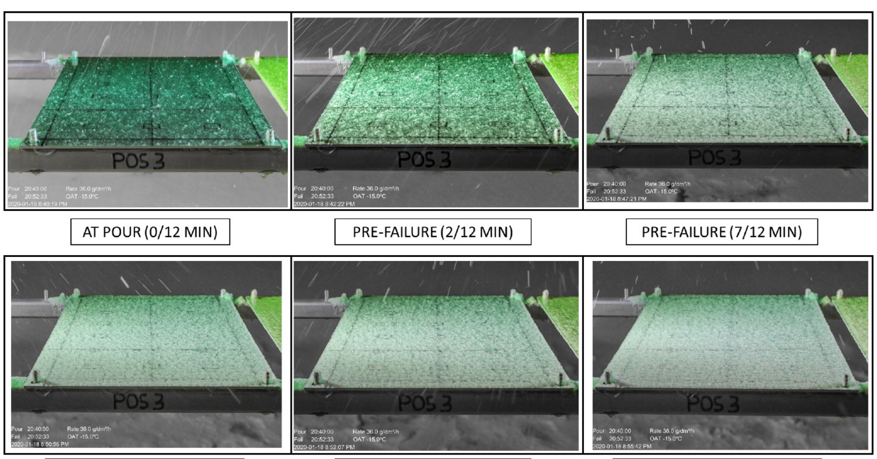

PG Type IV - Run #34 (Test #32) - Fluid Brix Progression
Start of Test 20:40
Fluid Brix
End of Test 20:52
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
Local Time


PG Type IV - Run #34 (Test #32) - Barometric Pressure
Start of Test 20:40
WS600 Sensor Barometric Pressure
End of Test 20:52
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
Local Time


PG Type IV - Run #34 (Test #32) - Fluid Layer Thickness Progression
Start of Test 20:40
Fluid Layer Thickness
End of Test 20:52
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
20:35
20:37
20:39
20:41
20:43
20:45
20:47
20:49
20:51
20:53
20:55
Local Time



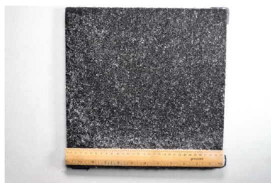
Polar Guard Advance – Run 34 (Test 32) – Failure Progression Photos



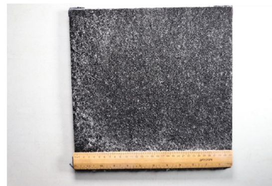
AT POUR (0/12 MIN) | PRE-FAILURE (2/12 MIN) | PRE-FAILURE (7/12 MIN)

PRE-FAILURE (10/12 MIN) | AT FAILURE (13/12 MIN) | POST-FAILURE (13/12 MIN)

Polar Guard Advance – Run 34 (Test 32) – Snow Characteristics Photos

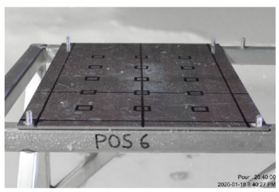


FELT PAD (1/12 MIN)

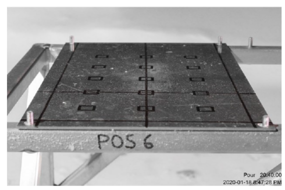


FELT PAD (10/12 MIN)

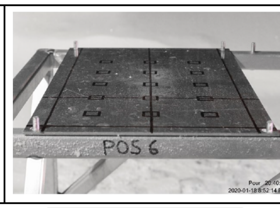
FELT PAD (20/12 MIN)



BARE PLATE (0/12 MIN)



BARE PLATE (7/12 MIN)



BARE PLATE (12/12 MIN)

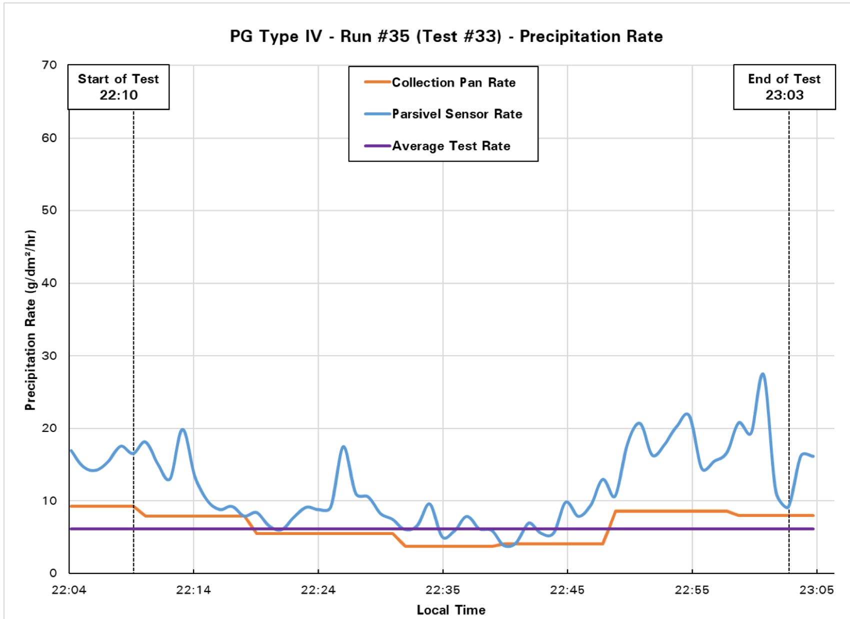
Final Bare Plate Contamination Thickness: **Nil (0mm)**

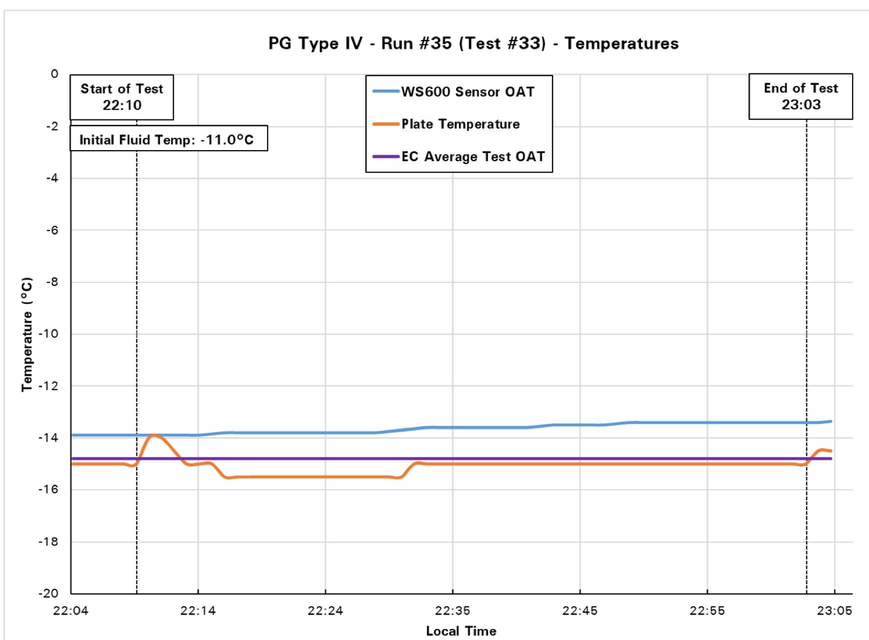
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

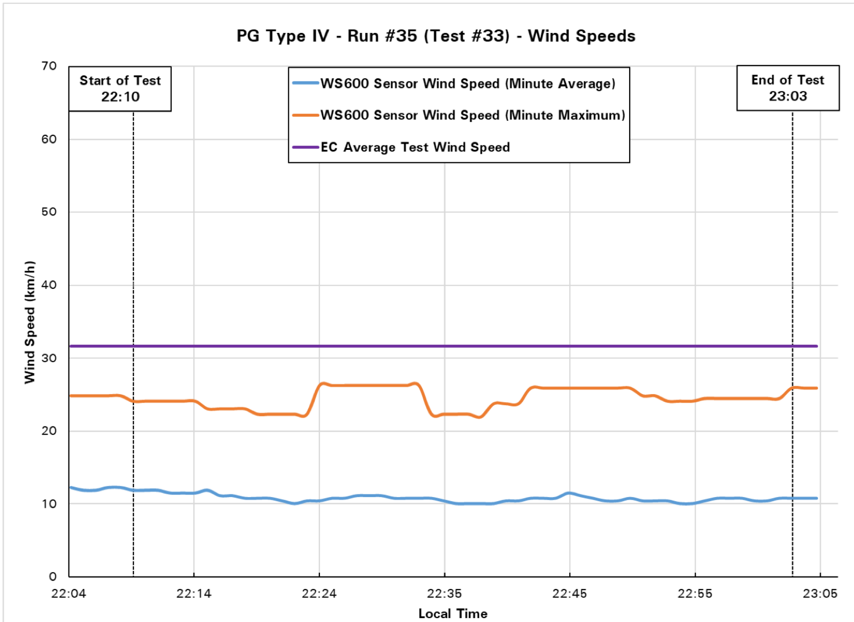
PG TYPE IV
RUN #35 (TEST #33) PG4-33

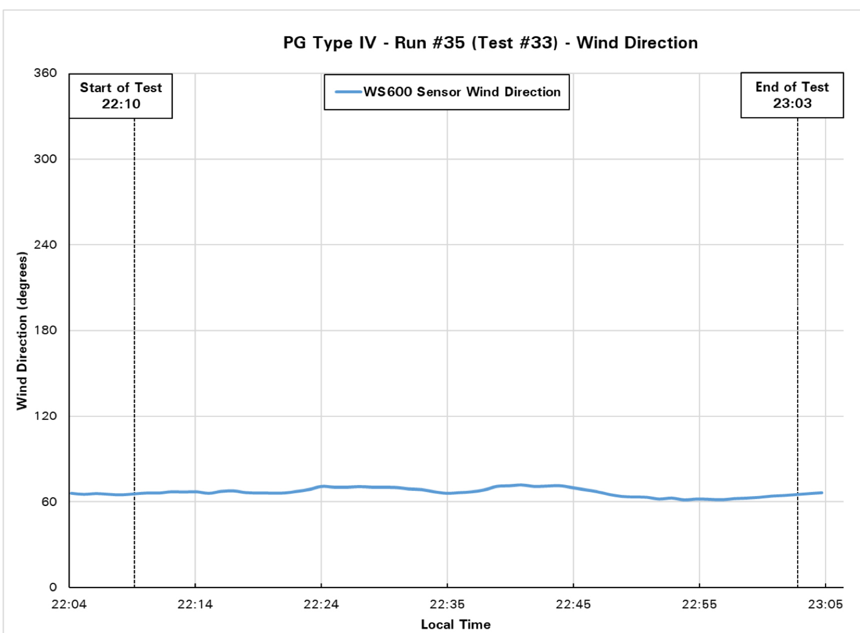
PG Type IV – Run #35 (Test #33) – General Test Information

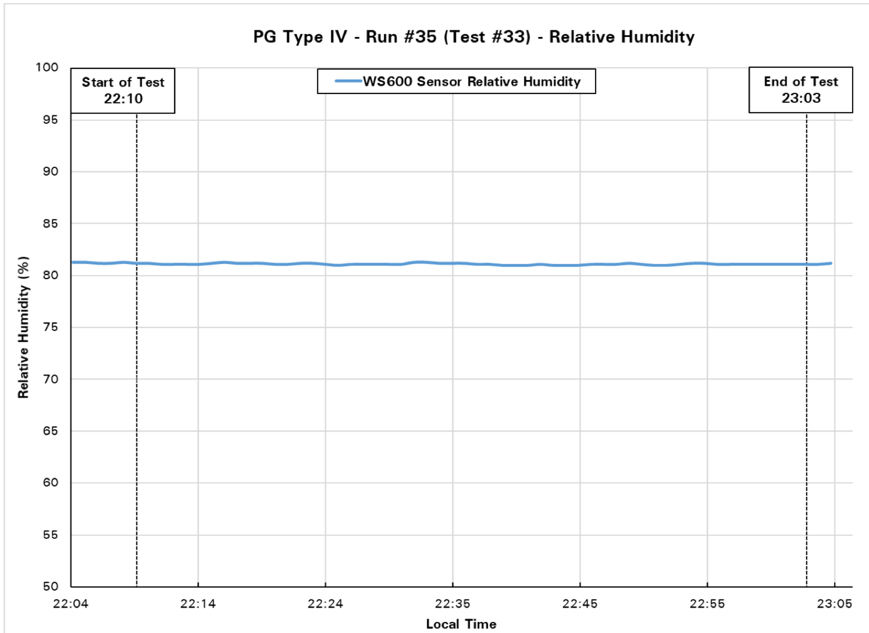
Test Number:	PG4-33
Date of Test:	January 18, 2020
Average OAT:	-14.8
Average Precipitation Rate:	6.2 g/dm²/h
Average Wind Speed:	31.6 km/h
Average Relative Humidity:	81.1%
Pour Time (Local):	22:10:00
Time of Fluid Failure (Local):	23:03:00
Fluid Brix at Failure:	23.5°
Endurance Time:	53 minutes
Expected Regression-Derived Endurance Time:	73.8 minutes
Difference (ET vs. Reg ET):	- 20.7 minutes (- 28.1%)

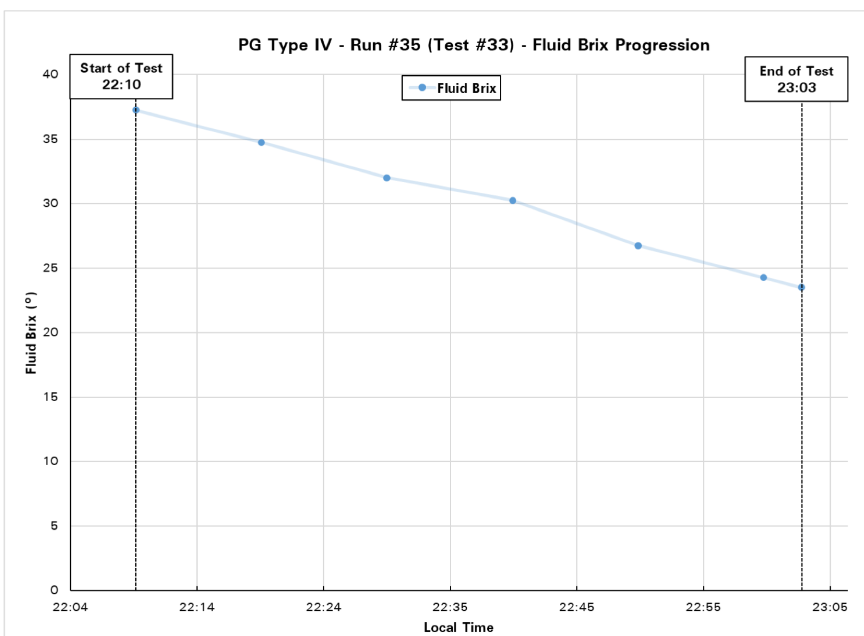

PG Type IV - Run #35 (Test #33) - Precipitation Rate
Start of Test 22:10
End of Test 23:03
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

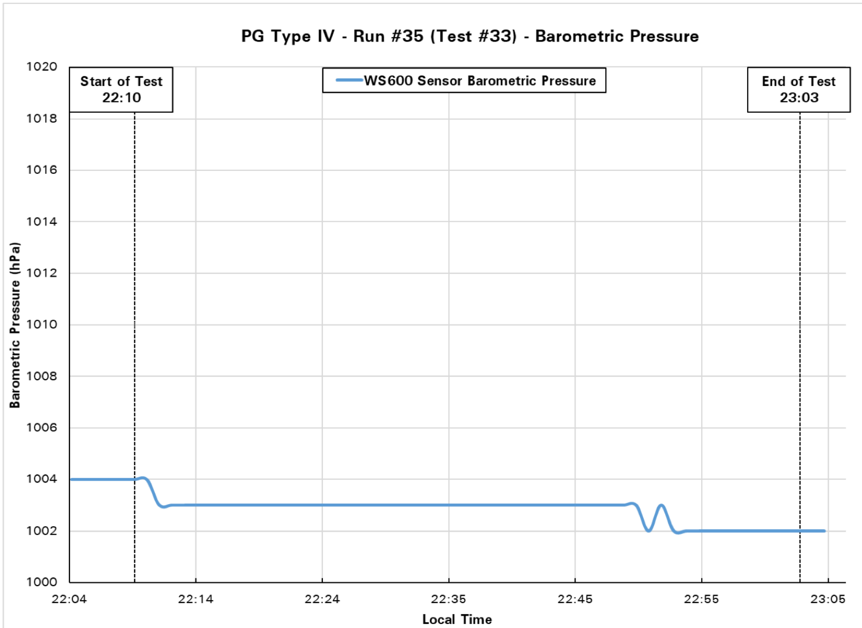

PG Type IV - Run #35 (Test #33) - Temperatures
Start of Test 22:10
Initial Fluid Temp: -11.0°C
End of Test 23:03
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

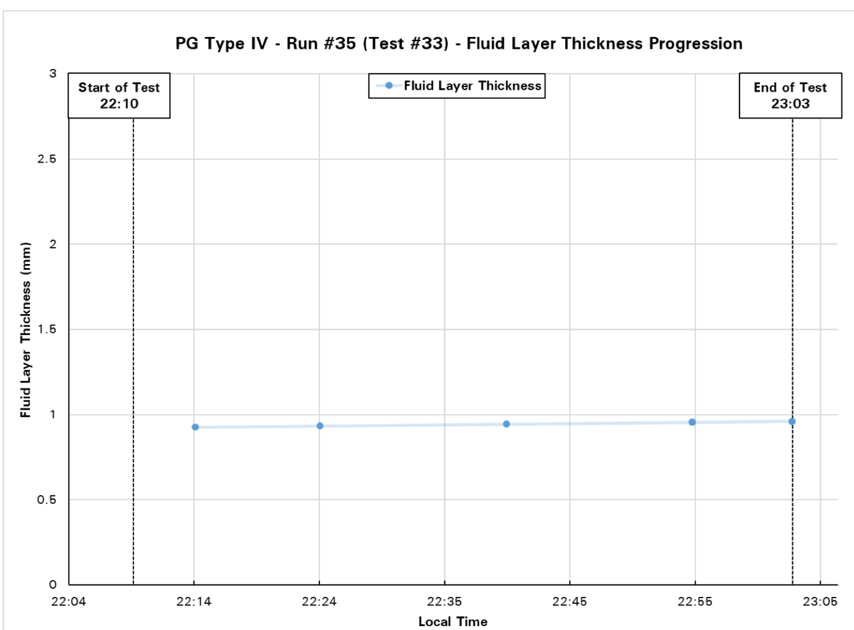

PG Type IV - Run #35 (Test #33) - Wind Speeds
Start of Test 22:10
End of Test 23:03
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

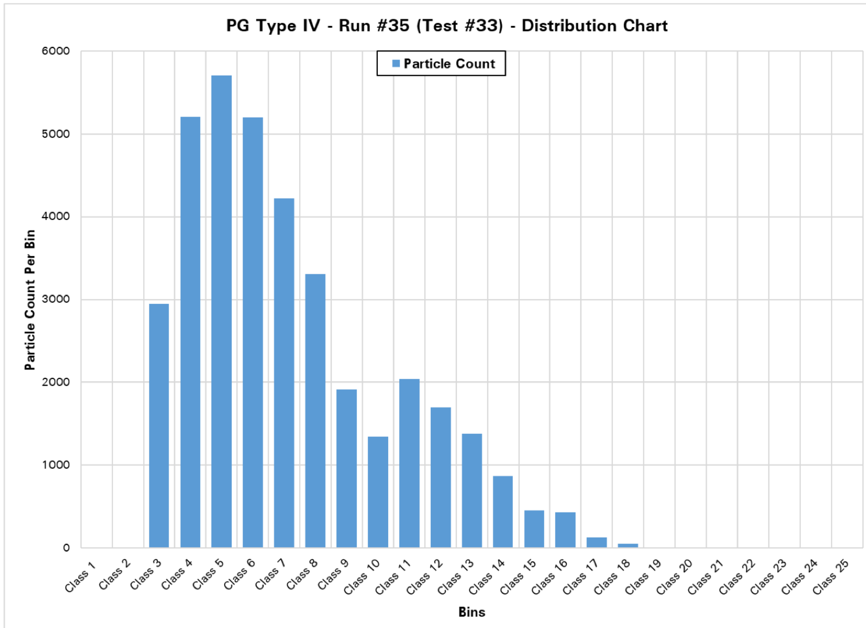

PG Type IV - Run #35 (Test #33) - Wind Direction
Start of Test 22:10
End of Test 23:03
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type IV - Run #35 (Test #33) - Relative Humidity
Start of Test 22:10
WS600 Sensor Relative Humidity
End of Test 23:03
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type IV - Run #35 (Test #33) - Fluid Brix Progression
Start of Test 22:10
Fluid Brix
End of Test 23:03
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

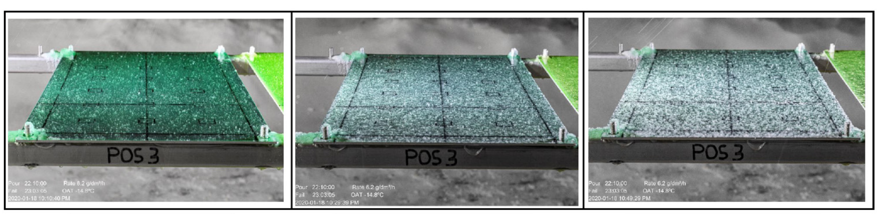

PG Type IV - Run #35 (Test #33) - Barometric Pressure
Start of Test
22:10
WS600 Sensor Barometric Pressure
End of Test
23:03
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time


PG Type IV - Run #35 (Test #33) - Fluid Layer Thickness Progression
Start of Test
22:10
Fluid Layer Thickness
End of Test
23:03
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
22:04
22:14
22:24
22:35
22:45
22:55
23:05
Local Time

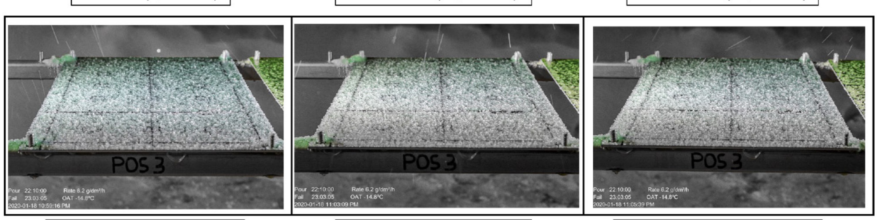


DATA PACKAGE – PG TYPE IV – RUN 35 (TEST 33)

Polar Guard Advance – Run 35 (Test 33) – Failure Progression Photos



AT POUR (0/53 MIN) | PRE-FAILURE (19/53 MIN) | PRE-FAILURE (39/53 MIN)



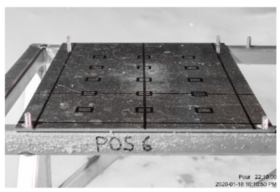
PRE-FAILURE (49/53 MIN) | AT FAILURE (53/53 MIN) | POST-FAILURE (55/53 MIN)

Polar Guard Advance – Run 35 (Test 33) – Snow Characteristics Photos

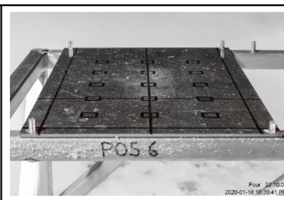
FELT PAD (10/53 MIN)

FELT PAD (30/53 MIN)

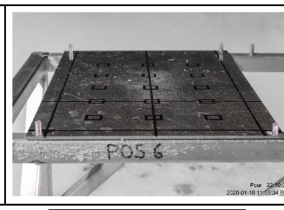
FELT PAD (50/53 MIN)



BARE PLATE (0/53 MIN)



BARE PLATE (29/53 MIN)



BARE PLATE (53/53 MIN)

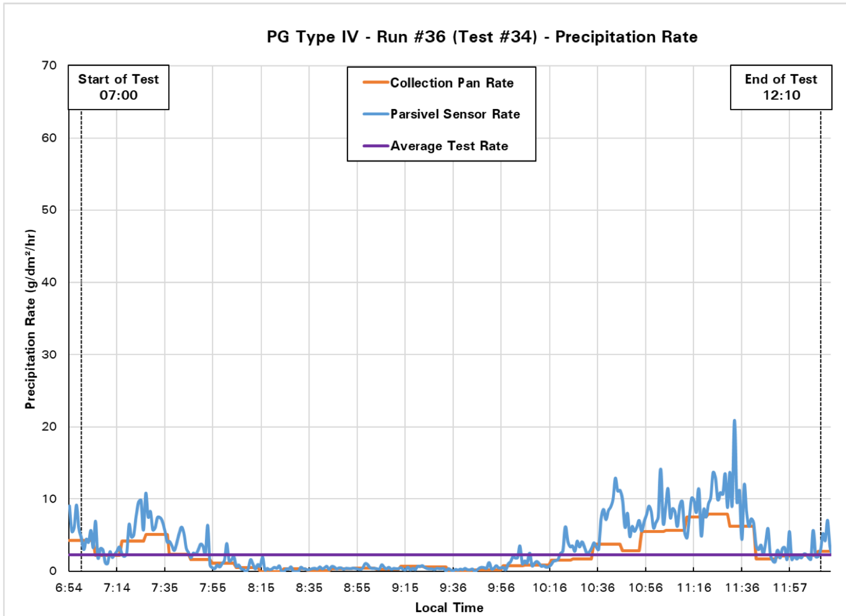
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

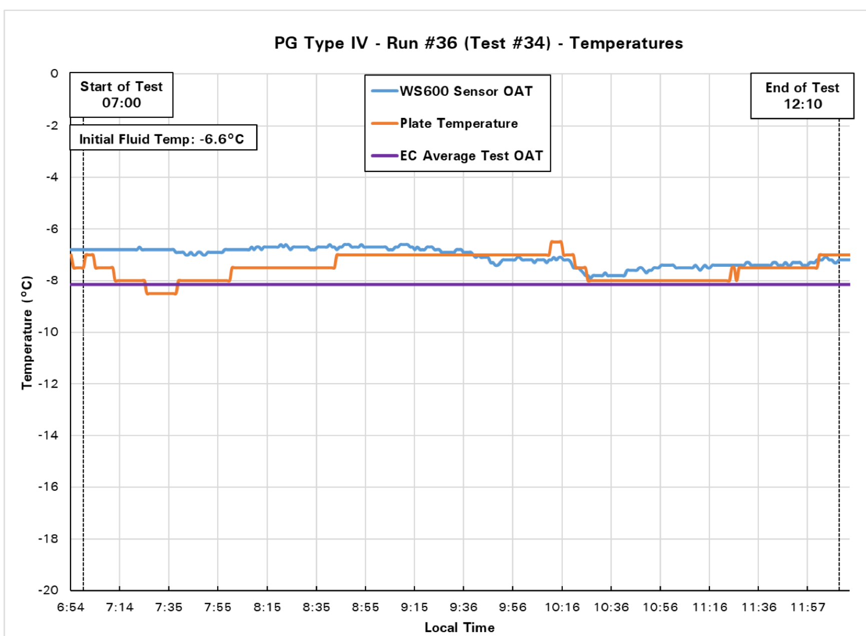
PG TYPE IV
RUN #36 (TEST #34) PG4-34

PG Type IV – Run #36 (Test #34)– General Test Information

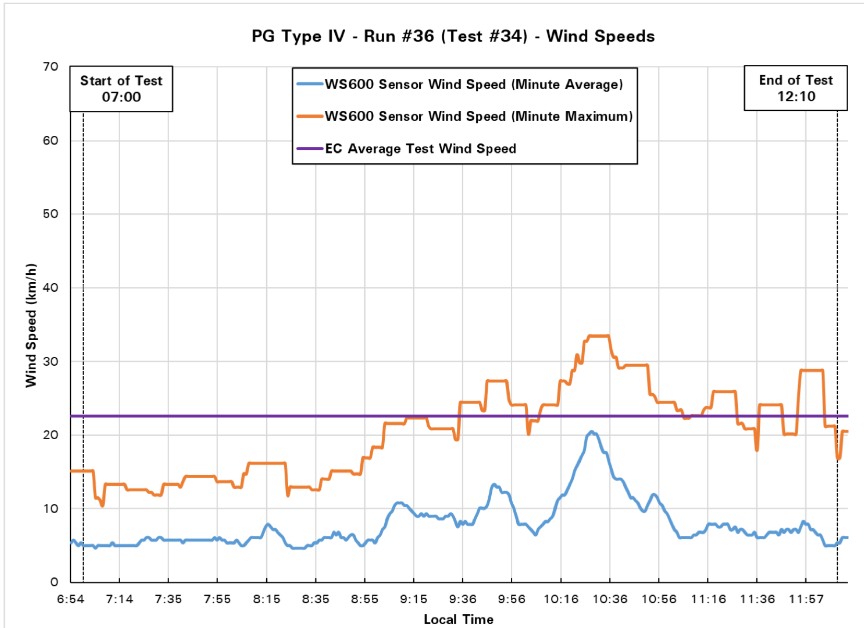
Test Number:	PG4-34
Date of Test:	February 6, 2020
Average OAT:	-8.2
Average Precipitation Rate:	2.3 g/dm²/h
Average Wind Speed:	22.6 km/h
Average Relative Humidity:	79.8%
Pour Time (Local):	07:00:00
Time of Fluid Failure (Local):	12:10:00
Fluid Brix at Failure:	14.5°
Endurance Time:	310 minutes
Expected Regression-Derived Endurance Time:	233.7 minutes
Difference (ET vs. Reg ET):	+86.3 minutes (+38.6%)

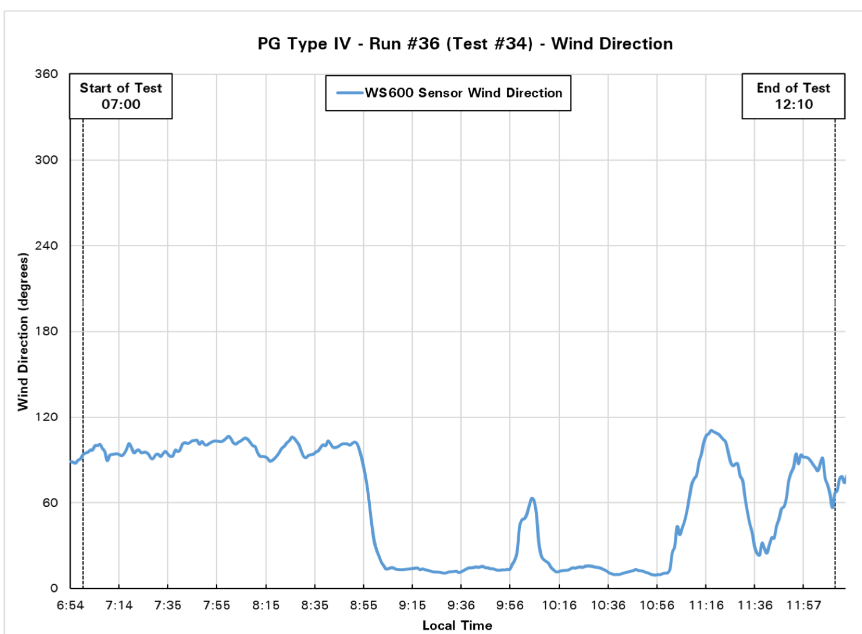


PG Type IV - Run #36 (Test #34) - Precipitation Rate
Start of Test 07:00
End of Test 12:10
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
Local Time

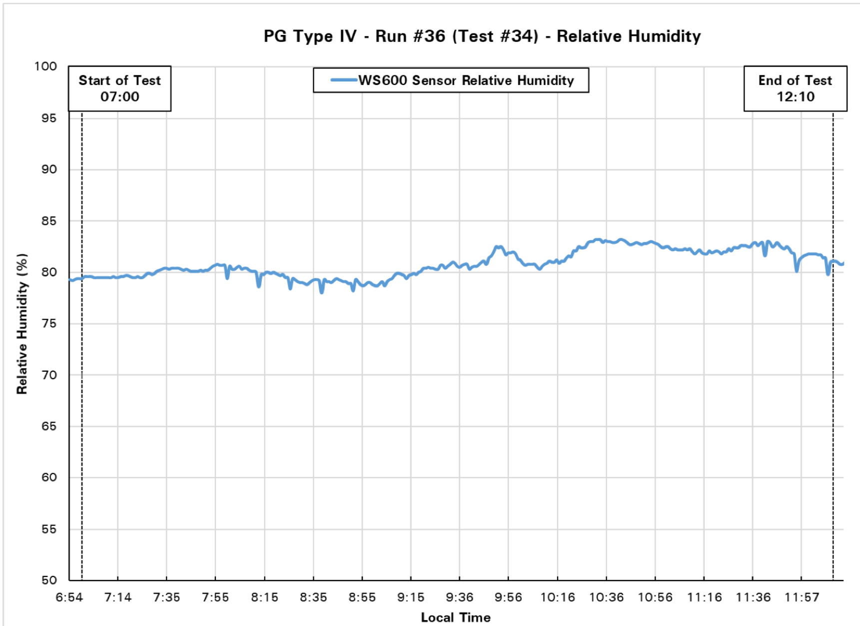


PG Type IV - Run #36 (Test #34) - Temperatures
Start of Test 07:00
Initial Fluid Temp: -6.6°C
End of Test 12:10
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
Local Time


PG Type IV - Run #36 (Test #34) - Wind Speeds
Start of Test 07:00
End of Test 12:10
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
Local Time


PG Type IV - Run #36 (Test #34) - Wind Direction
Start of Test 07:00
End of Test 12:10
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
Local Time

DATA PACKAGE – PG TYPE IV – RUN #36 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 36 - Test 34/Data Package - PG Type IV - Run 36 - Test 34.docx
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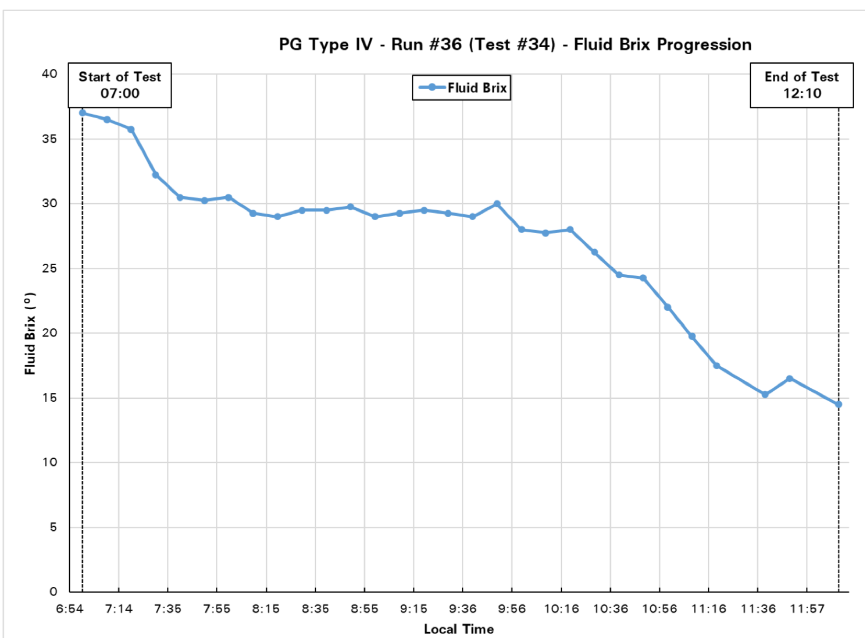
DATA PACKAGE – PG TYPE IV – RUN #36 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 36 - Test 34/Data Package - PG Type IV - Run 36 - Test 34.docx
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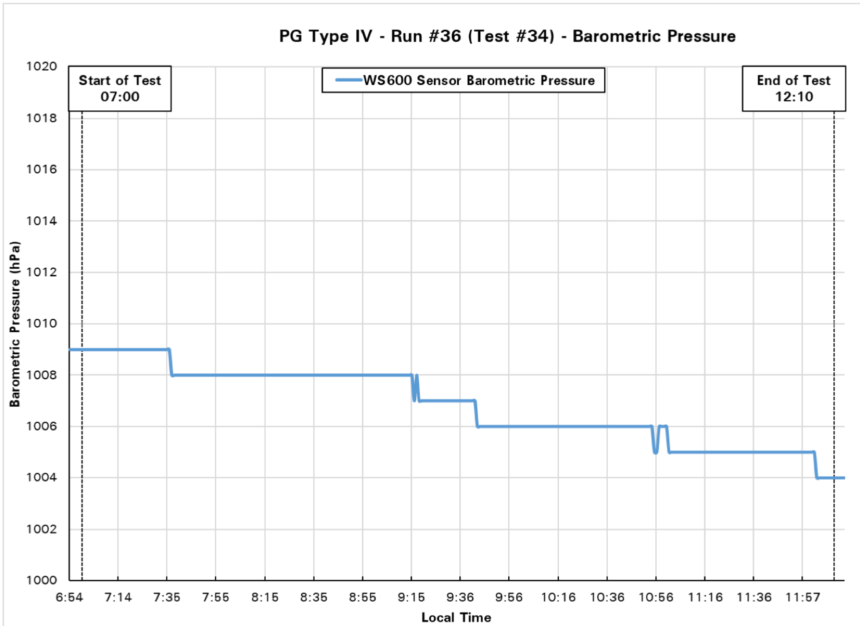
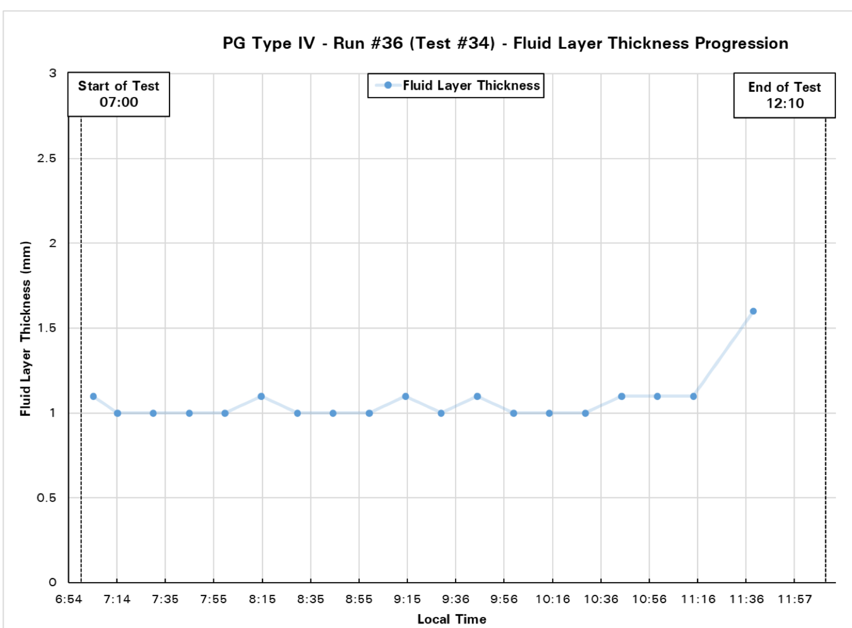
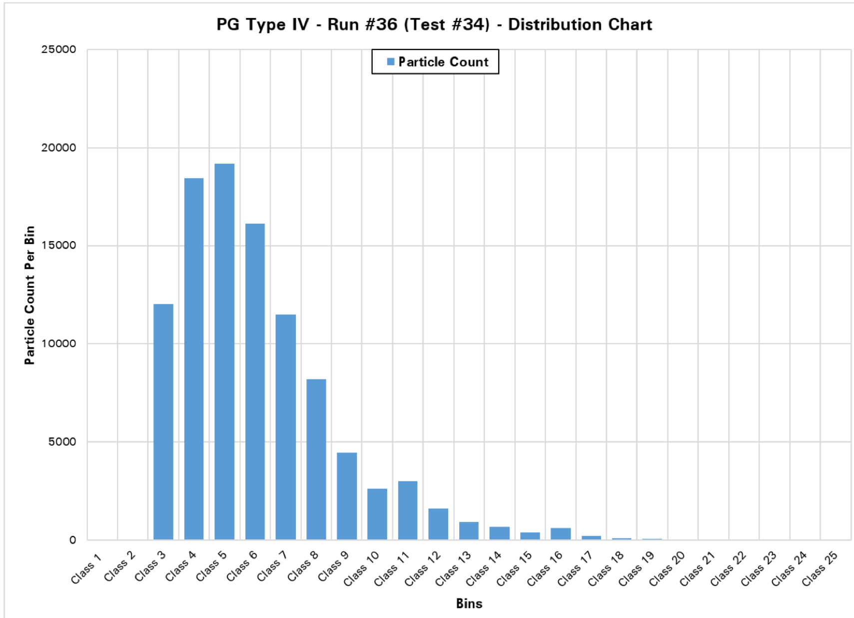

PG Type IV - Run #36 (Test #34) - Barometric Pressure
Start of Test 07:00
WS600 Sensor Barometric Pressure
End of Test 12:10
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
Local Time


PG Type IV - Run #36 (Test #34) - Fluid Layer Thickness Progression
Start of Test 07:00
Fluid Layer Thickness
End of Test 12:10
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:54
7:14
7:35
7:55
8:15
8:35
8:55
9:15
9:36
9:56
10:16
10:36
10:56
11:16
11:36
11:57
Local Time

DATA PACKAGE – PG TYPE IV – RUN #36 (TEST 34)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 36 - Test 34/Data Package - PG Type IV - Run 36 - Test 34.docx
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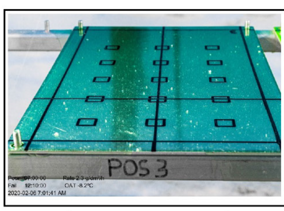
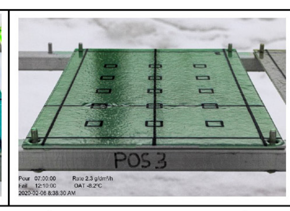
DATA PACKAGE – PG TYPE IV – RUN #36 (TEST 34)

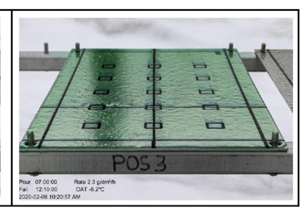
Polar Guard Advance – Run 36 (Test 34) – Failure Progression Photos



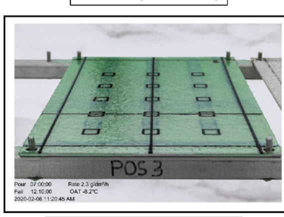
AT POUR (0/310 MIN)



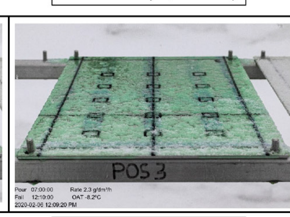
PRE-FAILURE (98/310 MIN)



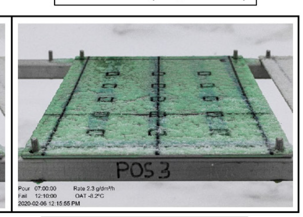
PRE-FAILURE (200/310 MIN)



PRE-FAILURE (260/310 MIN)



AT FAILURE (309/310 MIN)



POST-FAILURE (315/310 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 36 - Test 34/Data Package - PG Type IV - Run 36 - Test 34.docx
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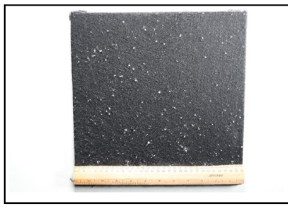
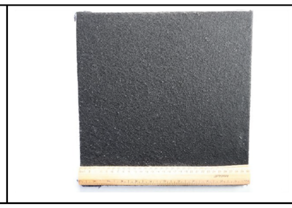
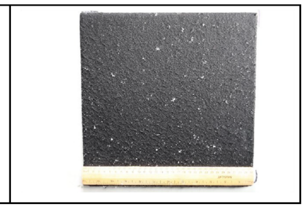
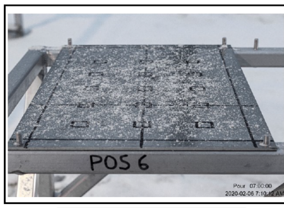
Polar Guard Advance – Run 36 (Test 34) – Snow Characteristics Photos

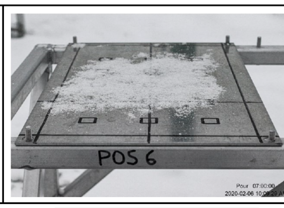

FELT PAD (30/310 MIN)


FELT PAD (160/310 MIN)

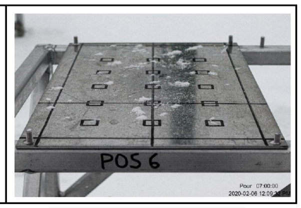

FELT PAD (289/310 MIN)



BARE PLATE (10/310 MIN)



BARE PLATE (189/310 MIN)



BARE PLATE (309/310 MIN)

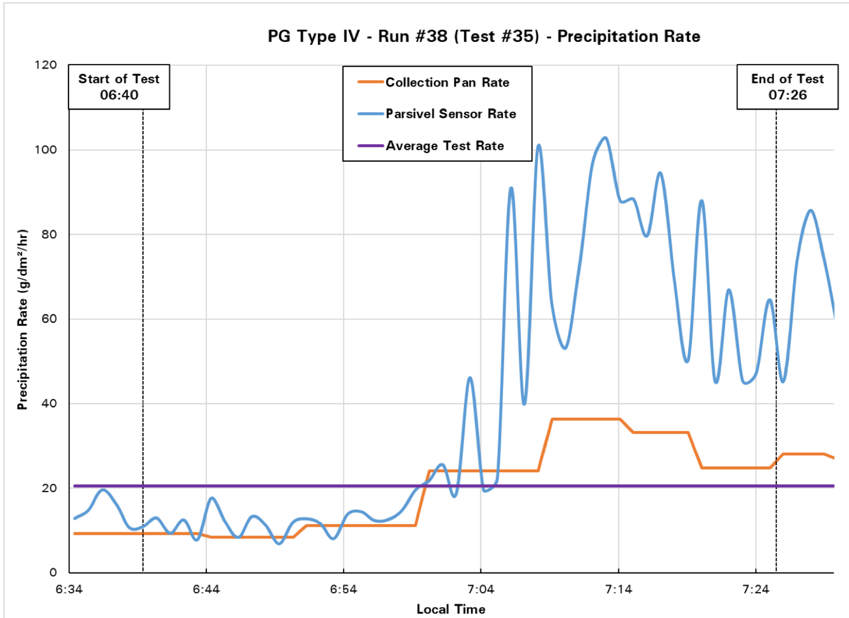
Final Bare Plate Contamination Thickness: **Nil (0mm)**

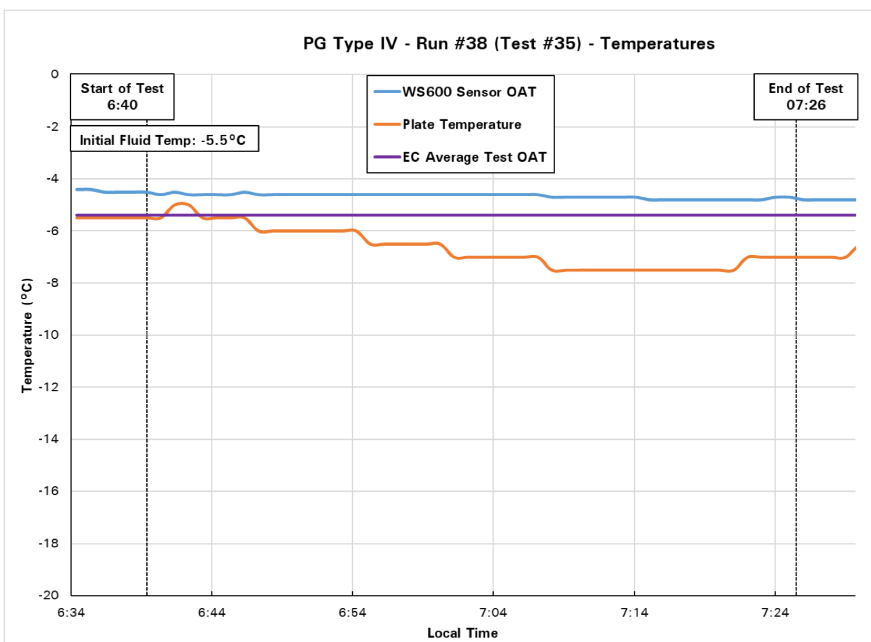
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

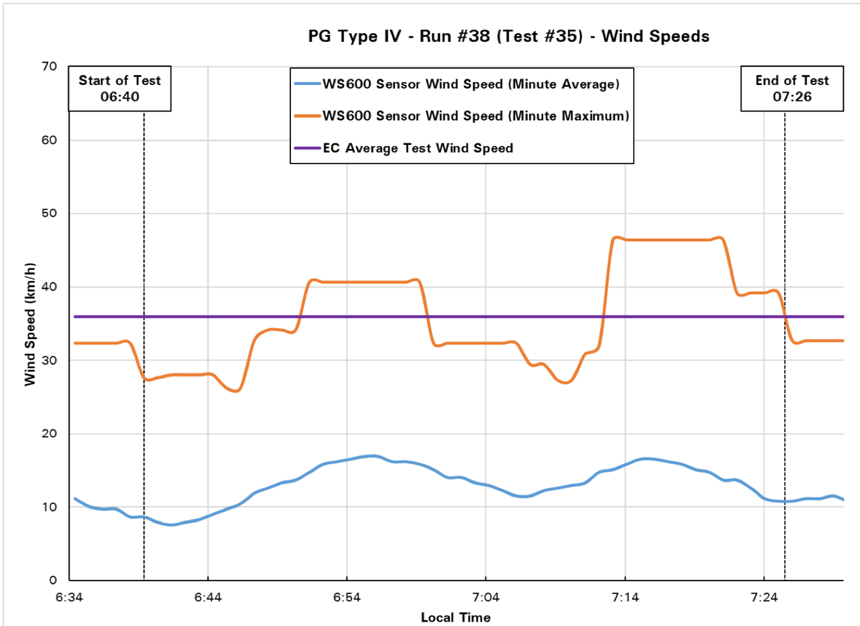
PG TYPE IV
RUN #38 (TEST #35) PG4-35

PG Type IV – Run #38 (Test #35) – General Test Information

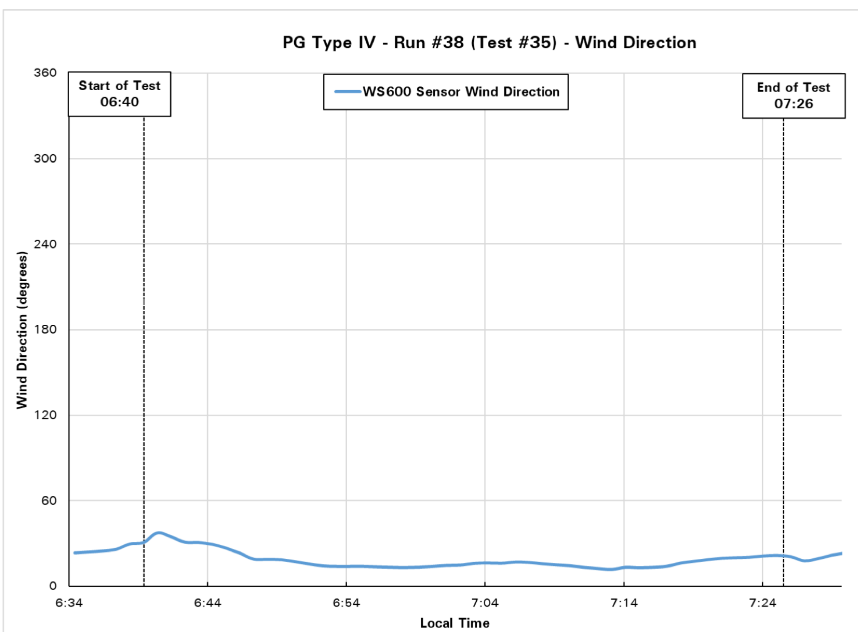
Test Number:	PG4-35
Date of Test:	February 7, 2020
Average OAT:	-5.4
Average Precipitation Rate:	20.5 g/dm²/h
Average Wind Speed:	36.0 km/h
Average Relative Humidity:	89.1%
Pour Time (Local):	06:40:00
Time of Fluid Failure (Local):	07:26:00
Fluid Brix at Failure:	14.75°
Endurance Time:	46 minutes
Expected Regression-Derived Endurance Time:	44.4 minutes
Difference (ET vs. Reg ET):	+ 2 minutes (+4.5%)


PG Type IV - Run #38 (Test #35) - Precipitation Rate
Start of Test 06:40
End of Test 07:26
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
20
40
60
80
100
120
6:34
6:44
6:54
7:04
7:14
7:24
Local Time

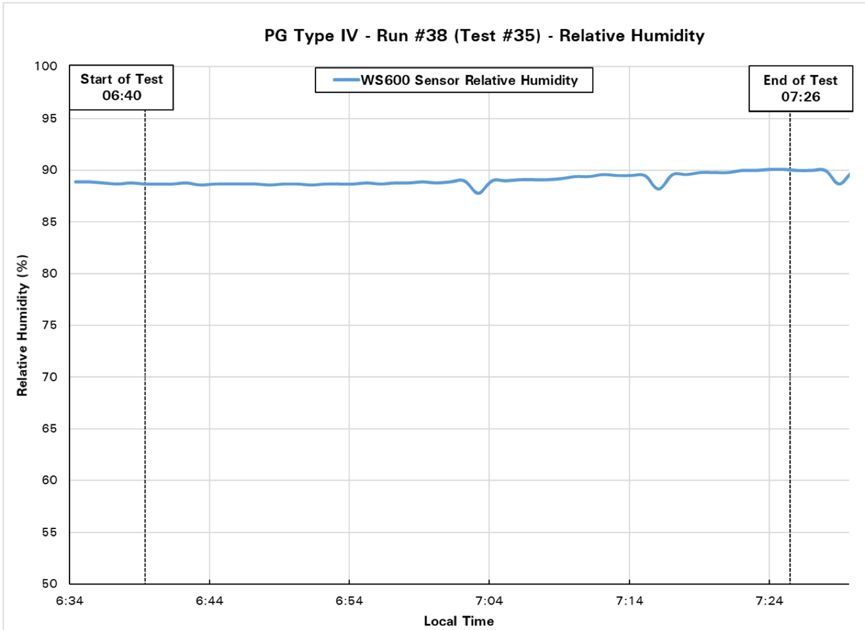

PG Type IV - Run #38 (Test #35) - Temperatures
Start of Test 6:40
Initial Fluid Temp: -5.5°C
End of Test 07:26
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
6:34
6:44
6:54
7:04
7:14
7:24
Local Time

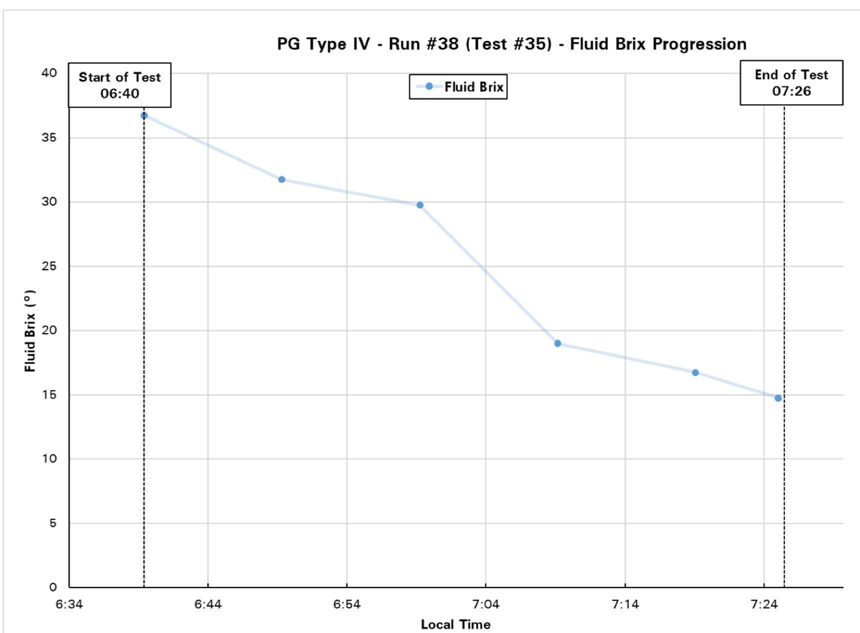


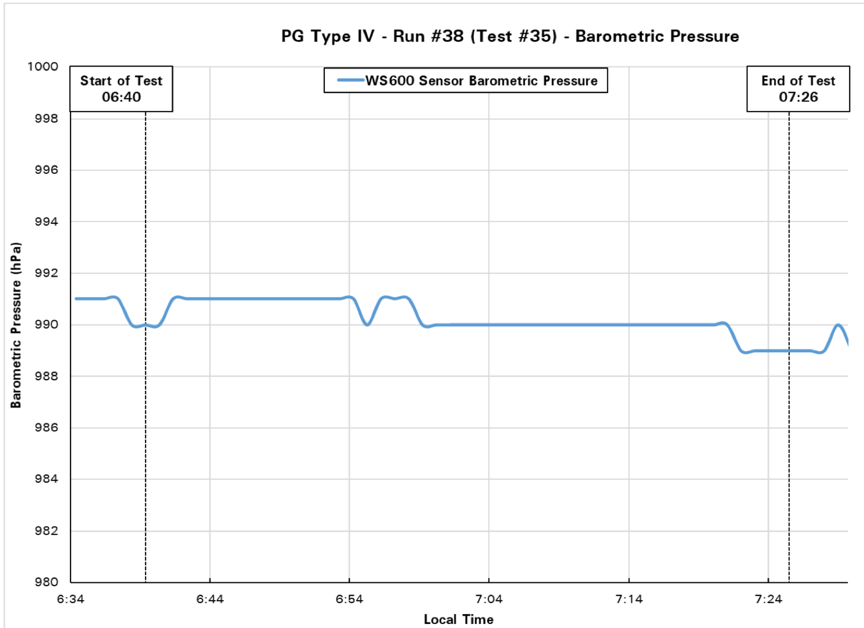
PG Type IV - Run #38 (Test #35) - Wind Speeds
Start of Test 06:40
End of Test 07:26
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
6:34
6:44
6:54
7:04
7:14
7:24
Local Time

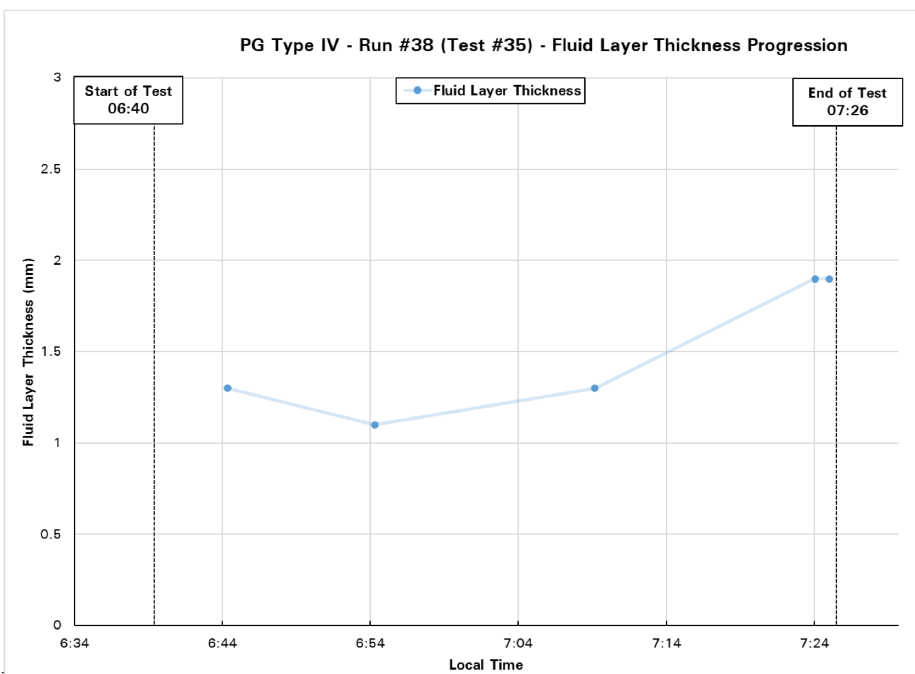


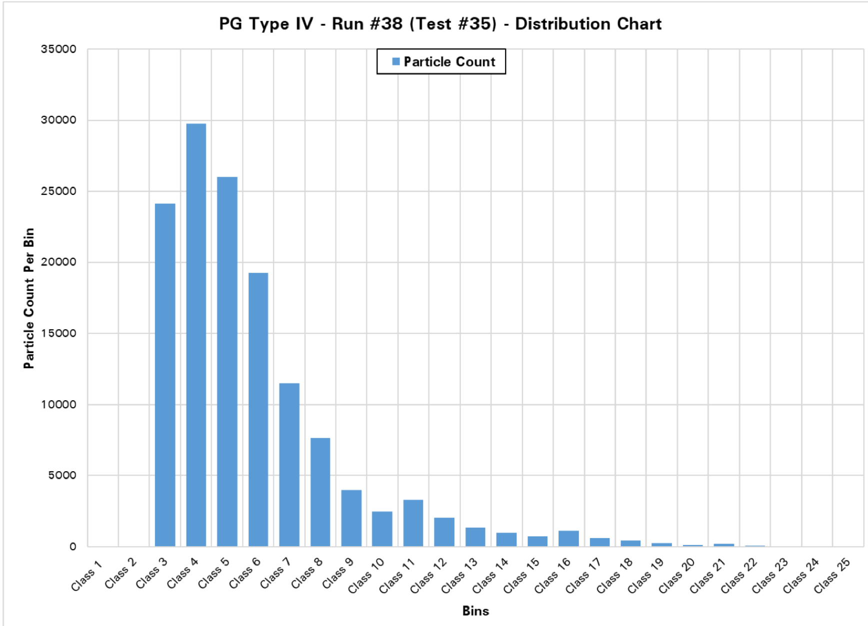
PG Type IV - Run #38 (Test #35) - Wind Direction
Start of Test 06:40
End of Test 07:26
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
6:34
6:44
6:54
7:04
7:14
7:24
Local Time


PG Type IV - Run #38 (Test #35) - Relative Humidity
Start of Test 06:40
WS600 Sensor Relative Humidity
End of Test 07:26
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
6:34
6:44
6:54
7:04
7:14
7:24
Local Time

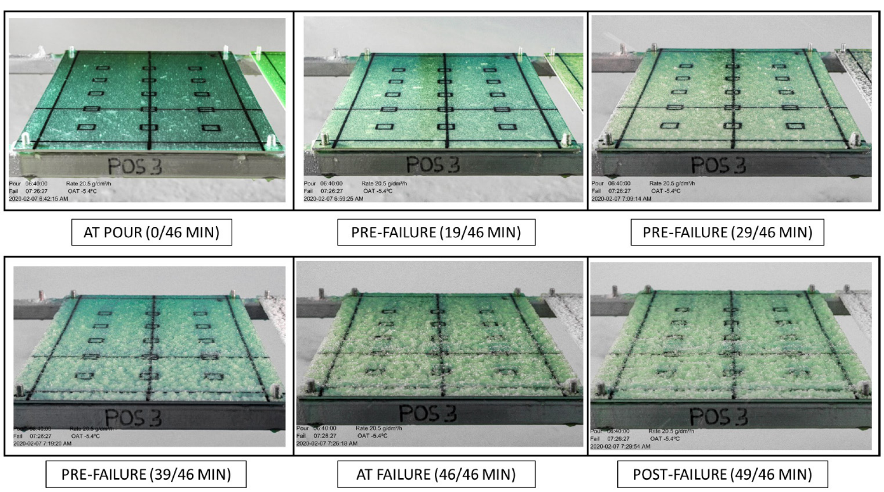

PG Type IV - Run #38 (Test #35) - Fluid Brix Progression
Start of Test 06:40
Fluid Brix
End of Test 07:26
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
6:34
6:44
6:54
7:04
7:14
7:24
Local Time


PG Type IV - Run #38 (Test #35) - Barometric Pressure
Start of Test 06:40
WS600 Sensor Barometric Pressure
End of Test 07:26
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
6:34
6:44
6:54
7:04
7:14
7:24
Local Time


PG Type IV - Run #38 (Test #35) - Fluid Layer Thickness Progression
Start of Test 06:40
Fluid Layer Thickness
End of Test 07:26
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
6:34
6:44
6:54
7:04
7:14
7:24
Local Time



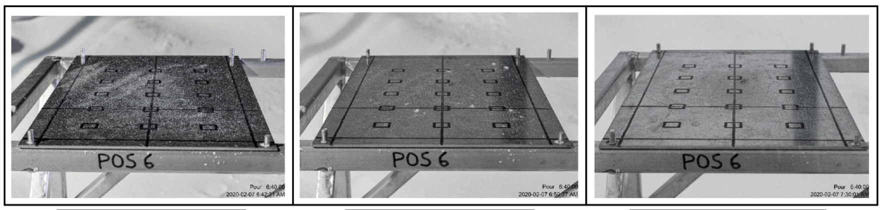
Polar Guard Advance – Run 38 (Test 35) – Failure Progression Photos



DATA PACKAGE – PG TYPE IV – RUN #38 (TEST 35)

Polar Guard Advance – Run 38 (Test 35) – Snow Characteristics Photos

FELT PAD (10/46 MIN) | FELT PAD (20/46 MIN) | FELT PAD (30/46 MIN)



BARE PLATE (2/46 MIN) | BARE PLATE (19/46 MIN) | BARE PLATE (50/46 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

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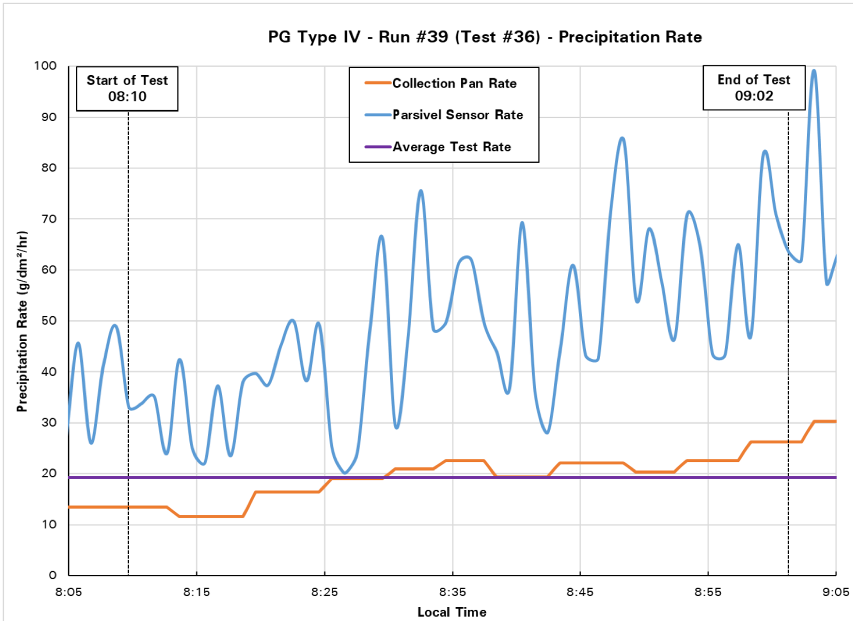
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

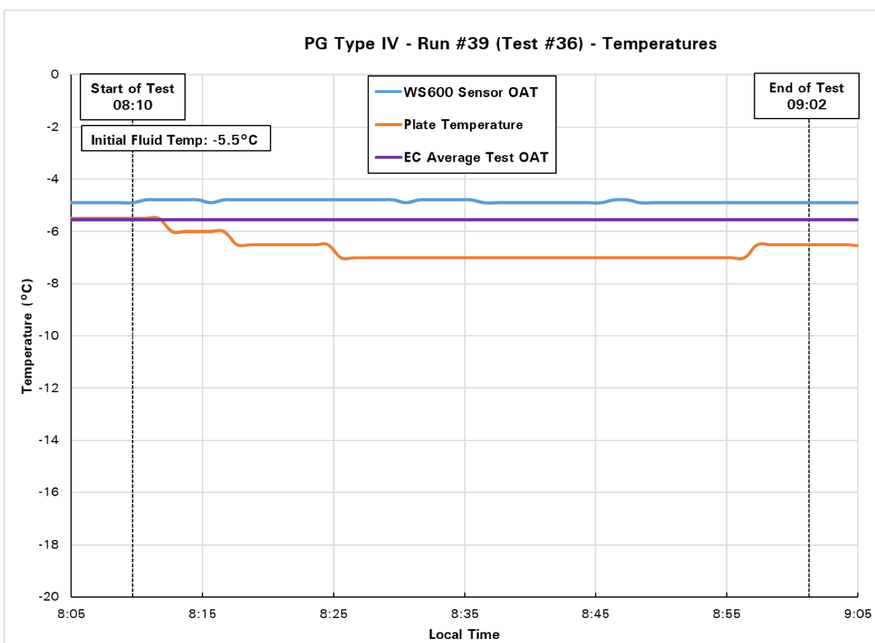
PG TYPE IV
RUN #39 (TEST #36) PG4-36

PG Type IV – Run #39 (Test #36) – General Test Information

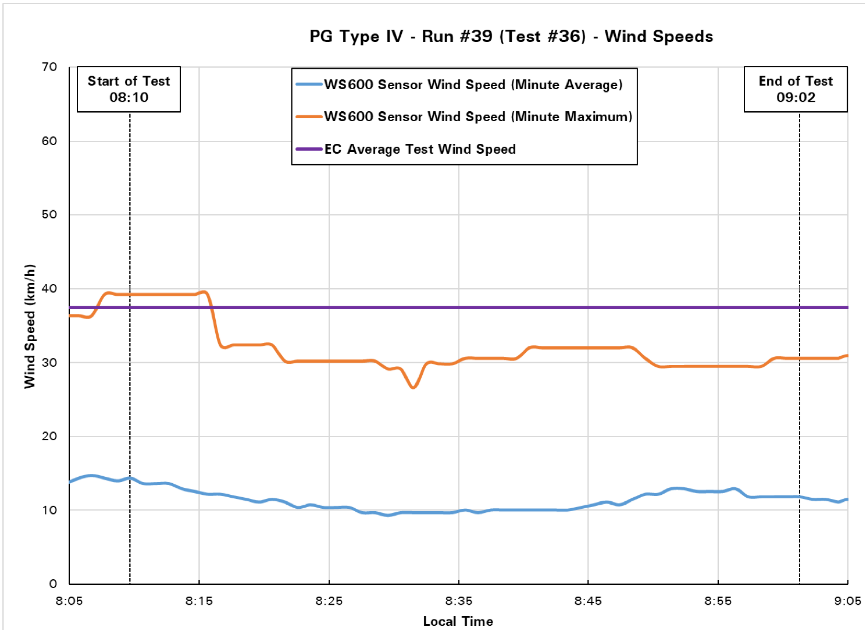
Test Number:	**PG4-36**
Date of Test:	**February 7, 2020**
Average OAT:	**-5.6**
Average Precipitation Rate:	**19.2 g/dm²/h**
Average Wind Speed:	**37.4 km/h**
Average Relative Humidity:	**89.5%**
Pour Time (Local):	**08:10:00**
Time of Fluid Failure (Local):	**09:02:00**
Fluid Brix at Failure:	**13.25°**
Endurance Time:	**52 minutes**
Expected Regression-Derived Endurance Time:	**46.3 minutes**
Difference (ET vs. Reg ET):	**+6.2 minutes (+13.4%)**

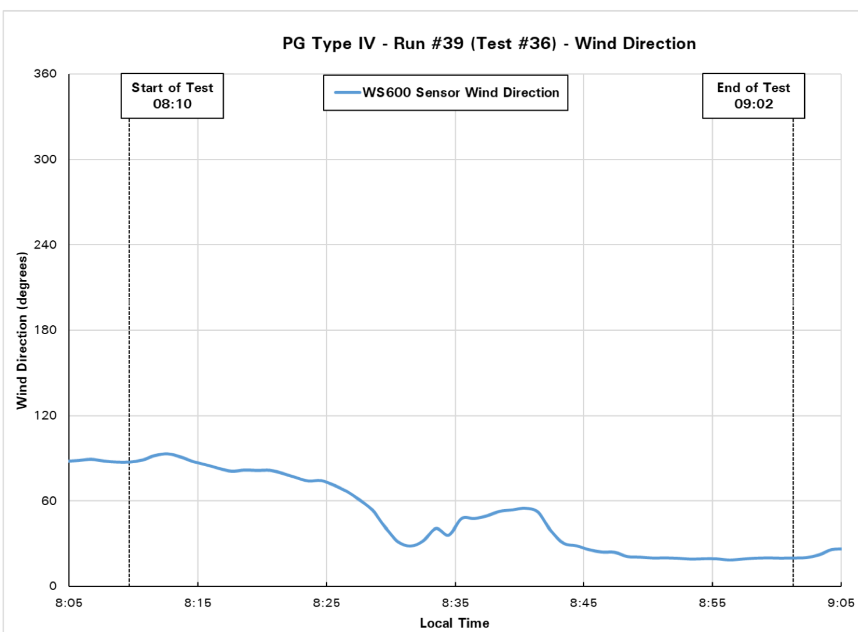


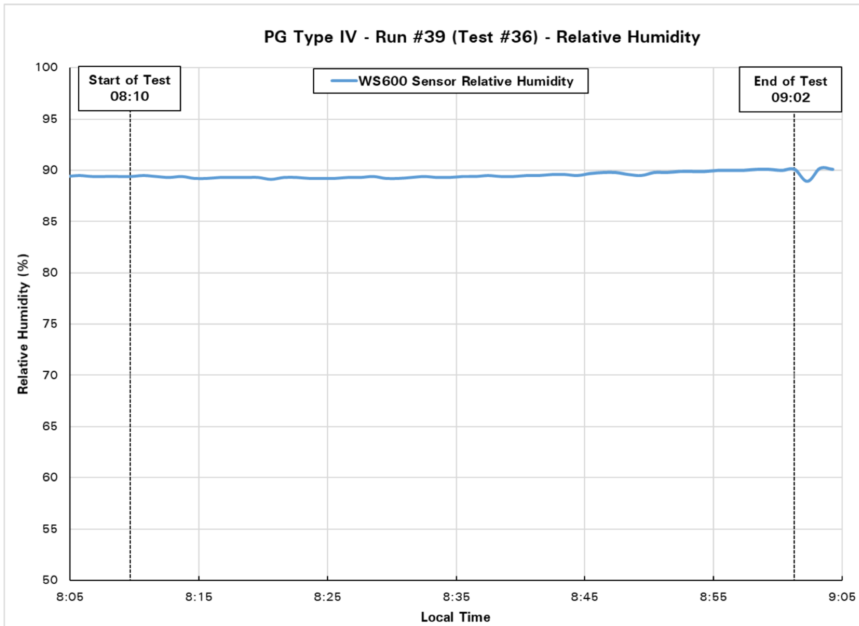
PG Type IV - Run #39 (Test #36) - Precipitation Rate
Start of Test
08:10
End of Test
09:02
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
80
90
100
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time



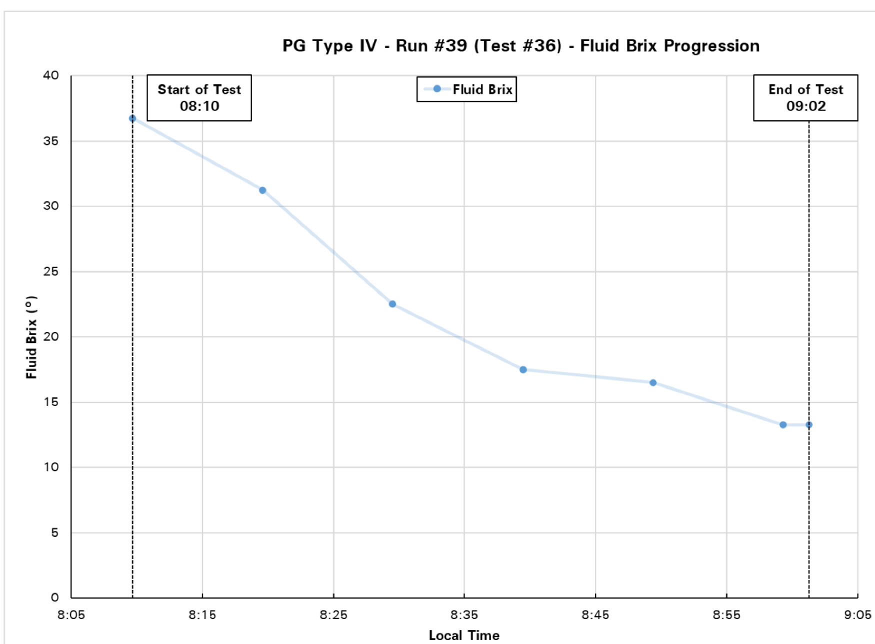
PG Type IV - Run #39 (Test #36) - Temperatures
Start of Test
08:10
Initial Fluid Temp: -5.5°C
End of Test
09:02
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time


PG Type IV - Run #39 (Test #36) - Wind Speeds
Start of Test 08:10
End of Test 09:02
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
8:05
8:15
8:25
8:35
8:45
8:55
9:05


PG Type IV - Run #39 (Test #36) - Wind Direction
Start of Test 08:10
WS600 Sensor Wind Direction
End of Test 09:02
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
8:05
8:15
8:25
8:35
8:45
8:55
9:05

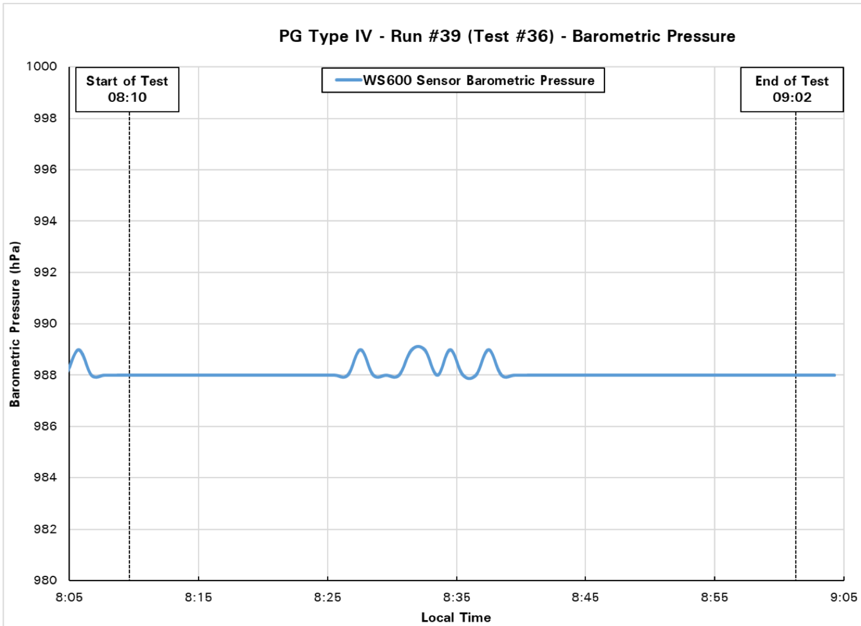


PG Type IV - Run #39 (Test #36) - Relative Humidity
Start of Test 08:10
WS600 Sensor Relative Humidity
End of Test 09:02
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time



PG Type IV - Run #39 (Test #36) - Fluid Brix Progression
Start of Test 08:10
Fluid Brix
End of Test 09:02
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
8:05
8:15
8:25
8:35
8:45
8:55
9:05
Local Time

DATA PACKAGE – PG TYPE IV – RUN #39 (TEST 36)



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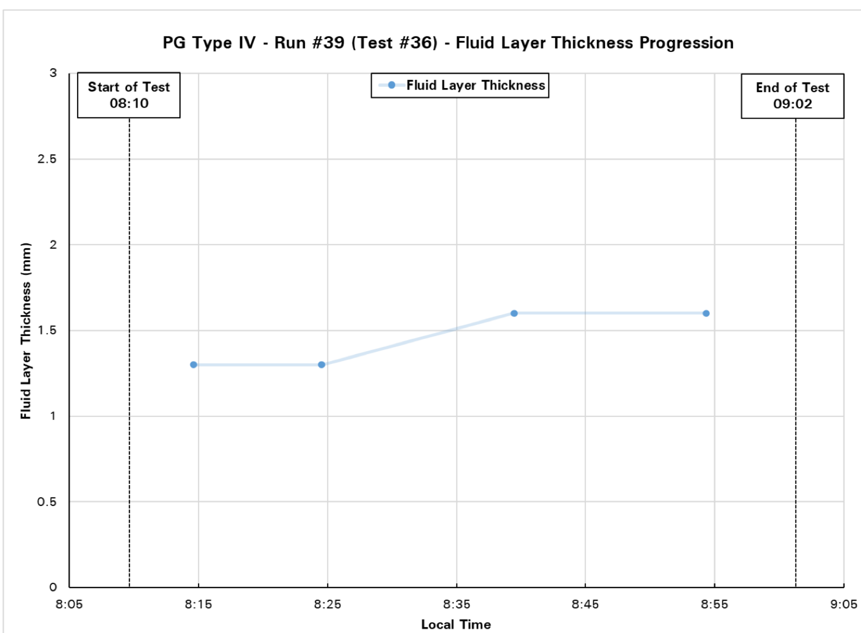
DATA PACKAGE – PG TYPE IV – RUN #39 (TEST 36)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 39 - Test 36/Data Package - PG Type IV - Run 39 - Test 36.docx
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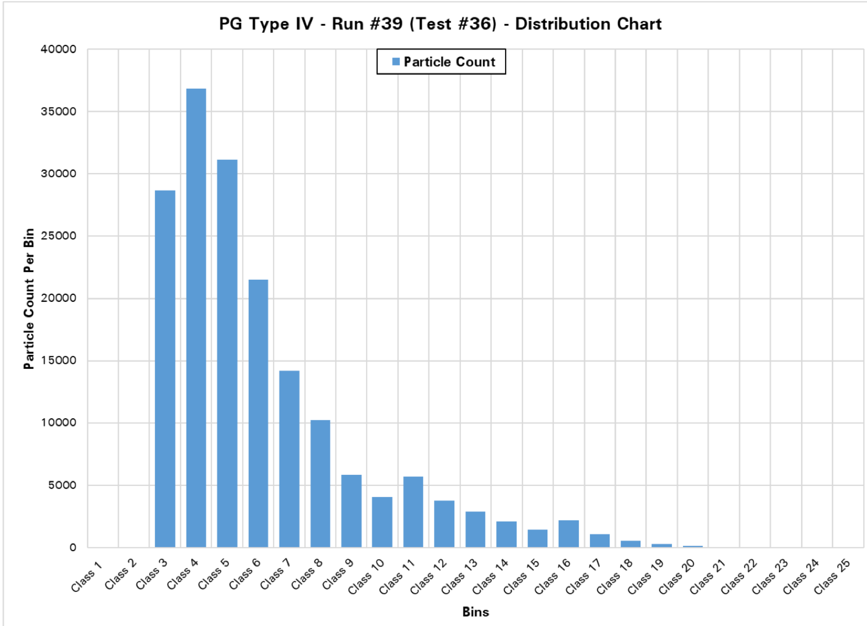
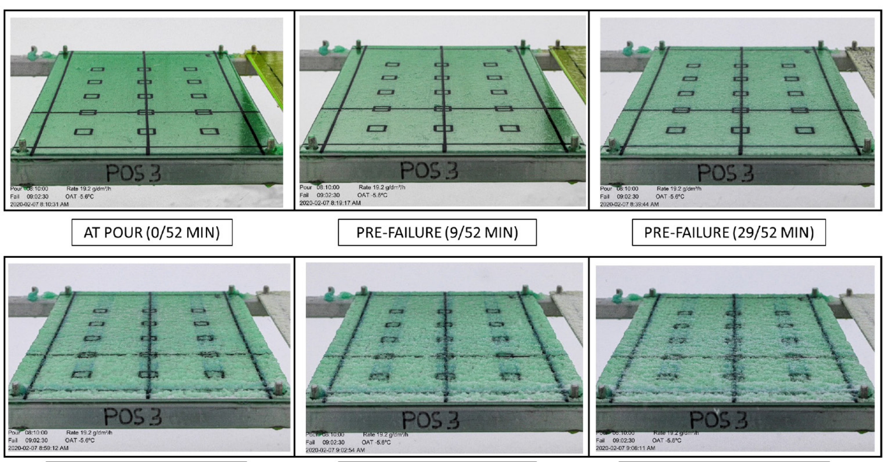


Polar Guard Advance – Run 39 – Test 36 – Failure Progression Photos



AT POUR (0/52 MIN)

PRE-FAILURE (9/52 MIN)

PRE-FAILURE (29/52 MIN)

PRE-FAILURE (49/52 MIN)

AT FAILURE (52/52 MIN)

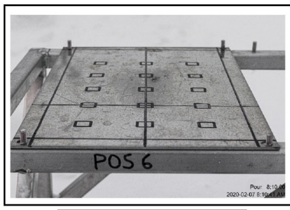
POST-FAILURE (56/52 MIN)

Polar Guard Advance – Run 39 – Test 36 – Snow Characteristics Photos

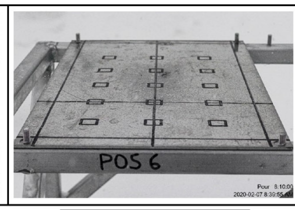
FELT PAD (3/52 MIN)

FELT PAD (19/52 MIN)

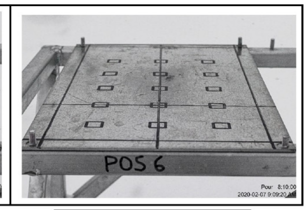
FELT PAD (50/52 MIN)



BARE PLATE (0/52 MIN)



BARE PLATE (29/52 MIN)



BARE PLATE (59/52 MIN)

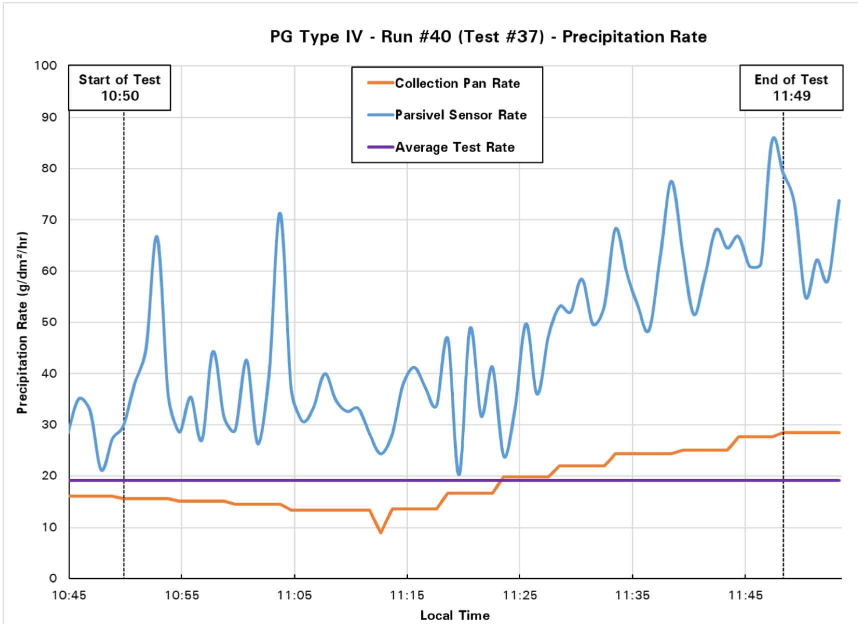
Final Bare Plate Contamination Thickness: **Nil (0 mm)**

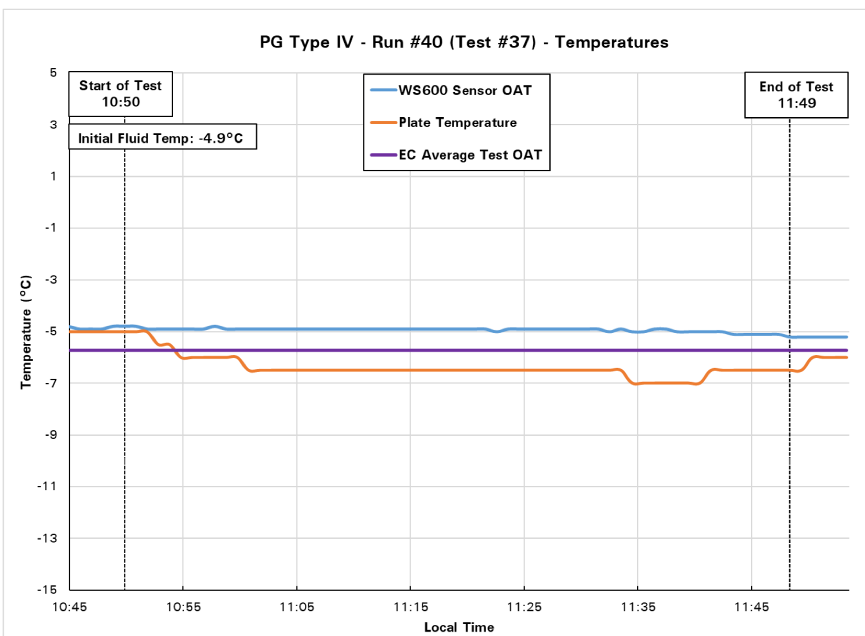
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

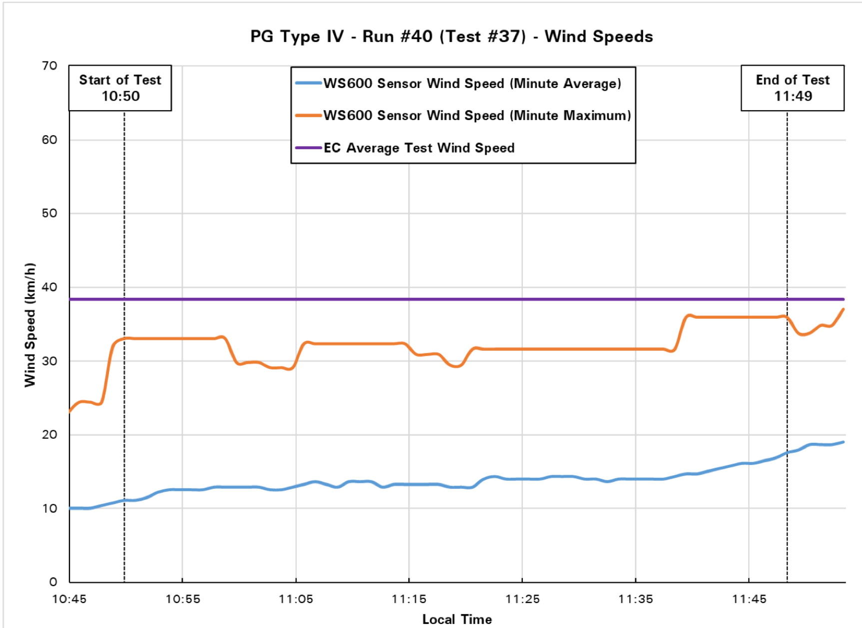
PG TYPE IV
RUN #40 (TEST #37) PG4-37

PG Type IV – Run #40 (Test #37) – General Test Information

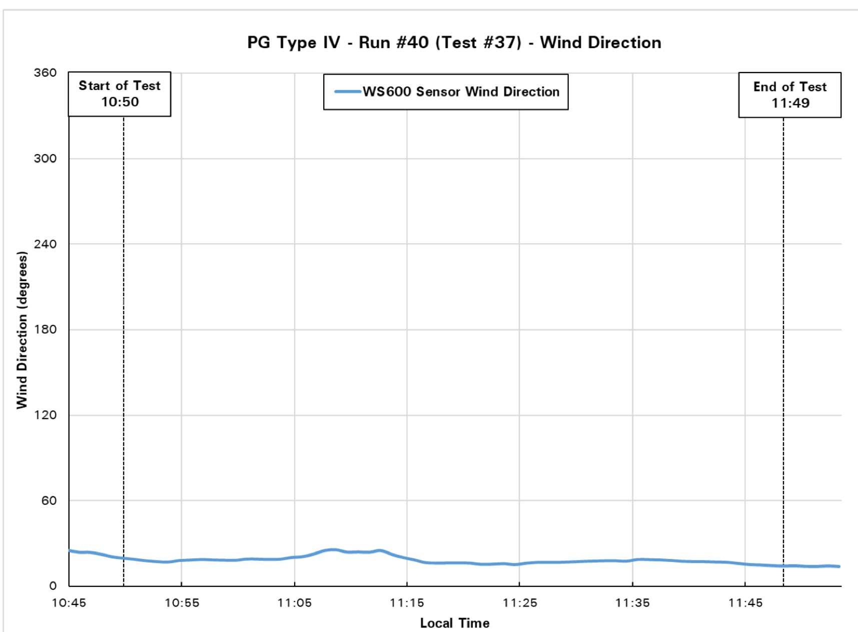
Test Number:	PG4-37
Date of Test:	February 7, 2020
Average OAT:	-5.7
Average Precipitation Rate:	19.1 g/dm²/h
Average Wind Speed:	38.4 km/h
Average Relative Humidity:	89.7%
Pour Time (Local):	10:50:00
Time of Fluid Failure (Local):	11:49:00
Fluid Brix at Failure:	12.5°
Endurance Time:	59 minutes
Expected Regression-Derived Endurance Time:	45.9 minutes
Difference (ET vs. Reg ET):	+13.1 minutes (+28.5%)


PG Type IV - Run #40 (Test #37) - Precipitation Rate
Start of Test 10:50
End of Test 11:49
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
Local Time
0
10
20
30
40
50
60
70
80
90
100
10:45
10:55
11:05
11:15
11:25
11:35
11:45

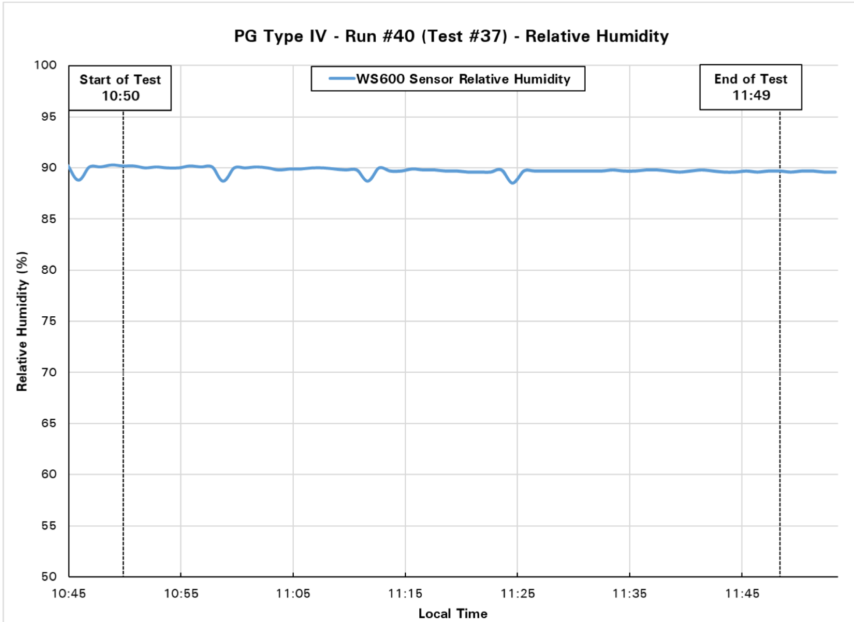

PG Type IV - Run #40 (Test #37) - Temperatures
Start of Test 10:50
Initial Fluid Temp: -4.9°C
End of Test 11:49
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
Local Time
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
10:45
10:55
11:05
11:15
11:25
11:35
11:45

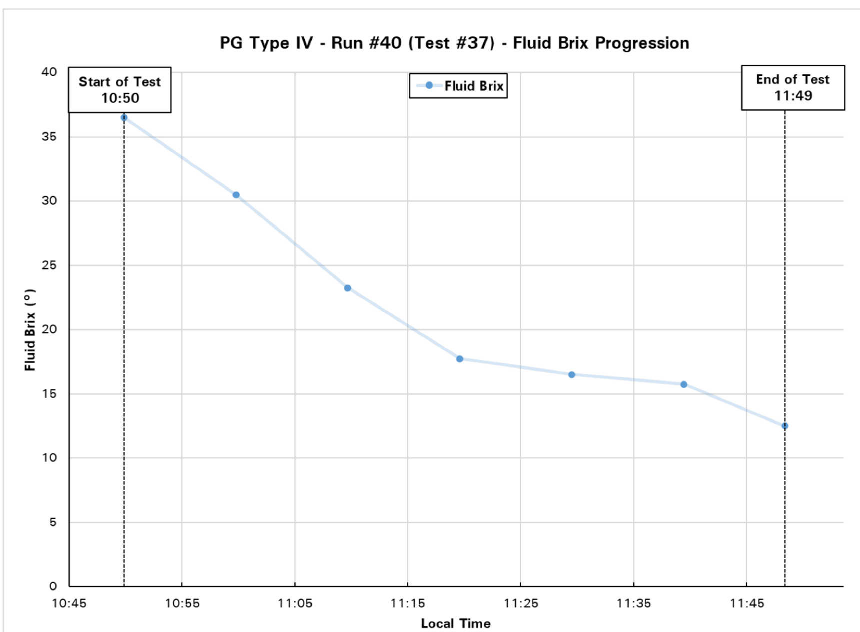


PG Type IV - Run #40 (Test #37) - Wind Speeds
Start of Test 10:50
End of Test 11:49
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
10:45
10:55
11:05
11:15
11:25
11:35
11:45
Local Time

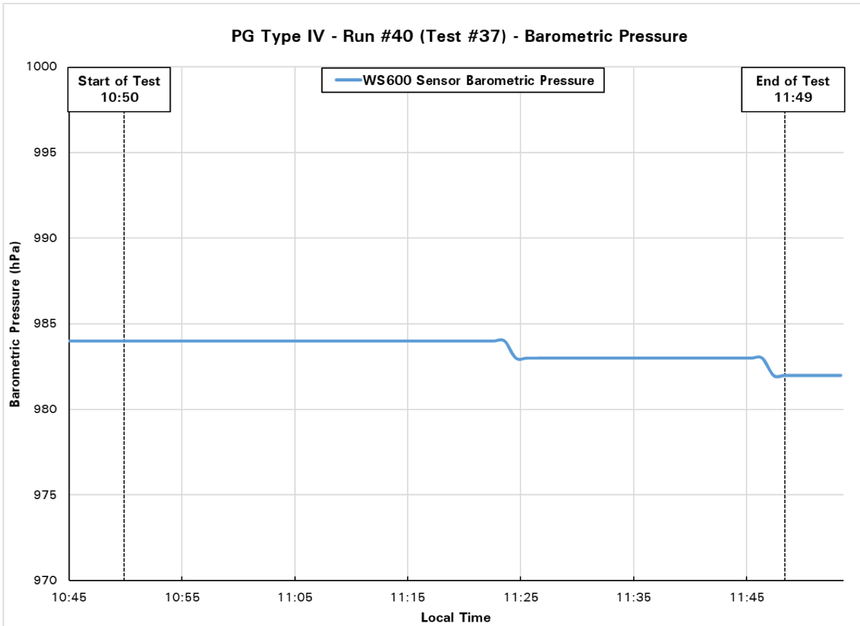


PG Type IV - Run #40 (Test #37) - Wind Direction
Start of Test 10:50
End of Test 11:49
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
10:45
10:55
11:05
11:15
11:25
11:35
11:45
Local Time


PG Type IV - Run #40 (Test #37) - Relative Humidity
Start of Test 10:50
WS600 Sensor Relative Humidity
End of Test 11:49
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:45
10:55
11:05
11:15
11:25
11:35
11:45
Local Time


PG Type IV - Run #40 (Test #37) - Fluid Brix Progression
Start of Test 10:50
Fluid Brix
End of Test 11:49
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:45
10:55
11:05
11:15
11:25
11:35
11:45
Local Time

DATA PACKAGE – PG TYPE IV – RUN #40 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 40 - Test 37/Data Package - PG Type IV - Run 40 - Test 37.docx
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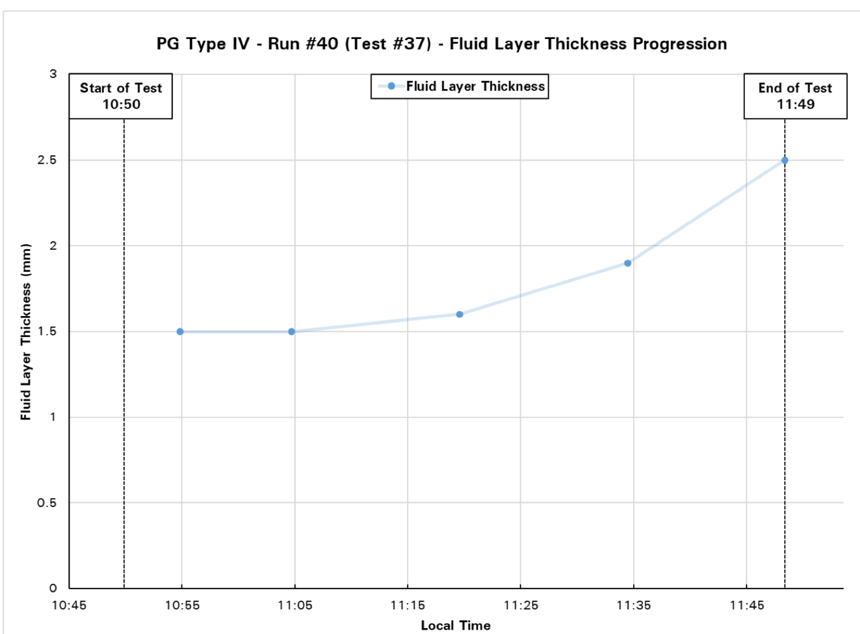
DATA PACKAGE – PG TYPE IV – RUN #40 (TEST 37)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 40 - Test 37/Data Package - PG Type IV - Run 40 - Test 37.docx
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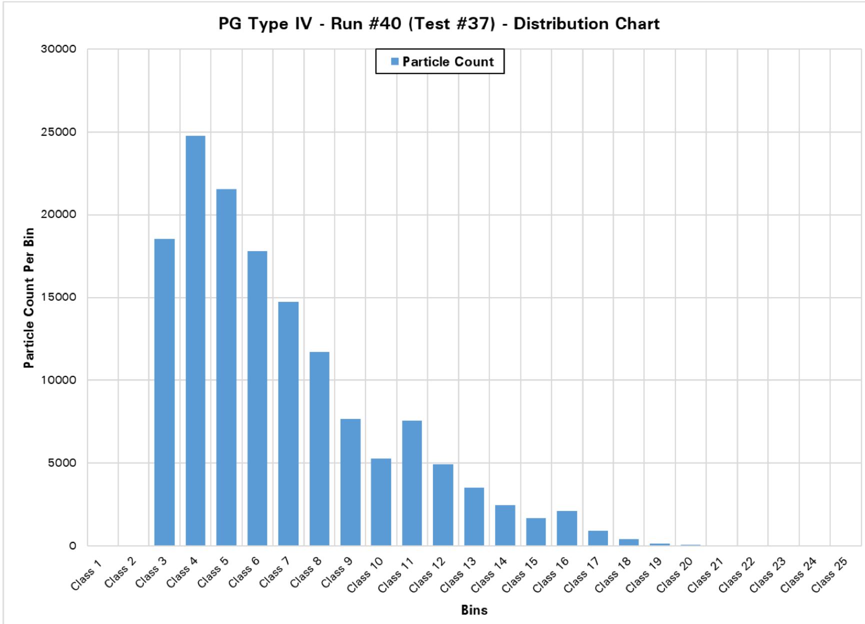
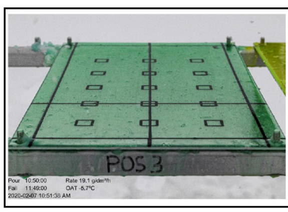
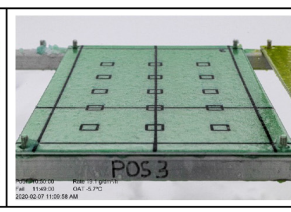


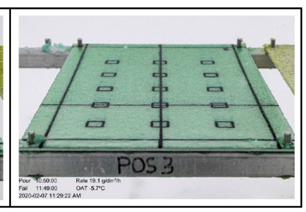
Polar Guard Advance – Run 40 (Test 37) – Failure Progression Photos



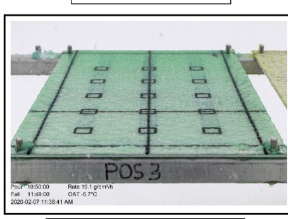
AT POUR (0/59 MIN)



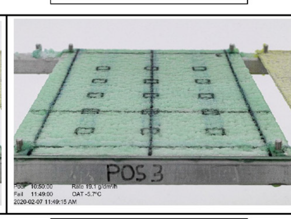
PRE-FAILURE (19/59 MIN)



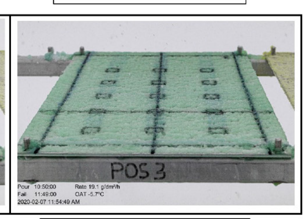
PRE-FAILURE (39/59 MIN)



PRE-FAILURE (48/59 MIN)

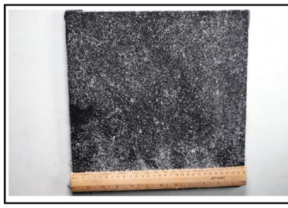


AT FAILURE (59/59 MIN)



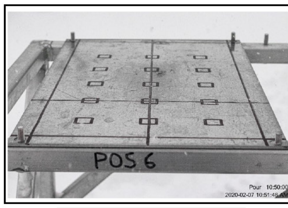
POST-FAILURE (64/59 MIN)

Polar Guard Advance – Run 40 (Test 37) – Snow Characteristics Photos

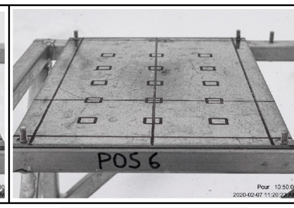

FELT PAD (1/59 MIN)


FELT PAD (31/59 MIN)

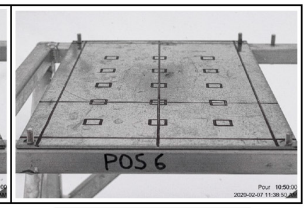

FELT PAD (59/59 MIN)



BARE PLATE (1/59 MIN)



BARE PLATE (30/59 MIN)



BARE PLATE (48/59 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

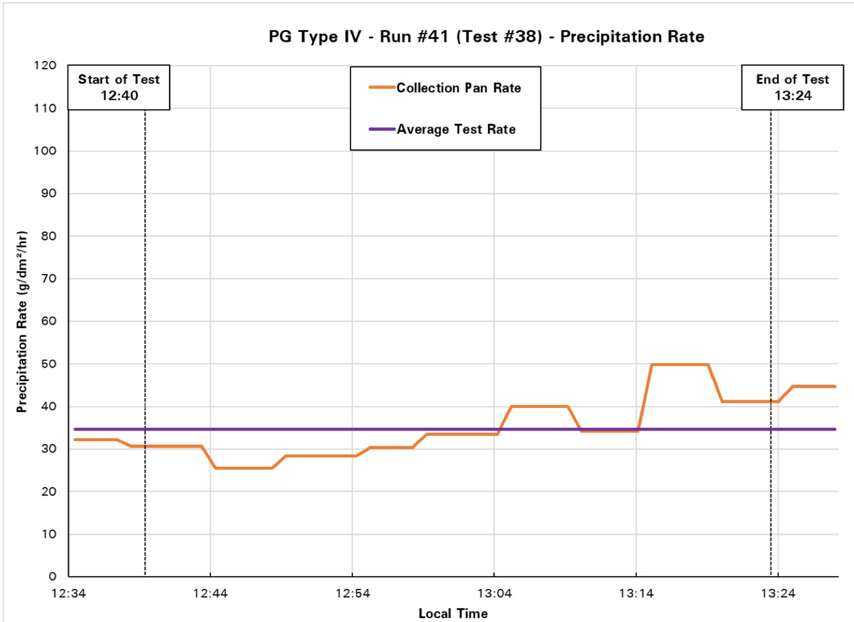
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #41 (TEST #38) PG4-38

PG Type IV – Run #41 (Test #38) – General Test Information

Test Number:	PG4-38
Date of Test:	February 12, 2020
Average OAT:	-6.0
Average Precipitation Rate:	34.6 g/dm²/h
Average Wind Speed:	38.0 km/h
Average Relative Humidity:	89.4%
Pour Time (Local):	12:40:00
Time of Fluid Failure (Local):	13:24:00
Fluid Brix at Failure:	14.5°
Endurance Time:	44 minutes
Expected Regression-Derived Endurance Time:	27.6 minutes
Difference (ET vs. Reg ET):	+16.1 minutes (+61.1%)

DATA PACKAGE – PG TYPE IV – RUN #41 (TEST 38)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 41 - Test 38/Data Package - PG Type IV - Run 41 - Test 38.docx
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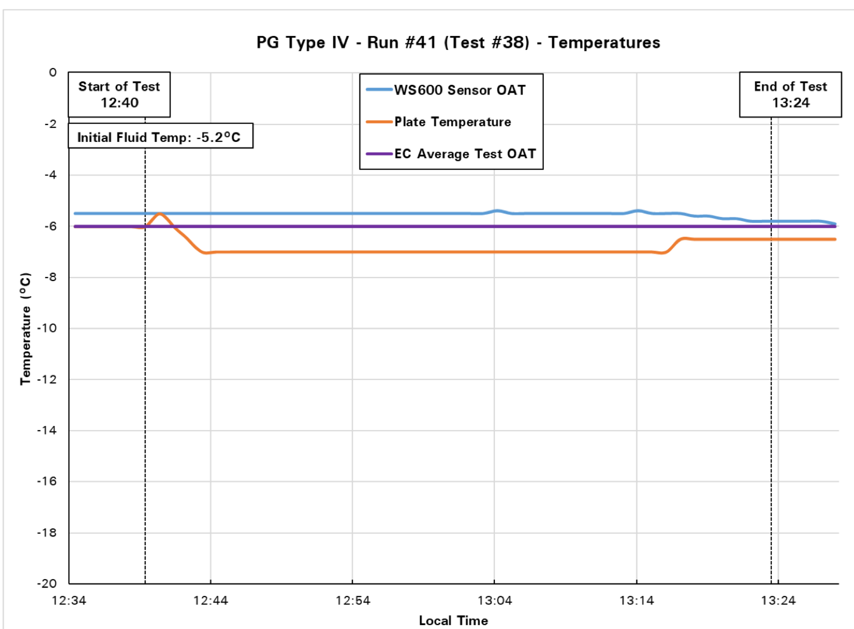
DATA PACKAGE – PG TYPE IV – RUN #41 (TEST 38)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 41 - Test 38/Data Package - PG Type IV - Run 41 - Test 38.docx
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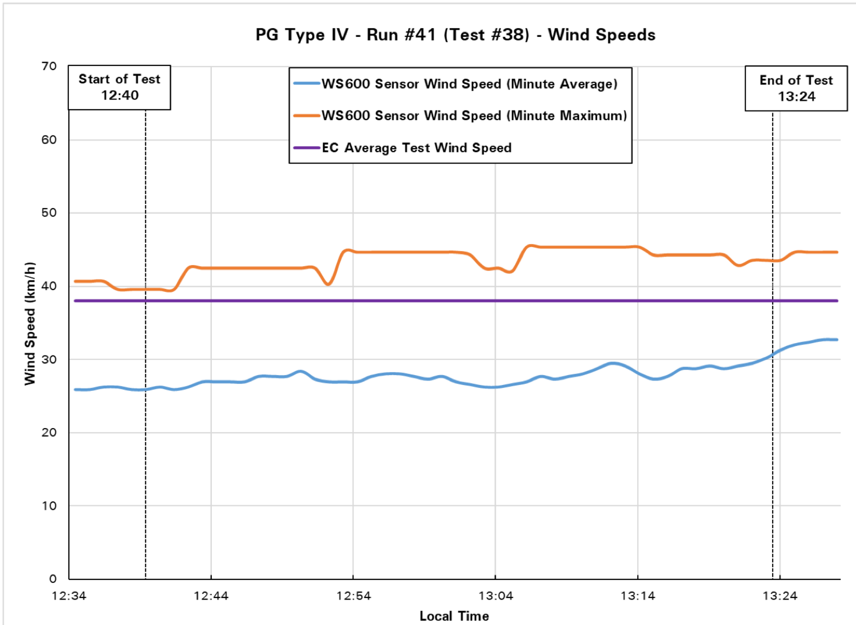
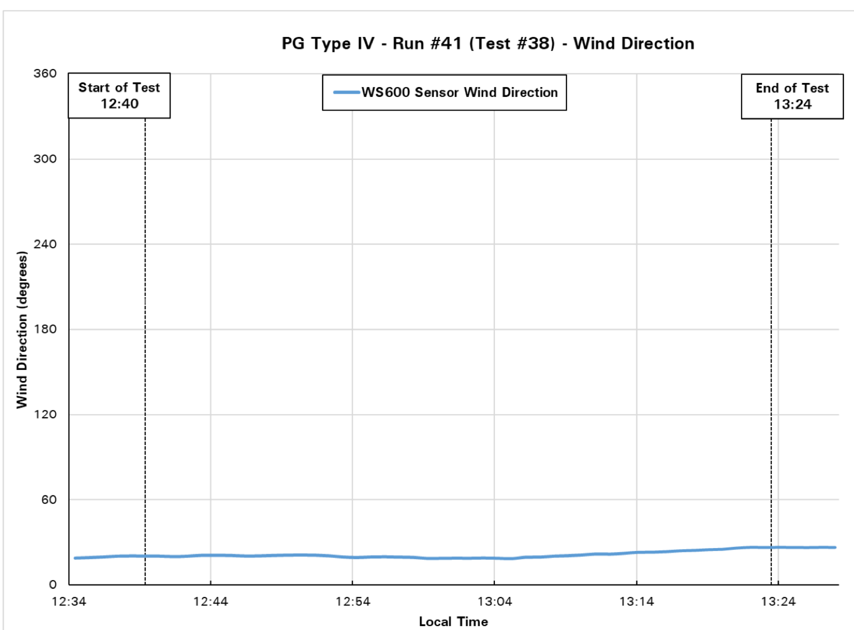
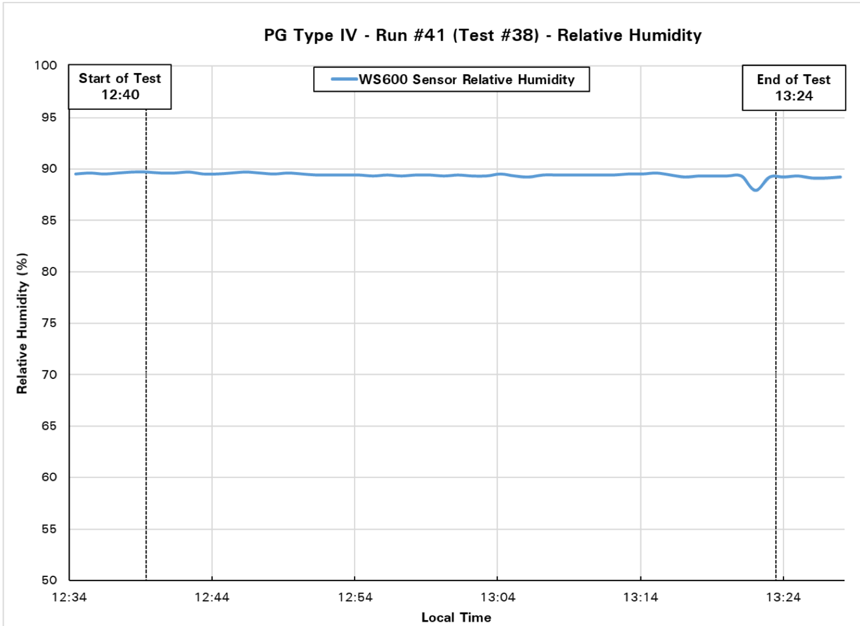
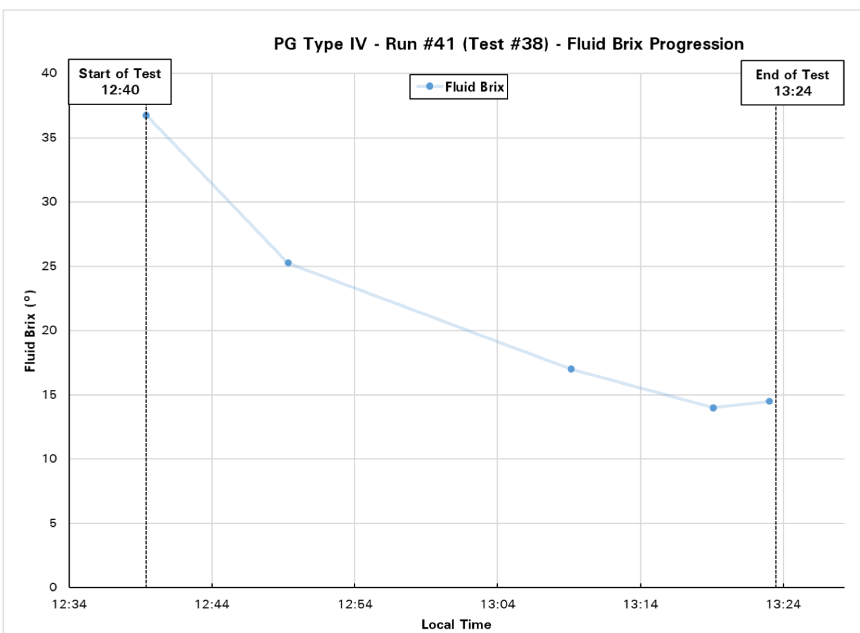
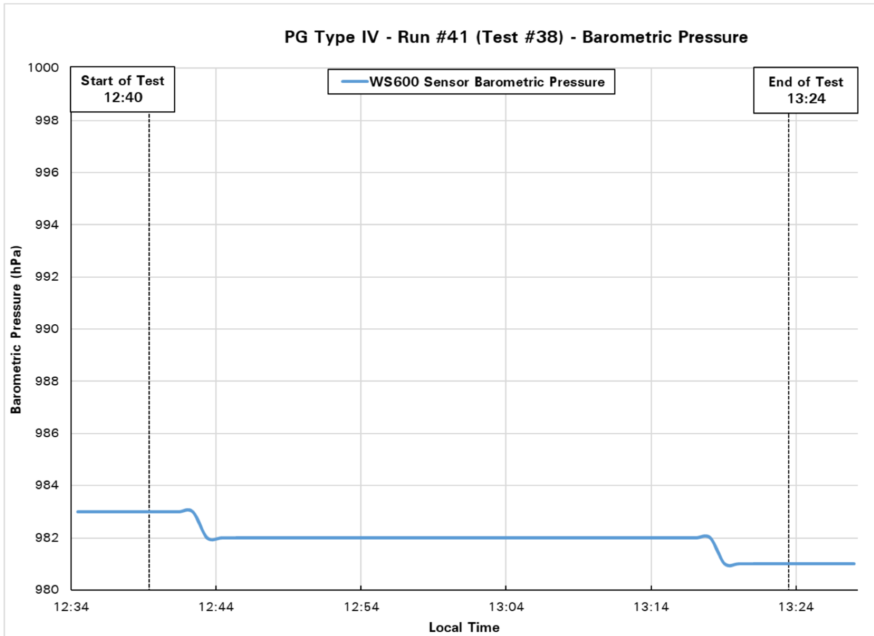
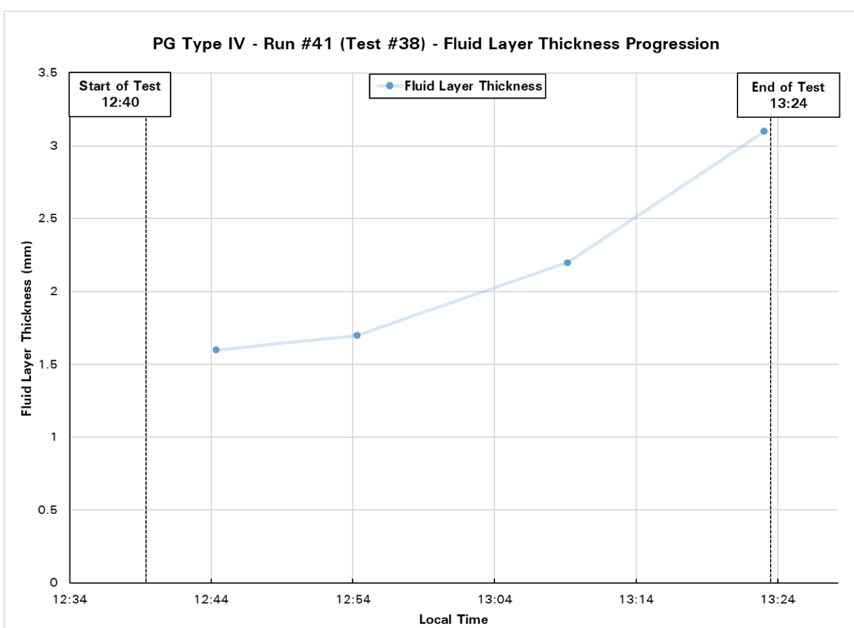

PG Type IV - Run #41 (Test #38) - Wind Speeds
Start of Test 12:40
End of Test 13:24
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
Local Time
0
10
20
30
40
50
60
70
12:34
12:44
12:54
13:04
13:14
13:24

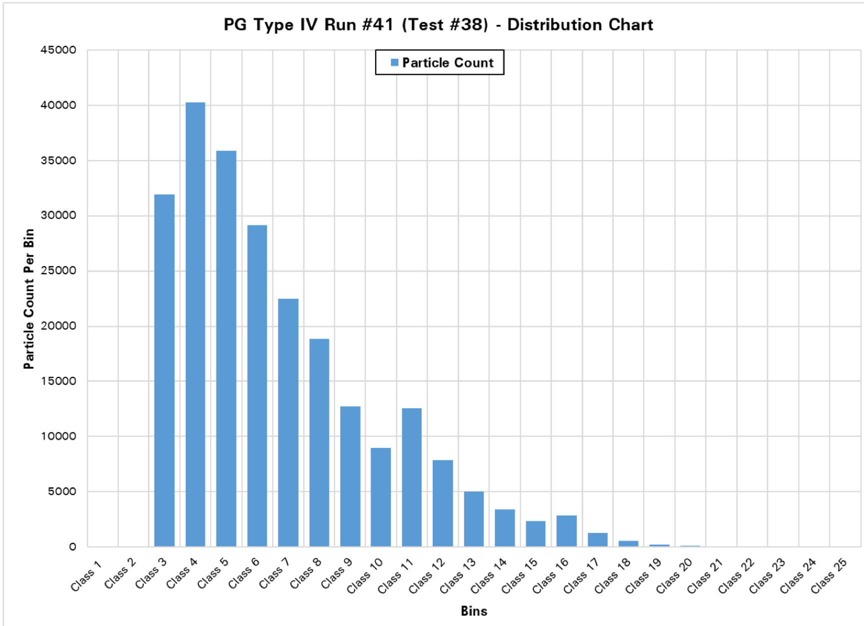

PG Type IV - Run #41 (Test #38) - Wind Direction
Start of Test 12:40
End of Test 13:24
WS600 Sensor Wind Direction
Wind Direction (degrees)
Local Time
0
60
120
180
240
300
360
12:34
12:44
12:54
13:04
13:14
13:24


PG Type IV - Run #41 (Test #38) - Relative Humidity
WS600 Sensor Relative Humidity
Start of Test 12:40
End of Test 13:24
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
12:34
12:44
12:54
13:04
13:14
13:24
Local Time

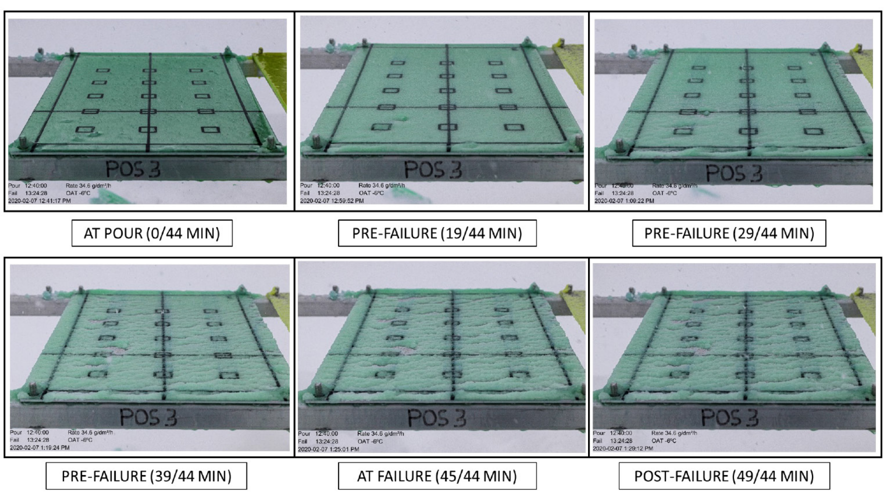

PG Type IV - Run #41 (Test #38) - Fluid Brix Progression
Fluid Brix
Start of Test 12:40
End of Test 13:24
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
12:34
12:44
12:54
13:04
13:14
13:24
Local Time


PG Type IV - Run #41 (Test #38) - Barometric Pressure
Start of Test 12:40
WS600 Sensor Barometric Pressure
End of Test 13:24
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
12:34
12:44
12:54
13:04
13:14
13:24
Local Time


PG Type IV - Run #41 (Test #38) - Fluid Layer Thickness Progression
Start of Test 12:40
Fluid Layer Thickness
End of Test 13:24
Fluid Layer Thickness (mm)
3.5
3
2.5
2
1.5
1
0.5
0
12:34
12:44
12:54
13:04
13:14
13:24
Local Time



Polar Guard Advance – Run 41 (Test 38) – Failure Progression Photos

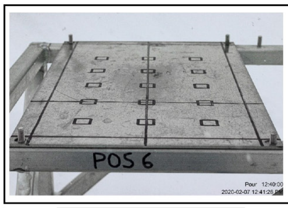


Polar Guard Advance – Run 41 (Test 38) – Snow Characteristics Photos

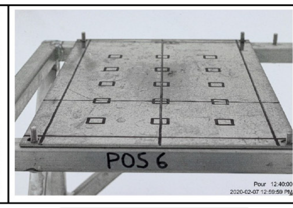
FELT PAD (1/44 MIN)

FELT PAD (20/44 MIN)

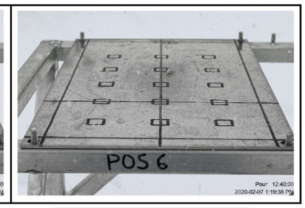
FELT PAD (40/44 MIN)



BARE PLATE (1/44 MIN)



BARE PLATE (19/44 MIN)



BARE PLATE (39/44 MIN)

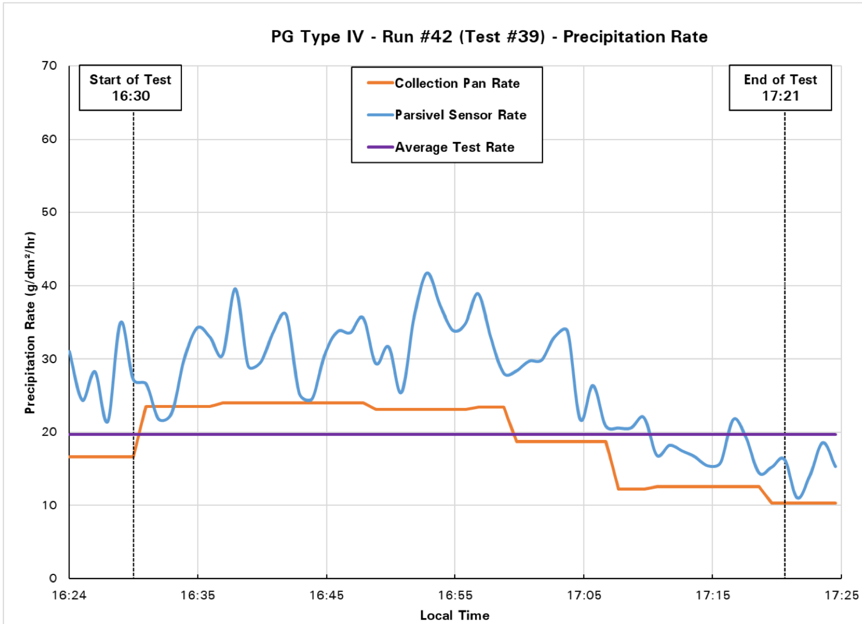
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

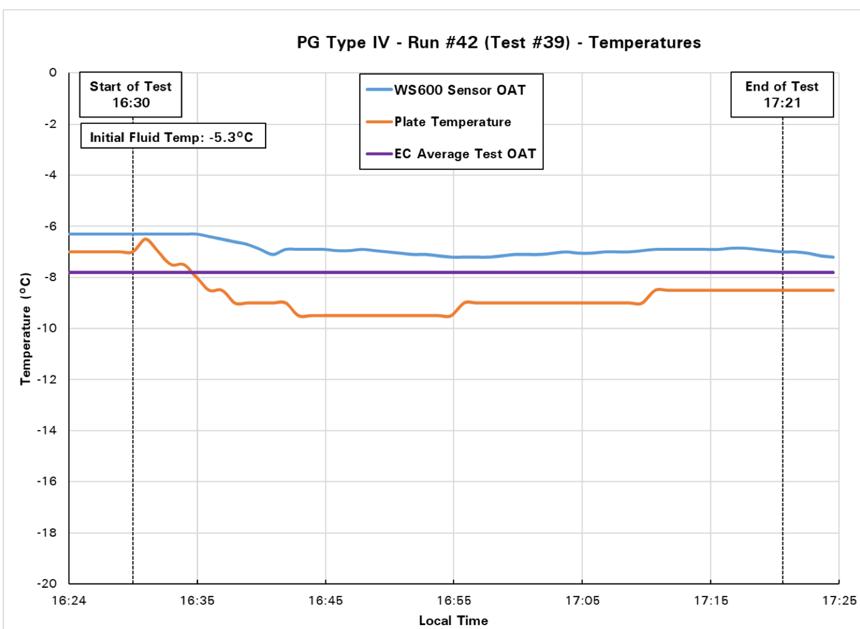
PG TYPE IV
RUN #42 (TEST #39) PG4-39

PG Type IV – Run #42 (Test #39) – General Test Information

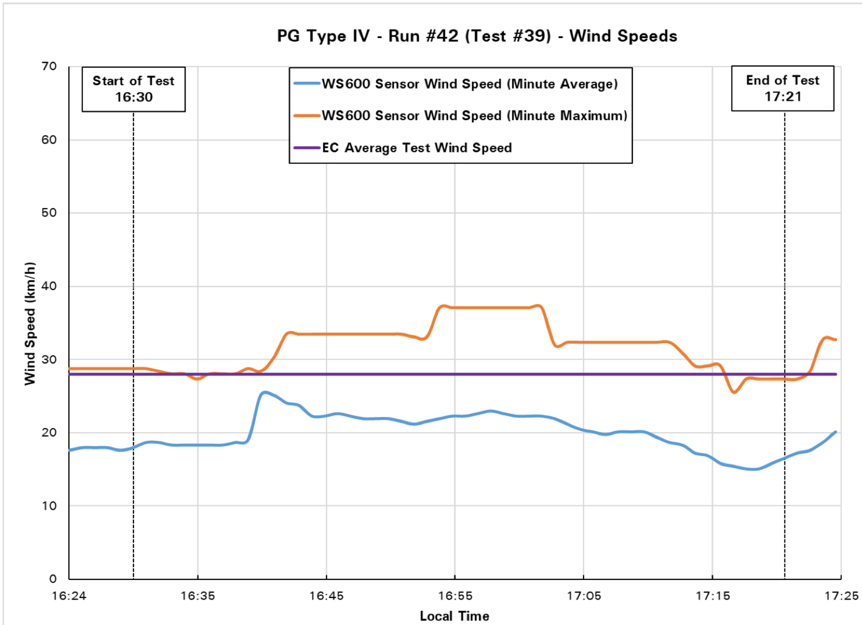
Test Number:	PG4-39
Date of Test:	February 7, 2020
Average OAT:	-7.8
Average Precipitation Rate:	19.7 g/dm²/h
Average Wind Speed:	28 km/h
Average Relative Humidity:	87.6%
Pour Time (Local):	16:30:00
Time of Fluid Failure (Local):	17:21:00
Fluid Brix at Failure:	16°
Endurance Time:	51 minutes
Expected Regression-Derived Endurance Time:	38.9 minutes
Difference (ET vs. Reg ET):	+12.2 minutes (+31.4%)

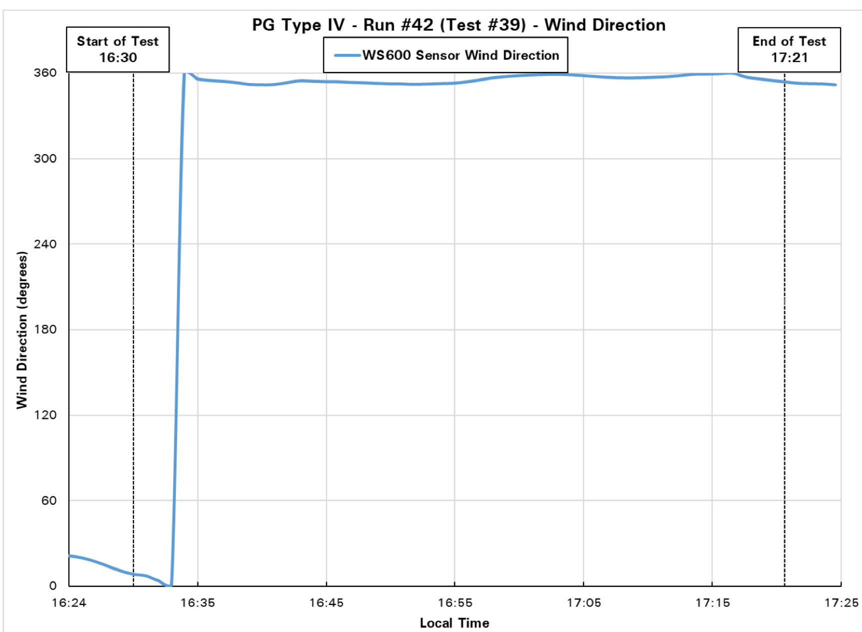


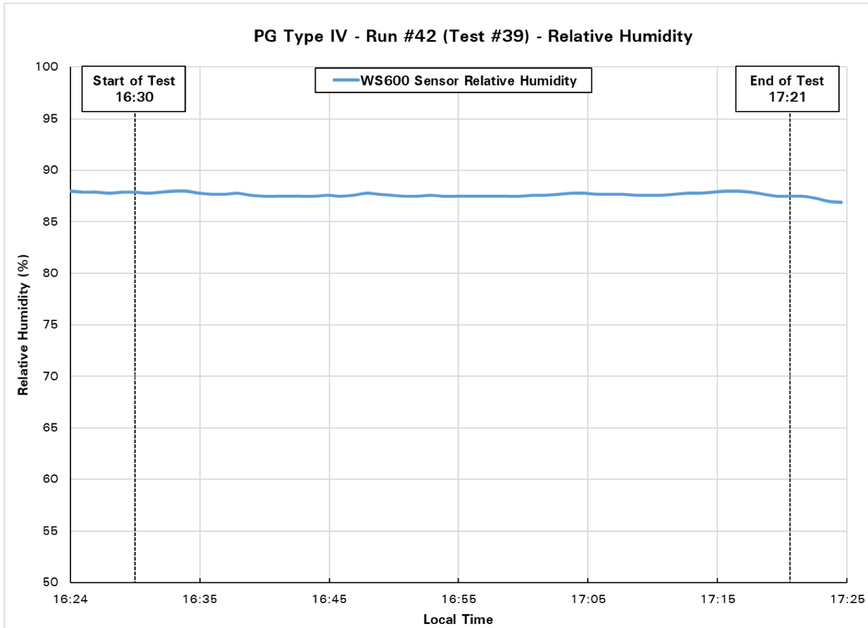
PG Type IV - Run #42 (Test #39) - Precipitation Rate
Start of Test 16:30
End of Test 17:21
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:24
16:35
16:45
16:55
17:05
17:15
17:25
Local Time



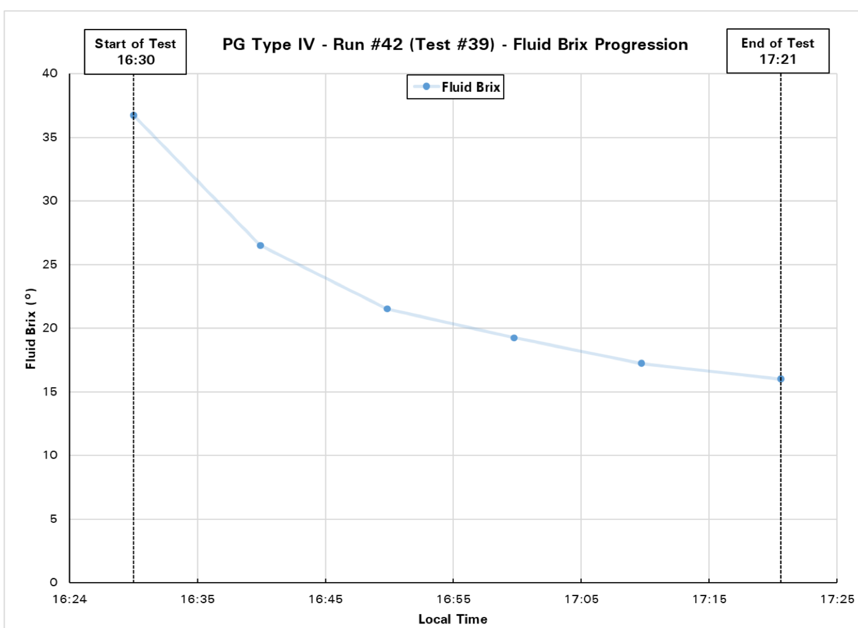
PG Type IV - Run #42 (Test #39) - Temperatures
Start of Test 16:30
Initial Fluid Temp: -5.3°C
End of Test 17:21
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
16:24
16:35
16:45
16:55
17:05
17:15
17:25
Local Time


PG Type IV - Run #42 (Test #39) - Wind Speeds
Start of Test 16:30
End of Test 17:21
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:24
16:35
16:45
16:55
17:05
17:15
17:25
Local Time


PG Type IV - Run #42 (Test #39) - Wind Direction
Start of Test 16:30
WS600 Sensor Wind Direction
End of Test 17:21
Wind Direction (degrees)
0
60
120
180
240
300
360
16:24
16:35
16:45
16:55
17:05
17:15
17:25
Local Time

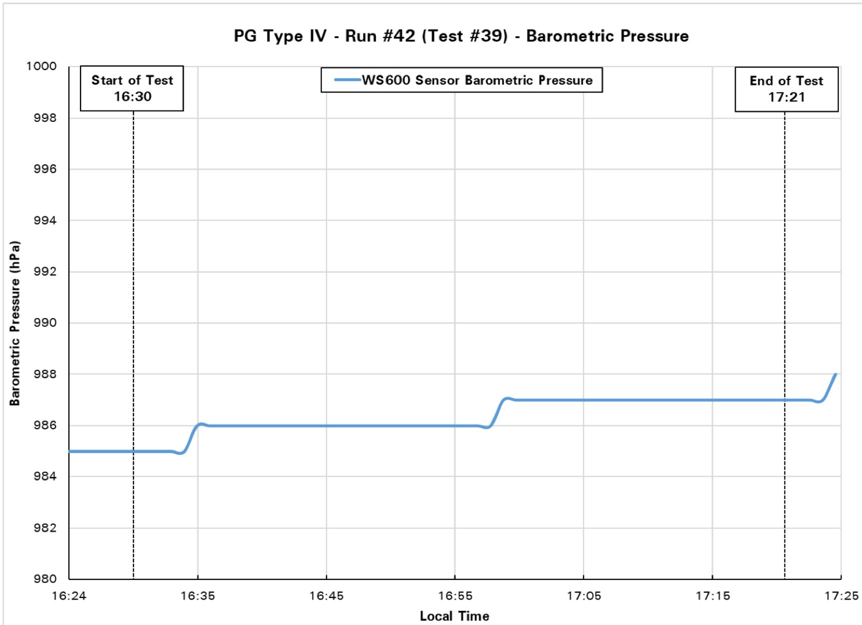


PG Type IV - Run #42 (Test #39) - Relative Humidity
Start of Test
16:30
WS600 Sensor Relative Humidity
End of Test
17:21
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
16:24
16:35
16:45
16:55
17:05
17:15
17:25
Local Time



Start of Test
16:30
PG Type IV - Run #42 (Test #39) - Fluid Brix Progression
End of Test
17:21
Fluid Brix
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
16:24
16:35
16:45
16:55
17:05
17:15
17:25
Local Time

DATA PACKAGE – PG TYPE IV – RUN #42 (TEST 39)



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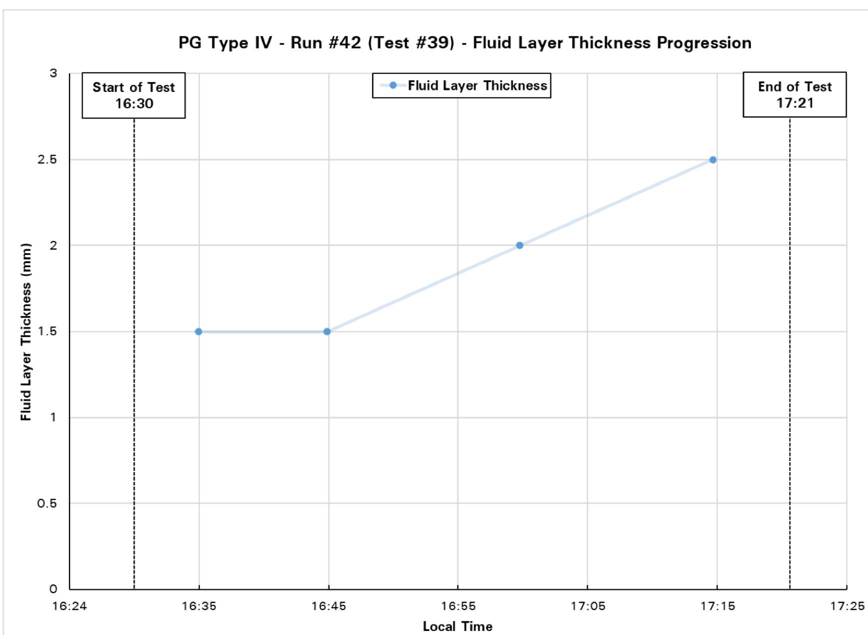
DATA PACKAGE – PG TYPE IV – RUN #42 (TEST 39)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 42 - Test 39/Data Package - PG Type IV - Run 42 - Test 39.docx
Final Version 1.0, March 2021

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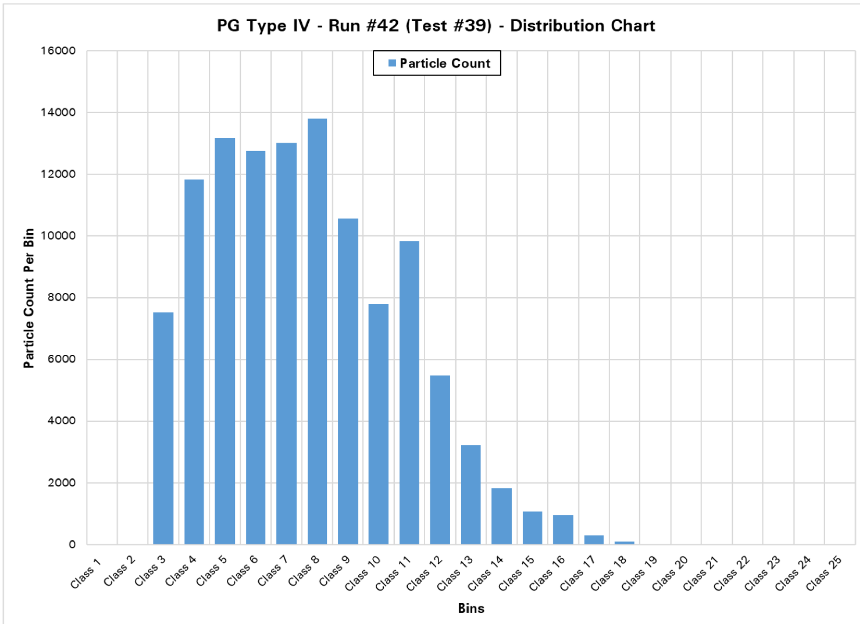
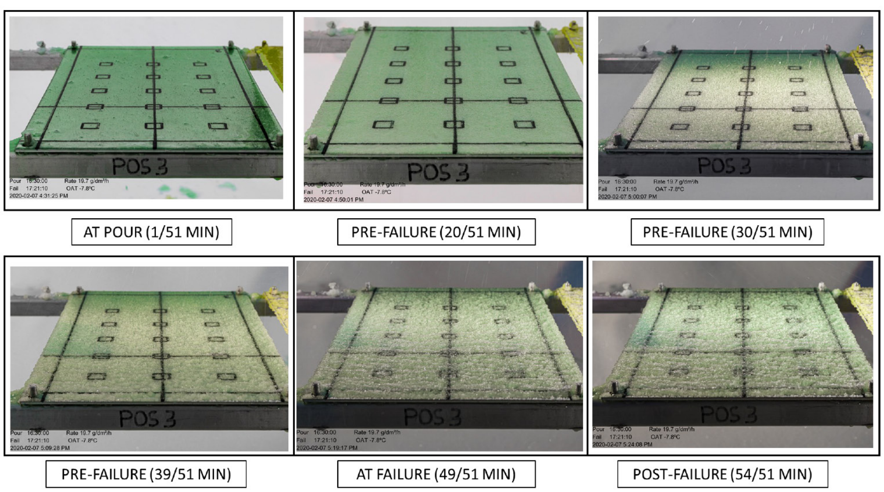
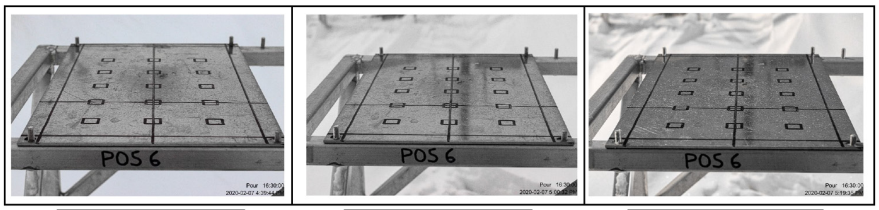


Polar Guard Advance – Run 42 (Test 39) – Failure Progression Photos



Polar Guard Advance – Run 42 (Test 39) – Snow Characteristics Photos

FELT PAD (11/51 MIN) | FELT PAD (20/51 MIN) | FELT PAD (40/51 MIN)



BARE PLATE (9/51 MIN) | BARE PLATE (30/51 MIN) | BARE PLATE (49/51 MIN)

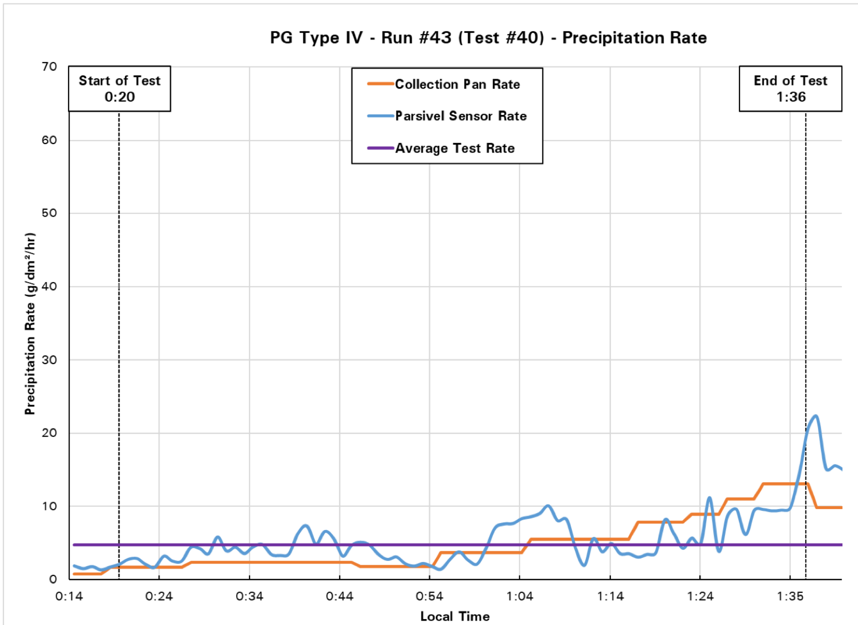
Final Bare Plate Contamination Thickness: **Nil (0 mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

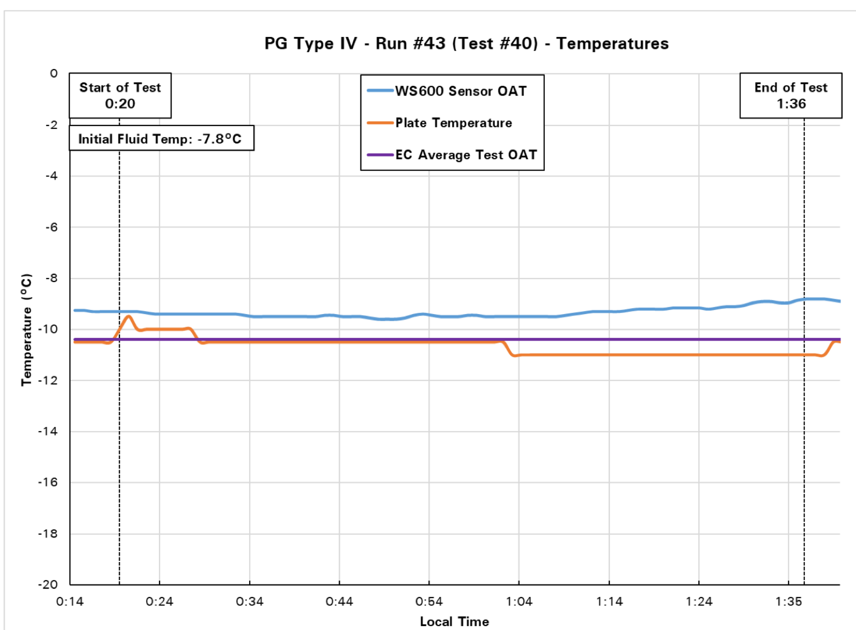
PG TYPE IV
RUN #43 (TEST #40) PG4-40

PG Type IV – Run #43 (Test #40) – General Test Information

Test Number:	**PG4-40**
Date of Test:	**February 10, 2020**
Average OAT:	**-10.4**
Average Precipitation Rate:	**4.8 g/dm²/h**
Average Wind Speed:	**12.0 km/h**
Average Relative Humidity:	**80.8%**
Pour Time (Local):	**00:20:00**
Time of Fluid Failure (Local):	**01:36:00**
Fluid Brix at Failure:	**19.25°**
Endurance Time:	**76 minutes**
Expected Regression-Derived Endurance Time:	**108.5 minutes**
Difference (ET vs. Reg ET):	**- 31.7 minutes (- 29.2%)**

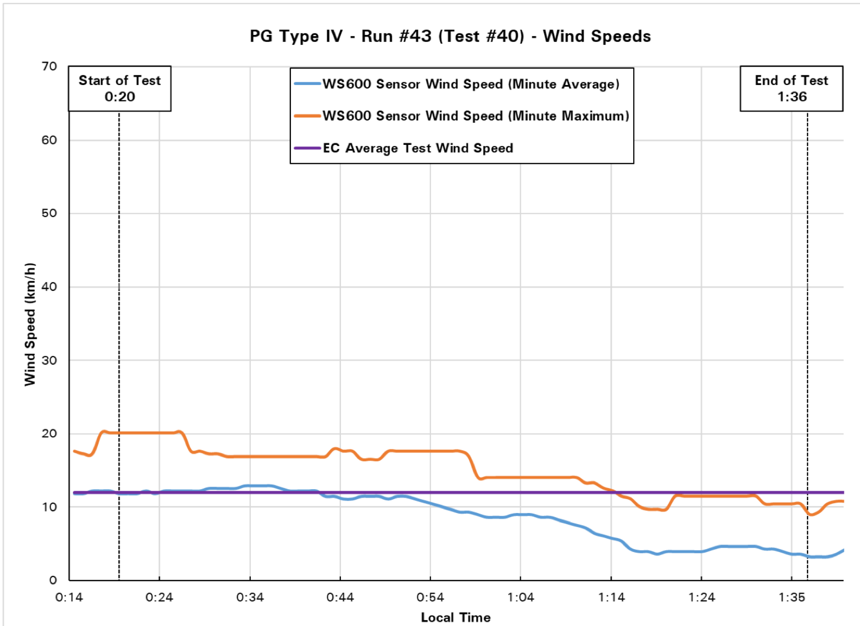


PG Type IV - Run #43 (Test #40) - Precipitation Rate
Start of Test 0:20
End of Test 1:36
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time



PG Type IV - Run #43 (Test #40) - Temperatures
Start of Test 0:20
Initial Fluid Temp: -7.8°C
End of Test 1:36
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN #43 (TEST 40)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 43 - Test 40/Data Package - PG Type IV - Run 43 - Test 40.docx
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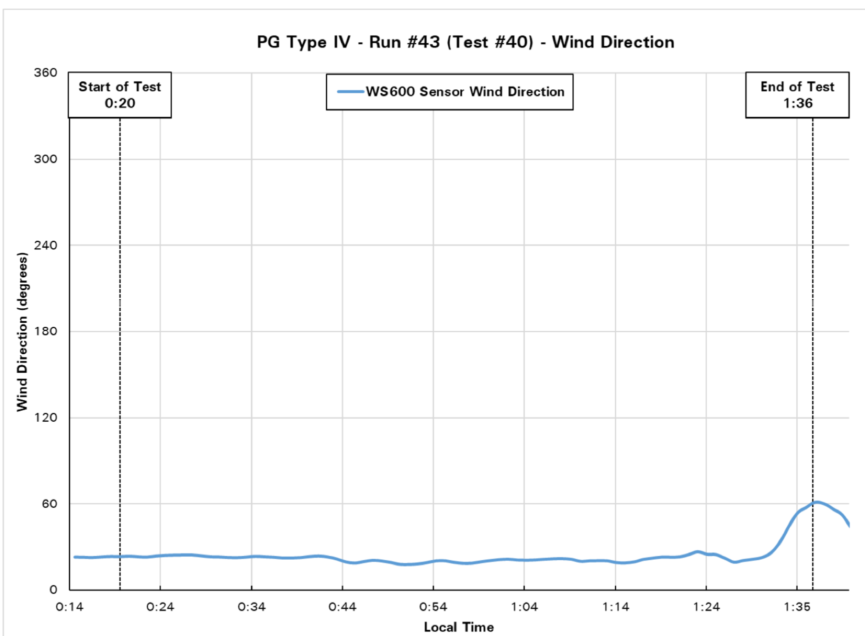
DATA PACKAGE – PG TYPE IV – RUN #43 (TEST 40)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 43 - Test 40/Data Package - PG Type IV - Run 43 - Test 40.docx
Final Version 1.0, March 2021

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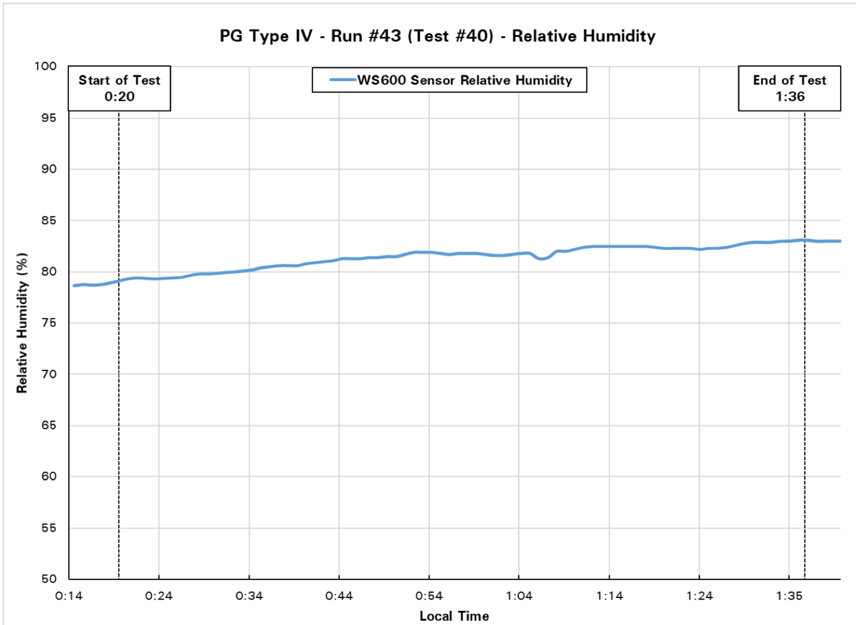
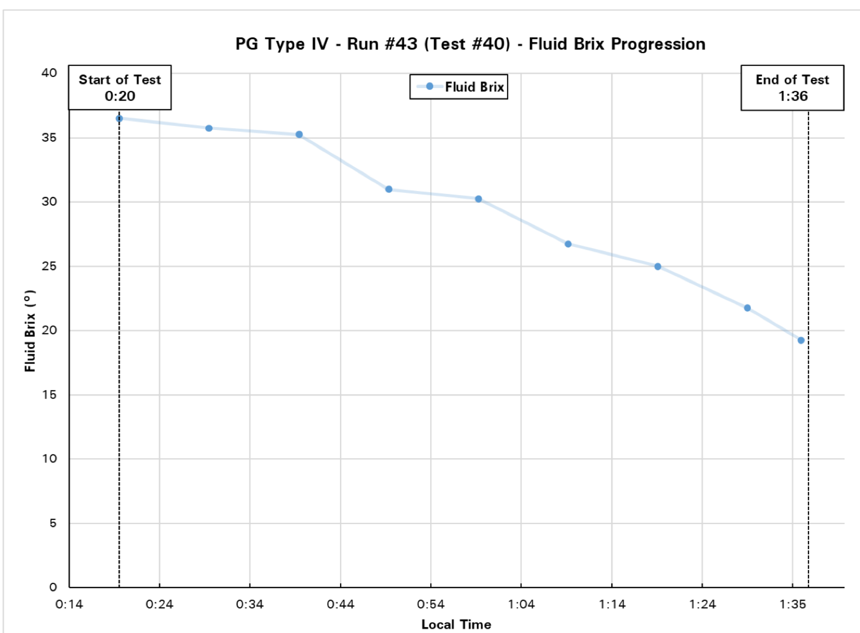
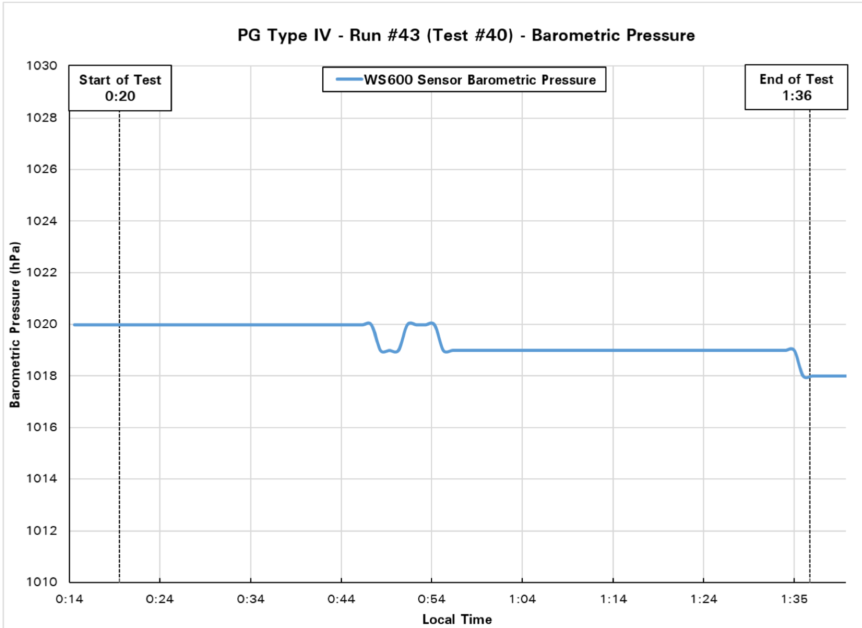
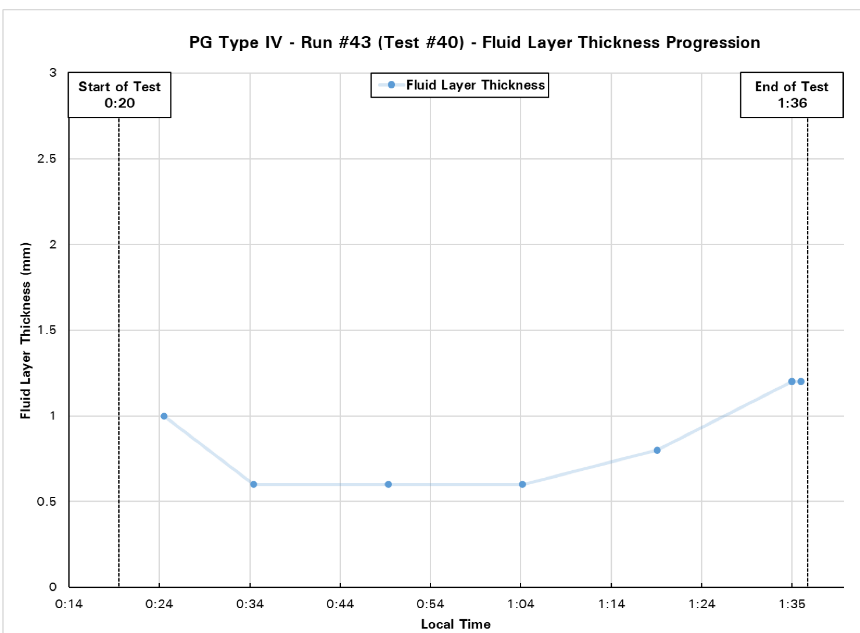
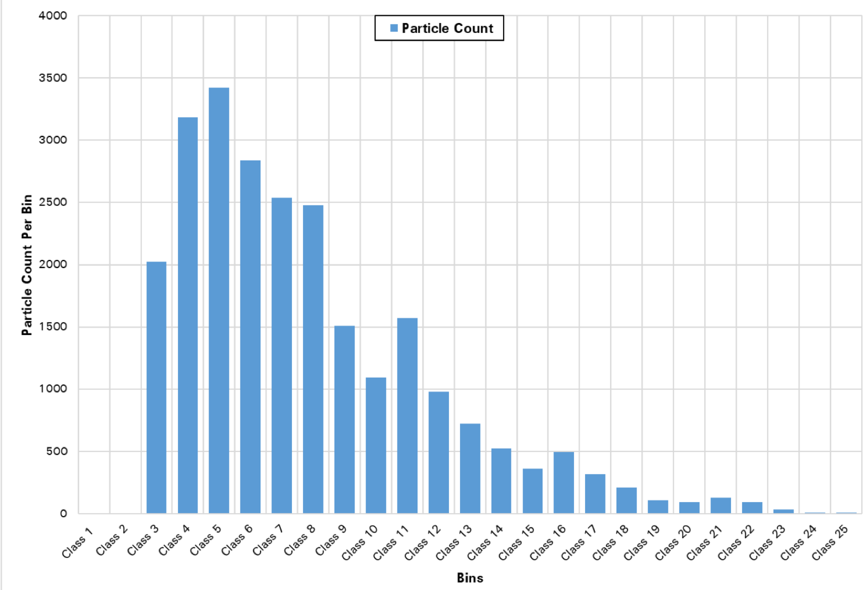

PG Type IV - Run #43 (Test #40) - Relative Humidity
Start of Test 0:20
WS600 Sensor Relative Humidity
End of Test 1:36
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time


PG Type IV - Run #43 (Test #40) - Fluid Brix Progression
Start of Test 0:20
Fluid Brix
End of Test 1:36
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

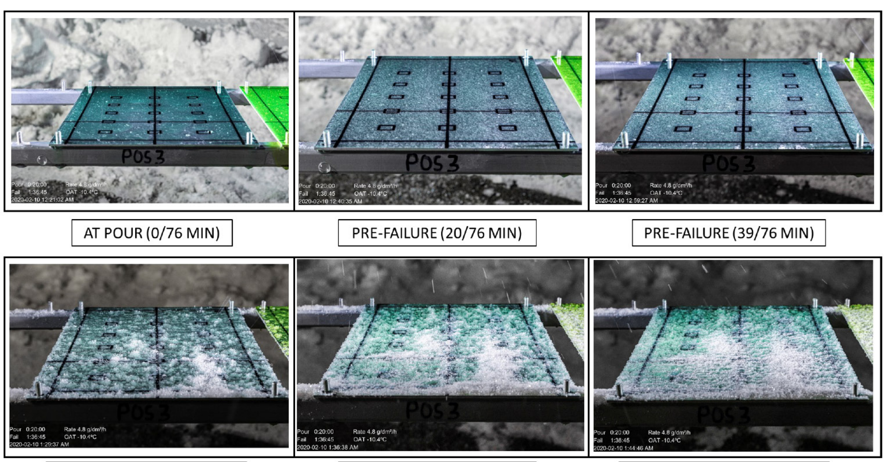

PG Type IV - Run #43 (Test #40) - Barometric Pressure
Start of Test 0:20
WS600 Sensor Barometric Pressure
End of Test 1:36
Barometric Pressure (hPa)
1030
1028
1026
1024
1022
1020
1018
1016
1014
1012
1010
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time


PG Type IV - Run #43 (Test #40) - Fluid Layer Thickness Progression
Start of Test 0:20
Fluid Layer Thickness
End of Test 1:36
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
0:14
0:24
0:34
0:44
0:54
1:04
1:14
1:24
1:35
Local Time

PG Type IV - Run #43 (Test #40) - Distribution Chart



Polar Guard Advance – Run 43 (Test 40) – Failure Progression Photos

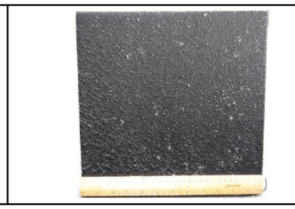


AT POUR (0/76 MIN) | PRE-FAILURE (20/76 MIN) | PRE-FAILURE (39/76 MIN)

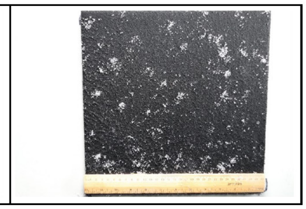
PRE-FAILURE (69/76 MIN) | AT FAILURE (77/76 MIN) | POST-FAILURE (84/76 MIN)

Polar Guard Advance – Run 43 (Test 40) – Snow Characteristics Photos

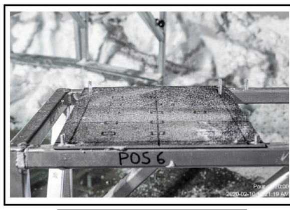
FELT PAD (11/76 MIN)



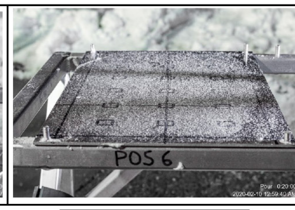
FELT PAD (40/76 MIN)



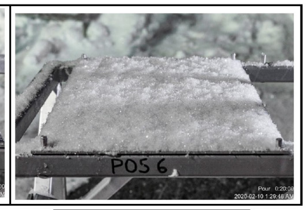
FELT PAD (70/76 MIN)



BARE PLATE (1/76 MIN)



BARE PLATE (39/76 MIN)



BARE PLATE (69/76 MIN)

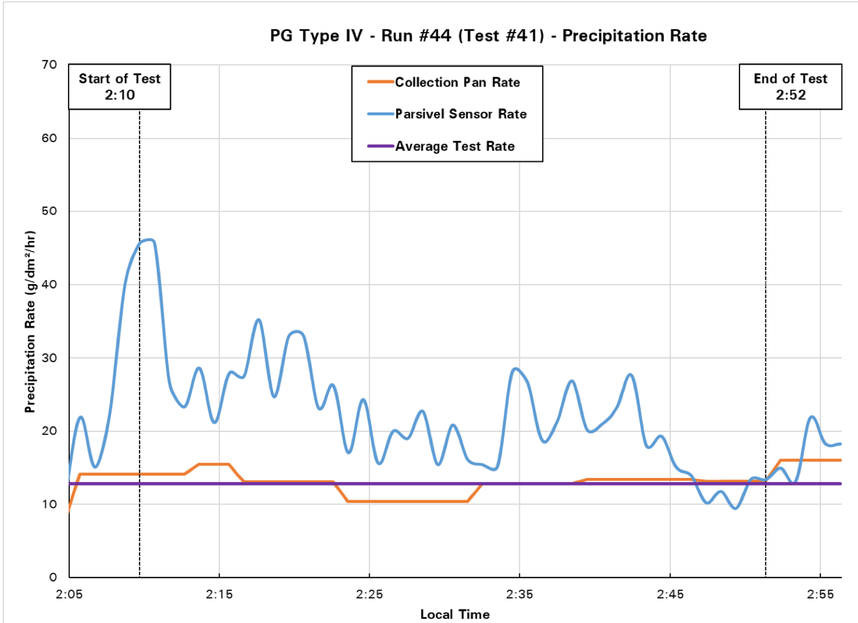
Final Bare Plate Contamination Thickness: **10mm**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

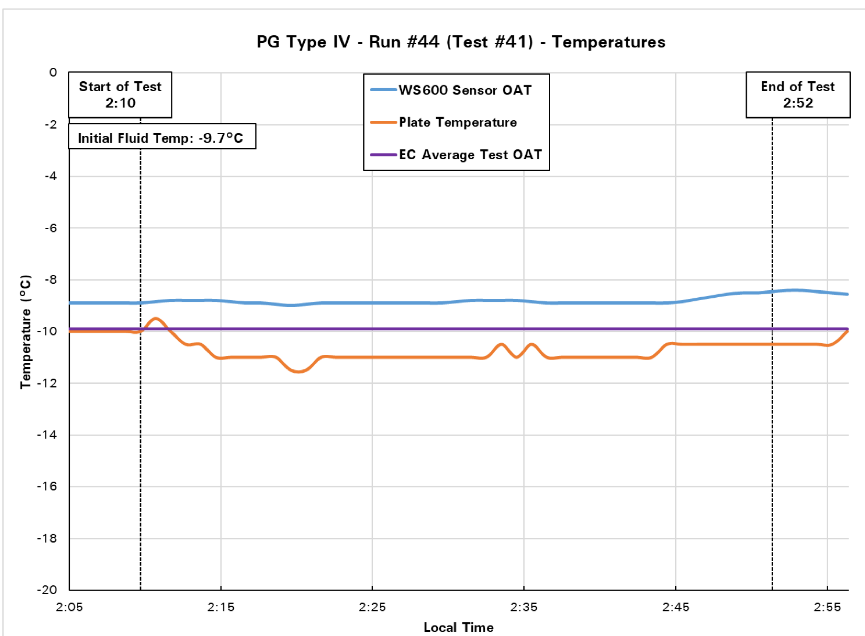
PG TYPE IV
RUN #44 (TEST #41) PG4-41

PG Type IV – Run #44 (Test #41) – General Test Information

Test Number:	**PG4-41**
Date of Test:	**February 10, 2020**
Average OAT:	**-9.9**
Average Precipitation Rate:	**12.8 g/dm²/h**
Average Wind Speed:	**13.6 km/h**
Average Relative Humidity:	**84.8%**
Pour Time (Local):	**02:10:00**
Time of Fluid Failure (Local):	**02:52:00**
Fluid Brix at Failure:	**19.75°**
Endurance Time:	**42 minutes**
Expected Regression-Derived Endurance Time:	**49.7 minutes**
Difference (ET vs. Reg ET):	**- 7.7 minutes (- 15.4%)**

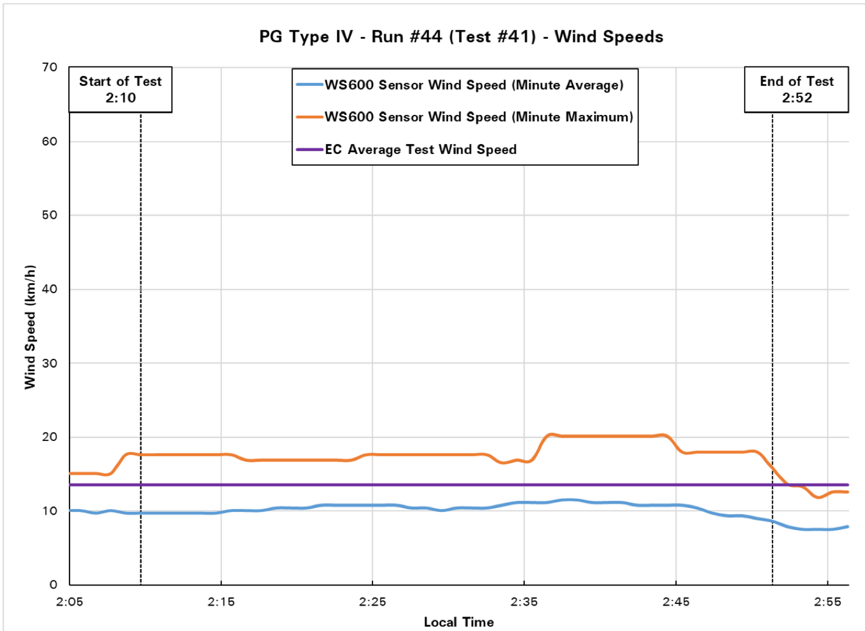


PG Type IV - Run #44 (Test #41) - Precipitation Rate
Start of Test 2:10
End of Test 2:52
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
2:05
2:15
2:25
2:35
2:45
2:55
Local Time



PG Type IV - Run #44 (Test #41) - Temperatures
Start of Test 2:10
Initial Fluid Temp: -9.7°C
End of Test 2:52
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
2:05
2:15
2:25
2:35
2:45
2:55
Local Time

DATA PACKAGE – PG TYPE IV – RUN #44 (TEST 41)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 44 - Test 41/Data Package - PG Type IV - Run 44 - Test 41.docx
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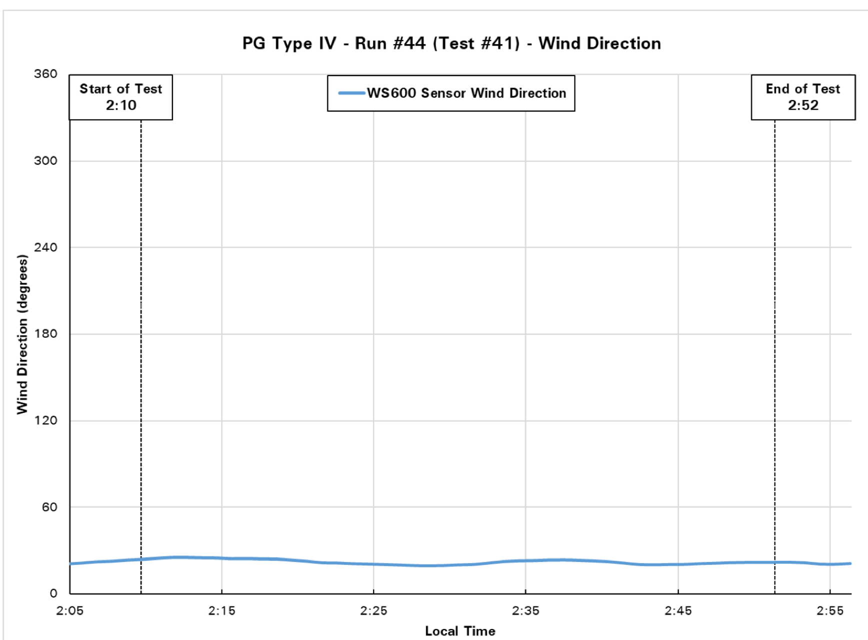
DATA PACKAGE – PG TYPE IV – RUN #44 (TEST 41)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 44 - Test 41/Data Package - PG Type IV - Run 44 - Test 41.docx
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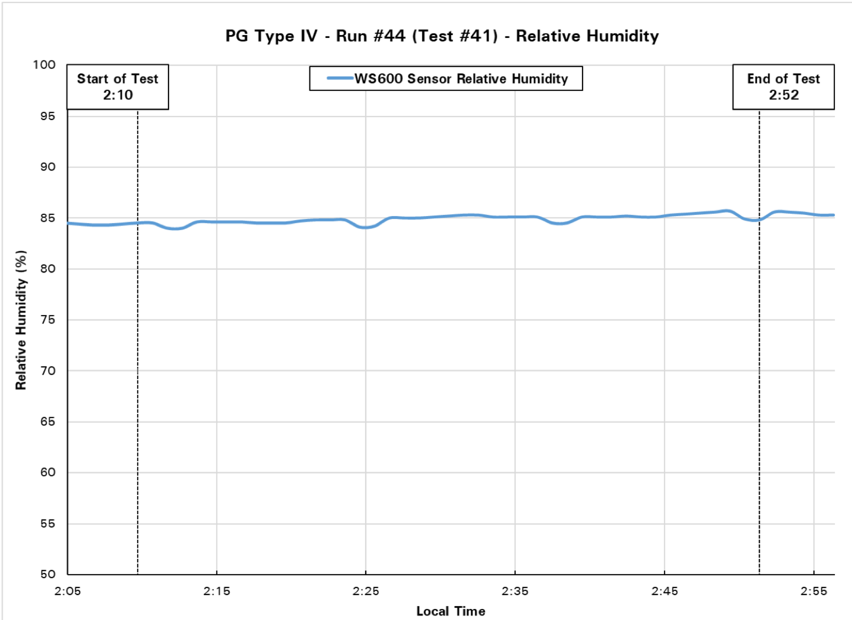
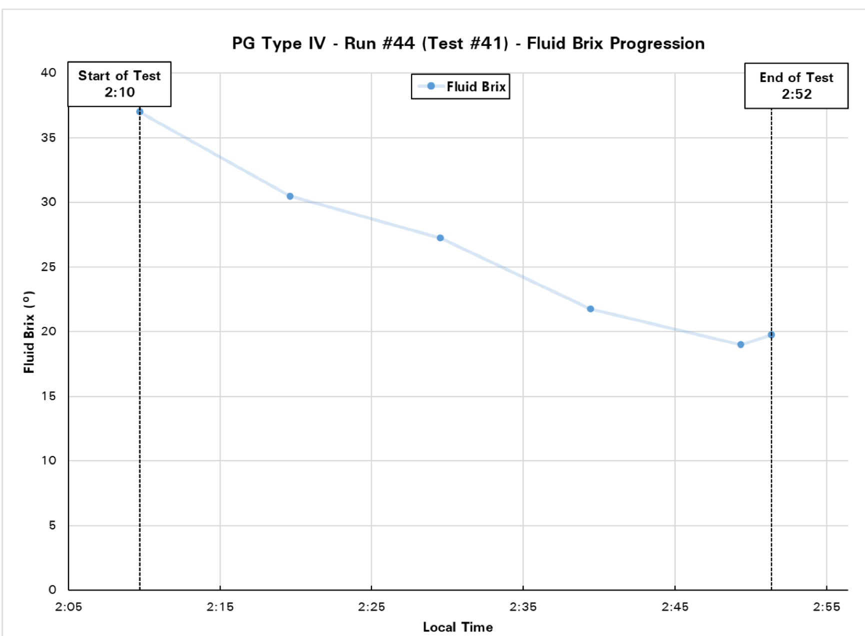
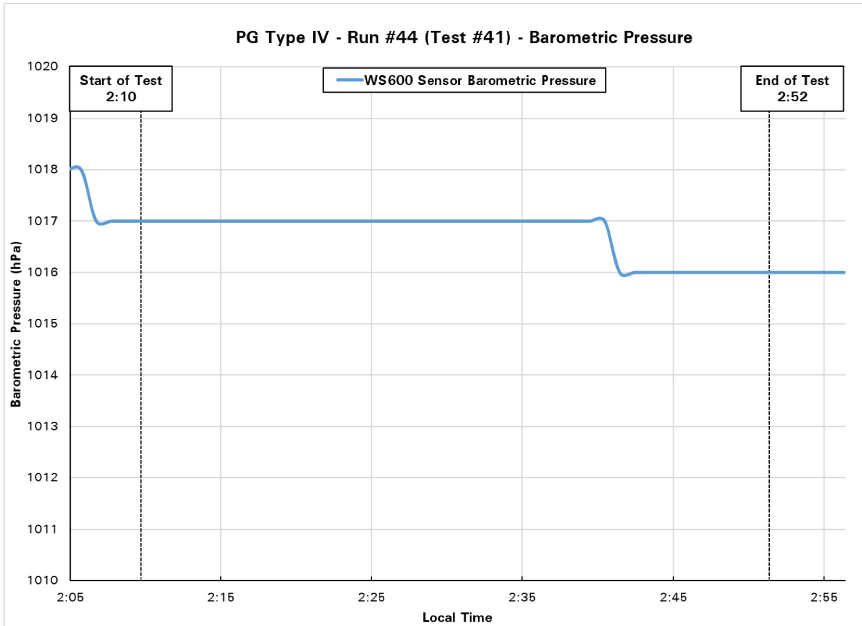
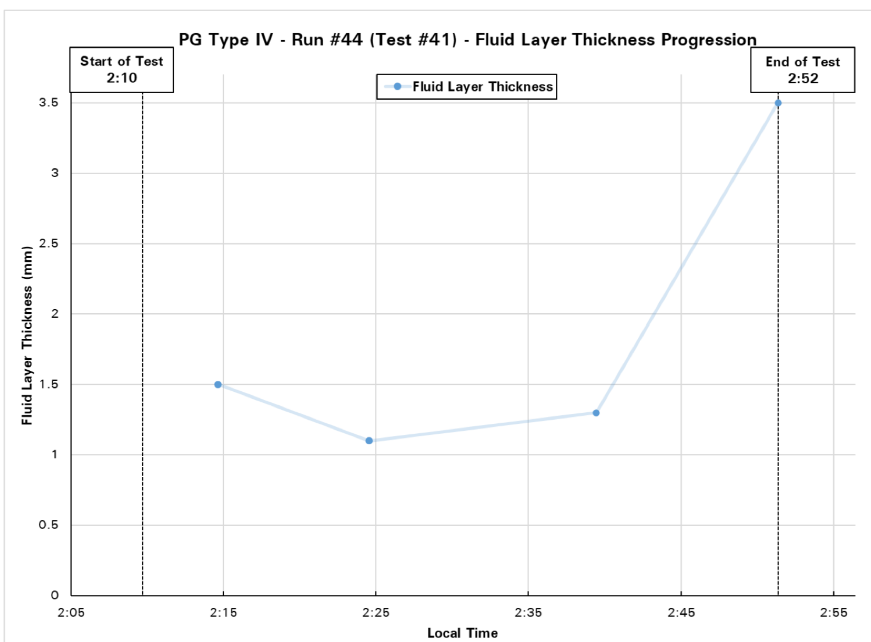
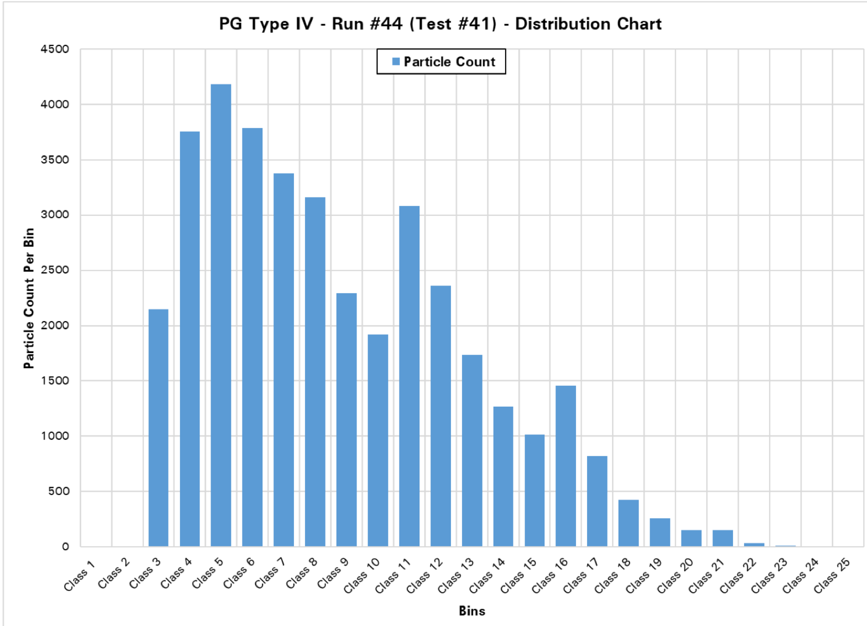

PG Type IV - Run #44 (Test #41) - Relative Humidity
Start of Test 2:10
WS600 Sensor Relative Humidity
End of Test 2:52
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
2:05
2:15
2:25
2:35
2:45
2:55
Local Time

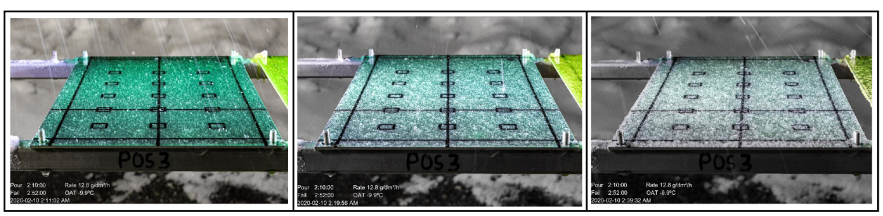

PG Type IV - Run #44 (Test #41) - Fluid Brix Progression
Start of Test 2:10
Fluid Brix
End of Test 2:52
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
2:05
2:15
2:25
2:35
2:45
2:55
Local Time


PG Type IV - Run #44 (Test #41) - Barometric Pressure
Start of Test 2:10
WS600 Sensor Barometric Pressure
End of Test 2:52
Barometric Pressure (hPa)
1020
1019
1018
1017
1016
1015
1014
1013
1012
1011
1010
2:05
2:15
2:25
2:35
2:45
2:55
Local Time

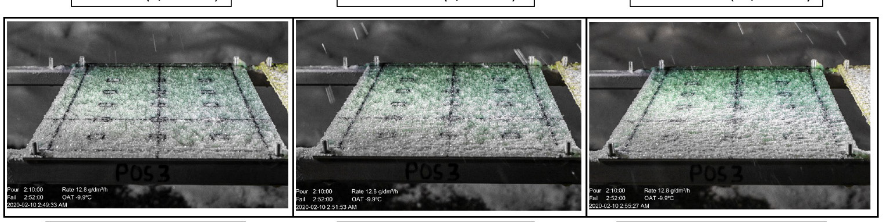

PG Type IV - Run #44 (Test #41) - Fluid Layer Thickness Progression
Start of Test 2:10
Fluid Layer Thickness
End of Test 2:52
Fluid Layer Thickness (mm)
3.5
3
2.5
2
1.5
1
0.5
0
2:05
2:15
2:25
2:35
2:45
2:55
Local Time



Polar Guard Advance – Run 44 (Test 41) – Failure Progression Photos



AT POUR (0/42 MIN) | PRE-FAILURE (9/42 MIN) | PRE-FAILURE (29/42 MIN)

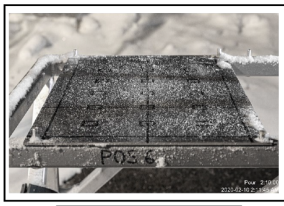
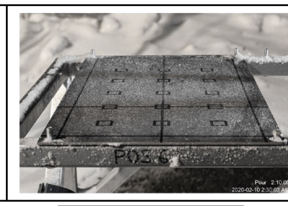


PRE-FAILURE (39/42 MIN) | AT FAILURE (42/42 MIN) | POST-FAILURE (45/42 MIN)

Polar Guard Advance – Run 44 (Test 41) – Snow Characteristics Photos



FELT PAD (3/42 MIN) | FELT PAD (20/42 MIN) | FELT PAD (40/42 MIN)


BARE PLATE (1/42 MIN) | BARE PLATE (20/42 MIN) | BARE PLATE (39/42 MIN)

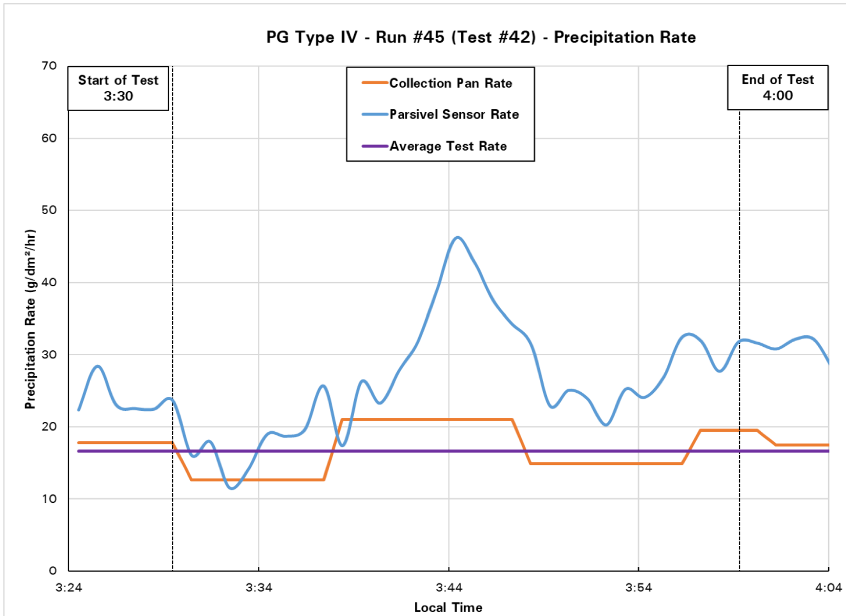
Final Bare Plate Contamination Thickness: **Nil (0mm)**

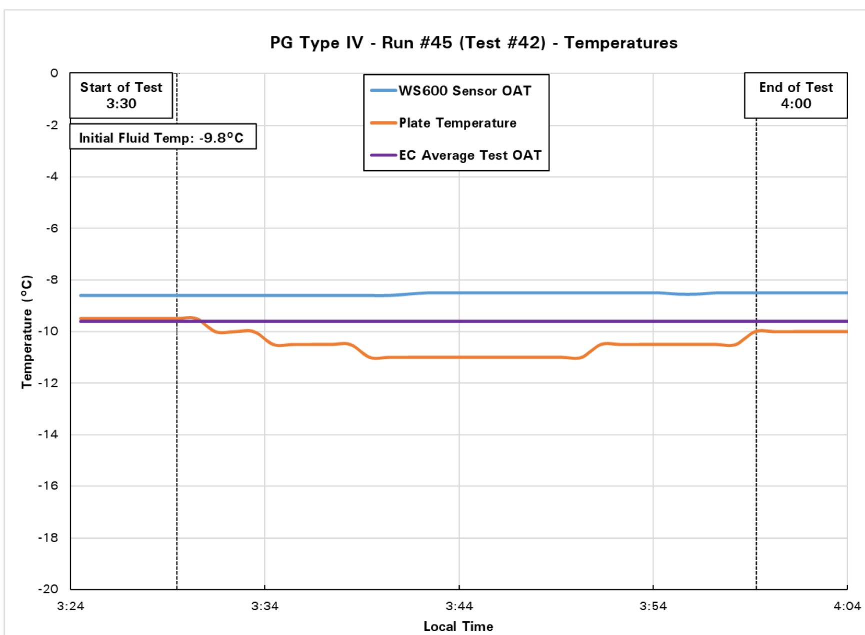
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

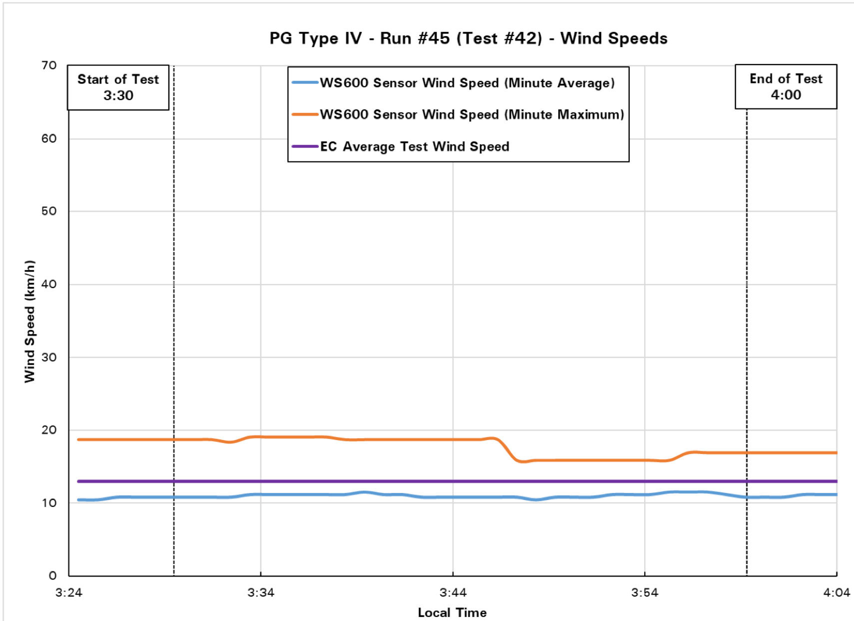
PG TYPE IV
RUN #45 (TEST #42) PG4-42

PG Type IV – Run #45 (Test #42) – General Test Information

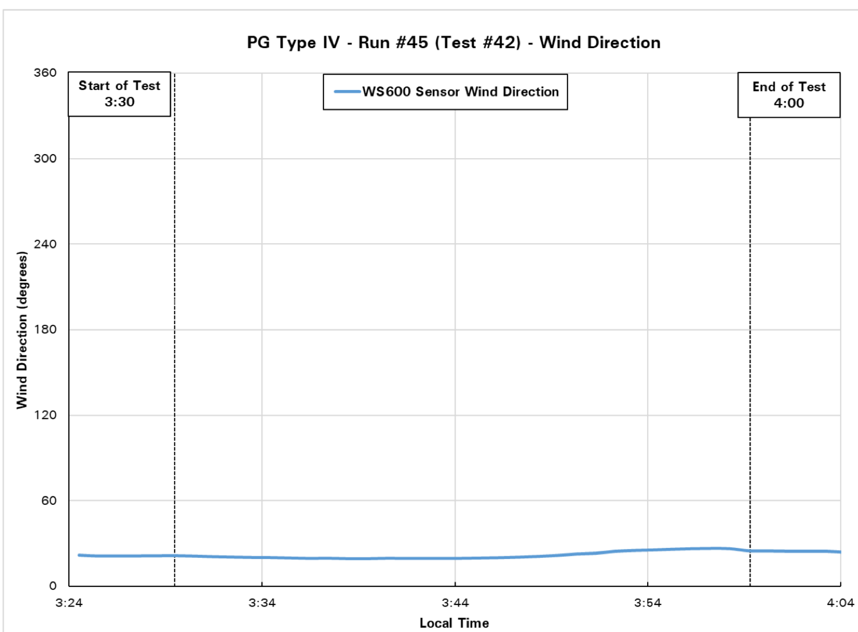
Test Number:	**PG4-42**
Date of Test:	**February 10, 2020**
Average OAT:	**-9.6**
Average Precipitation Rate:	**16.6 g/dm²/h**
Average Wind Speed:	**13.0 km/h**
Average Relative Humidity:	**85.7%**
Pour Time (Local):	**03:30:00**
Time of Fluid Failure (Local):	**04:00:00**
Fluid Brix at Failure:	**18.25°**
Endurance Time:	**30 minutes**
Expected Regression-Derived Endurance Time:	**40.7 minutes**
Difference (ET vs. Reg ET):	**- 10.6 minutes (- 26.0%)**


PG Type IV - Run #45 (Test #42) - Precipitation Rate
Start of Test
3:30
End of Test
4:00
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
3:24
3:34
3:44
3:54
4:04
Local Time

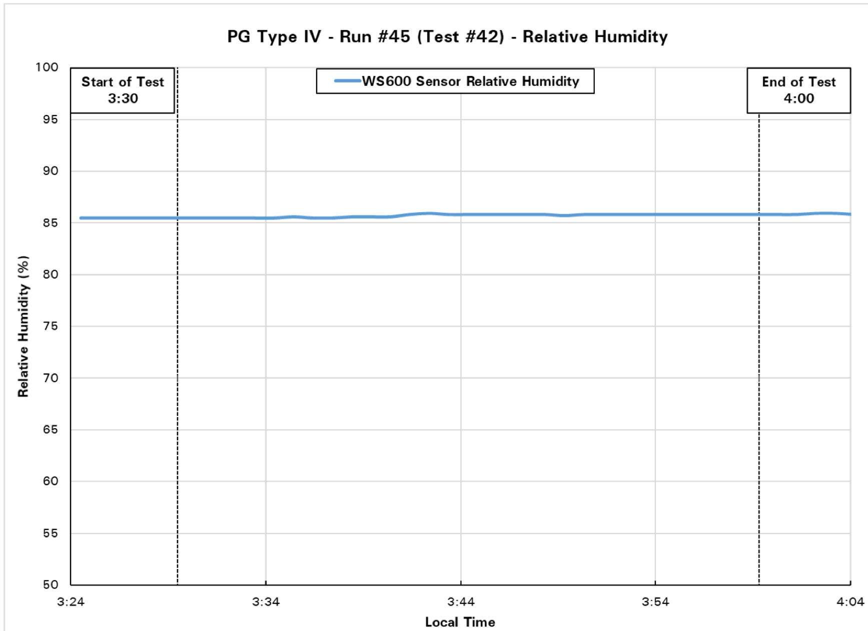

PG Type IV - Run #45 (Test #42) - Temperatures
Start of Test
3:30
Initial Fluid Temp: -9.8°C
End of Test
4:00
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
3:24
3:34
3:44
3:54
4:04
Local Time



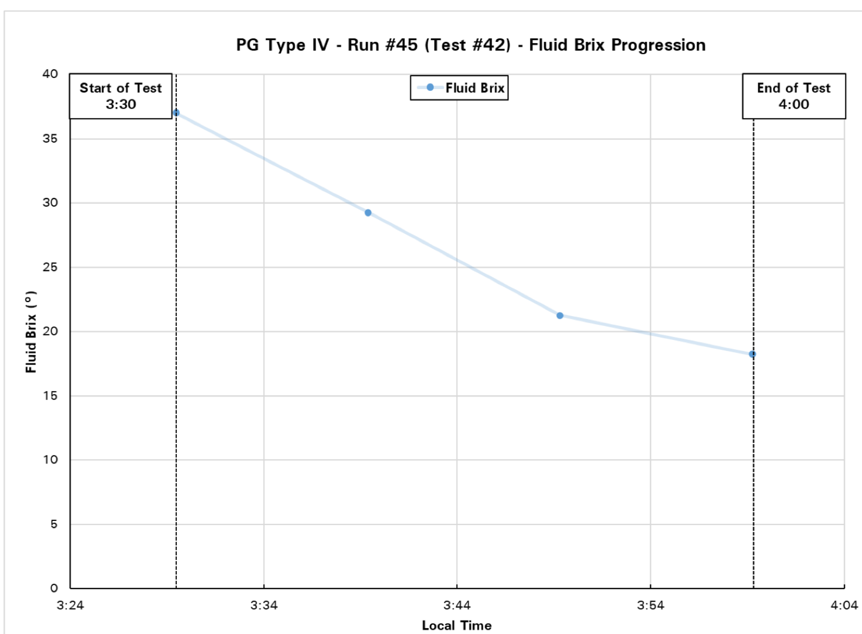
PG Type IV - Run #45 (Test #42) - Wind Speeds
Start of Test 3:30
End of Test 4:00
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
3:24
3:34
3:44
3:54
4:04
Local Time



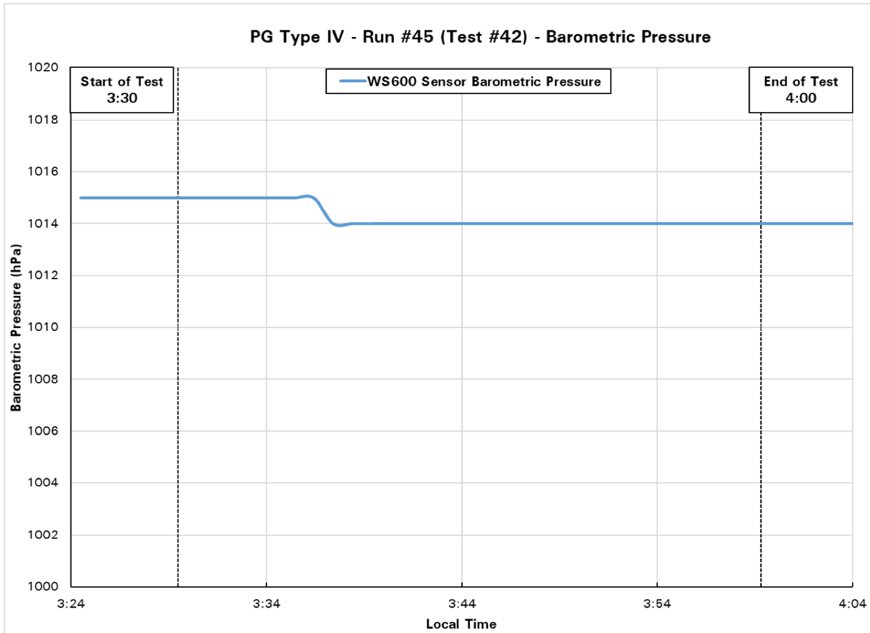
PG Type IV - Run #45 (Test #42) - Wind Direction
Start of Test 3:30
End of Test 4:00
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
3:24
3:34
3:44
3:54
4:04
Local Time

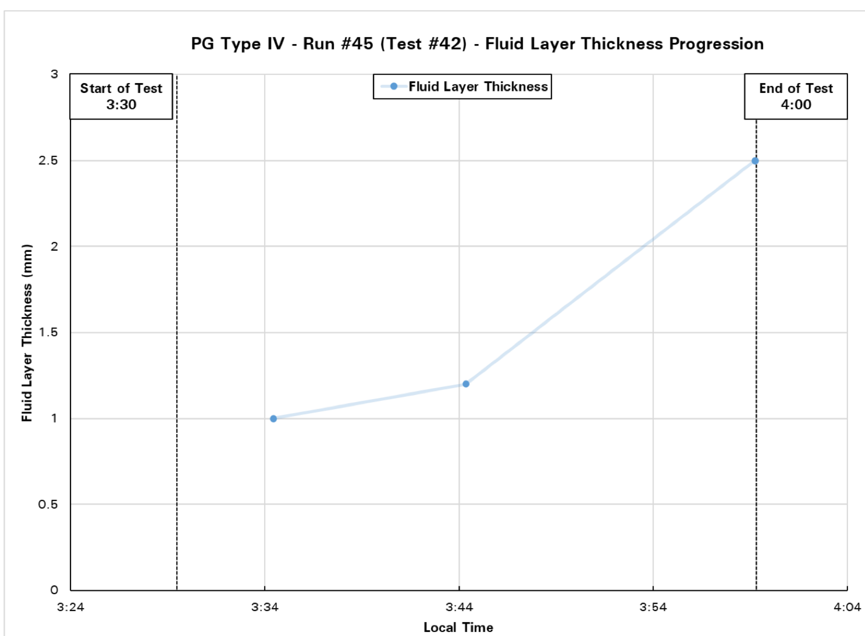


PG Type IV - Run #45 (Test #42) - Relative Humidity
WS600 Sensor Relative Humidity
Start of Test
3:30
End of Test
4:00
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
3:24
3:34
3:44
3:54
4:04
Local Time

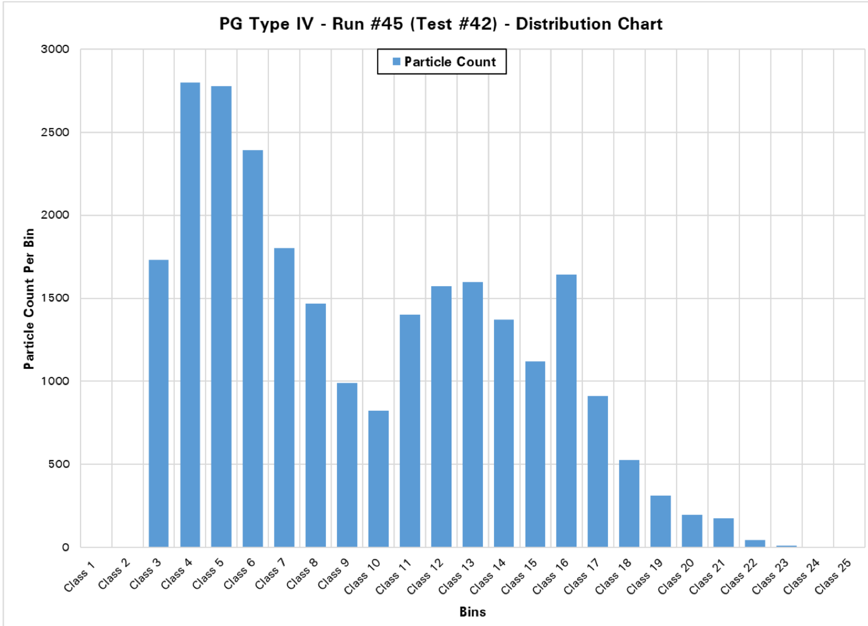


PG Type IV - Run #45 (Test #42) - Fluid Brix Progression
Fluid Brix
Start of Test
3:30
End of Test
4:00
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
3:24
3:34
3:44
3:54
4:04
Local Time


PG Type IV - Run #45 (Test #42) - Barometric Pressure
Start of Test
3:30
WS600 Sensor Barometric Pressure
End of Test
4:00
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
3:24
3:34
3:44
3:54
4:04
Local Time


PG Type IV - Run #45 (Test #42) - Fluid Layer Thickness Progression
Start of Test
3:30
Fluid Layer Thickness
End of Test
4:00
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
3:24
3:34
3:44
3:54
4:04
Local Time

DATA PACKAGE – PG TYPE IV – RUN #45 (TEST 42)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 45 - Test 42/Data Package - PG Type IV - Run 45 - Test 42.docx
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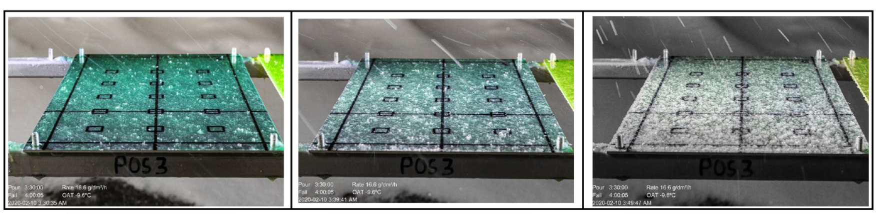
DATA PACKAGE – PG TYPE IV – RUN #45 (TEST 42)

Polar Guard Advance – Run 45 (Test 42) – Failure Progression Photos



AT POUR (0/30 MIN) | PRE-FAILURE (9/30 MIN) | PRE-FAILURE (19/30 MIN)

PRE-FAILURE (25/30 MIN) | AT FAILURE (29/30 MIN) | POST-FAILURE (33/30 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 45 - Test 42/Data Package - PG Type IV - Run 45 - Test 42.docx
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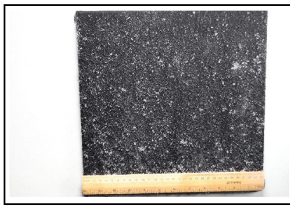
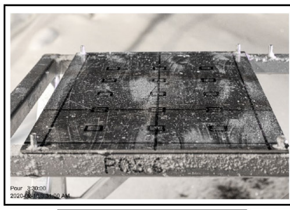
Polar Guard Advance – Run 45 (Test 42) – Snow Characteristics Photos



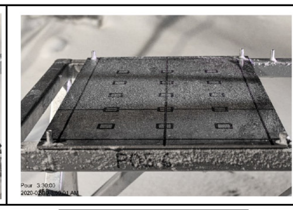
FELT PAD (1/30 MIN)

FELT PAD (10/30 MIN)

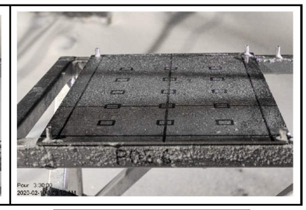
FELT PAD (20/30 MIN)



BARE PLATE (1/30 MIN)



BARE PLATE (20/30 MIN)



BARE PLATE (29/30 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

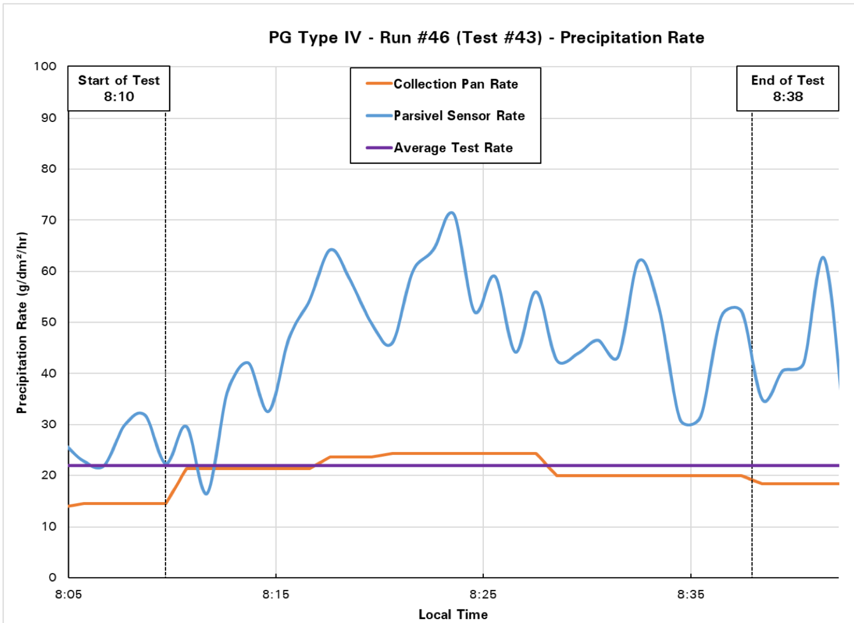
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #46 (TEST #43) PG4-43

PG Type IV – Run #46 (Test #43) – General Test Information

Test Number:	**PG4-43**
Date of Test:	**February 18, 2020**
Average OAT:	**-12.0**
Average Precipitation Rate:	**22.0 g/dm²/h**
Average Wind Speed:	**16.2 km/h**
Average Relative Humidity:	**75.9%**
Pour Time (Local):	**08:10:00**
Time of Fluid Failure (Local):	**08:38:00**
Fluid Brix at Failure:	**20.25°**
Endurance Time:	**28 minutes**
Expected Regression-Derived Endurance Time:	**29 minutes**
Difference (ET vs. Reg ET):	**-0.5 minutes (-1.8%)**

DATA PACKAGE – PG TYPE IV – RUN #46 (TEST 43)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 46 - Test 43/Data Package - PG Type IV - Run 46 - Test 43.docx
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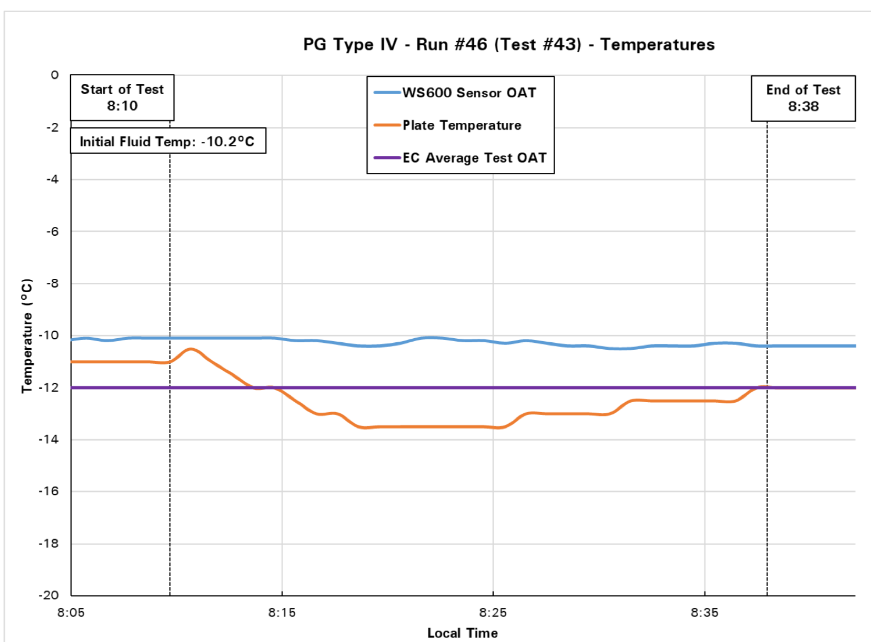
DATA PACKAGE – PG TYPE IV – RUN #46 (TEST 43)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 46 - Test 43/Data Package - PG Type IV - Run 46 - Test 43.docx
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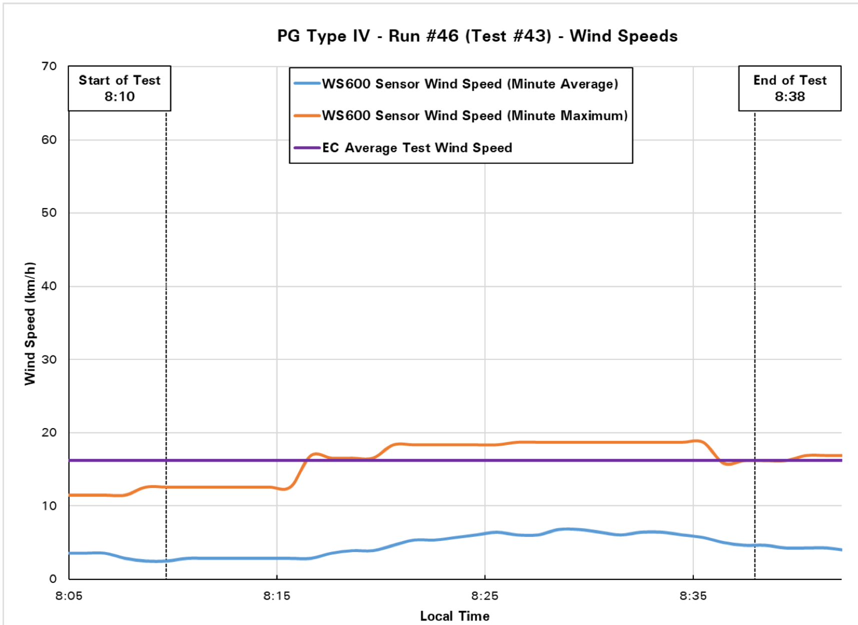
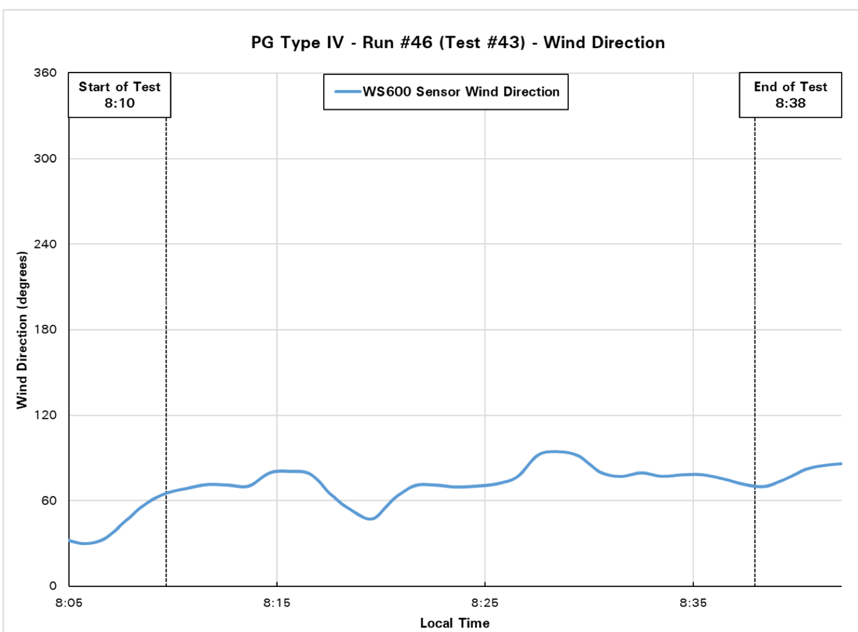
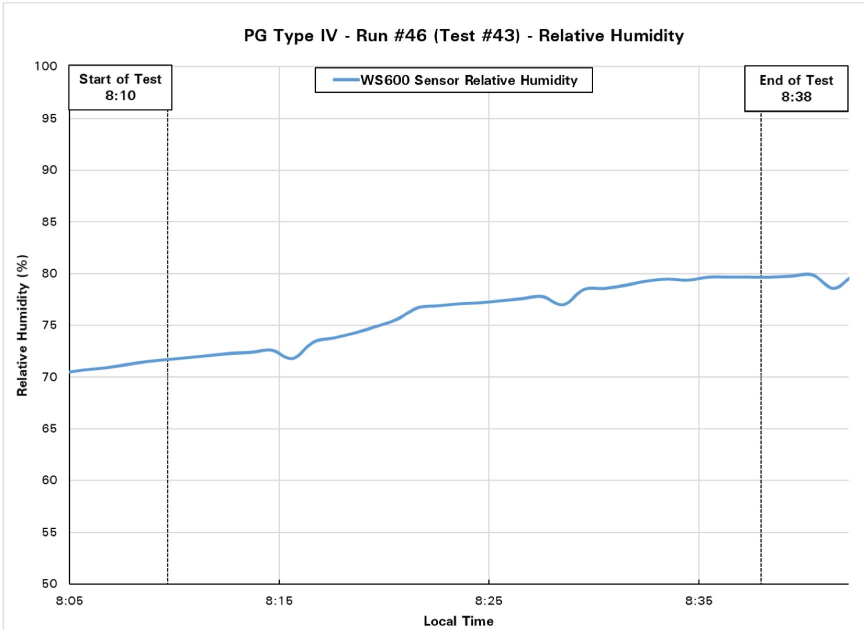
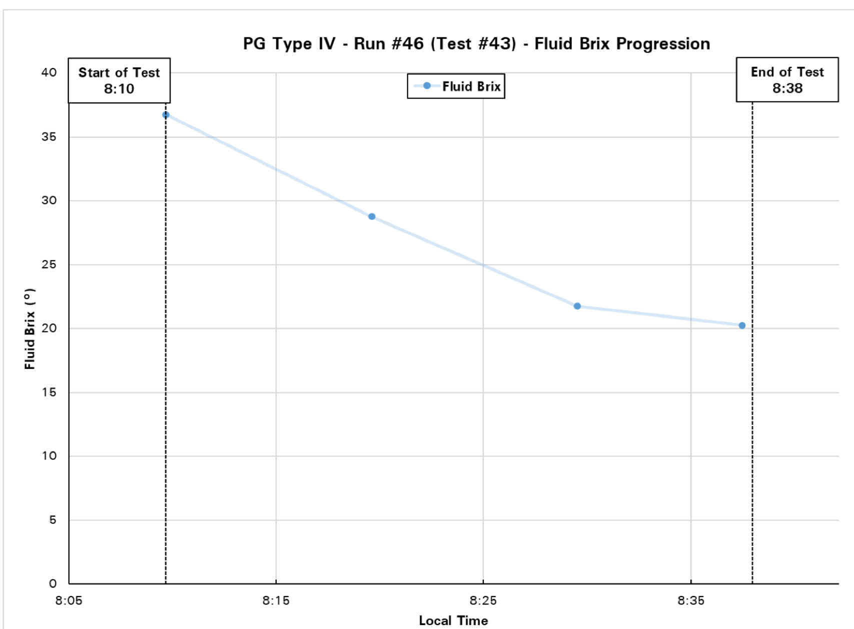
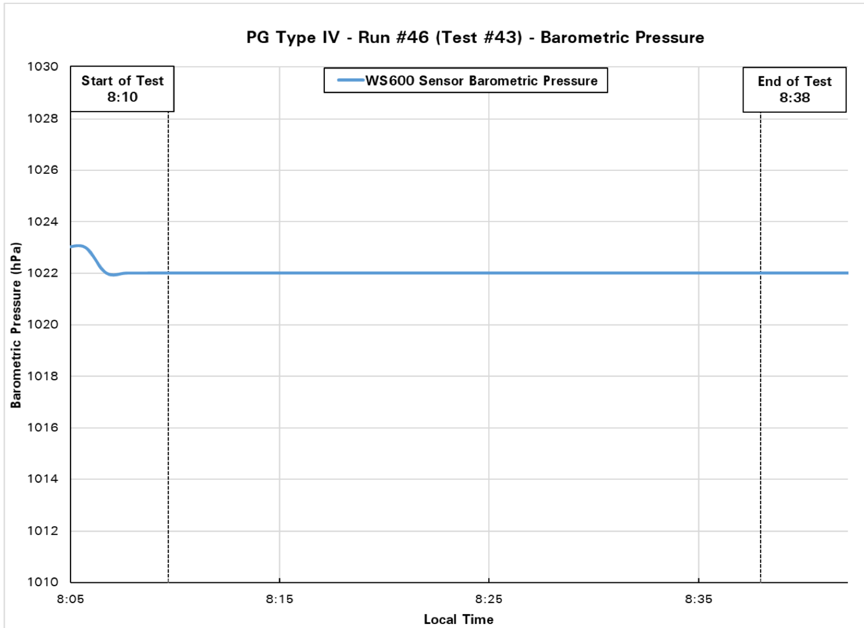

PG Type IV - Run #46 (Test #43) - Wind Speeds
Start of Test 8:10
End of Test 8:38
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
8:05
8:15
8:25
8:35
Local Time


PG Type IV - Run #46 (Test #43) - Wind Direction
Start of Test 8:10
End of Test 8:38
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
8:05
8:15
8:25
8:35
Local Time


PG Type IV - Run #46 (Test #43) - Relative Humidity
Start of Test 8:10
WS600 Sensor Relative Humidity
End of Test 8:38
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
8:05
8:15
8:25
8:35
Local Time


PG Type IV - Run #46 (Test #43) - Fluid Brix Progression
Start of Test 8:10
Fluid Brix
End of Test 8:38
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
8:05
8:15
8:25
8:35
Local Time

DATA PACKAGE – PG TYPE IV – RUN #46 (TEST 43)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 46 - Test 43/Data Package - PG Type IV - Run 46 - Test 43.docx
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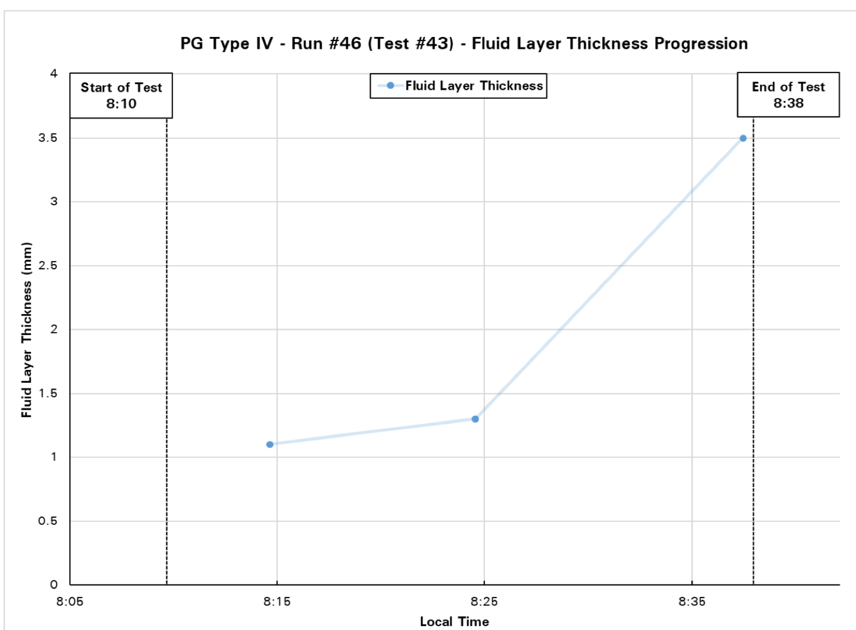
DATA PACKAGE – PG TYPE IV – RUN #46 (TEST 43)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 46 - Test 43/Data Package - PG Type IV - Run 46 - Test 43.docx
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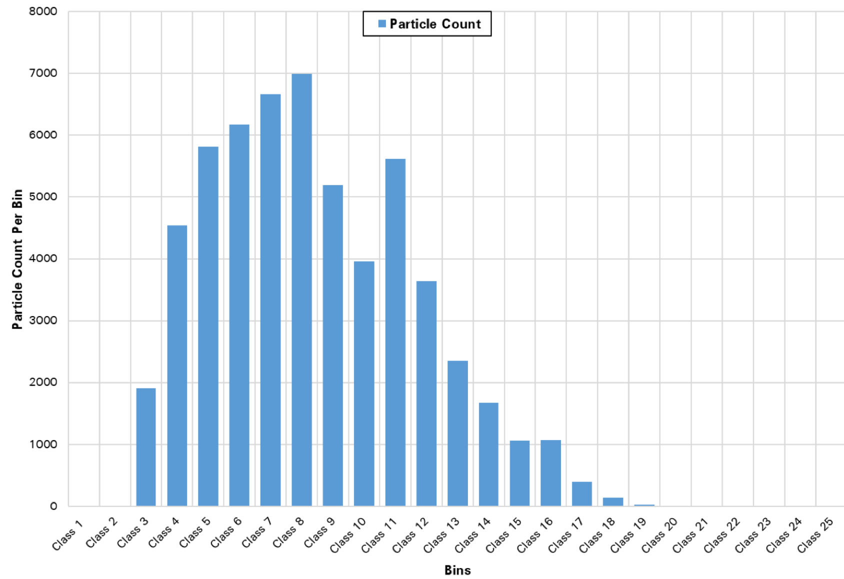
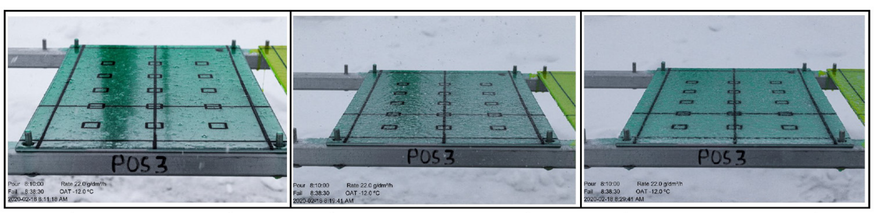
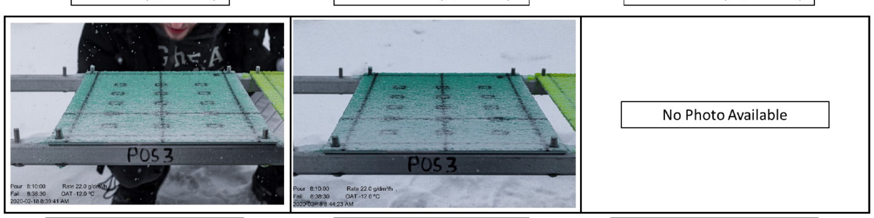
PG Type IV - Run #46 (Test #43) - Distribution Chart



Polar Guard Advance – Run 46 (Test 43) – Failure Progression Photos

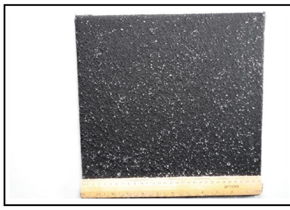


AT POUR (0/28 MIN) | PRE-FAILURE (9/28 MIN) | PRE-FAILURE (19/28 MIN)

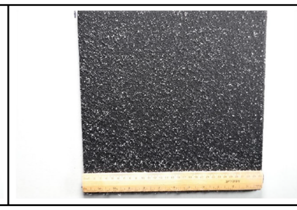


AT FAILURE (29/28 MIN) | POST-FAILURE (34/28 MIN) | POST-FAILURE (-/- MIN)

Polar Guard Advance – Run 46 (Test 43) – Snow Characteristics Photos



FELT PAD (1/28 MIN)

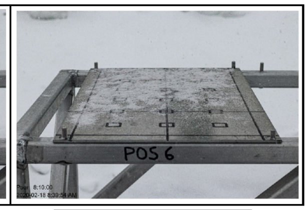


FELT PAD (10/28 MIN)

FELT PAD (20/28 MIN)

BARE PLATE (1/28 MIN)

BARE PLATE (9/28 MIN)



BARE PLATE (29/28 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

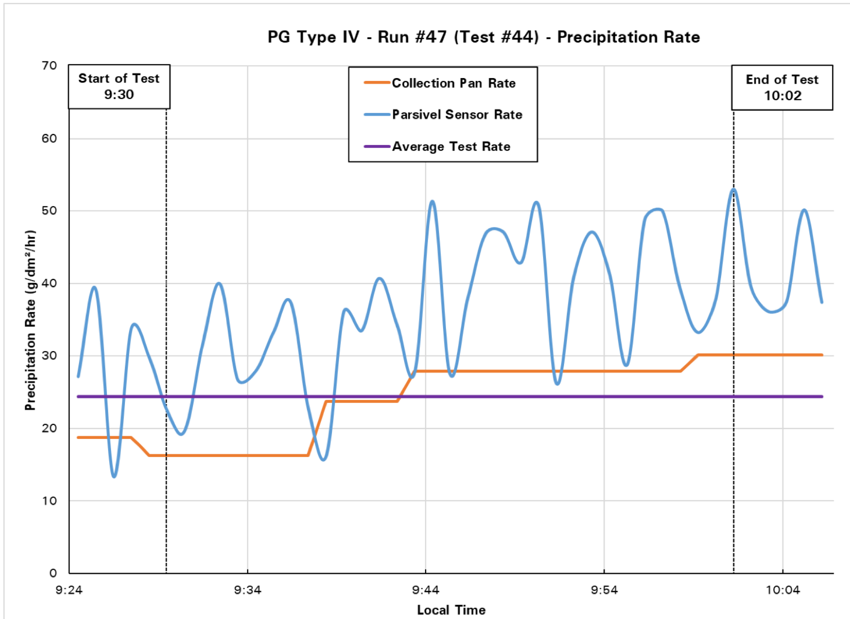
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #47 (TEST #44) PG4-44

PG Type IV – Run #47 (Test #44) – General Test Information

Test Number:	**PG4-44**
Date of Test:	**February 18, 2020**
Average OAT:	**-8.7**
Average Precipitation Rate:	**24.4 g/dm²/h**
Average Wind Speed:	**10.0 km/h**
Average Relative Humidity:	**83.0%**
Pour Time (Local):	**09:30:00**
Time of Fluid Failure (Local):	**10:02:00**
Fluid Brix at Failure:	**17.75°**
Endurance Time:	**32 minutes**
Expected Regression-Derived Endurance Time:	**31.1 minutes**
Difference (ET vs. Reg ET):	**+0.9 minutes (+2.8%)**

DATA PACKAGE – PG TYPE IV – RUN #47 (TEST 44)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 47 - Test 44/Data Package - PG Type IV - Run 47 - Test 44.docx
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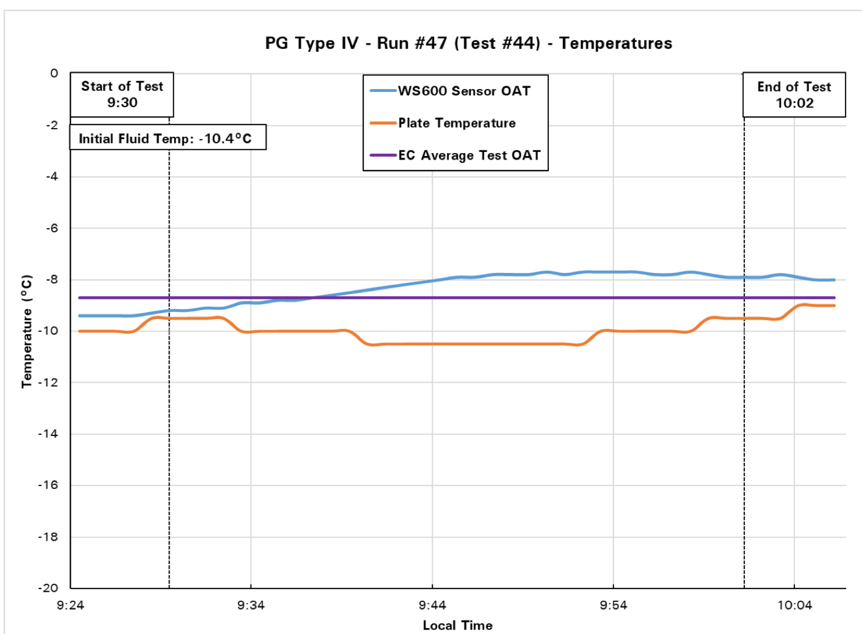
DATA PACKAGE – PG TYPE IV – RUN #47 (TEST 44)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 47 - Test 44/Data Package - PG Type IV - Run 47 - Test 44.docx
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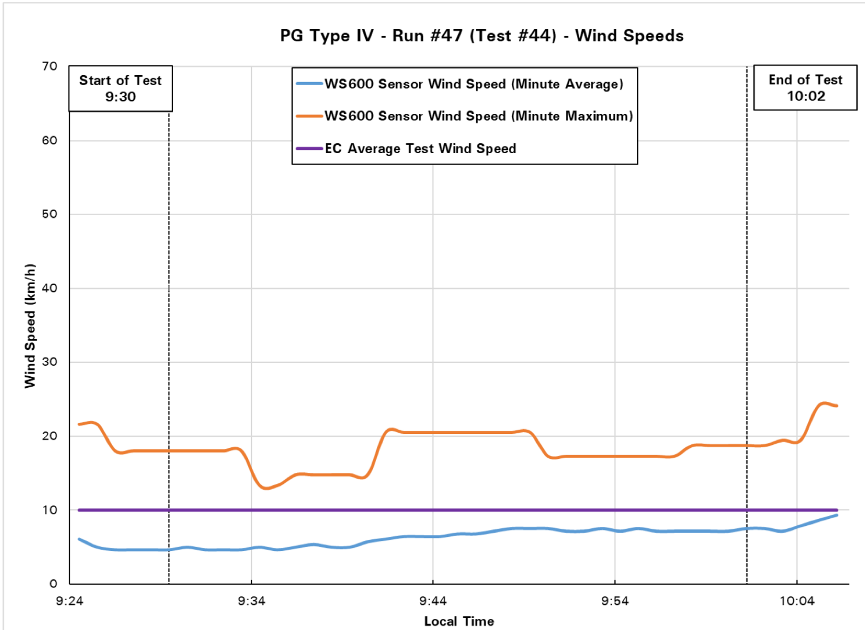
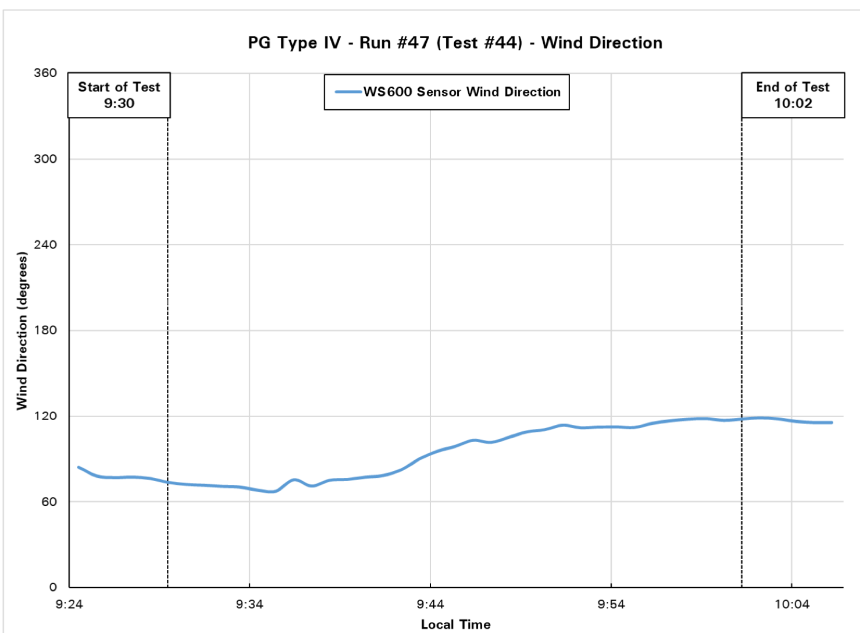
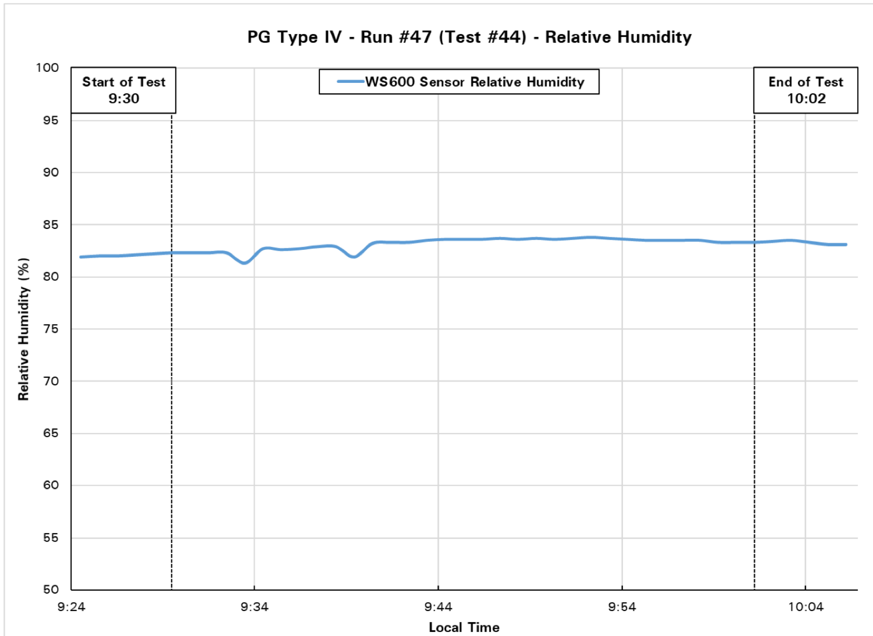
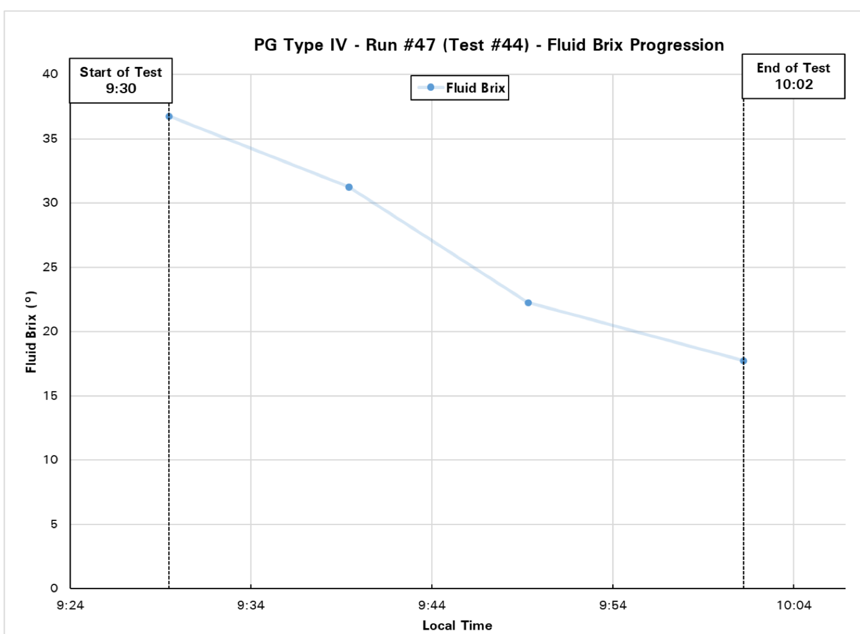
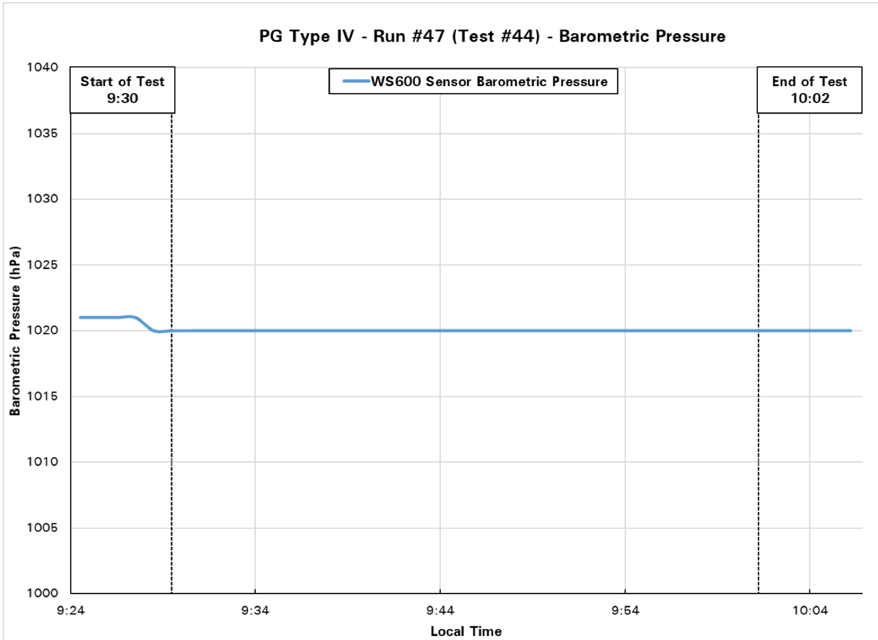
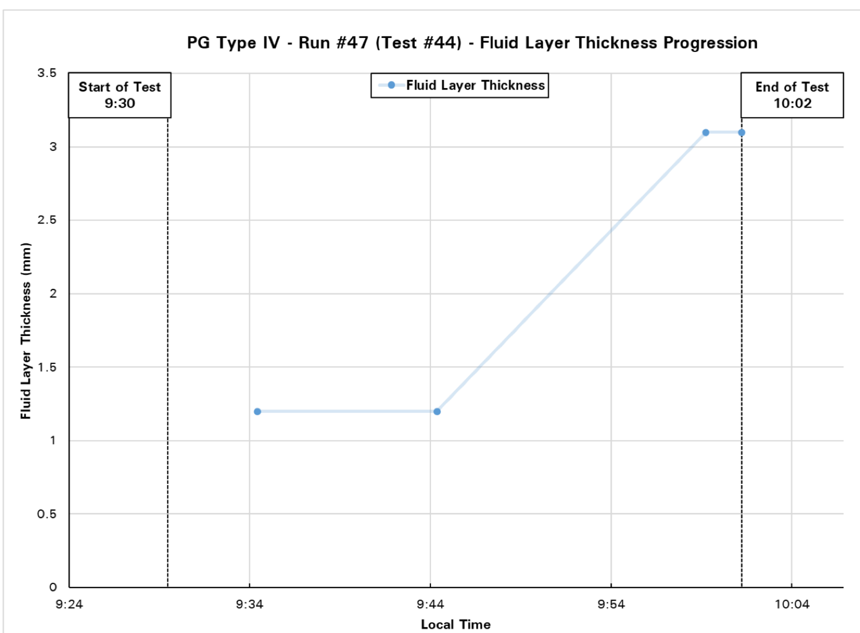

PG Type IV - Run #47 (Test #44) - Wind Speeds
Start of Test 9:30
End of Test 10:02
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
9:24
9:34
9:44
9:54
10:04
Local Time

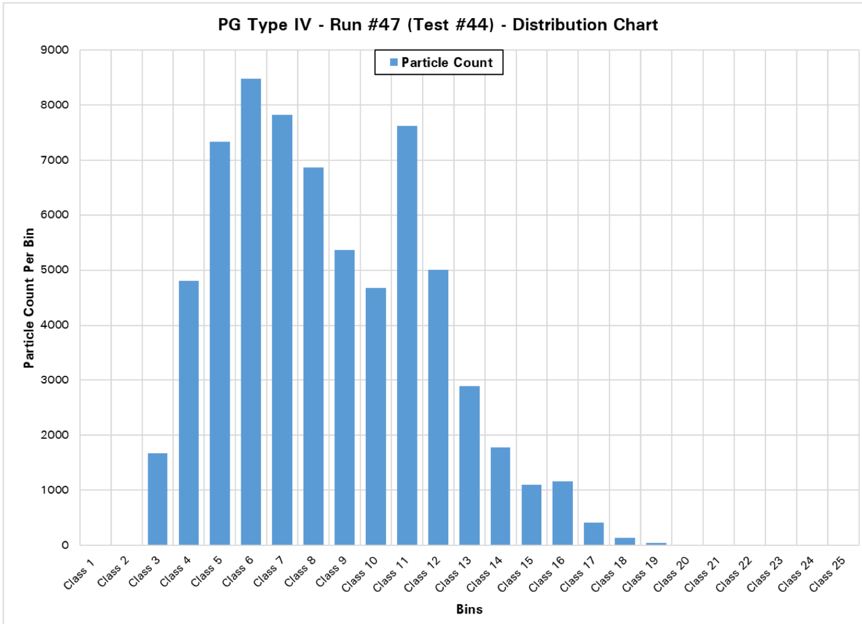

PG Type IV - Run #47 (Test #44) - Wind Direction
Start of Test 9:30
End of Test 10:02
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
9:24
9:34
9:44
9:54
10:04
Local Time


PG Type IV - Run #47 (Test #44) - Relative Humidity
Start of Test 9:30
WS600 Sensor Relative Humidity
End of Test 10:02
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
9:24
9:34
9:44
9:54
10:04
Local Time


PG Type IV - Run #47 (Test #44) - Fluid Brix Progression
Start of Test 9:30
Fluid Brix
End of Test 10:02
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
9:24
9:34
9:44
9:54
10:04
Local Time

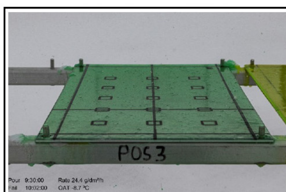

PG Type IV - Run #47 (Test #44) - Barometric Pressure
Start of Test 9:30
WS600 Sensor Barometric Pressure
End of Test 10:02
Barometric Pressure (hPa)
1040
1035
1030
1025
1020
1015
1010
1005
1000
9:24
9:34
9:44
9:54
10:04
Local Time


PG Type IV - Run #47 (Test #44) - Fluid Layer Thickness Progression
Start of Test 9:30
Fluid Layer Thickness
End of Test 10:02
Fluid Layer Thickness (mm)
3.5
3
2.5
2
1.5
1
0.5
0
9:24
9:34
9:44
9:54
10:04
Local Time

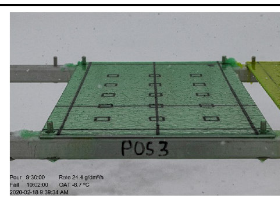


DATA PACKAGE – PG TYPE IV – RUN #47 (TEST 44)

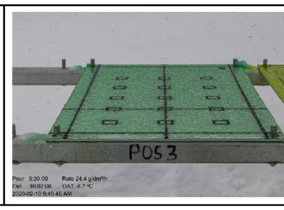
Polar Guard Advance – Run 47 (Test 44) – Failure Progression Photos



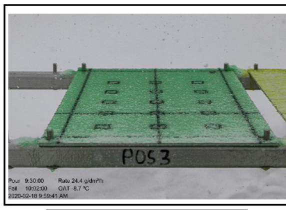
AT POUR (0/32 MIN)



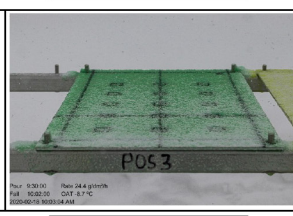
PRE-FAILURE (9/32 MIN)



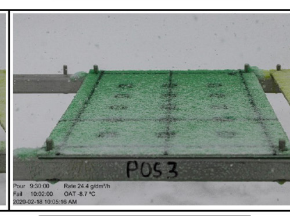
PRE-FAILURE (19/32 MIN)



PRE-FAILURE (29/32 MIN)



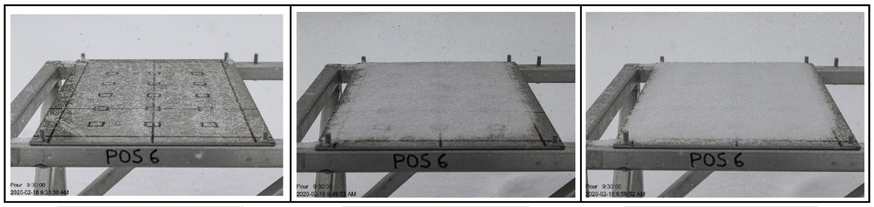
AT FAILURE (33/32 MIN)



POST-FAILURE (35/32 MIN)

Polar Guard Advance – Run 47 (Test 44) – Snow Characteristics Photos

FELT PAD (1/32 MIN) | FELT PAD (10/32 MIN) | FELT PAD (20/32 MIN)



BARE PLATE (1/32 MIN) | BARE PLATE (19/32 MIN) | BARE PLATE (29/32 MIN)

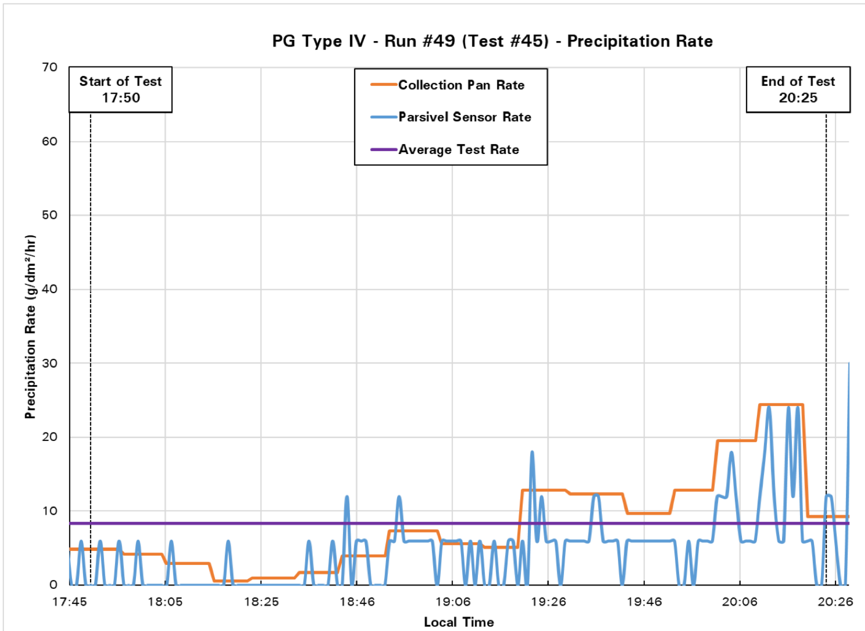
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

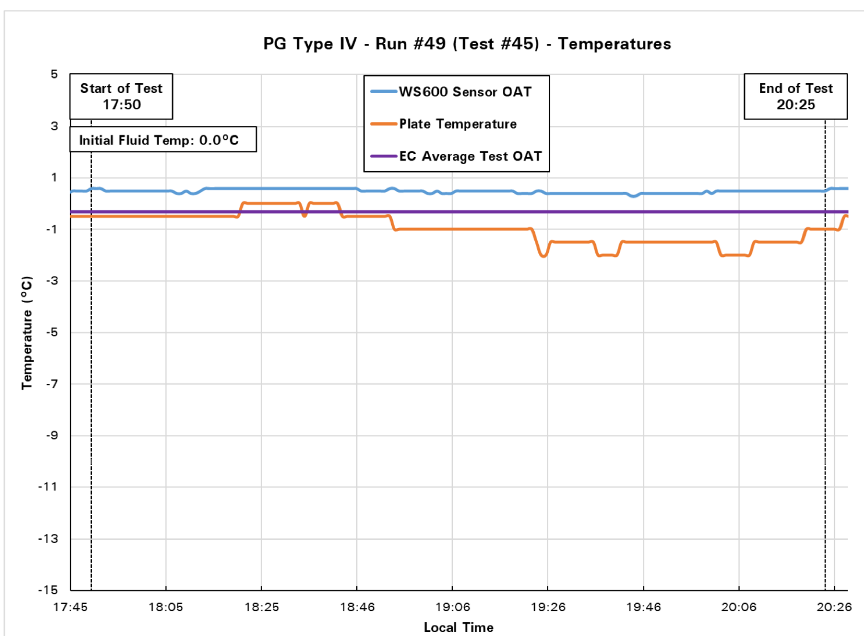
PG TYPE IV
RUN #49 (TEST #45) – TEST PG4-45

PG Type IV – Run #49 (Test #45)– General Test Information

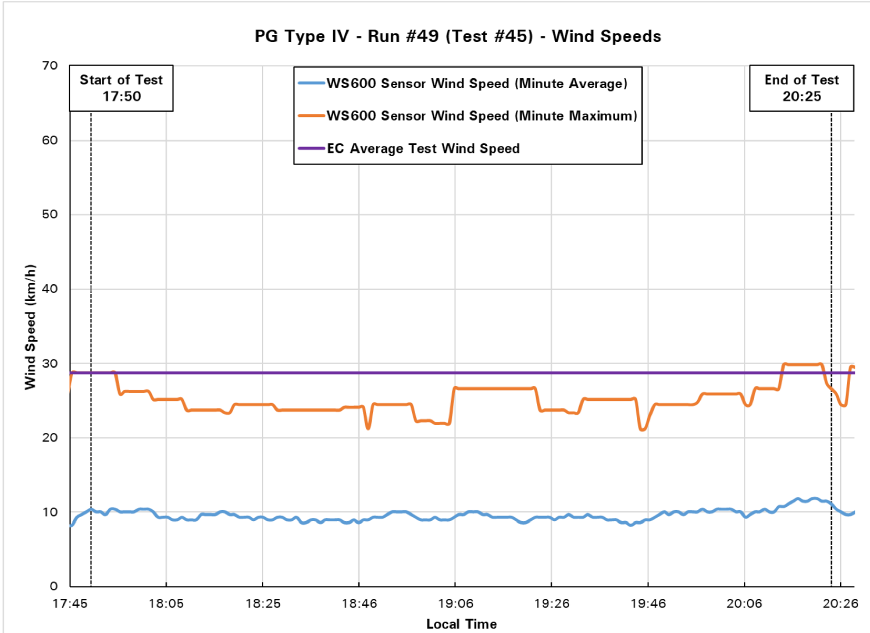
Test Number:	**PG4-45**
Date of Test:	**February 26, 2020**
Average OAT:	**-0.3**
Average Precipitation Rate:	**8.3 g/dm²/h**
Average Wind Speed:	**28.8 km/h**
Average Relative Humidity:	**83.0%**
Pour Time (Local):	**17:50:00**
Time of Fluid Failure (Local):	**20:25:00**
Fluid Brix at Failure:	**3.25°**
Endurance Time:	**155 minutes**
Expected Regression-Derived Endurance Time:	**183 minutes**
Difference (ET vs. Reg ET):	**- 28 minutes (- 15.3%)**

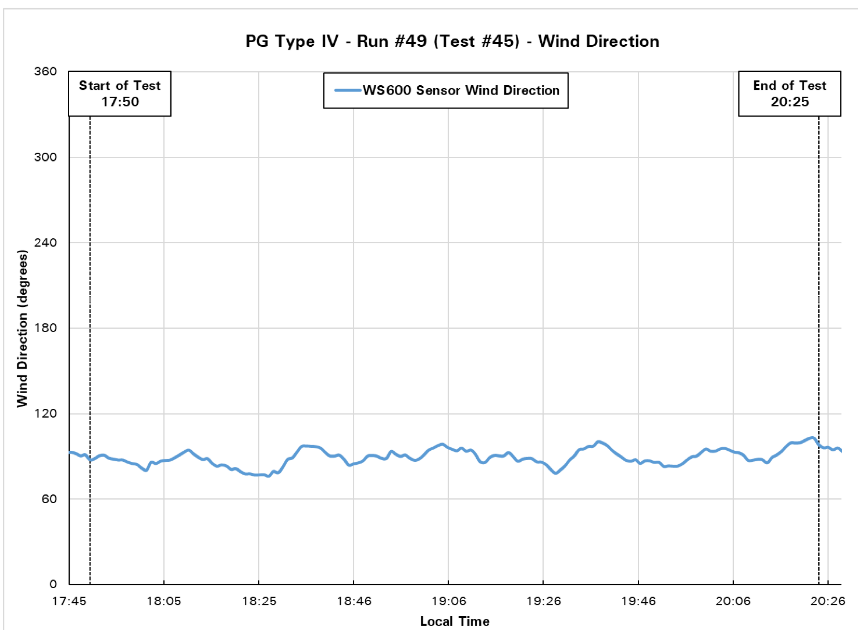


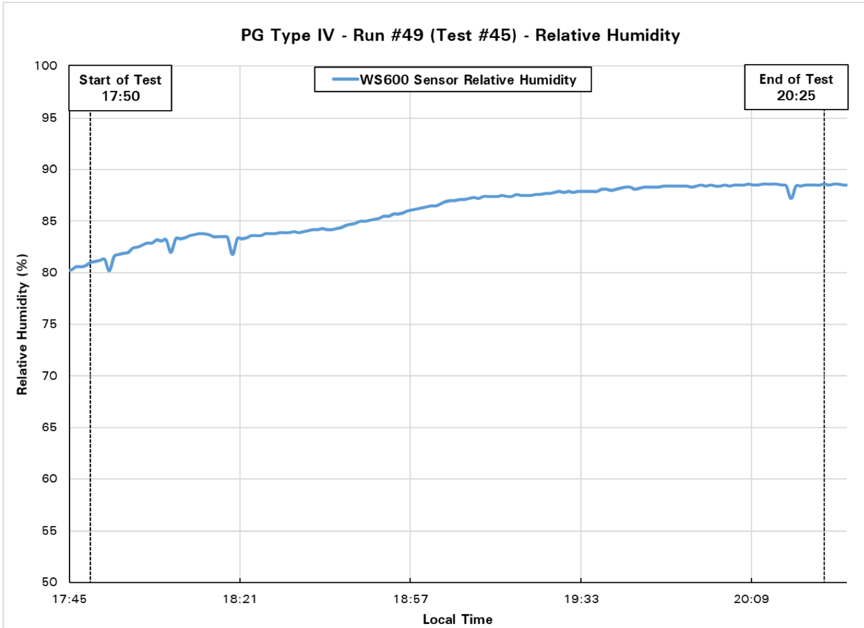
PG Type IV - Run #49 (Test #45) - Precipitation Rate
Start of Test 17:50
End of Test 20:25
Collection Pan Rate
Parsivel Sensor Rate
Average Test Rate
Precipitation Rate (g/dm²/hr)
0
10
20
30
40
50
60
70
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

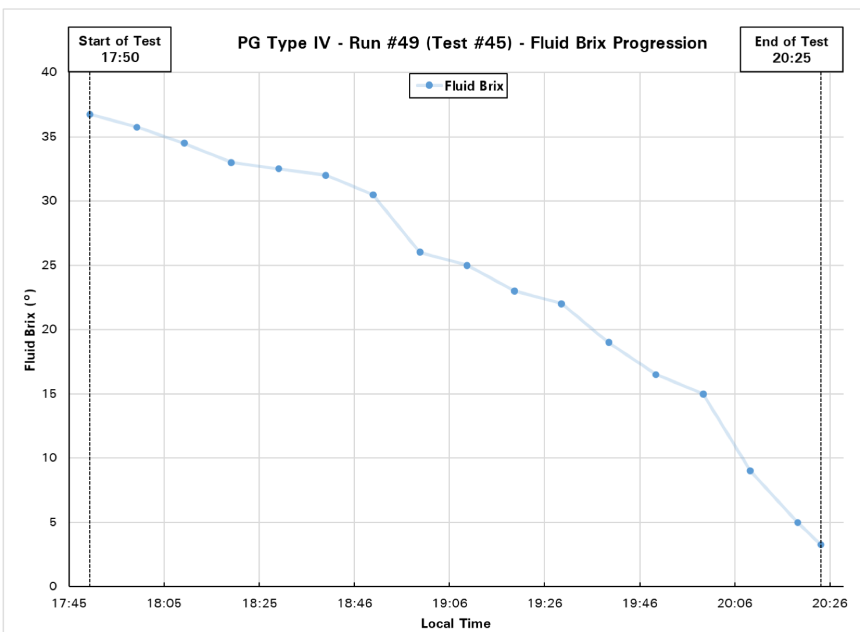


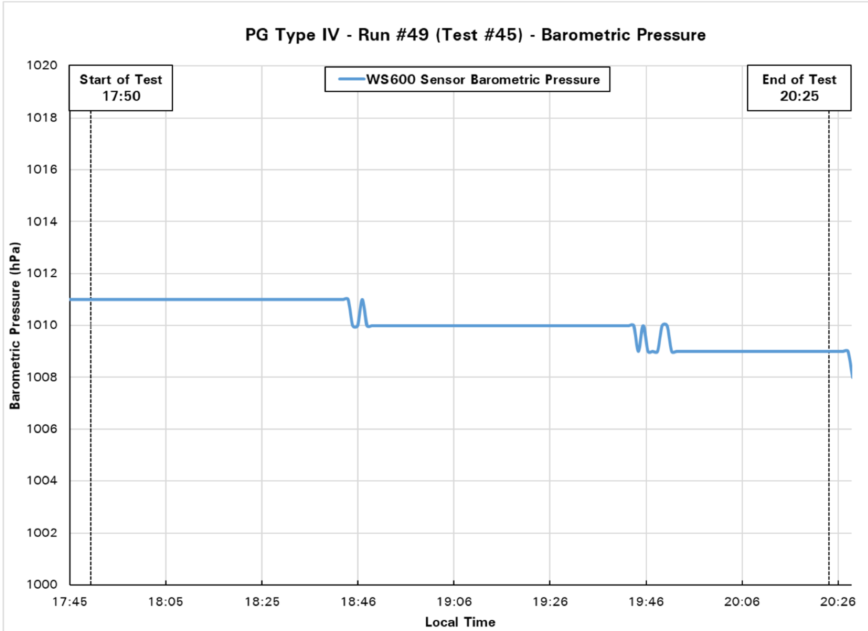
PG Type IV - Run #49 (Test #45) - Temperatures
Start of Test 17:50
End of Test 20:25
Initial Fluid Temp: 0.0°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

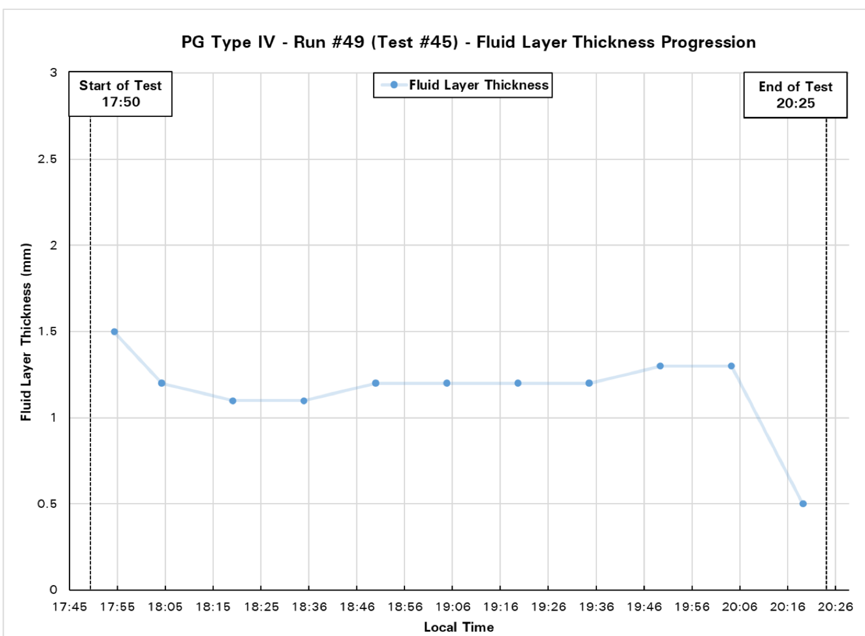

PG Type IV - Run #49 (Test #45) - Wind Speeds
Start of Test 17:50
End of Test 20:25
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
70
60
50
40
30
20
10
0
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

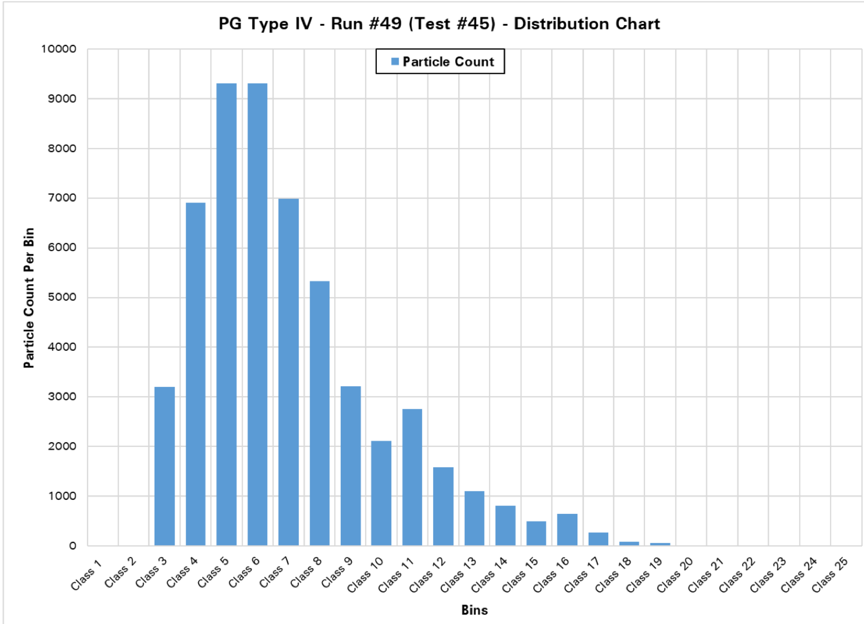

PG Type IV - Run #49 (Test #45) - Wind Direction
Start of Test 17:50
End of Test 20:25
WS600 Sensor Wind Direction
Wind Direction (degrees)
360
300
240
180
120
60
0
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time


PG Type IV - Run #49 (Test #45) - Relative Humidity
Start of Test 17:50
WS600 Sensor Relative Humidity
End of Test 20:25
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
17:45
18:21
18:57
19:33
20:09
Local Time

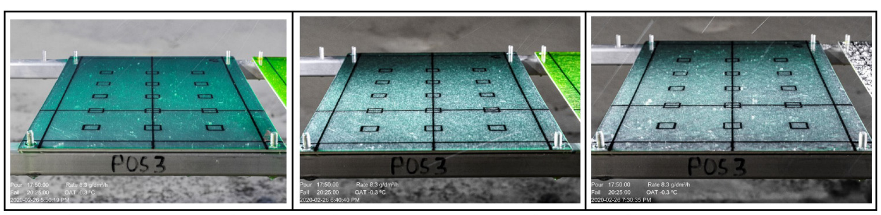

PG Type IV - Run #49 (Test #45) - Fluid Brix Progression
Start of Test 17:50
End of Test 20:25
Fluid Brix
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time


PG Type IV - Run #49 (Test #45) - Barometric Pressure
Start of Test 17:50
WS600 Sensor Barometric Pressure
End of Test 20:25
Barometric Pressure (hPa)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
17:45
18:05
18:25
18:46
19:06
19:26
19:46
20:06
20:26
Local Time

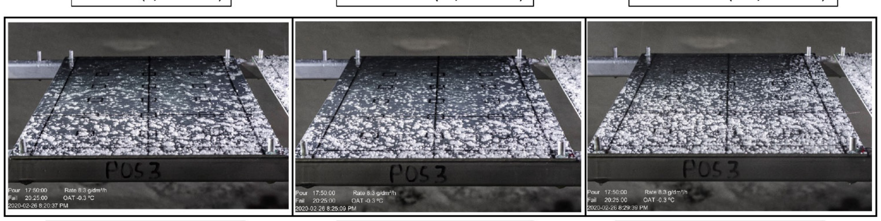

PG Type IV - Run #49 (Test #45) - Fluid Layer Thickness Progression
Start of Test 17:50
Fluid Layer Thickness
End of Test 20:25
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
17:45
17:55
18:05
18:15
18:25
18:36
18:46
18:56
19:06
19:16
19:26
19:36
19:46
19:56
20:06
20:16
20:26
Local Time



Polar Guard Advance – Run 49 (Test 45) – Failure Progression Photos



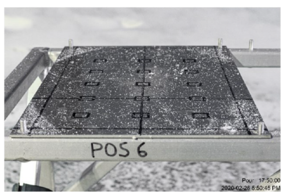
AT POUR (0/155 MIN) | PRE-FAILURE (50/155 MIN) | PRE-FAILURE (100/155 MIN)



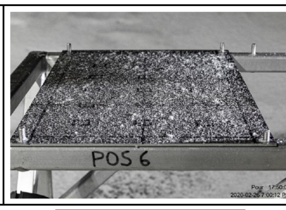
PRE-FAILURE (150/155 MIN) | AT FAILURE (155/155 MIN) | POST-FAILURE (159/155 MIN)

Polar Guard Advance – Run 49 (Test 45) – Snow Characteristics Photos

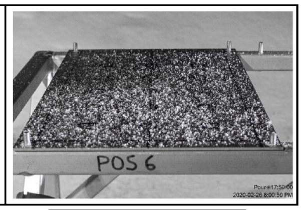
No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (0/155 MIN)



BARE PLATE (70/155 MIN)



BARE PLATE (130/155 MIN)

Final Bare Plate Contamination Thickness: **1.7mm**

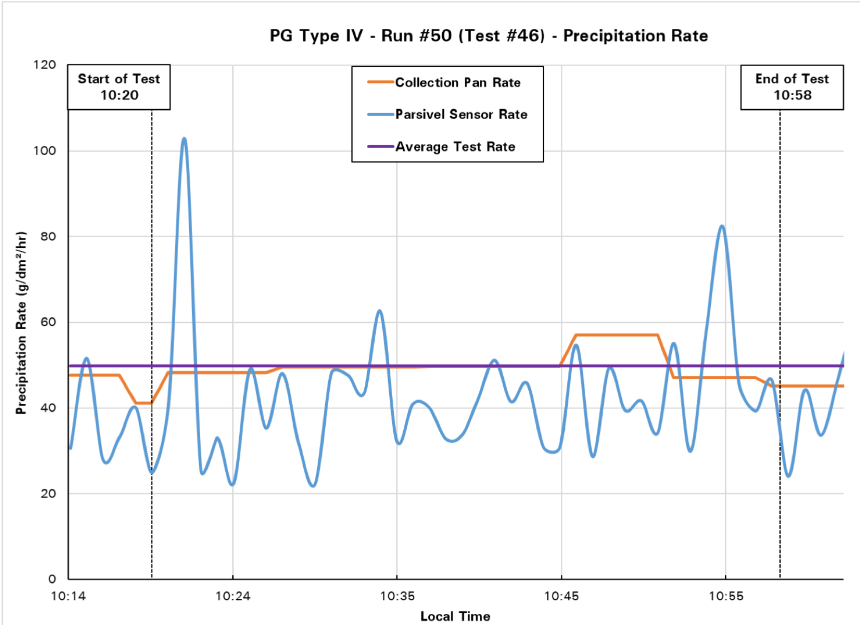
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

PG TYPE IV
RUN #50 (TEST #46) PG4-46

PG Type IV – Run #50 (Test #46) – General Test Information

Test Number:	PG4-46
Date of Test:	February 27, 2020
Average OAT:	0.5
Average Precipitation Rate:	49.9 g/dm²/h
Average Wind Speed:	20.5 km/h
Average Relative Humidity:	91.6%
Pour Time (Local):	10:20:00
Time of Fluid Failure (Local):	10:58:00
Fluid Brix at Failure:	1.5°
Endurance Time:	38 minutes
Expected Regression-Derived Endurance Time:	53.2 minutes
Difference (ET vs. Reg ET):	- 14.7 minutes (- 27.6%)

DATA PACKAGE – PG TYPE IV – RUN #50 (TEST #46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 50 - Test 46/Data Package - PG Type IV - Run 50 - Test 46.docx
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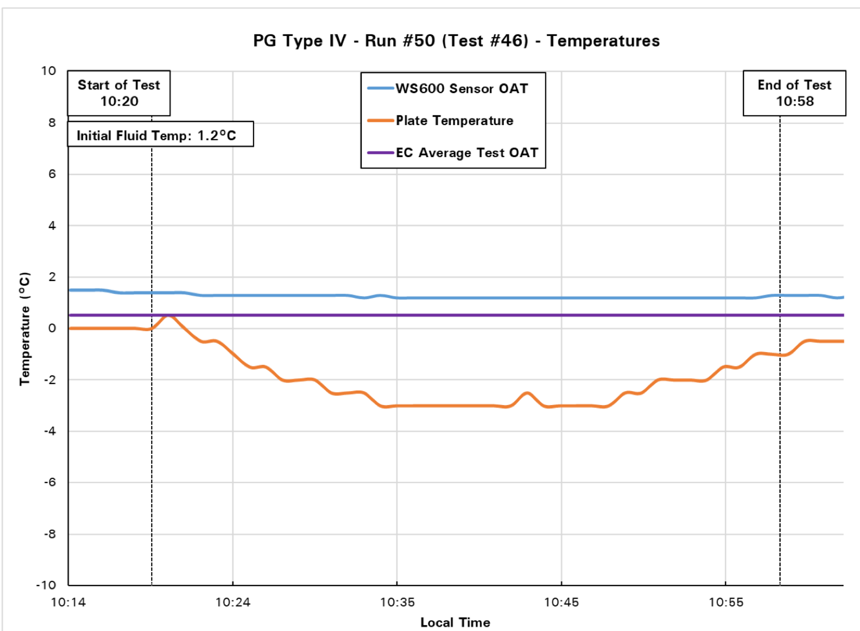
DATA PACKAGE – PG TYPE IV – RUN #50 (TEST #46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 50 - Test 46/Data Package - PG Type IV - Run 50 - Test 46.docx
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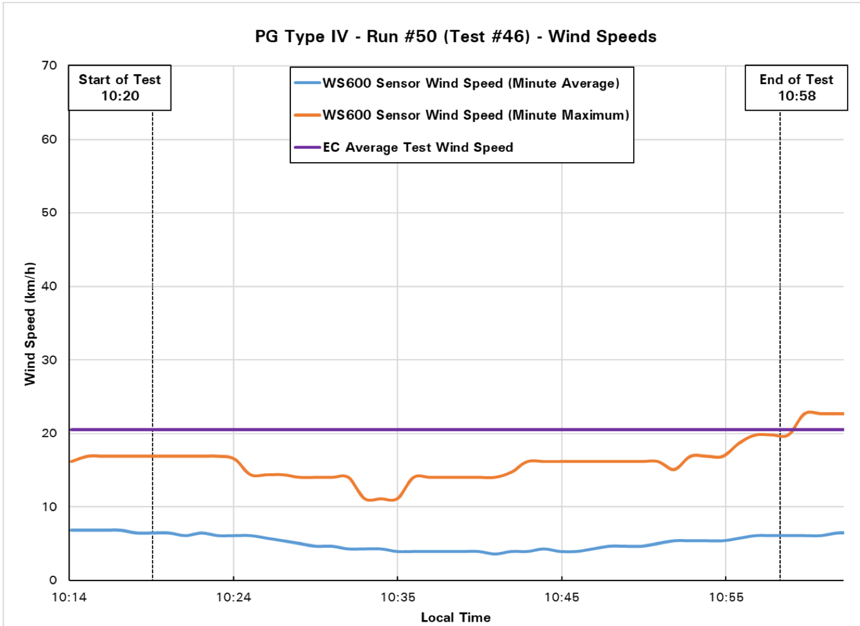
DATA PACKAGE – PG TYPE IV – RUN #50 (TEST #46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 50 - Test 46/Data Package - PG Type IV - Run 50 - Test 46.docx
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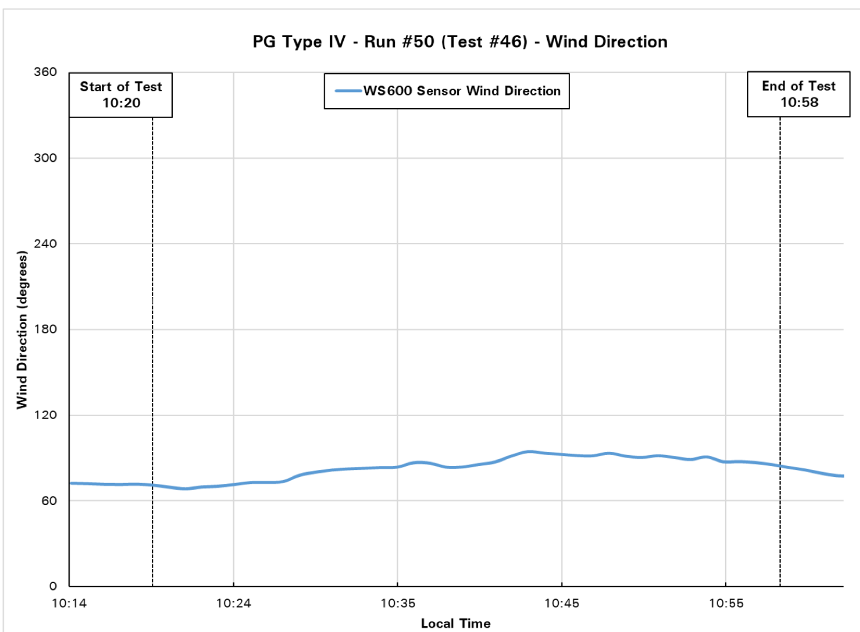
DATA PACKAGE – PG TYPE IV – RUN #50 (TEST #46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 50 - Test 46/Data Package - PG Type IV - Run 50 - Test 46.docx
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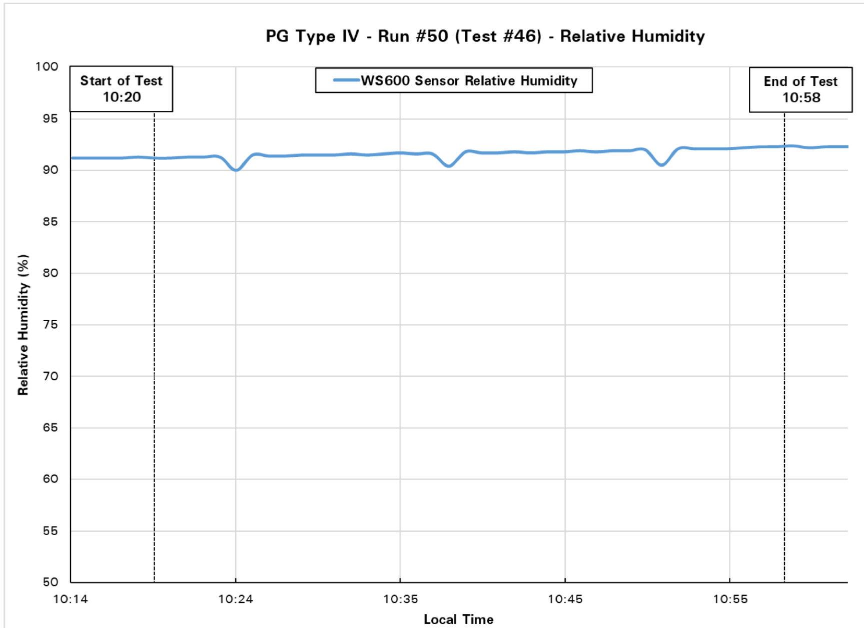
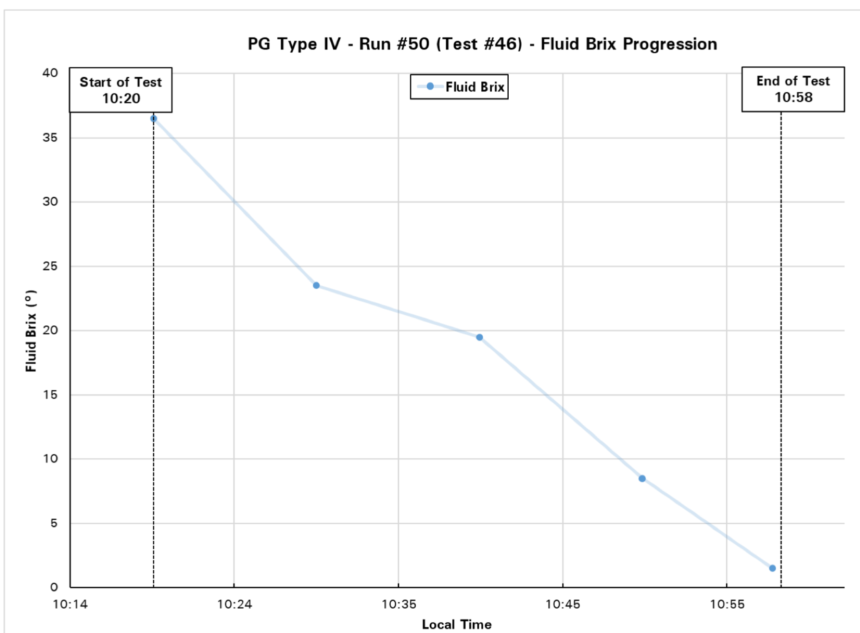
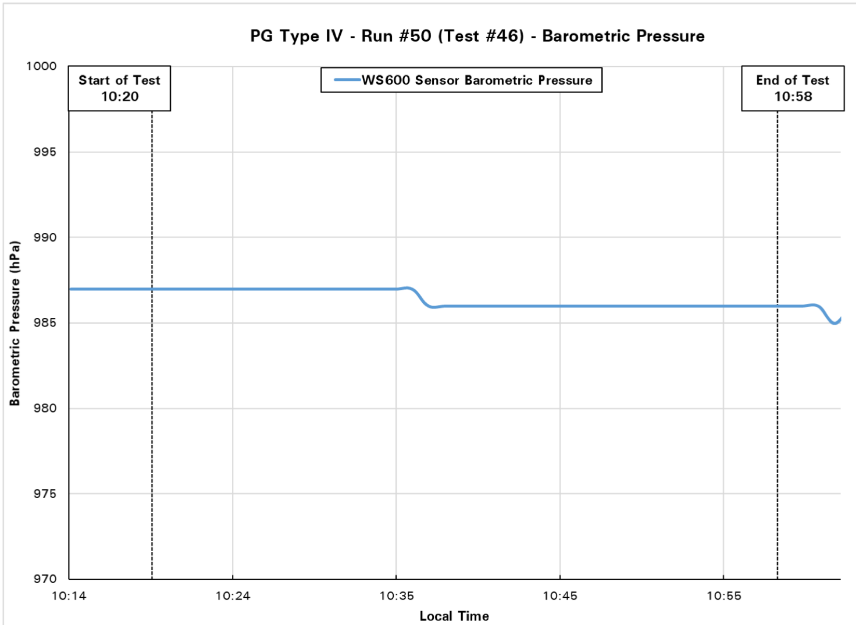
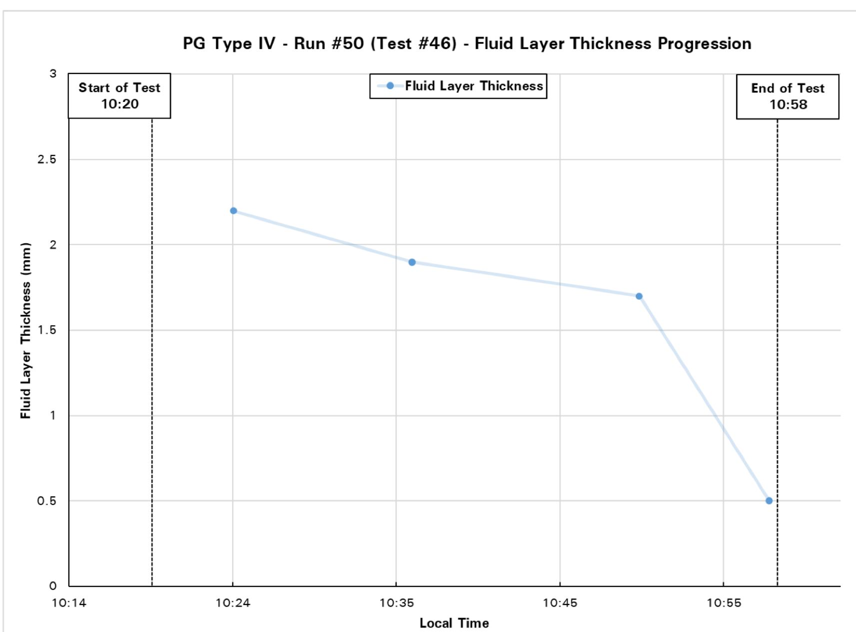


PG Type IV - Run #50 (Test #46) - Relative Humidity
Start of Test 10:20
WS600 Sensor Relative Humidity
End of Test 10:58
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
10:14
10:24
10:35
10:45
10:55
Local Time

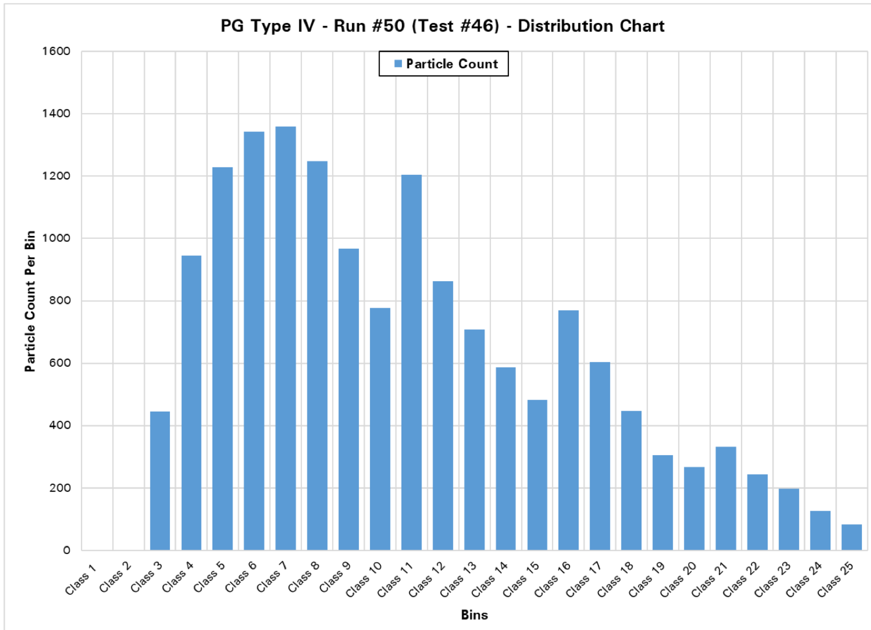


PG Type IV - Run #50 (Test #46) - Fluid Brix Progression
Start of Test 10:20
Fluid Brix
End of Test 10:58
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
10:14
10:24
10:35
10:45
10:55
Local Time


PG Type IV - Run #50 (Test #46) - Barometric Pressure
WS600 Sensor Barometric Pressure
Start of Test
10:20
End of Test
10:58
Barometric Pressure (hPa)
1000
995
990
985
980
975
970
10:14
10:24
10:35
10:45
10:55
Local Time


PG Type IV - Run #50 (Test #46) - Fluid Layer Thickness Progression
Fluid Layer Thickness
Start of Test
10:20
End of Test
10:58
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
10:14
10:24
10:35
10:45
10:55
Local Time

DATA PACKAGE – PG TYPE IV – RUN #50 (TEST #46)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 50 - Test 46/Data Package - PG Type IV - Run 50 - Test 46.docx
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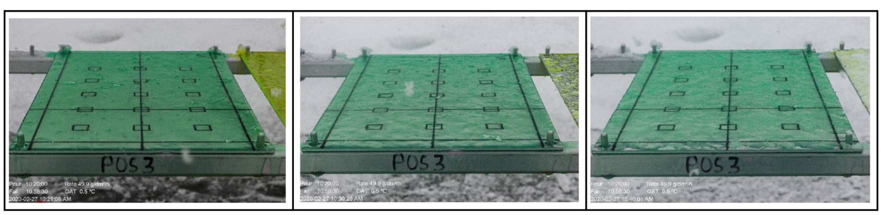
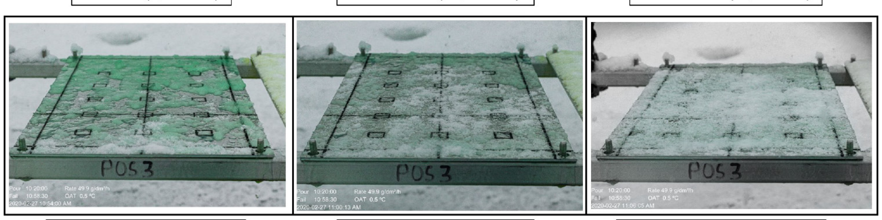
DATA PACKAGE – PG TYPE IV – RUN #50 (TEST #46)

Polar Guard Advance – Run 50 (Test 46) – Failure Progression Photos



AT POUR (0/38 MIN) | PRE-FAILURE (10/38 MIN) | PRE-FAILURE (20/38 MIN)



PRE-FAILURE (34/38 MIN) | AT FAILURE (40/38 MIN) | POST-FAILURE (46/38 MIN)

APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 50 - Test 46/Data Package - PG Type IV - Run 50 - Test 46.docx
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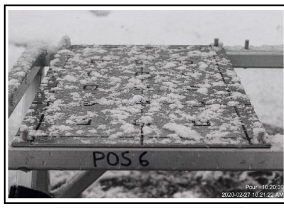
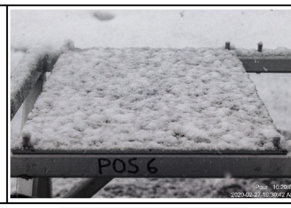
Polar Guard Advance – Run 50 (Test 46) – Snow Characteristics Photos

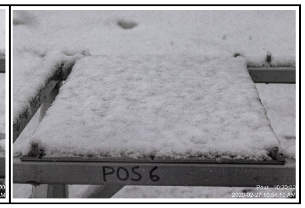
No Felt Pad Photos	No Felt Pad Photos	No Felt Pad Photos
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (1/38 MIN)



BARE PLATE (10/38 MIN)



BARE PLATE (34/38 MIN)

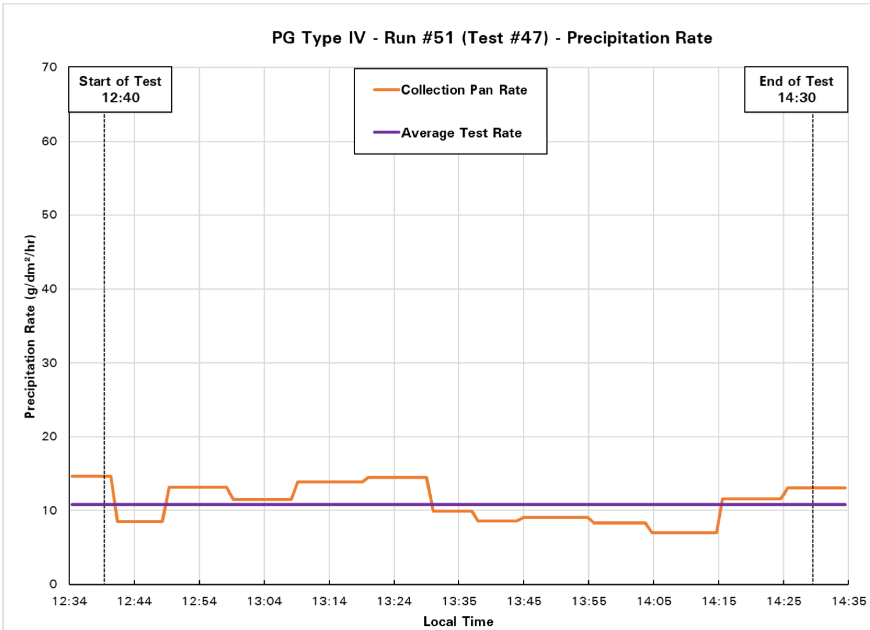
Final Bare Plate Contamination Thickness: **Nil (0mm)**

NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

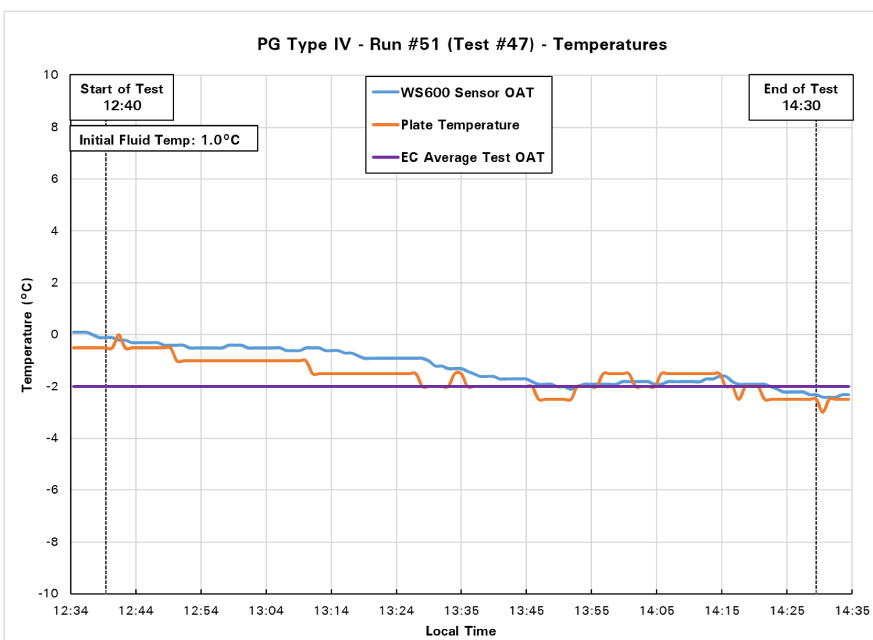
PG TYPE IV
RUN #51 (TEST #47) PG4-47

PG Type IV – Run #51 (Test #47) – General Test Information

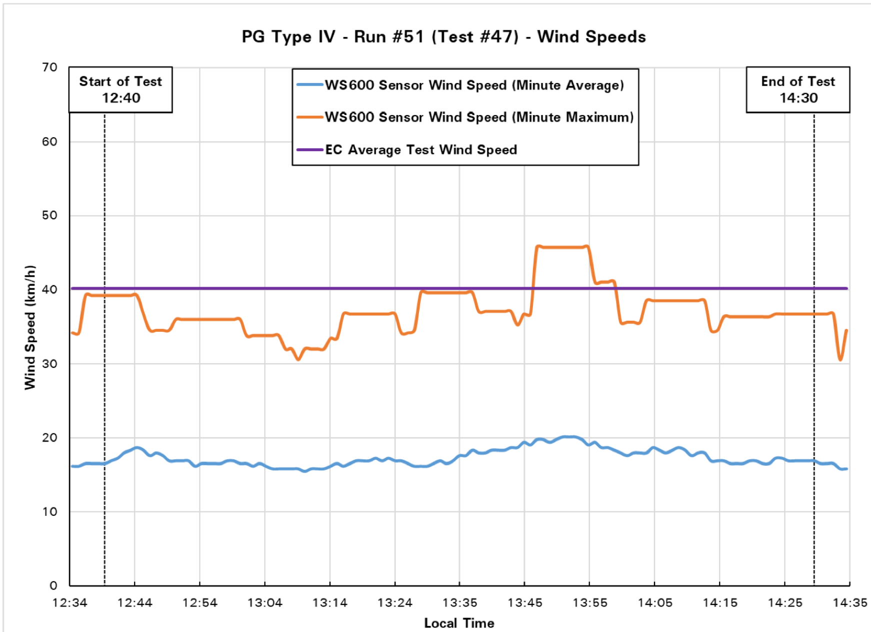
Test Number:	PG4-47
Date of Test:	February 27, 2020
Average OAT:	-2.0
Average Precipitation Rate:	10.8 g/dm²/h
Average Wind Speed:	40.2 km/h
Average Relative Humidity:	93.3%
Pour Time (Local):	12:40:00
Time of Fluid Failure (Local):	14:30:00
Fluid Brix at Failure:	7°
Endurance Time:	110 minutes
Expected Regression-Derived Endurance Time:	107.4 minutes
Difference (ET vs. Reg ET):	+2.6 minutes (+2.5%)



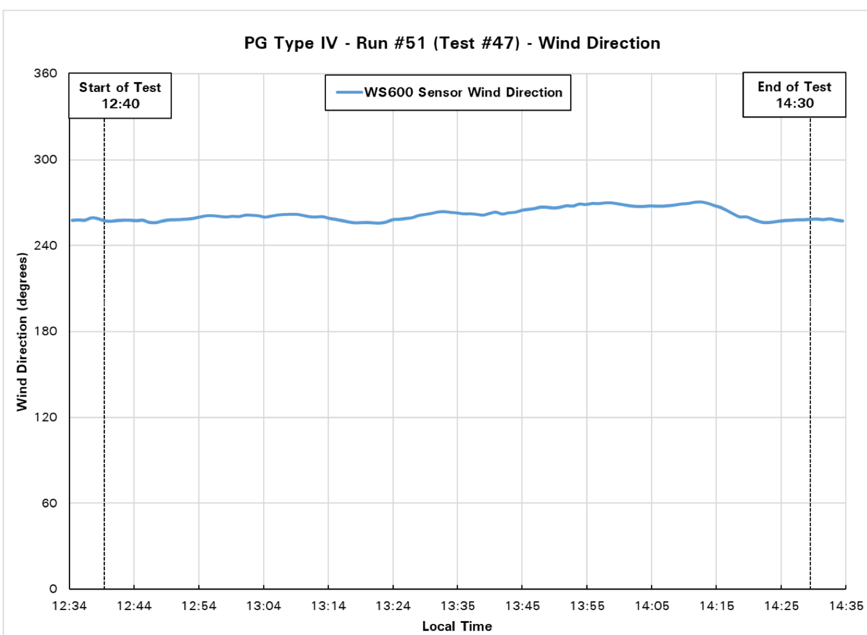
PG Type IV - Run #51 (Test #47) - Precipitation Rate
Start of Test 12:40
Collection Pan Rate
Average Test Rate
End of Test 14:30
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time



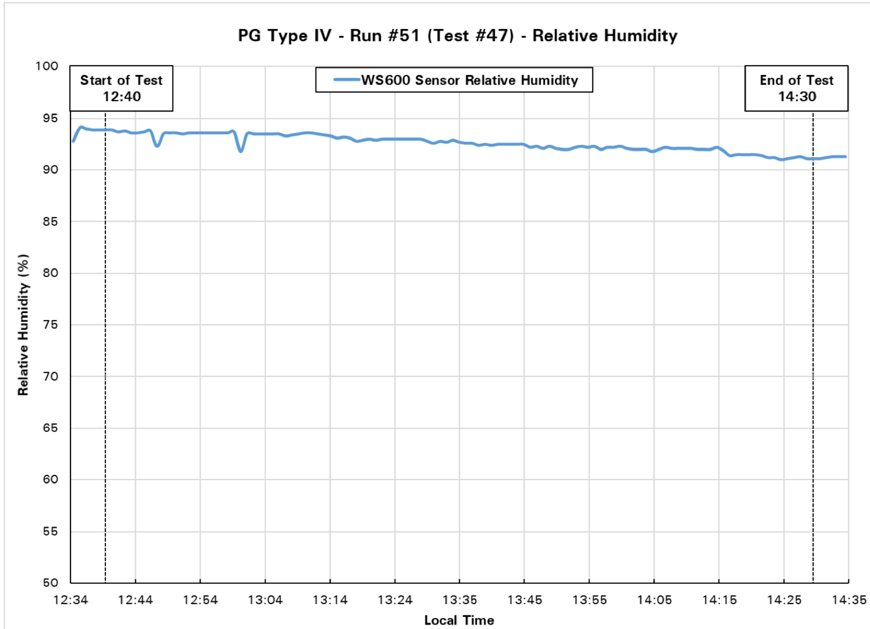
PG Type IV - Run #51 (Test #47) - Temperatures
Start of Test 12:40
Initial Fluid Temp: 1.0°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test 14:30
Temperature (°C)
10
8
6
4
2
0
-2
-4
-6
-8
-10
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

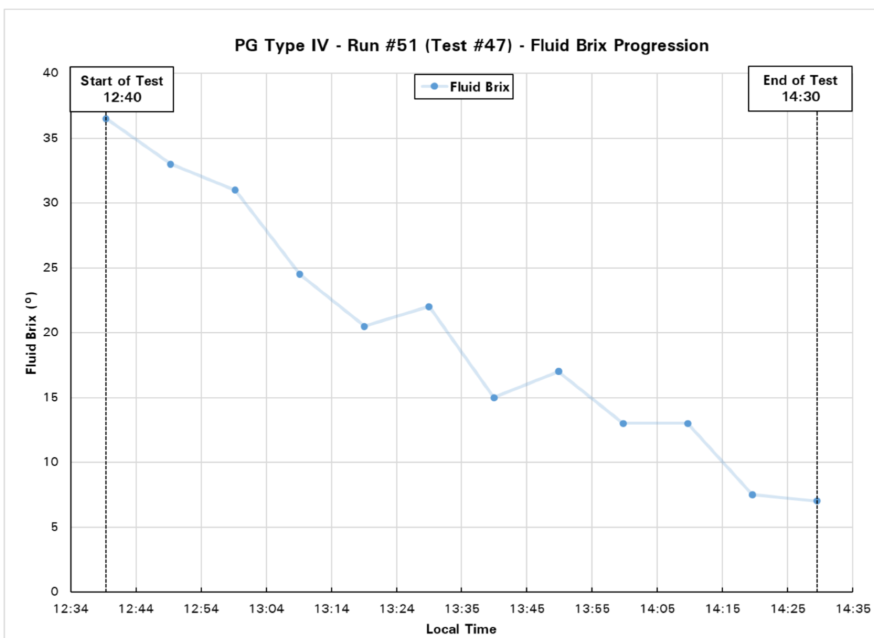


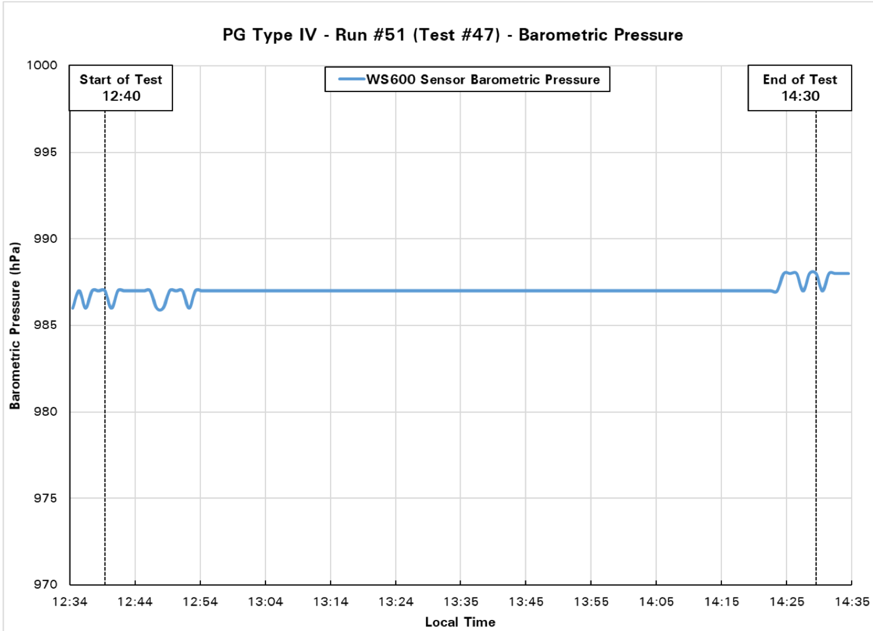
PG Type IV - Run #51 (Test #47) - Wind Speeds
Start of Test 12:40
End of Test 14:30
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

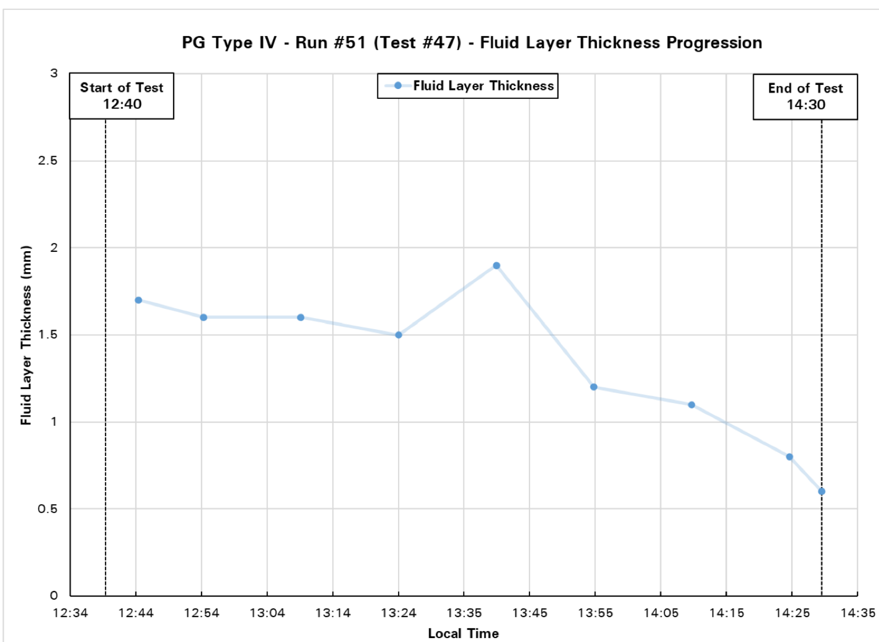


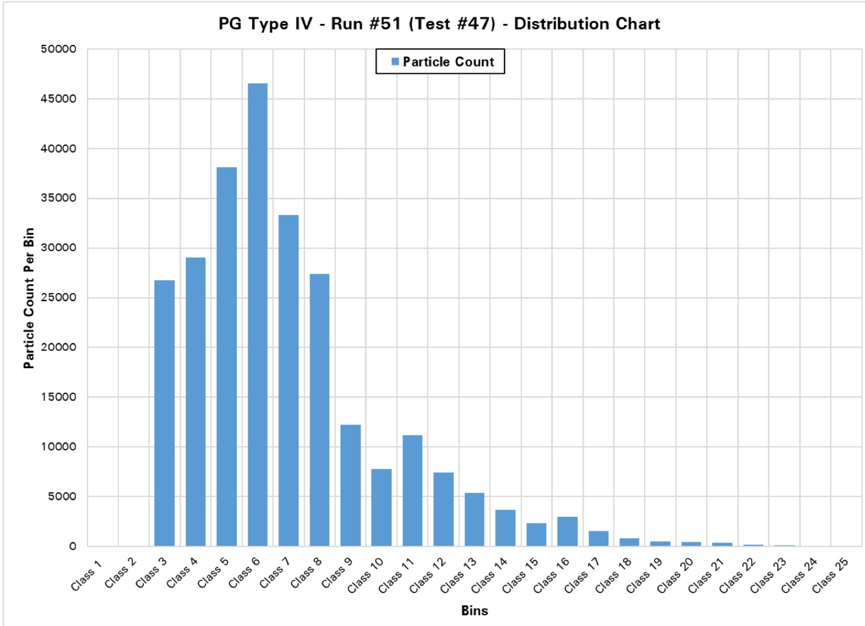
PG Type IV - Run #51 (Test #47) - Wind Direction
Start of Test 12:40
End of Test 14:30
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time


PG Type IV - Run #51 (Test #47) - Relative Humidity
Start of Test
12:40
WS600 Sensor Relative Humidity
End of Test
14:30
Relative Humidity (%)
100
95
90
85
80
75
70
65
60
55
50
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

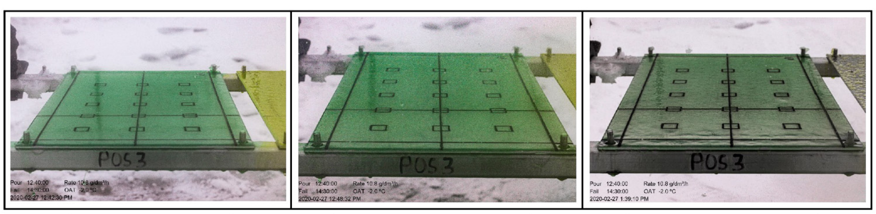

PG Type IV - Run #51 (Test #47) - Fluid Brix Progression
Start of Test
12:40
Fluid Brix
End of Test
14:30
Fluid Brix (°)
40
35
30
25
20
15
10
5
0
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time


PG Type IV - Run #51 (Test #47) - Barometric Pressure
Start of Test 12:40
WS600 Sensor Barometric Pressure
End of Test 14:30
Barometric Pressure (hPa)
1000
995
990
985
980
975
970
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time

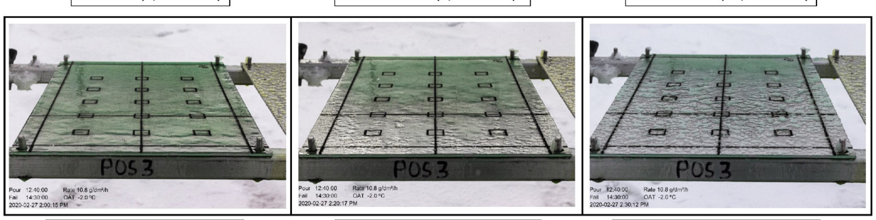

PG Type IV - Run #51 (Test #47) - Fluid Layer Thickness Progression
Start of Test 12:40
Fluid Layer Thickness
End of Test 14:30
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
12:34
12:44
12:54
13:04
13:14
13:24
13:35
13:45
13:55
14:05
14:15
14:25
14:35
Local Time



Polar Guard Advance – Run 51 (Test 47) – Failure Progression Photos

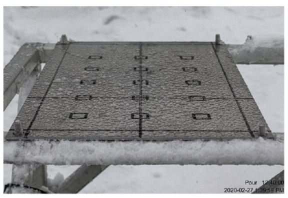
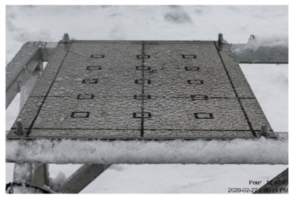
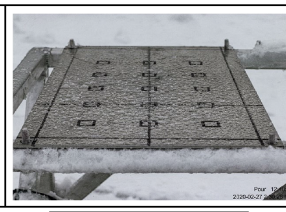


AT POUR (0/110 MIN) | PRE-FAILURE (8/110 MIN) | PRE-FAILURE (59/110 MIN)



PRE-FAILURE (80/110 MIN) | PRE-FAILURE (100/110 MIN) | AT FAILURE (110/110 MIN)

Polar Guard Advance – Run 51 (Test 47) – Snow Characteristics Photos

No Felt Pad Photo	No Felt Pad Photo	No Felt Pad Photo
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)
		
BARE PLATE (59/110 MIN)	BARE PLATE (80/110 MIN)	BARE PLATE (110/110 MIN)

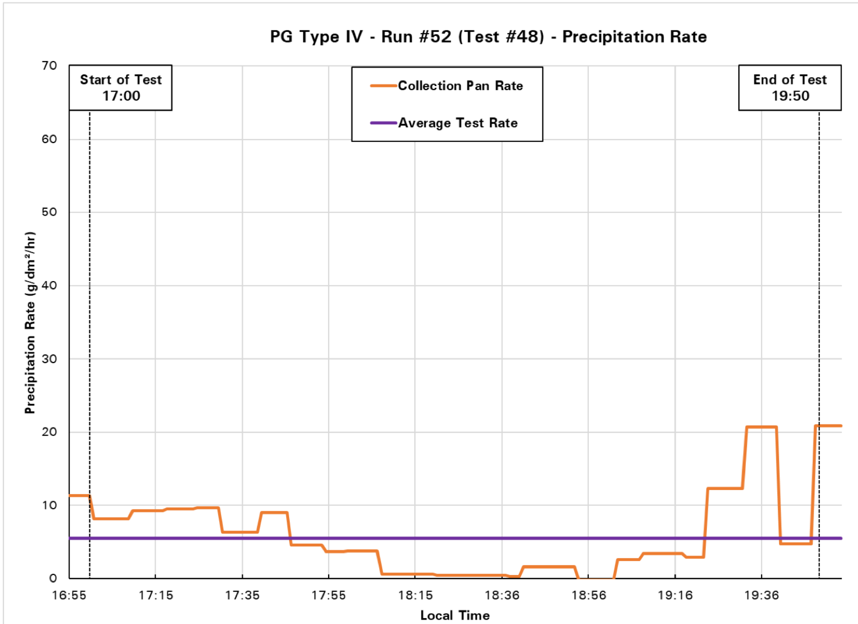
Final Bare Plate Contamination Thickness: **Nil (0mm)**

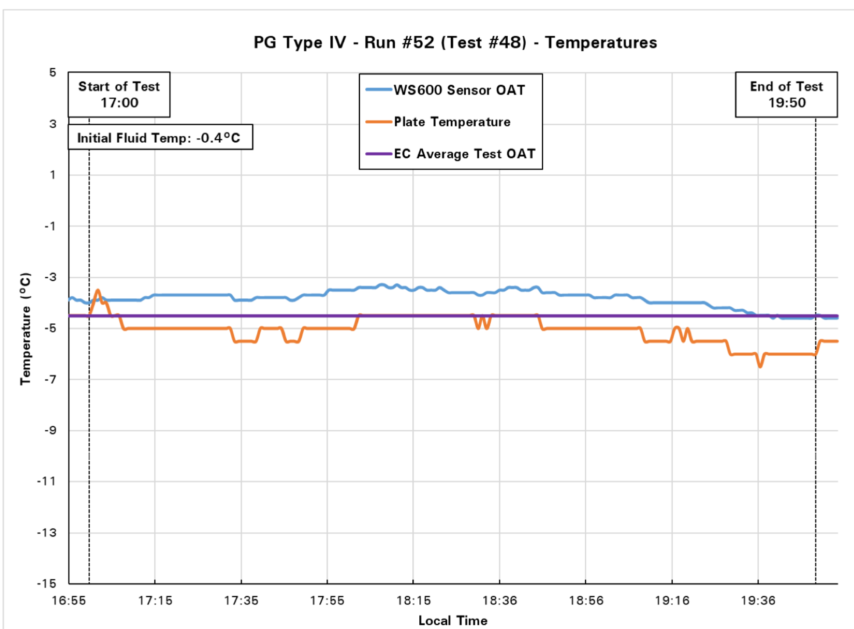
NATURAL SNOW CHARACTERIZATION
DATA AND ASSOCIATED CHARTS

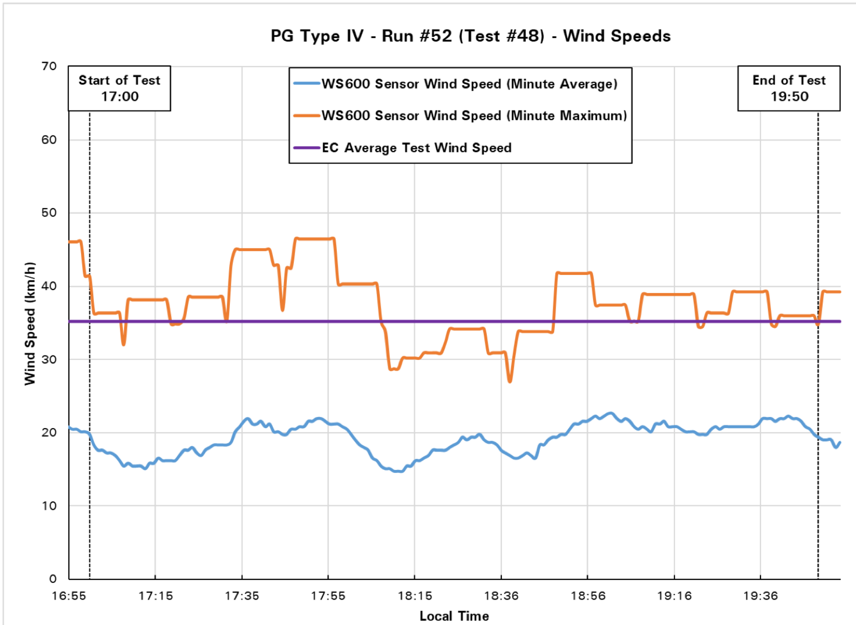
PG TYPE IV
RUN #52 (TEST #48) PG4-48

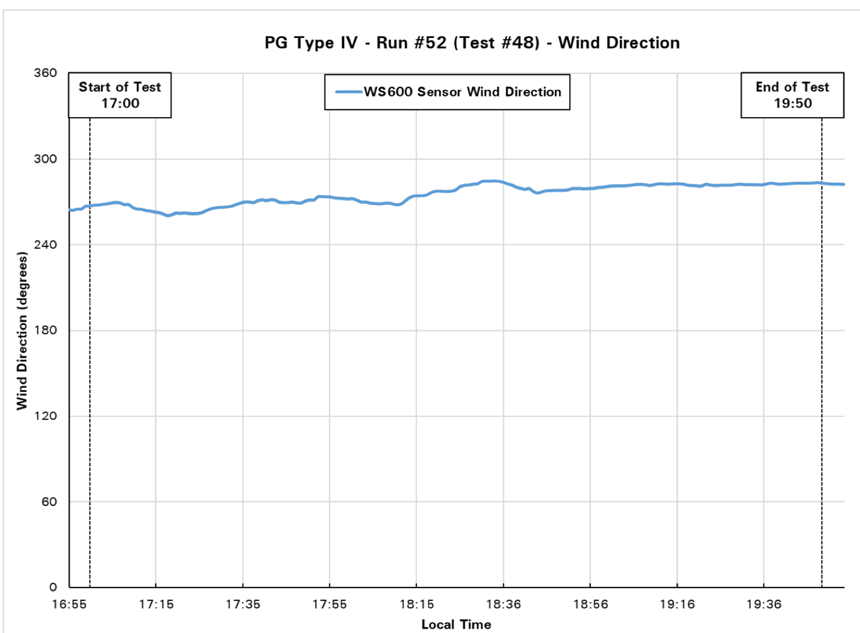
PG Type IV – Run #52 (Test #48) – General Test Information

Test Number:	**PG4-48**
Date of Test:	**February 27, 2020**
Average OAT:	**-4.5**
Average Precipitation Rate:	**5.5 g/dm²/h**
Average Wind Speed:	**35.2 km/h**
Average Relative Humidity:	**90.1%**
Pour Time (Local):	**17:00:00**
Time of Fluid Failure (Local):	**19:50:00**
Fluid Brix at Failure:	**12°**
Endurance Time:	**170 minutes**
Expected Regression-Derived Endurance Time:	**140.6 minutes**
Difference (ET vs. Reg ET):	**+29.4 minutes (+20.9%)**

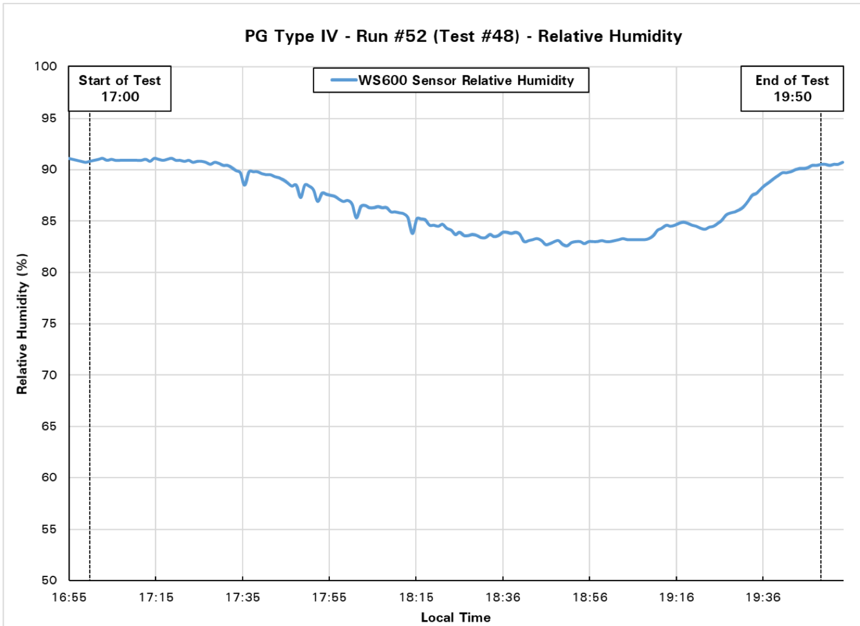

PG Type IV - Run #52 (Test #48) - Precipitation Rate
Start of Test
17:00
Collection Pan Rate
Average Test Rate
End of Test
19:50
Precipitation Rate (g/dm²/hr)
70
60
50
40
30
20
10
0
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
Local Time


PG Type IV - Run #52 (Test #48) - Temperatures
Start of Test
17:00
Initial Fluid Temp: -0.4°C
WS600 Sensor OAT
Plate Temperature
EC Average Test OAT
End of Test
19:50
Temperature (°C)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
Local Time


PG Type IV - Run #52 (Test #48) - Wind Speeds
Start of Test 17:00
End of Test 19:50
WS600 Sensor Wind Speed (Minute Average)
WS600 Sensor Wind Speed (Minute Maximum)
EC Average Test Wind Speed
Wind Speed (km/h)
0
10
20
30
40
50
60
70
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
Local Time


PG Type IV - Run #52 (Test #48) - Wind Direction
Start of Test 17:00
End of Test 19:50
WS600 Sensor Wind Direction
Wind Direction (degrees)
0
60
120
180
240
300
360
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
Local Time

DATA PACKAGE – PG TYPE IV – RUN #52 (TEST 48)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 52 - Test 48/Data Package - PG Type IV - Run 52 - Test 48.docx
Final Version 1.0, March 2021

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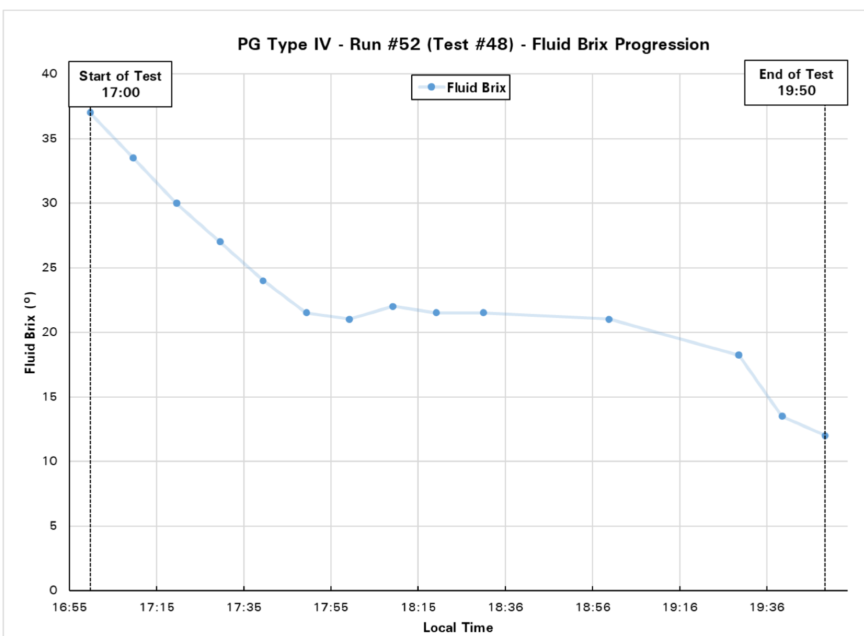
DATA PACKAGE – PG TYPE IV – RUN #52 (TEST 48)



APS/Library/Projects/300293 (TC Deicing 2019-20)/Analysis/Natural Snow Characterization/Data Packages/All Year's Data Packages/PG Type IV/PG Type IV - Run 52 - Test 48/Data Package - PG Type IV - Run 52 - Test 48.docx
Final Version 1.0, March 2021

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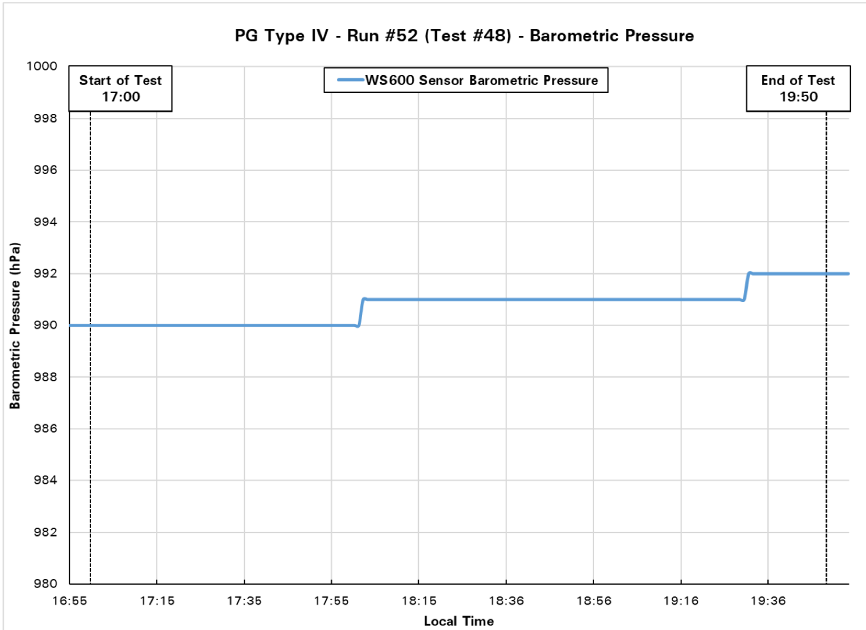
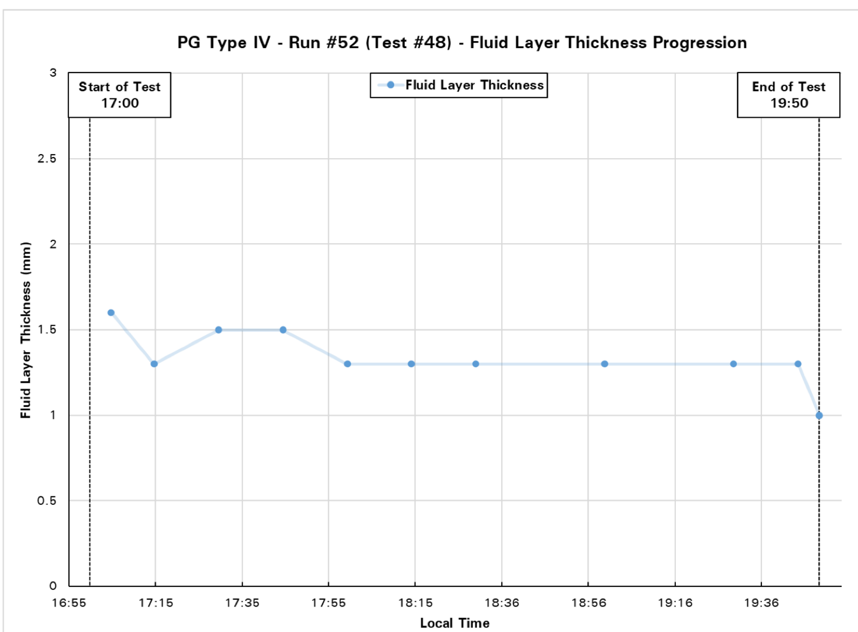
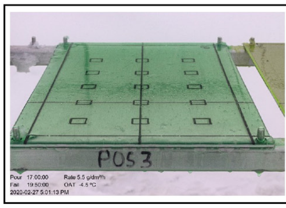
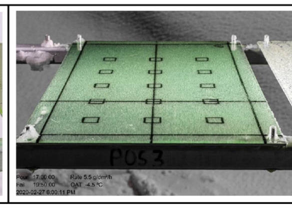

PG Type IV - Run #52 (Test #48) - Barometric Pressure
Start of Test
17:00
WS600 Sensor Barometric Pressure
End of Test
19:50
Barometric Pressure (hPa)
1000
998
996
994
992
990
988
986
984
982
980
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
Local Time


PG Type IV - Run #52 (Test #48) - Fluid Layer Thickness Progression
Start of Test
17:00
Fluid Layer Thickness
End of Test
19:50
Fluid Layer Thickness (mm)
3
2.5
2
1.5
1
0.5
0
16:55
17:15
17:35
17:55
18:15
18:36
18:56
19:16
19:36
Local Time

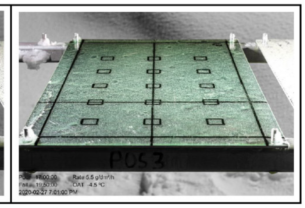
Polar Guard Advance – Run 52 (Test 48) – Failure Progression Photos



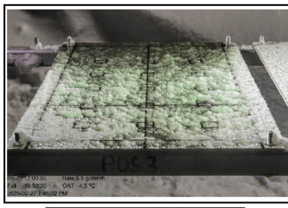
AT POUR (0/170 MIN)



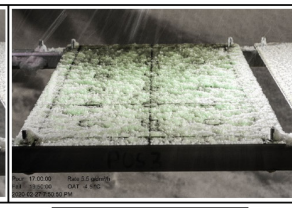
PRE-FAILURE (60/170 MIN)



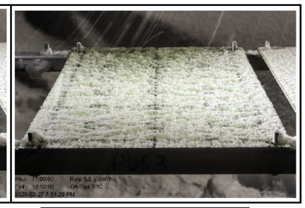
PRE-FAILURE (121/170 MIN)



PRE-FAILURE (165/170 MIN)



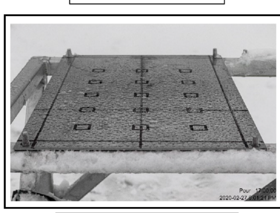
AT FAILURE (170/170 MIN)



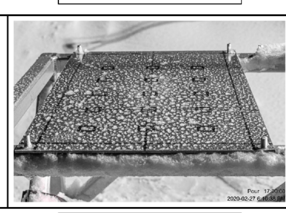
POST-FAILURE (174/170 MIN)

Polar Guard Advance – Run 52 (Test 48) – Snow Characteristics Photos

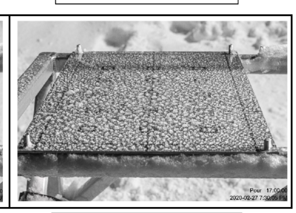
No Felt Pad Photo	No Felt Pad Photo	No Felt Pad Photo
FELT PAD (-/- MIN)	FELT PAD (-/- MIN)	FELT PAD (-/- MIN)



BARE PLATE (1/170 MIN)



BARE PLATE (70/170 MIN)



BARE PLATE (150/170 MIN)

Final Bare Plate Contamination Thickness: **Nil (0mm)**

Particle Size Classes Explained

After determining the volume equivalent diameter (D) and the particle speed (V), the OTT Parsivel² subdivides the particles into appropriate classes. The scale of this classification is smaller for small, slow particles than for large and fast particles.

C.1 Class limits

The measured particles are subdivided into D and V classes in a two-dimensional field, wherein there are 32 different D and V classes so that there are a total of 32 x 32 = 1024 classes.

Classification according to volume-equivalent diameter

Class number	Mid-value of class [mm]	Class spread [mm]
1	0.062	0.125
2	0.187	0.125
3	0.312	0.125
4	0.437	0.125
5	0.562	0.125
6	0.687	0.125
7	0.812	0.125
8	0.937	0.125
9	1.062	0.125
10	1.187	0.125
11	1.375	0.250
12	1.625	0.250
13	1.875	0.250
14	2.125	0.250
15	2.375	0.250
16	2.750	0.500
17	3.250	0.500
18	3.750	0.500
19	4.250	0.500
20	4.750	0.500
21	5.500	1.000
22	6.500	1.000
23	7.500	1.000
24	8.500	1.000
25	9.500	1.000
26	11.000	2.000
27	13.000	2.000
28	15.000	2.000
29	17.000	2.000
30	19.000	2.000
31	21.500	3.000
32	24.500	3.000

Note:
Class 1 and class 2 are limits and are not evaluated at the current time in measurements using the OTT Parsivel² since they are outside the measurement range of the device.

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APPENDIX G

GLOBAL DATA SET ANALYSIS – MULTIPLE REGRESSION DATA SETS

PG Type II Analysis

Test #	Average Test Rate (g/dm²/h)	Average Test Temperature (°C)	Measured Endurance Time (min)	Regression Expected Endurance Time (min)	Measured vs. Regression-Expected (min)	ET Variance	Average Wind Speed (km/h)	Average Particle Size (Parsivel Bin)	Final Rate vs. Average Rate	Rate Standard Deviation	Average RH (%)	Average Barometric Pressure (hPa)	Day/Night	Day/Night Binary
PG2-1	4.6	-9.0	131.2	144.8	-13.6	-9.4%	14.3	6.7	3.5	1.7	80.1	1012.2	Day	1
PG2-2	8.5	-7.8	120.3	93.0	27.4	29.5%	13.5	6.4	-1.9	1.9	83.0	1009.5	Day	1
PG2-3	15.2	-11.5	95.5	49.0	46.5	94.9%	17.2	6.9	1.8	2.7	79.2	1018.3	Day	1
PG2-4	16.9	-9.8	71.8	48.1	23.8	49.4%	18.3	6.8	0.8	2.6	83.2	1014.5	Night	0
PG2-5	23.5	-8.2	43.5	39.8	3.7	9.2%	14.6	7.0	1.9	2.2	86.4	1011.3	Night	0
PG2-6	32.1	-6.5	41.0	34.0	7.0	20.7%	15.0	7.0	0.6	4.4	88.9	1008.5	Night	0
PG2-7	38.3	-7.2	34.2	28.3	5.9	20.8%	15.8	6.3	18.1	11.3	88.6	1006.4	Night	0
PG2-8	45.3	-7.3	38.7	24.5	14.2	58.1%	18.3	7.0	-8.3	11.1	88.9	1003.7	Night	0
PG2-9	58.4	-7.3	21.3	19.9	1.5	7.4%	16.0	6.9	-13.5	6.6	89.0	1002.0	Night	0
PG2-10	32.1	-6.9	34.4	33.1	1.3	4.0%	15.1	7.4	-5.2	4.1	89.5	999.5	Night	0
PG2-11	20.2	-5.9	43.0	51.7	-8.7	-16.8%	6.3	6.6	3.8	5.5	85.2	1011.7	Night	0
PG2-12	48.6	-6.7	16.0	23.9	-7.9	-33.1%	7.8	8.3	-4.5	3.0	87.8	1011.0	Night	0
PG2-13	22.5	-7.4	35.0	43.1	-8.1	-18.8%	11.6	5.7	4.2	3.0	87.6	1008.5	Night	0
PG2-14	9.1	-7.1	89.0	91.6	-2.6	-2.9%	10.3	5.8	-0.3	3.0	87.8	1005.9	Night	0
PG2-15	36.7	-1.8	36.2	46.5	-10.4	-22.3%	10.0	7.3	0.9	4.8	92.0	1015.1	Day	1
PG2-16	47.6	-1.7	39.3	38.2	1.1	2.8%	12.2	6.7	-9.4	11.0	94.8	1013.4	Day	1
PG2-17	31.4	-1.3	50.2	56.9	-6.7	-11.7%	11.1	7.1	10.5	14.4	95.5	1011.4	Day	1
PG2-18	4.1	-7.8	241.4	168.2	73.2	43.5%	-	-	-2.7	2.3	-	-	Day	1
PG2-19	8.2	-1.7	133.5	162.0	-28.5	-17.6%	7.8	8.0	-1.9	1.6	90.7	1009.7	Night	0
PG2-20	6.7	-1.9	175.6	183.4	-7.9	-4.3%	9.9	7.7	-2.7	4.0	93.1	1009.4	Day	1
PG2-21	11.5	-15.1	41.2	54.2	-13.0	-23.9%	15.2	6.8	1.0	1.2	75.5	1012.0	Day	1
PG2-22	26.5	-15.1	19.5	27.4	-7.9	-28.9%	12.7	7.0	7.3	3.0	78.3	1010.6	Night	0
PG2-23	33.1	-15.0	16.3	23.0	-6.6	-28.9%	12.7	6.9	-10.6	7.9	80.9	1007.0	Night	0
PG2-24	6.3	-14.8	57.0	89.5	-32.6	-36.4%	10.8	7.3	1.7	1.9	81.1	1002.8	Night	0
PG2-25	2.4	-8.2	331.5	253.2	78.3	30.9%	7.9	6.1	4.3	2.3	80.9	1006.7	Day	1
PG2-26	20.7	-5.4	47.8	52.2	-4.4	-8.5%	13.2	5.8	7.4	10.2	89.1	990.3	Day	1

PG Type II Analysis (cont'd)

Test #	Average Test Rate (g/dm²/h)	Average Test Temperature (°C)	Measured Endurance Time (min)	Regression Expected Endurance Time (min)	Measured vs. Regression-Expected (min)	ET Variance	Average Wind Speed (km/h)	Average Particle Size (Parsivel Bin)	Final Rate vs. Average Rate	Rate Standard Deviation	Average RH (%)	Average Barometric Pressure (hPa)	Day/Night	Day/Night Binary
PG2-27	19.7	-5.6	55.3	53.8	1.4	2.6%	11.3	6.2	10.6	4.6	89.5	988.1	Day	1
PG2-28	20.1	-5.8	72.5	52.1	20.5	39.3%	14.9	6.9	8.1	5.7	89.7	983.3	Day	1
PG2-29	36.0	-6.1	55.3	31.8	23.5	74.0%	28.6	6.8	1.5	7.2	89.4	981.8	Day	1
PG2-30	16.8	-7.8	70.0	53.3	16.7	31.4%	20.4	7.6	-8.1	6.4	87.4	986.7	Day	1
PG2-31	5.0	-10.4	79.8	126.6	-46.8	-37.0%	8.7	8.0	4.8	3.6	81.5	1019.4	Night	0
PG2-32	13.2	-9.9	49.0	58.6	-9.6	-16.4%	10.0	8.9	1.1	1.7	84.9	1016.6	Night	0
PG2-33	17.4	-9.6	43.0	47.5	-4.5	-9.4%	11.2	9.0	1.4	3.3	85.7	1014.2	Night	0
PG2-34	22.0	-12.0	28.0	35.6	-7.6	-21.3%	4.9	8.4	-2.0	2.3	76.1	1022.0	Day	1
PG2-35	24.1	-8.7	30.5	38.0	-7.5	-19.8%	6.3	8.4	6.1	5.2	83.1	1020.0	Day	1
PG2-36	8.7	-0.3	161.0	195.1	-34.1	-17.5%	9.7	7.1	11.2	6.8	86.1	1010.1	Night	0
PG2-37	46.9	0.4	53.3	60.8	-7.5	-12.3%	5.4	10.3	-13.8	6.4	91.8	986.1	Day	1
PG2-38	11.2	-2.3	135.5	114.4	21.1	18.4%	17.3	7.0	3.5	2.5	92.4	987.2	Day	1
PG2-39	6.4	-4.5	174.2	146.0	28.2	19.3%	19.2	-	14.5	5.7	86.8	990.8	Night	0

EG Type III Analysis

Test #	Average Test Rate (g/dm²/h)	Average Test Temperature (°C)	Measured Endurance Time (min)	Regression Expected Endurance Time (min)	Measured vs. Regression-Expected (min)	ET Variance	Average Wind Speed (km/h)	Average Particle Size (Parsivel Bin)	Final Rate vs. Average Rate	Rate Standard Deviation	Average RH (%)	Average Barometric Pressure (hPa)	Day/Night	Day/Night Binary
EG3-3	6.3	-11.9	63.0	57.5	5.5	9.6%	11.5	7.0	-0.5	1.5	80.9	1014.4	Day	1
EG3-4	3.1	-10.6	107.0	92.1	14.9	16.2%	12.6	7.2	0.1	0.4	80.8	1013.5	Day	1
EG3-5	27.3	-8.6	29.0	22.1	6.9	31.5%	11.2	9.4	-1.0	1.5	85.1	1009.3	Day	1
EG3-6	4.8	-10.4	67.0	69.3	-2.3	-3.3%	14.6	9.1	2.4	1.5	82.7	1006.6	Day	1
EG3-7	10.5	-10.8	41.0	41.3	-0.3	-0.7%	13.2	8.9	2.4	1.0	82.9	1006.1	Night	0
EG3-8	11.7	-10.7	39.0	38.5	0.5	1.3%	10.4	8.6	0.2	1.8	83.6	1006.0	Night	0
EG3-9	12.8	-9.8	34.0	36.2	-2.2	-6.2%	11.0	9.4	-3.2	1.3	84.7	1005.0	Night	0
EG3-10	3.4	-9.2	81.2	86.0	-4.8	-5.6%	16.0	6.4	0.7	0.6	79.4	1012.8	Day	1
EG3-11	8.8	-8.1	43.3	46.4	-3.2	-6.8%	13.9	6.2	0.8	1.8	82.6	1010.0	Day	1
EG3-12	14.5	-11.6	60.0	33.3	26.7	80.0%	16.6	7.0	-1.3	2.8	78.4	1018.7	Day	1
EG3-13	16.6	-10.0	44.8	30.6	14.3	46.7%	18.5	6.8	1.1	3.0	82.7	1015.1	Night	0
EG3-14	23.9	-8.5	24.8	24.1	0.8	3.2%	13.7	6.4	-2.9	2.5	86.1	1011.6	Night	0
EG3-15	31.6	-6.5	29.7	20.0	9.7	48.3%	14.8	7.2	2.4	5.1	88.7	1008.7	Night	0
EG3-16	33.9	-7.1	27.5	19.1	8.4	43.9%	15.1	5.2	21.5	8.3	88.6	1006.5	Night	0
EG3-17	54.9	-7.4	18.3	13.9	4.4	31.6%	19.2	7.1	-1.3	3.6	88.8	1004.0	Night	0
EG3-18	61.9	-7.3	15.8	12.9	2.9	22.3%	15.4	7.0	-7.5	2.7	89.0	1002.0	Night	0
EG3-19	32.7	-7.0	24.2	19.6	4.6	23.5%	14.9	7.6	3.3	3.8	89.5	999.7	Night	0
EG3-20	19.3	-5.7	30.0	27.6	2.4	8.6%	6.0	7.0	-1.2	6.2	84.8	1012.0	Night	0
EG3-21	48.4	-6.7	17.0	15.1	1.9	12.3%	7.8	8.3	-4.3	3.1	87.8	1011.0	Night	0
EG3-22	21.8	-7.4	30.0	25.5	4.5	17.5%	11.7	6.8	4.9	2.7	87.6	1008.6	Night	0
EG3-23	8.9	-7.1	52.5	46.2	6.3	13.7%	10.7	5.8	-1.0	3.7	87.9	1006.3	Night	0
EG3-24	1.8	-3.7	152.0	131.5	20.5	15.6%	6.1	5.4	-1.6	0.7	88.5	1010.1	Night	0
EG3-25	34.4	-1.8	14.0	18.9	-4.9	-26.1%	9.8	7.7	-8.7	2.0	90.8	1015.1	Day	1
EG3-26	56.0	-1.7	12.7	13.7	-1.1	-7.9%	11.5	6.9	1.7	7.1	94.5	1014.0	Day	1
EG3-27	20.8	-1.3	29.7	26.3	3.4	13.1%	11.6	6.7	12.7	6.7	95.4	1011.7	Day	1

EG Type III Analysis (cont'd)

Test #	Average Test Rate (g/dm²/h)	Average Test Temperature (°C)	Measured Endurance Time (min)	Regression Expected Endurance Time (min)	Measured vs. Regression-Expected (min)	ET Variance	Average Wind Speed (km/h)	Average Particle Size (Parsivel Bin)	Final Rate vs. Average Rate	Rate Standard Deviation	Average RH (%)	Average Barometric Pressure (hPa)	Day/Night	Day/Night Binary
EG3-28	6.2	-3.7	50.5	58.0	-7.5	-12.9%	14.7	5.9	-1.5	0.6	88.2	1002.3	Day	1
EG3-29	3.3	-8.1	73.0	88.8	-15.8	-17.8%	-	-	1.1	0.8	-	-	Day	1
EG3-30	9.8	-1.6	36.3	43.1	-6.8	-15.9%	11.2	8.1	-0.5	0.6	90.3	1010.0	Night	0
EG3-31	12.2	-1.8	29.0	37.5	-8.5	-22.6%	6.2	8.4	-1.2	2.8	92.8	1010.0	Day	1
EG3-32	11.4	-15.1	37.0	39.1	-2.1	-5.4%	15.3	6.8	1.5	1.2	75.3	1012.1	Day	1
EG3-33	26.2	-15.1	18.6	22.6	-4.1	-18.0%	12.8	7.0	7.6	2.6	78.3	1010.6	Night	0
EG3-34	34.2	-15.0	14.8	19.0	-4.3	-22.5%	12.6	6.9	-10.0	7.4	80.9	1007.0	Night	0
EG3-35	6.3	-14.8	55.7	57.9	-2.2	-3.9%	10.8	7.2	1.7	1.9	81.1	1002.8	Night	0
EG3-36	1.2	-8.0	202.5	167.5	35.0	20.9%	7.2	7.3	0.3	1.4	80.1	1007.7	Day	1
EG3-37	4.7	-8.2	57.0	69.5	-12.5	-18.0%	8.5	5.9	1.6	1.3	82.6	1003.1	Day	1
EG3-38	13.4	-5.4	27.0	35.1	-8.1	-23.1%	12.8	5.3	10.7	6.4	88.7	990.6	Day	1
EG3-39	15.9	-5.5	24.2	31.5	-7.3	-23.2%	11.3	5.9	5.1	3.5	89.3	988.1	Day	1
EG3-40	14.2	-5.6	26.3	33.9	-7.6	-22.3%	12.8	6.6	-0.6	1.4	89.9	984.0	Day	1
EG3-41	28.5	-6.0	19.4	21.4	-2.0	-9.3%	27.2	6.8	1.9	2.1	89.5	982.2	Day	1
EG3-42	23.5	-7.8	20.9	24.3	-3.3	-13.7%	20.9	7.5	-0.4	1.6	87.7	985.8	Day	1
EG3-43	4.1	-10.4	70.3	76.7	-6.4	-8.4%	9.3	7.4	4.9	2.5	81.3	1019.5	Night	0
EG3-44	12.6	-9.9	31.0	36.6	-5.6	-15.2%	10.5	8.7	0.7	1.6	84.7	1017.0	Night	0
EG3-45	16.5	-9.6	27.0	30.7	-3.7	-12.1%	11.0	9.6	-1.5	3.6	85.7	1014.3	Night	0
EG3-46	22.3	-12.1	24.0	25.1	-1.1	-4.5%	4.8	8.4	-2.3	2.4	75.6	1022.0	Day	1
EG3-47	22.0	-8.7	20.0	25.4	-5.4	-21.2%	5.8	8.6	5.9	5.3	82.9	1020.0	Day	1
EG3-48	2.5	-2.9	152.2	105.4	46.8	44.4%	13.2	4.9	2.2	2.2	85.4	1012.3	Day	1
EG3-49	3.7	-0.3	87.5	81.9	5.6	6.9%	9.5	7.1	1.4	2.1	84.4	1010.6	Night	0
EG3-50	48.3	0.6	11.8	15.1	-3.4	-22.4%	5.8	12.0	1.3	2.3	91.3	987.0	Day	1
EG3-51	11.8	-1.4	33.8	38.3	-4.6	-11.9%	16.8	6.5	2.1	2.1	93.5	986.9	Day	1
EG3-52	8.5	-4.5	40.4	47.3	-6.9	-14.5%	17.8	-	0.5	1.3	90.6	990.0	Day	1

PG Type IV Analysis

Test #	Average Test Rate (g/dm²/h)	Average Test Temperature (°C)	Measured Endurance Time (min)	Regression Expected Endurance Time (min)	Measured vs. Regression-Expected (min)	ET Variance	Average Wind Speed (km/h)	Average Particle Size (Parsivel Bin)	Final Rate vs. Average Rate	Rate Standard Deviation	Average RH (%)	Average Barometric Pressure (hPa)	Day/Night	Day/Night Binary
PG4-3	6.5	-11.8	76.0	79.5	-3.5	-4.4%	11.7	7.1	2.0	1.5	80.9	1014.5	Day	1
PG4-4	3.0	-9.6	206.0	167.9	38.1	22.7%	11.4	6.8	5.7	1.5	81.5	1012.4	Day	1
PG4-5	27.2	-8.6	26.0	28.6	-2.6	-9.0%	11.4	9.1	-0.9	1.6	85.0	1009.3	Day	1
PG4-6	5.0	-10.5	75.0	103.8	-28.8	-27.8%	14.5	9.2	2.2	1.6	82.8	1006.6	Day	1
PG4-7	10.7	-10.8	44.0	55.3	-11.3	-20.4%	13.1	9.0	2.2	1.1	82.9	1006.1	Night	0
PG4-8	11.7	-10.7	43.0	51.6	-8.6	-16.6%	10.4	8.5	-1.6	1.8	83.6	1006.0	Night	0
PG4-9	12.1	-9.8	45.0	52.2	-7.2	-13.8%	11.1	9.3	-1.4	1.6	84.7	1005.0	Night	0
PG4-10	4.6	-9.0	131.2	120.4	10.7	8.9%	14.3	6.7	3.5	1.7	80.1	1012.2	Day	1
PG4-11	9.2	-8.0	82.3	72.1	10.2	14.2%	13.2	6.4	1.0	1.5	82.7	1009.7	Day	1
PG4-12	16.2	-11.8	35.5	37.5	-2.0	-5.2%	16.3	7.0	-4.6	2.2	77.3	1019.0	Day	1
PG4-13	16.9	-10.0	50.0	39.4	10.6	26.8%	18.4	6.8	2.4	2.9	82.8	1015.0	Night	0
PG4-14	23.5	-8.2	42.5	33.0	9.5	28.8%	14.6	6.6	1.9	2.2	86.4	1011.3	Night	0
PG4-15	32.0	-6.5	37.0	28.4	8.6	30.1%	15.1	7.0	1.4	4.6	88.8	1008.6	Night	0
PG4-16	32.6	-7.1	24.5	26.9	-2.4	-8.9%	14.9	6.3	8.0	6.0	88.6	1006.6	Night	0
PG4-17	51.4	-7.3	26.1	18.3	7.8	42.9%	19.2	7.0	-19.1	8.6	88.8	1004.0	Night	0
PG4-18	60.9	-7.3	18.0	15.9	2.1	13.1%	15.8	6.9	-6.5	3.8	89.0	1002.0	Night	0
PG4-19	32.9	-7.0	30.3	26.9	3.4	12.5%	15.1	7.6	3.1	3.7	89.5	999.6	Night	0
PG4-20	20.2	-5.9	44.0	43.3	0.7	1.7%	6.3	6.6	3.8	5.5	85.2	1011.7	Night	0
PG4-21	48.0	-6.8	18.0	20.0	-2.0	-10.0%	7.7	8.3	-21.0	5.7	87.7	1011.0	Night	0
PG4-22	22.7	-7.4	36.0	35.7	0.3	0.8%	11.6	5.7	31.6	6.0	87.6	1008.5	Night	0
PG4-23	8.8	-7.1	114.7	79.2	35.4	44.7%	10.4	5.9	-1.4	2.7	87.8	1005.7	Night	0
PG4-24	36.5	-1.8	31.0	40.8	-9.8	-23.9%	10.0	7.3	1.1	5.1	91.8	1015.1	Day	1
PG4-25	50.4	-1.7	30.5	31.8	-1.3	-4.0%	12.1	6.7	-15.4	11.0	94.7	1013.5	Day	1
PG4-26	31.8	-1.3	51.8	50.0	1.8	3.5%	11.1	7.2	10.1	14.3	95.6	1011.4	Day	1
PG4-27	5.1	-7.9	151.6	116.9	34.7	29.7%	-	-	2.1	2.2	-	-	Day	1

PG Type IV Analysis (cont'd)

Test #	Average Test Rate (g/dm²/h)	Average Test Temperature (°C)	Measured Endurance Time (min)	Regression Expected Endurance Time (min)	Measured vs. Regression-Expected (min)	ET Variance	Average Wind Speed (km/h)	Average Particle Size (Parsivel Bin)	Final Rate vs. Average Rate	Rate Standard Deviation	Average RH (%)	Average Barometric Pressure (hPa)	Day/Night	Day/Night Binary
PG4-28	8.3	-1.6	124.1	140.9	-16.8	-11.9%	7.9	8.0	-1.5	1.6	91.7	1009.7	Night	0
PG4-29	7.3	-1.9	138.8	149.7	-10.8	-7.2%	9.7	7.7	-2.2	4.3	93.1	1009.3	Day	1
PG4-30	11.4	-15.1	38.0	44.1	-6.1	-13.9%	15.3	6.8	1.4	1.2	75.4	1012.1	Day	1
PG4-31	25.9	-15.1	16.7	22.5	-5.7	-25.5%	13.0	7.1	0.6	1.9	78.2	1010.6	Night	0
PG4-32	36.0	-15.0	12.5	17.2	-4.7	-27.2%	12.5	7.0	-11.9	6.5	80.9	1007.0	Night	0
PG4-33	6.2	-14.8	53.1	73.8	-20.7	-28.1%	10.8	7.2	1.8	1.9	81.1	1002.8	Night	0
PG4-34	2.3	-8.2	310.0	223.7	86.3	38.6%	8.0	6.1	0.5	2.3	80.9	1006.8	Day	1
PG4-35	20.5	-5.4	46.5	44.4	2.0	4.5%	13.3	5.8	4.3	10.4	89.1	990.3	Day	1
PG4-36	19.2	-5.6	52.5	46.3	6.2	13.4%	11.3	6.1	7.1	4.2	89.5	988.1	Day	1
PG4-37	19.1	-5.7	59.0	45.9	13.1	28.5%	13.8	6.8	9.4	5.1	89.8	983.6	Day	1
PG4-38	34.6	-6.0	44.5	27.6	16.9	61.1%	27.7	6.7	6.6	7.2	89.4	982.0	Day	1
PG4-39	19.7	-7.8	51.2	38.9	12.2	31.4%	20.3	7.7	-9.4	5.0	87.7	986.3	Day	1
PG4-40	4.8	-10.4	76.8	108.5	-31.7	-29.2%	8.9	7.8	8.3	3.5	81.4	1019.4	Night	0
PG4-41	12.8	-9.9	42.0	49.7	-7.7	-15.4%	10.4	8.8	0.4	1.4	84.9	1016.7	Night	0
PG4-42	16.6	-9.6	30.1	40.7	-10.6	-26.0%	11.0	9.5	2.9	3.5	85.7	1014.3	Night	0
PG4-43	22.0	-12.0	28.5	29.0	-0.5	-1.8%	4.9	8.4	-2.0	2.3	76.1	1022.0	Day	1
PG4-44	24.4	-8.7	32.0	31.1	0.9	2.8%	6.3	8.5	5.7	5.3	83.1	1020.0	Day	1
PG4-45	8.3	-0.3	155.0	183.0	-28.0	-15.3%	9.6	7.0	1.0	6.5	86.0	1010.1	Night	0
PG4-46	49.9	0.5	38.5	53.2	-14.7	-27.6%	4.9	10.8	-4.7	3.5	91.6	986.4	Day	1
PG4-47	10.8	-2.0	110.0	107.4	2.6	2.5%	17.4	7.0	2.2	2.5	92.6	987.0	Day	1
PG4-48	5.5	-4.5	170.0	140.6	29.4	20.9%	19.2	-	15.4	5.3	86.7	990.7	Night	0

APPENDIX H

POINT-TO-POINT ANALYSIS — MATHEMATICAL PROOF

NS Characterization Information

Mathematical Proof Illustrating the Surface Area Available for Absorption between Two Different Particle Sizes

General Concept:

Assuming the geometry of a Snowflake is a Sphere:

$$\frac{Surface\ Area}{Volume} = \frac{4\pi R^2}{\frac{4}{3}\pi r^3} = \frac{3}{r}$$

Where, $R = Radius\ of\ Large\ Particle$ & $r = Radius\ of\ Small\ Particle$.

Thus, the Surface Area to Volume Ratio is inversely proportional to the Radius i.e., increasing the particle size decreases the surface Area to volume ratio.

Example of the Above Concept

Volume:

Assuming 1 large snowflake particle is broken down to 1,000 smaller snowflake particles with conservation of volume:

$$V = 1{,}000\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$$

Where, $R = Radius\ of\ Large\ Particle$ & $r = Radius\ of\ Small\ Particle$; thus, $r = \frac{R}{10}$.

Surface Area:

Total Surface Area of 1 Large Particle:

$$Total\ Surface\ Area_{\ Large\ Particle} = 4\pi R^2$$

Total Area of 1,000 Small Particles:

$$Total\ Surface\ Area\ _{1{,}000\ small\ Particles} = 1{,}000\ (4\pi r^2)$$

Solving:

$$\frac{Total\ Surface\ Area\ _{1{,}000\ small\ Particles}}{Total\ Surface\ Area\ _{Large\ Particle}} = \frac{1{,}000\ (4\pi r^2)}{4\pi R^2}$$

$$\frac{Total\ Surface\ Area\ _{1{,}000\ small\ Particles}}{Total\ Surface\ Area\ _{Large\ Particle}} = 1{,}000\left(\frac{r^2}{R^2}\right)$$

Knowing that $r = \frac{R}{10}$ as stated above, substitute and simplify:

$$\frac{Total\ Surface\ Area\ _{1{,}000\ Small\ Particles}}{Total\ Surface\ Area\ _{Large\ Particle}} = 1{,}000\left(\frac{\left(\frac{R}{10}\right)^2}{R^2}\right) = 10$$

Therefore, if a large snowflake particle is broken up into 1,000 pieces, the surface area for absorption into the fluid increases 10 fold.

Proof that the overall surface area of breaking up a large particle into many smaller pieces increases if keeping the volume constant.

APPENDIX I

DETAILED POINT-TO-POINT COMPARISON METHODOLOGY

1. DETAILED POINT-TO-POINT COMPARISON METHODOLOGY

The following point-to-point comparison examples are included in this appendix to demonstrate the analytical methodology used and to clarify/provide additional context to Subsection 4.4 of the report.

1.1 Classification of Variables

To effectively describe which variables/parameters may directly influence the HOT of a fluid, the list depicted in Table 1.1 was split into two categories. The first is described as the **independent variables** which can be “manipulated.” For example, if HOT tests are being conducted at the APS test facility, the *rate* may change from one test to another. The rate, in this case, would be considered the manipulated or independent variable. The second category, the **dependent variables**, are affected by a change in the independent variable. In other words, by manipulating the independent variable, a change in the dependent variable can be “measured.” Taking the above example, if the rate is manipulated or varies from one event to another, the measured endurance time (ET) will be affected and thus result in a different value.

Table 1.1: List of Variables Obtained for Each Test Run

Variable
Date
OAT (°C)
Average Rate (g/dm^2/hr)
Fail Time (min)
Brix @ fail (°)
Average Wind Speed (km/hr)
Wind Direction (°)
Average Snowflake Size (Bin)
Thickness @ 5 min (mm)
Thickness @ Mid Test (mm)
Thickness @ fail (mm)
Rate last 15 min (g/dm^2/hr)
Failure Call By
Day/Night
Amount of Precipitation on Bare Plate at End of Test (mm)
Average Humidity (%)
Average Pressure (hPa)

In a particular test comparison, not all independent variables need to be considered. In fact, only the independent variables, which are determined to be significant were evaluated. Significance was thus characterized by contrasting the pair of data points to be compared. Generally, if the independent variable contrasted had a significant difference, the variable was considered in the final analysis. If no differences were observed, then the variable was not considered. The same approach was taken when considering only the dependent variables.

The general trend of a variable during a test can also be of interest when comparing data points. This information is obtained from the data packs and is included in the analysis if deemed to be significant.

A thermal analysis was also conducted to determine the effects of thermal energy, or more specifically, temperature differences on the *system* i.e., the fluid, precipitation, and test plate. Table 1.2 shows the thermal parameters which were measured or calculated.

Table 1.2: List of Thermal Parameters Measured or Calculated

Temperature (°C)
Average OAT - APS
Average OAT - NCAR
Average OAT - NCAR & APS
Average Initial OAT - NCAR & APS
Fluid Temperature @ Start
Fluid Temperature Gradient
Starting Plate Temp
Average Plate Temperature
Plate Temperature Gradient
Plate Temp @ Fail

N.B.: The fluid temperature gradient refers to:

$$T_{\text{Fluid Gradient}} = T_{\text{Fluid, Initial}} - T_{\text{OAT, Initial}}$$

While the plate temperature gradient refers to:

$$T_{\text{Plate Gradient}} = T_{\text{Plate, Average}} - T_{\text{OAT, Average}}$$

In industry, it is commonly known that de/anti-icing fluids increase in viscosity with decreasing temperature. Therefore, it is reasonable to assume that if the fluid temperature gradient is negative (cooler fluid compared to that of OAT), the viscosity of the fluid being poured on the test plate is greater than it should be for that particular test. The opposite is also said to hold true. The effects of a cooler or warmer fluid during HOT testing is discussed below in Subsection 1.2.

The plate temperature gradient was calculated to determine if thermal energy is being transferred from the environment to the system or vice versa, since the transfer of energy may influence the ET of a fluid. The system which includes the aluminum test plate, anti-icing fluid (glycol based) and snow as the main form of precipitation, forms part of the testing process. Specifically, the snow, which is a solid, is converted to the liquid phase when forming part of the glycol-water mixture on the aluminum test plate. This change in phase, from solid to liquid, is an endothermic process. Thermal energy is required for a solid to melt and in this case, the energy is extracted from the glycol-water mixture. Therefore, in a typical HOT test, the plate temperature decreases below that of the OAT. The plate temperature remains below OAT until the mixture reaches saturation and no more solid is converted to liquid. Thus, a negative temperature gradient is expected and indicative that the fluid is performing.

To further justify if key variables should be considered for comparison and to aid in determining general hypotheses for the comparison analysis and/or test in question, some essential statistics were calculated. Table 1.3 refers to these key statistical calculations.

Table 1.3: List of Statistical Variables Calculated

Statistical Variables
APS Average Rate ($g/dm^2/hr$)
APS Rate Standard Deviation ($g/dm^2/hr$)
APS Rate Variance $(g/dm^2/hr)^2$
NCAR Average Wind Speed (km/hr)
NCAR Wind Speed Standard Deviation (km/hr)
NCAR Wind Speed Variance $(km/hr)^2$
Average Snowflake Size (mm)
Difference in Size (%)
Kurtosis
Skewness
Range
OAT (°C)
Plate Temperature Standard Deviation (°C)
Plate Temperature Variance $(°C)^2$

Besides determining the standard statistical values for precipitation rate, wind speed, OAT and plate temperature, which include the averages, standard deviations and variances, the average bin particle size was also determined. In addition, the kurtosis, skewness, and range were calculated from the snowflake distribution plots. The coefficient of kurtosis is a measure for the degree of peakeness/flatness in the variable distribution and is thus negative, zero or positive in value. In other words, it describes the distribution as being "peaked" giving rise to a positive value, "flatness or square" giving rise to a negative value and zero which results in a standard distribution. The coefficient of skewness is a measure of the degree of symmetry in the variable distribution. A positive value means the distribution is skewed to the right, a negative value indicates it is skewed to the left and a value of zero implies a symmetrical distribution. The range in statistics represents the difference between the highest and the lowest value obtained.

The point-to-point analysis was thus conducted in the following order:

1) Determine all **variables** available for comparison;
2) Determine which variables are **independent variables**;
3) Determine which **independent variables** are **significant** when compared;
4) Determine which variables are **dependent variables**;
5) Determine which **dependent variables** are **significant** when compared;
6) Document the **general trend** of all **variables** from the data packs;
7) Determine which **variables** have a **general trend** which need to be **considered** when compared;
8) Perform a **thermal analysis** and contrast;
9) Calculate **statistical** values for key variables and contrast; and
10) Determine a **hypothesis** for what is observed and verify with findings from multi variable analysis (Global Data Set Analysis).

1.2 Example 1 – Pairing # 6 (Test PG2-11 vs. Test PG2-28)

The regression curve for PG Type II in Subsection 4.3 of this report illustrates where the two points to be compared are relative to each other and to the expected HOT for that temperature band and rate.

Using the analytical methodology presented in Subsection 4.4, the relevant variables for each test comprising this pairing are identified and compiled. Table 1.4 depicts these variables for the two tests (PG2-11 vs PG2-28).

Table 1.4: List of Variables for Pairing # 6 Point-to-Point Comparison

Variable	Test PG2-11	Test PG2-28
Date	21-Feb	07-Feb
OAT (°C)	-5.9	-5.8
Average Rate (g/dm^2hr)	20.2	20.1
Fail Time (min)	43	72.5
Brix @ Fail (°)	14	13
Average Wind Speed (km/hr)	15.5	38.1
Wind Direction (°)	Varies between 95 and 72	17
Thickness @ 5 min (mm)	1.2	1.5
Estimated Thickness @ Mid Test (mm)	1.55	1.45
Thickness @ Fail (mm)	1.6	3.3
Average Snowflake Size (Bin)	6.3	6.87
Rate last 15 min	At Average — 21.64	Above Average — 27.19
Failure Call By	Senior Observer	Senior Observer
Day/Night	Night	Day
Amount of Precipitation on Bare Plate at End of Test (mm)	1.25	0
Average Humidity (%)	85	90
Average Pressure (hPa)	1012	983

Independent variables are identified and tracked by adding a check mark (✓) as depicted in Table 1.5. A second check mark is added next to the variable if it is determined to be significant and should be considered as part of the analysis. For Test PG2-11 vs. Test PG2-28, the independent variables are circled in red as shown in Table 1.5.

Table 1.5: Identification of Independent Variables – Test PG2-11 vs. Test PG2-28

Variable	Test PG2-11	Test PG2-28	Independent Variable? (✓)	Significant Independent Variable? (✓or ✗)
Date	21-Feb	07-Feb	✓	–
OAT (°C)	-5.9	-5.8	✓	✗
Average Rate (g/dm^2/hr)	20.2	20.1	✓	✗
Fail Time (min)	43	72.5	–	–
Brix at Fail	14	13	–	–
Average Wind Speed (km/hr)	15.5	38.1	✓	✓
Wind Direction (°)	Varies between 95 and 72	17	✓	✓
Thickness @ 5 min (mm)	1.2	1.5	–	–
Estimated Thickness @ Mid Test (mm)	1.55	1.45	–	–
Thickness @ fail (mm)	1.6	3.3	–	–
Average Snowflake Size (Bin)	6.3	6.87	✓	✗
Rate last 15 min	At Average - 21.64	Above Average - 27.19	✓	✓
Failure Called By	Senior Observer	Senior Observer	✓	✗
Day/Night	Night	Day	✓	✓
Amount of Precipitation on Bare Plate at End of Test (mm)	1.25	0	–	–
Average Humidity (%)	85	90	✓	✗
Average Pressure (hPa)	1012	983	✓	✓

To summarize Table 1.5, the independent variables comprise of:

- Wind Speed;
- Wind Direction;
- Rate Last 15 mins;
- Day or Night Testing; and
- Pressure.

Dependent variables are identified and tracked by adding a check mark (✓) as depicted in Table 1.6. A second check mark is added next to the variable if it is determined to be significant and should be considered as part of the analysis. For Test PG2-11 vs. Test PG2-28, the dependent variables are circled in blue as shown in Table 1.6.

To summarize Table 1.6, the dependent variables comprise of:

- ET (Fail Time);
- Brix at Fail (Glycol Concentration at Fail);
- Fluid Thickness at 5 min;
- Estimated fluid Thickness at Mid-Test;
- Thickness at Failure; and
- Bare Plate Thickness at Fail.

The general trend of each variable obtained from the data packs are summarized in Table 1.7.

Table 1.6: Identification of Dependent Variables - Test PG2-11 vs. Test PG2-28

Variable	Test PG2-11	Test PG2-28	Independent Variable? (✓)	Significant Independent Variable? (✓or ×)	Dependent Variable? (✓)	Significant Dependant Variable? (✓or ×)
Date	21-Feb	07-Feb	✓	–	–	–
OAT (°C)	-5.9	-5.8	✓	×	–	–
Average Rate (g/dm^2/hr)	20.2	20.1	✓	×	–	–
Fail Time (min)	43	72.5	–	–	✓	✓
Brix at Fail	14	13	–	–	✓	✓
Average Wind Speed (km/hr)	15.5	38.1	✓	✓	–	–
Wind Direction (°)	Varies between 95 and 72	17	✓	✓	–	–
Thickness @ 5 min (mm)	1.2	1.5	–	–	✓	✓
Estimated Thickness @ Mid Test (mm)	1.55	1.45	–	–	✓	✓
Thickness @ fail (mm)	1.6	3.3	–	–	✓	✓
Average Snowflake Size (Bin)	6.3	6.87	✓	×	–	–
Rate last 15 min	At Average - 21.64	Above Average - 27.19	✓	✓	–	–
Failure Called By	Senior Observer	Senior Observer	✓	×	–	–
Day/Night	Night	Day	✓	✓	–	–
Amount of Precipitation on Bare Plate at End of Test (mm)	1.25	0	–	–	✓	✓
Average Humidity (%)	85	90	✓	×	–	–
Average Pressure (hPa)	1012	983	✓	✓	–	–

Table 1.7: Identification of Independent and Dependent General Trend Variables — Test PG2-11 vs. Test PG2-28

Variable	Test PG2-11	Test PG2-28	Independent Variable? (✓)	Significant Independent Variable? (✓ or ✘)	Dependent Variable? (✓)	Significant Dependent Variable? (✓ or ✘)		Variable	Test PG2-11 Comments from Data Packs	Test PG2-28 Comments from Data Packs
Date	21-Feb	07-Feb	✓	–	–	–		–	–	–
OAT (°C)	-5.9	-5.8	✓	✘	–	–		OAT	Relatively Constant	Relatively Constant
Average Rate (g/dm²/hr)	20.2	20.1	✓	✘	–	–		Rate	Begins above average, decreasing to below average and finally increases to above average for end of test	Begins below average, increasing to above average for second half of test
Fail Time (min)	43	72.5	–	–	✓	✓		–	–	–
Brix @ fail (°)	14	13	–	–	✓	✓		Brix	Relatively linear decrease	Relatively linear decrease except for end of test remaining constant
Average Wind Speed (km/hr)	15.5	38.1	✓	✓	–	–		Wind Speed	Relatively constant	Relatively constant but slowly increasing for last 30% of test
Wind Direction (°)	Varies between 95 and 72	17	✓	✓	–	–		Wind Direction	Varies, starting at 95 changing to 60, 72 and finally remains constant for rest of test	Constant
Thickness @ 5 min (mm)	1.2	1.5	–	–	✓	✓		–	–	–
Estimated Thickness @ Mid Test (mm)	1.55	1.45	–	–	✓	✓		–	–	–
Thickness @ fail (mm)	1.6	3.3	–	–	✓	✓		Thickness	Relatively linear increase	Relatively constant followed by significant increase at end of test
Average Snowflake Size (Bin)	6.3	6.87	✓	✘	–	–		Snowflake	Slightly lower variance	Slightly greater variance
Rate last 15 min	At Average - 21.64	Above Average - 27.19	✓	✓	–	–		Rate last 15 min	Begins with a below average rate but increases to above giving rise to a similar average test rate and last 15 min rate	Above average
Failure Call By	Senior Observer	Senior Observer	✓	✘	–	–		–	–	–
Day/Night	Night	Day	✓	✓	–	–		–	–	–
Accumulation of Precipitation on Bare Plate at End of Test (mm)	1.25	0	–	–	✓	✓		–	–	–
Average Humidity (%)	85	90	✓	✘	–	–		Humidity	Slowly increasing by 2% throughout test	Constant
Average Pressure (hPa)	1012	983	✓	✓	–	–		Pressure	Relatively constant	Relatively constant but slowly dropping throughout test

If the general trend of the variable in question is significantly different when contrasted, it is included in the analysis. In this example, the following are the independent variables which have differences in trends (circled in red in Table 1.7):

- Rate;
- Wind Speed; and
- Rate Last 15 min.

The dependent variable with differences in trend is (circled in blue in Table 1.7):

- Fluid Thickness.

The thermal analysis (illustrated in Table 1.8 with dependent variables circled in blue) indicates that the plate temperature gradient for Test PG2-11 is 2.7 °C below that of the OAT compared to 0.8 °C for Test PG2-28. This suggests one of two possibilities. The first is that Test PG2-11 is converting more snow (solid) into water (liquid - forming part of the glycol-water mixture) than Test PG2-28. The second is the higher wind speed and daytime testing during Test PG2-28 supplies a greater amount of thermal energy to the system by convective heat transfer and thermal radiation, respectively. Of the two possible scenarios, the latter is the only credible case to consider. The former would require the systems to be physically different, for example, different plate sizes, different amounts of fluid used etc., which was not the case as all tests were conducted using the same methodology. Hence, the thermal analysis strongly suggests that wind speed and daytime testing are key factors to consider for the difference in ETs.

Statistical values and significant coefficients were calculated for both tests and are illustrated in Table 1.9. The key factor to consider is the difference in the average wind speed using both the APS data (obtained form Environment Canada) and NCAR weather sensor positioned near the test stand (circled in red). This further supports the thermal analysis conducted above.

To determine the variables affecting the outcome of this test, all variables must be accounted for. In other words, an independent variable usually affects a depended variable where appropriate. The thermal analysis and calculated statistics also serve part of the overall findings of this comparison.

Table 1.8: Thermal Analysis — Test PG2-11 vs. Test PG2-28

Temperature (°C)	Test PG2- 11	Test PG2-28	Variable	Test PG2-11 Comments from the Data Pack	Test PG2-28 Comments from the Data Pack
Average OAT - APS	-5.9	-5.8	**OAT - APS**	Constant	Constant
Average OAT - NCAR	-5.1	-5.0	**OAT - NCAR**	Relatively Constant	Relatively Constant
Average OAT - NCAR & APS	-5.5	-5.4	–	–	–
Average Initial OAT - NCAR & APS	-5.4	-5.3	–	–	–
Fluid Temperature @ Start	-5.2	-5	–	–	–
Fluid Temperature Gradient	0.1	0.3	–	–	–
Starting Plate Temp	-5.5	-5	–	–	–
Average Plate Temperature	-8.1	-6.2	**Plate Temperature**	Typical profile but significantly below OAT	Typical profile just under OAT
Average Plate Temperature Gradient	-2.7	-0.8	–	–	–
Plate Temp @ Fail	-8	-6	–	–	–
Final Analysis	Plate temperature gradient is below that of OAT	Plate temperature gradient is approx. at OAT			
Conclusion	Test PG2-28 plate temperature gradient indicates an added source of energy to the system. Possibly by convection and thermal radiation				

Table 1.9: Statistical Values and Coefficients — Test PG2-11 vs. Test PG2-28

Variable	Test PG2-11	Test PG2-28
APS Average Rate (g/dm^2/hr)	20.4	20.1
APS Rate Standard Deviation (g/dm^2/hr)	5.5	5.7
APS Rate Variance (g/dm^2/hr)^2	29.9	32.2
APS Average Wind Speed (km/hr)	15.5	38.1
NCAR Average Wind Speed (km/hr)	6.3	14.9
NCAR Wind Speed Standard Deviation (km/hr)	0.7	2.7
NCAR Wind Speed Variance (km/hr)^2	0.5	7.4
Average Snowflake Size (mm)	0.766	0.795
Difference in Size (%)	-3.8	3.8
Kurtosis	1.6	0.2
Skewness	1.6	1.2
Range	15979	31929
Average OAT - NCAR & APS	-5	-5
Plate Temperature Standard Deviation (°C)	0.6	0.4
Plate Temperature Variance (°C)^2	0.4	0.1

1.2.1 Impacts of Independent Variables on Dependent Variables

The following subsection explains the effect of each independent variable on the dependent variable(s) for Test PG2-11 vs. PG2-28.

1.2.1.1 Effect of Wind Direction on ET

The wind direction for this example and all tests conducted, did not influence the measured ETs due to the way tests are run. The procedure is to position the test stand into the wind during testing. If the wind direction happened to change during a test, the test stand was repositioned to account for the change. Therefore, the wind direction does not have an effect of a fluids ET.

1.2.1.2 Effect of Pressure on ET

The atmospheric pressure for the tests conducted in this example and all other tests performed, did not influence the measured ETs. A drop in atmospheric pressure is indicative of an arriving form of precipitation. The drop mainly occurs due to changes in temperature and humidity. Hence, the atmospheric pressure does not have an effect of a fluids ET.

1.2.1.3 Effect of Rate Last 15 min on Thickness at Failure

The rate during the last 15 min for test PG2-28 increased significantly to affect the thickness at failure. This is also observed in the general trend of the variable. As the glycol concentration decreases on the plate, snow begins to accumulate. This ultimately increases the thickness measurements and is observed in Test PG2-28 to have a value of 3.3 mm compared to 1.6 mm for Test PG2-11.

1.2.1.4 Effect of Day/Night Testing on the Plate Temperature Gradient

ET testing conducted during the day may provide thermal energy to the fluid being tested. For this comparison, Test PG2-28 was conducted during the day while Test PG2-11 was performed at night. Thus, it is probable that thermal energy from the atmosphere slightly heated the plate temperature of Test PG2-28 to obtain a smaller plate temperature gradient compared to Test PG2-11. This in turn may influence the ET of Test PG2-28 by extending its performance.

1.2.1.5 Effect of Wind Speed on Fluid Thickness at 5 min, Estimated Fluid Thickness at Mid-Test, Bare Plate Thickness at Fail, Brix at Fail and ET

The wind speed can affect the outcome of a test by the two-pronged manner as previously discussed in the report. The higher average wind speed and higher minute maximum wind speed for Test PG2-28 may have affected the fluid thickness at 5 minutes by preventing some fluid runoff. The recorded wind speeds for this comparison may possibly support this hypothesis. Test PG2-28 had an average wind speed and minute maximum wind speed of 14.9 and 33 km/hr respectively, while Test PG2-11 was 6.3 and 16 km/hr, respectively.

The estimated thickness at mid test of Test PG2-28 was similar to Test PG2-11. This may be due errors associated with thickness measurements during testing since the overall fluid thickness trend for Test PG2-28 is increasing and not decreasing.

The amount of precipitation on the bare plate may also be affected by wind speed. If wind speeds are relatively low as is the case for Test PG2-11, accumulation may be seen on the bare plate. If the wind speeds are relatively high however, no accumulation is usually present. Another factor which may affect the accumulation of snow on a bare plate is the water content (wet snow). The added water may aid in “sticking” compared to its dry counterpart.

The ET of Test PG2-28 is primarily extended due to convective heat transfer and viscous drag from the air to the fluid. As the plate temperature decreases due to a phase change (solid snow particle to liquid water-glycol mixture), the warmer air transfers some thermal energy to the fluid. This essentially keeps the plate temperature just slightly below OAT by -0.8 °C for Test PG2-28 compared to -2.7°C for PG2-11. This smaller temperature gradient aids in extending the ET of the fluid. By consequence, the final brix/concentration is lower compared to Test PG2-11.

1.2.2 Additional Information from Data Packs

The following subsection documents a key independent variable to be considered in the final analysis when its general trend is taken into account and contrasted.

1.2.2.1 Effect of Rate on ET

When the rates of precipitation of Test PG2-28 and Test PG2-11 are contrasted, the different trends observed may have an impact on the final ETs. Test PG2-28, with an average rate of 20 g/dm^2 hr, started below average and stayed below average for the first 39 minutes of the test run. The average rate during the first 39 minutes, however, was approximately 15 g/dm^2 hr. The ET of Test PG2-11 is 43 minutes with an average rate of 20 g/dm^2 hr. Thus, Test PG2-11 reaches its ET while Test PG2-28 is approximately midway before finally reaching failure. Hence, the rate difference of 5 g/dm^2 hr for the first 39 minutes of this comparison may contribute to the extended ET of Test PG2-28.

1.2.3 Summary of Pertinent Variables and Hypothesis to Consider for Example 1 — Test PG2-11 vs. PG2-28

Overall, the key variables to consider for the ET extension of Test PG2-28 are the higher wind speed, thermal radiation from daytime testing and possibly the rate variance. The combined effects of thermal radiation and convective heat transfer supplies the system with energy which effectively keeps the fluid at a warmer temperature and closer to OAT compared to that of Test PG2-11. In addition, the higher wind speeds experienced by Test PG2-28 may also extend the ET by preventing fluid runoff. By doing so, more precipitation would be required to achieve fluid failure. Finally, the rate variance may also contribute to Test PG2-28 extended ET by maintaining a lower average rate for the first half of the test compared to that of Test PG2-11. All key variables namely, wind speed, daytime testing, and rate variance when combined, aid in extending the ET of Test PG2-28.

1.3 Example 2 – Pairing #23 (Test PG4-6 vs. Test PG4-10)

Using the analytical methodology presented in Section 4.4, the relevant variables for each test comprising this pairing are identified and compiled. Table 4.4 depicts these variables for the two tests (PG4-6 vs. PG4-10).

Table 1.10: List of Variables for Pairing #23 Point to Point Comparison

Variable	Test PG4-6	Test PG4-10
Date	29-Jan	02-Feb
OAT (°C)	-10.5	-9
Average Rate (g/dm^2/hr)	5	4.6
Fail Time (min)	75	131.2
Brix @ fail (°)	19.5	14
Average Wind Speed (km/hr)	19	26
Wind Direction (°)	Consistent between 28 to 34	Consistent between 230 to 250
Average Snowflake Size (Bin)	9.19	6.68
Thickness @ 5 min (mm)	0.7	1
Thickness @ Mid Test (mm)	1	1.1
Thickness @ fail (mm)	1	1.1
Rate last 15 min	Above Average – 6.91	Above Average – 7.54
Failure Call By	Senior Observer	Senior Observer
Day/ Night	Night	Day
Accumulation of Precipitation on bare plate at end of test (mm)	0	0
Average Humidity (%)	83	80
Average Pressure (hPa)	1007	1012

Independent variables are identified and tracked by adding a check mark (✓) as depicted in Table 1.11. A second check mark is added next to the variable if it is determined to be significant and should be considered as part of the analysis. For Test PG4-6 vs. Test PG4-10, the independent variables are circled in red as depicted in Table 1.11.

To summarize Table 1.11, the independent variables comprise of:

- Snowflake Size and;
- Day or Night Testing.

Dependent variables are identified and tracked by adding a check mark (✓) as depicted in Table 1.12. A second check mark is added next to the variable if it is determined to be significant and should be considered as part of the analysis. For Test PG4-6 vs. Test PG4-10, the dependent variables are circled in blue as shown in Table 1.12.

Table 1.11: Identification of Independent Variables – Test PG4-6 vs. Test PG4-10

Variable	Test PG4-6	Test PG4-10	Independent Variable? (✓)	Significant Independent Variable? (✓or ✘)
Date	29-Jan	02-Feb	✓	–
OAT (°C)	-10	-9	✓	✘
Average Rate (g/dm²/hr)	5	4.6	✓	✘
Fail Time (min)	75	131.2	–	–
Brix @ fail (°)	19.5	14	–	–
Average Wind Speed (km/hr)	19	26	✓	✘
Wind Direction (°)	Consistent between 28 to 34	Consistent between 230 to 250	✓	✘
Average Snowflake Size (Bin)	9.19	6.68	✓	✓
Thickness @ 5 min (mm)	0.7	1	–	–
Thickness @ Mid Test (mm)	1	1.1	–	–
Thickness @ fail (mm)	1	1.1	–	–
Rate last 15 min	Above Average - 6.91	Above Average - 7.54	✓	✘
Failure Call By	Senior Observer	Senior Observer	✓	✘
Day/Night	Night	Day	✓	✓
Accumulation of snow on bare plate at end of test at failure (mm)	0	0	–	–
Average Humidity (%)	83	80	✓	✘
Average Pressure (hPa)	1007	1012	✓	✘

Table 1.12: Identification of Dependent Variables – Test PG4-6 vs. PG4-10

Variable	Test PG4-6	Test PG4-10	Independent Variable? (✓)	Significant Independent Variable? (✓or ✗)	Dependent Variable? (✓)	Significant Dependent Variable? (✓or ✗)
Date	29-Jan	02-Feb	✓	–	–	–
OAT (°C)	-10	-9	✓	✗	–	–
Average Rate (g/dm^2/hr)	5	4.6	✓	✗	–	–
Fail Time (min)	75	131.2	–	–	✓	✓
Brix @ fail (°)	19.5	14	–	–	✓	✓
Average Wind Speed (km/hr)	19	26	✓	✗	–	–
Wind Direction (°)	Consistent between 28 to 34	Consistent between 230 to 250	✓	✗	–	–
Average Snowflake Size (Bin)	9.19	6.68	✓	✓	–	–
Thickness @ 5 min (mm)	0.7	1	–	–	✓	✓
Thickness @ Mid Test (mm)	1	1.1	–	–	✓	✗
Thickness @ fail (mm)	1	1.1	–	–	✓	✗
Rate last 15 min	Above Average - 6.91	Above Average - 7.54	✓	✗	–	–
Failure Call By	Senior Observer	Senior Observer	✓	✗	–	–
Day/ Night	Night	Day	✓	✓	–	–
Accumulation of Precipitation on Bare Plate at End of Test (mm)	0	0	–	–	✓	✗
Average Humidity (%)	83	80	✓	✗	–	–
Average Pressure (hPa)	1007	1012	✓	✗	–	–

To summarize Table 1.12, the dependent variables comprise of:

- ET (Fail Time);
- Brix at Fail (Glycol Concentration at Fail) and;
- Fluid Thickness at 5 minutes.

The general trend of each variable obtained from the data packs are summarized in Table 1.13.

Table 1.13: Identification of Independent and Dependent General Trend Variables – Test PG4-6 vs. Test PG4-10

Variable	Test PG4-6	Test PG4-10	Independent Variable? (✓)	Significant Independent Variable? (✓ or ✖)	Dependent Variable? (✓)	Significant Dependent Variable? (✓ or ✖)	Variable	Test PG4-6 Comments from Data Pack	Test PG4-10 Comments from Data Packs
Date	29-Jan	02-Feb	✓	–	–	–	–	–	–
OAT (°C)	-10	-9	✓	✖	–	–	**OAT**	Relatively constant, slightly cooling throughout test	Slightly warming throughout test
Average Rate (g/dm²/hr)	5	4.6	✓	✖	–	–	**Rate**	Begins at a higher rate but subsequently decreases to below average until finally increasing for final portion of test	Begins below average until finally increasing for the last 40 min of the test
Fail Time (min)	75	131.2	–	–	✓	✓	–	–	–
Brix @ fail (°)	19.5	14	–	–	✓	✓	**Brix**	Linear decrease. Similar slope	Linear decrease. Similar slope
Average Wind Speed (km/hr)	19	26	✓	✖	–	–	**Wind Speed**	Constant	Varies. Initially slightly higher until dropping off
Wind Direction (°)	Consistent between 28 to 34	Consistent between 230 to 250	✓	✖	–	–	**Wind Direction**	Constant	Constant
Average Snowflake Size (Bin)	9.19	6.68	✓	✓	–	–	**Snowflake**	Smaller variance	Greater variance
Thickness @ 5 min (mm)	0.7	1	–	–	✓	✓	**Thickness**	Relatively constant	Fairly constant. Very slow increase
Thickness @ Mid Test (mm)	1	1.1	–	–	✓	✖	–	–	–
Thickness @ fail (mm)	1	1.1	–	–	✓	✖	–	–	–
Rate last 15 min	Above Average - 6.91	Above Average - 7.54	✓	✖	–	–	**Rate last 15 min**	Increasing	Increasing
Failure Call By	Senior Observer	Senior Observer	✓	✖	–	–	–	–	–
Day/ Night	Night	Day	✓	✓	–	–	–	–	–
Accumulation of Precipitation on Bare Plate at End of Test (mm)	0	0	–	–	✓	✖	–	–	–
Average Humidity (%)	83	80	✓	✖	–	–	**Humidity**	Fairly constant. Slow increase from 82 to 84%	Slow increase from 77 to 82%
Average Pressure (hPa)	1007	1012	✓	✖	–	–	**Pressure**	Relatively constant	Relatively constant

If the general trend of the variable in question is significantly different when contrasted, it is included in the analysis. In this example, the following are the independent variables which have differences in trends (circled in red in Table 1.13):

- OAT;
- Rate;
- Wind Speed and;
- Snowflake Distribution/Variance.

The dependent variable with differences in trend is (circled in blue in Table 1.13):

- Fluid Thickness.

The thermal analysis, as illustrated in Table 1.14 with independent and dependent variables circled in red and blue, respectively, indicates that the plate temperature gradient for Test PG4-6 is NA however, Test PG4-10 is 1.4 °C above that of the OAT. This suggests that the thermal radiation from daytime testing is causing the plate temperature to remain above that of the OAT. It is important to note that although the average wind speed is the same for both runs, the minute maximum wind speed is higher for most of Test PG4-10 than Test PG4-6. Furthermore, the average wind speed for Test PG4-10 was greater than the average wind speed of Test PG4-6 for 52 minutes of the 131-minute duration. This represents 40 percent of Test PG4-10. Thus, it is possible, although minor, that thermal energy was added to the system by convective heat transfer and resulted in an increase in plate temperature. In addition, the higher wind speed during Test PG4-10 may have contributed to the greater fluid thickness on the plate during testing resulting in the extension of Test PG4-10's ET. Hence, the thermal analysis suggests that thermal radiation and to a minor extent, convective heat transfer, are factors to consider for the difference in ET.

The initial fluid temperature gradient was calculated to be -2.9 °C for Test PG4-10 compared to 0.8 °C for Test PG4-6. This indicates that the fluid temperature for Test PG4-10 was substantially cooler than Test PG4-6 and may result in a thicker fluid layer due to the greater viscosity. Progression thickness data for both runs may support the hypothesis that pouring a thicker fluid can result in a thicker fluid layer during testing.

Table 1.14: Thermal Analysis – Test PG4-6 vs. Test PG4-10

Temperature (°C)	Test PG4-6	Test PG4-10	Variable	Test PG4-6 Comments from Data Pack	Test PG4-10 Comments from Data Pack
Average OAT - APS	-10	-9	**OAT - APS**	Constant	Constant
Average OAT - NCAR	-9.4	-7.9	**OAT - NCAR**	Relatively constant, slightly cooling throughout test	Slightly warming throughout test
Average OAT - APS & NCAR	-9.7	-8.5	–	–	–
Average Initial OAT - APS & NCAR	-9.8	-8.8	–	–	–
Temperature (Fluid) @ Start	-9	-11.7	–	–	–
Fluid Temperature Gradient	0.8	-2.9	–	–	–
Starting Temp (Plate)	NA	-8	–	–	–
Average Plate Temperature	NA	-7.1	**Plate Temperature**	NA	Fairly Constant, slowly warming. Temperature above OAT
Plate Temperature Gradient	NA	1.4	–	–	–
Plate Temp @ Fail	NA	-6.5	–	–	–
Final Analysis	–	Greater cooler fluid temperature gradient than Test PG4-6. Plate is warming through test			
Conclusion	Although the plate seems to be warming for Test PG4-10, this is probably due to thermal radiation, slightly warming OAT and possibly wind effects				

Statistical values and significant coefficients were calculated for both tests and are displayed in Table 1.15. The key factor to consider is the coefficient of kurtosis for this comparison. The coefficient was -1.2 for Test PG4-6 and +0.9 for Test PG4-10. The negative coefficient for Test PG4-6 describes a "squarer" snowflake distribution compared to Test PG4-10. The hypothesis for a negative kurtosis is the implication that smaller snowflakes may be hindered from being absorbed due to the larger snowflakes "resting" on top of the fluid. It is possible that as the test is progressing and a greater number of large snowflakes accumulate on the fluid, the smaller snowflakes may not be able to completely be absorbed by the fluid. This would result in a greater amount of snow resting on the fluid over time and ultimately prompt visual failure. The coefficient of skewness, 0.5 and 1.4 for Test PG4-6 and PG4-10, respectively and the calculated range, 2166 and 16948, respectively also supports the latter hypothesis.

Table 1.15: Statistical Values and Coefficients – Test PG4-6 vs. PG4-10

Variable	Test PG4-6	Test PG4-10
APS Average Rate ($g/dm^2/hr$)	5	4.6
APS Rate Standard Deviation ($g/dm^2/hr$)	1.6	1.7
APS Rate Variance $(g/dm^2/hr)^2$	2.5	3.0
APS Average Wind Speed (km/hr)	19	26
NCAR Average Wind Speed (km/hr)	15	14
NCAR Wind Speed Standard Deviation (km/hr)	0.4	2.6
NCAR Wind Speed Variance $(km/hr)^2$	0.1	6.7
Average Snowflake Size (mm)	1.072	0.772
Difference in Size (%)	21	-21
Kurtosis	-1.2	0.9
Skewness	0.5	1.4
Range	2166	16948
OAT (°C)	-10	-9
Plate Temperature Standard Deviation (°C)	NA	0.4
Plate Temperature Variance $(°C)^2$	NA	0.1

To determine the variables affecting the outcome of this test, all variables must be accounted for. In other words, an independent variable usually affects a depended variable where appropriate. The thermal analysis and calculated statistics also serve part of the overall findings of this comparison.

1.3.1 Impacts of Independent Variables on Dependent Variables

The following subsection explains the effect of each independent variable on the dependent variable(s) for Test PG4-6 vs. PG4-10.

1.3.1.1 Effect of Snowflake Size on ET and Brix/Concentration at Fail

The snowflake size will have an effect on the ET of a fluid based on the surface area available for absorption. The mathematical proof can be found in Appendix H but is summarized here for completeness. Assuming a large snowflake is broken into 1,000 smaller pieces, the surface area available for absorption increases 10-fold. Hence, a smaller snowflake will have the tendency to prolong the ET of a fluid while a larger snowflake will have the opposite effect. Test PG4-6 for this comparison had a 21 percent larger average snowflake size (average bin range size) compared to Test PG-10. Therefore, Test PG4-6 should theoretically reach visual failure in a shorter time span than Test PG4-10, as is the case.

By shortening or extending the ET of a fluid, it is reasonable to assume that the concentration/brix at fail will be affected. Test PG4-6 with a shortened ET than Test PG4-10, therefore, has a higher brix compared to that of Test PG4-10.

1.3.1.2 Effect of Initial Fluid Temperature (From Thermal Analysis) on Fluid Thickness at 5 Minutes

As previously discussed, a negative fluid temperature gradient may result in a thicker fluid layer upon pouring and remains thicker throughout the test. From the thickness data obtained during testing, the fluid thickness is greater for Test PG4-10 compared to test PG4-6 at 5 minutes. In fact, it is almost consistently higher throughout the progression of Test PG4-10 compared to Test PG4-6. This supports the previously presented hypothesis that a cooler initial fluid temperature will result in a thicker fluid layer.

1.3.1.3 Effect of Day/Night Testing on the Plate Temperature Gradient

ET testing conducted during the day may provide thermal energy to the fluid being tested. For this comparison, Test PG4-10 was conducted during the day while Test PG4-6 was performed at night. Thus, it is possible that thermal energy from the atmosphere slightly heated the plate temperature of Test PG4-10 to obtain a positive plate temperature gradient. This in turn may influence the ET of Test PG4-10 by extending its performance.

1.3.2 Additional Information from Data Packs

The following subsection documents key independent variables to be considered in the final analysis when the general trends are taken into account and contrasted.

1.3.2.1 Effect of Rate on ET

When the rates of precipitation of Test PG4-6 and Test PG4-10 are contrasted, the different trends in rate observed may have an impact on the final ETs. The total amount of time under the average rate for Test PG4-10 was 62 percent or 81 minutes. Comparably, Test PG4-6 was under average for 53 percent or 38 minutes. The approximately 10 percent longer time under average for Test PG4 10 may have contributed to the ET by withstanding a longer duration due to a lower rate.

1.3.2.2 Effect of OAT on ET

The OAT may have slightly contributed to the ET of Test PG4-10 by increasing from -8.5 to -7.4 °C.

1.3.3 Summary of Pertinent Variables and Hypothesis to Consider for Example 2 — Test PG4-6 vs. PG4-10

The key variables associated with this comparison are the snowflake size and time of testing (day/night). Test PG4-10 had a smaller snowflake size and was conducted during the day while PG4-6 had a larger snowflake size and was performed at night. The combined effects of a smaller particle size and thermal radiation supplies a greater overall surface area for absorption and thermal energy to the system, respectively. This effectively prolongs the ET of Test PG4-10 compared to Test PG4-6 and decreases the brix/concentration at fail.

APPENDIX J

POINT-TO-POINT COMPARISON

Note: All photos and data references in this appendix can be found in Appendix D to Appendix F. Temperature calculations may include the average between EC and NCAR data.

Point-to-Point Comparison – PG Type II Test PG2-13 vs. Test PG2-11

For this comparison, many variables influence the fail times of these tests. Starting with Test PG2-11, the initial fluid temperature is closer to the actual OAT compared to Test PG2-13; this indicates the correct fluid layer thickness for Test PG2-11. Test PG2-13, however, is slightly warmer and tends to be slightly thinner than expected, possibly decreasing the ET. The OAT for Test PG2-13 is also 1°C cooler which should slightly decrease the ET as well, however, the slightly higher wind speed and smaller snowflake size induce a longer ET. Specifically, for Test PG2-13, a warmer initial fluid temperature gradient, slightly cooler OAT, and slightly higher average rate all contribute to reducing the ET, while the smaller snowflake size and slightly higher wind speed extend the ET.

Overall, the variables either seem to cancel each other out or are not significant enough to have a relevant impact on the ET. The opposite also holds true for Test PG2-11. The rate variance for Test PG2-13 is much smaller than Test PG2-11. Test PG2-11 is below average until it rises at the end of the test. Test PG2-13 is approximately at average then increases at the end of the test. Thickness at 5 minutes is explained by starting at a rate below average for Test PG2-13, whereas Test PG2-11 starts above average. Brix and thicknesses at fail can also be explained by the rate variances between tests. The amount of snow on the bare plate is explained by the difference in wind speeds.

Usually, the bare plate is also indicative of wet snow, however, in this case both tests appear to include this type of precipitation. No significant effect is observed by the change in wind direction. No significant variable stands out for this comparison. Instead, a combination of variables is observed which effectively cancel each other out or are not significant enough to have a meaningful impact on the ET.

Point-to-Point Comparison – PG Type II Test PG2-35 vs. Test PG2-5

This conclusion was streamlined and put into bullet form; please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- Initial fluid temperature and gradient is cooler for Test PG2-35 than Test PG2-5. There is no evidence that Test PG2-35 resulted in a thicker fluid application. Variable not to be considered.
- The OAT is slightly warming for Test PG2-35 (1.5°C) and Test PG2-5 (0.6°C); however, Test PG2-35 is warming at a slightly higher rate. This may positively impact the ET of both Runs (greater for Test PG2-35) to a minor extent. Variable to be considered.
- Wind speed for Test PG2-5 is greater than Test PG2-35 using both APS and NCAR data. Minute maximum is also greater for Test PG2-5. Variable to be considered.
- Test PG2-35 was conducted during the day while Test PG2-5 was performed at night. Variable to be considered.
- The rate during the last 15 minutes of Test PG2-35 is slightly greater than the average rate, however, it is not significant enough to be considered as a variable. The rate in the last 15 minutes for Test PG2-5 is at average. Variable not to be considered.
- Test PG2-5 barometric pressure was lower than Test PG2-35. This is indicative of high wind speed during the storm and is supported by the NCAR minute maximum data. Variable to be considered.
- The snowflake size for Test PG2-5 is significantly smaller (27%) than Test PG2-35. This has the tendency to extend the ET of the fluid, as is the case. The kurtosis can help explain the flakes on top of other flakes during visual failure (hypothesis). The skewness and range are evidence in support of Test PG2-5 having a smaller snowflake. Variable to be considered.
- The bare plate shows some sign of accumulation on Test PG2-35. This may indicate the presence of wet snow in the form of snow pellets/graupel (see pad pictures) and/or low wind speed. If this wet snow is indeed present, the snow pellets/graupel will melt at a slower rate compared to crystalized snow. This may also explain the linear decrease in concentration of Test PG2-35 compared to the parabolic for Test PG2-5. The larger wet snow pellets/graupel particles melt at a slower rate and accumulate more readily on the fluid until failure is reached, decreasing the ET. Variable to be considered.
- Test PG2-35 plate temperatures are slightly cooler than Test PG2-5 due to the lower wind speed despite being conducted in the day. This is also evidenced by the lower minute maximum of Test PG2-35. The plate temperature gradient for both runs is approximately the same.

- Test PG2-5 plate temperatures are slightly warmer compared to Test PG2-35 due to the greater wind speed despite being conducted at night. This is also evidenced by the greater minute maximum of Test PG2-5. The temperature gradient for both runs is approximately the same.
- Test PG2-5 fluid thickness is greater throughout the first 15 minutes compared to Test PG2-35 due to the higher wind speed and greater precipitation rate during this time. The thickness at fail is NA for Test PG2-5 but has significantly increased for Test PG2-35. This is most likely due to the large snowflakes resting on top of the plate and further influenced by the slightly elevated precipitation rate and lower wind speed (thermal effects).
- No effect of wind direction on the ET of both runs is observed.

Point-to-Point Comparison – PG Type II Test PG2-14 vs. Test PG2-2

For this comparison, the rate variance (time below average), rate last 15 minutes, day/night testing and snowflake size are the variables to consider. The high initial rate for Test PG2-14 explains why the concentration has a steeper initial drop compared to Test PG2-2. The initial fluid thickness is also greater for Test PG2-14 due to the higher rate. PG fluids have been known to experience an initial increase in thickness before subsequently decreasing, further validating the former. In addition, theoretically, the run with the cooler initial fluid temperature should result in a thicker fluid layer at the start of the test. However, the initial fluid temperature for Test PG2-14 is not supported by this as the temperature is warmer when compared to Test PG2-2.

On another note, the fluid temperature and gradient illustrate that the cooler fluid (Test PG2-2) cools the plate down to OAT. Test PG2-14 however (the warmer fluid), quickly cools down the plate below OAT and remains constant. This difference is due, in part, by thermal radiation from daytime testing (Test PG2-2) compared to nighttime testing (Test PG2-14). As can be seen from the temperature chart, Test PG2-14 is consistently below the OAT without warming. Test PG2-2, on the other hand, is approximately at OAT and warms up throughout the test. This suggests that more fluid may be involved in providing protection (more snow going through a phase change) due to the warmer plate temperature gradient. This observation is also supported, in part, by the difference in final concentration of both runs where Test PG2-2 is significantly less than Test PG2-14.

The rate variance also plays a key role for this comparison. For Test PG2-14, 40% (approx. 35 of 89 minutes) of the test is below average (from mid point of test) and picks up near the end to above/at average. The increased rate seems to allow more snow accumulation as slush (see photos). This snow also seems to have minimal water content as seen in the pad and bare plate pics. The snowflake size is also smaller for Test PG2-14 which should theoretically increase the ET by allowing a greater amount of snow to be absorbed by the fluid which eventually results in a slush as well, as less glycol becomes available for protection. This may explain the increase in fluid thickness at the end of the test. For Test PG2-2, the rate during testing is average however, the last 15 minutes is below average. In fact, it is below average for the last 37 of the 120 minutes of total test time (31%). The rate during the last 15 minutes should therefore aid in prolonging Test PG2-2 compared to Test PG2-14. Although the wind direction changed during Test PG2-14, no significant impact was observed.

Another way to interpret this comparison is to state that for Test PG2-2, the below average rate during the last 15 minutes and daytime testing overcame the impacts of having a consistent rate and slightly larger snowflake size to prolong the ET. The opposite also holds true for Test PG2-14 with the rate in the last 15 minutes at average.

Point-to-Point Comparison – PG Type II Test PG2-32 vs. Test PG2-3

The comparison of these tests includes the combined effects of multiple variables, however there are a few which need consideration. To begin, the initial fluid temperature gradient for Test PG2-3 was warmer than Test PG2-32 by approximately 1°C. Although this has the tendency to decrease the fluid viscosity which is in turn observed as the fluid thickness on the plate, the thickness plots show no significant differences at the 5-minute mark. Furthermore, the plate temperature plots show little differences between runs. In fact, the slightly higher thickness for Test PG2-3 can be attributed to the higher-than-average precipitation rate at the start of the test.

However, one can also argue that the initial fluid temperature of Test PG2-3 was 0.7°C cooler compared to Test PG2-32 which may also result in an increase in fluid layer thickness; however, since the difference is small (0.7°C), this effect is considered minor when compared to the initial precipitation rate. The remaining 5 independent variables all contribute, to some extent, to the extension of the ET for Test PG2-3. The first variable considered is the day/night testing. Test PG2-3 was performed in part during the day (first 16 min) and at night (remainder of test) while Test PG2-32 was performed at night. Since only a small fraction of test 3 was performed during the day, it is reasonable to assume that the thermal radiation from sunlight only had a marginal contribution to the extension of the ET.

The next variable, the variance in rate, on the other hand is seen to contribute to the extension of the ET. The rate for Test PG2-3 was below average for approximately 33 minutes (mid test) while Test PG2-32 was under average for approximately 8 minutes (mid test). The extended time of precipitation below average extends the ET. In addition, the rate the last 15 minutes for Test PG2-3 is above average and ultimately ends the test run. Using both APS & NCAR data obtained for wind speeds, there is no doubt that this variable contributed to the fail time extension of Test PG2-3. Wind speeds contribute by warming the fluid by convection and induces viscous drag on the fluid. The viscous drag not only warms the fluid but also reduces fluid runoff, keeping more of the fluid on the plate. The wind speed minute maximum for Test PG2-3 also indicates strong wind bursts which aids in keeping the fluid on the plate. The OAT for Test PG2-3 can also contribute to the extension of the ET since the air temperature is warming throughout the test while air temperature in Test PG2-32 is constant. Although Test PG2-3 is warming by 1°C, the impact of this variable is minor at best.

The last and most significant variable observed for this comparison is the snowflake size. Test PG2-3 has a 27% smaller average snowflake size compared to Test PG2-32. The statistical skewness and range also provide additional evidence that the snowflake size in Test PG2-3 is smaller during this test. As seen from the progression pictures, the larger flakes rest on top of the plate to a greater extent compared to Test PG2-3 due to a lower absorption rate. This is also evidenced in the plate temperature plot as the temperature remains cooler for Test PG2-32 than Test PG2-3.

In addition, the final concentration of Test PG2-32 is greater than Test PG2-3, which also suggests a lower absorption. Another mechanism which may demonstrate as to why the concentration at the end of Test PG2-32 is greater can be explained with the obtained statistical results. The kurtosis of Test PG2-3 is positive 1 while it is a negative 1.1 for Test PG2-32. The negative value suggests a squarer distribution. As the test progresses for Test PG2-32 and nears its end, the larger snowflakes which remain on the plate prevent the smaller flakes (and other large flakes) from reaching the fluid. This effectively reduces the amount of snow absorbed by the fluid in a 2-pronged manner, keeping the final concentration greater. The final thickness of Test PG2-32 is therefore greater than Test PG2-3 and is illustrated in the thickness plots.

Point-to-Point Comparison – PG Type II Test PG2-33 vs. Test PG2-4

The main variables for this comparison are the snowflake size, wind speed, OAT, and the initial fluid temperature. For Test PG2-4, the initial fluid temperature is warmer than the OAT. This can result in a thinner fluid layer on the plate after pouring, however, this is not the case. The fluid layer is thicker at 5 minutes when compared to Test PG2-33. The skewness and range data support Test PG2-4 having a smaller snowflake size. The smaller snowflake size for Test PG2-4 has the tendency to extend the ET, which is observed. The larger snowflakes also increase the fluid thickness as observed by the higher mid and final thickness values of Test PG2-33. The negative kurtosis of Test PG2-33 indicates somewhat of a "square" distribution where some snowflakes are hindered from contacting the fluid by the larger snowflakes present on the plate near the end of a test.

The OAT may also play a minor role for Test PG2-33 as the temperature is slightly warming, extending the ET. The high wind speed of Test PG2-4 compared to Test PG2-33 plays a role in extending the ET. This is done through convective heat transfer due to viscous drag and by decreasing fluid run off from the plate during testing. The high minute maximum for Test PG2-4 also indicates strong blowing winds which supports the retainment of fluid on the plate and is evidenced by the greater fluid thicknesses. The final concentration for Test PG2-33 is lower than expected (assuming Test PG2-4 is accurate). This may be due to testing a spot on the plate with a high amount of fresh snow, effectively lowering the final concentration.

Point-to-Point Comparison – PG Type II Test PG2-11 vs. Test PG2-28

For this comparison, many factors are at play in determining the failure mechanism responsible for the extension of the ET for Test PG2-28. To begin, the rate variance (time below average) has some effect on the prolonged duration of Test PG2-28. The rate for the 1st half of Test PG2-28 is consistently below average and only increases in the 2nd half of the test. The rate during the last 15 minutes, however, is also higher for this run producing the opposite effect. Since the rate is below average for the 1st half of the run, it must increase the ET as it has almost reached the calculated regression ET while being below. Test PG2-28 has a higher wind speed than Test PG2-11. This has a tendance to warm up the fluid on the plate due to convective heat transfer and aids in keeping the fluid on the plate by reducing fluid runoff.

Test PG2-28 is also conducted during the day while Test PG2-11 was tested at night. Day testing also tends to heat the fluid due to thermal radiation. The effects of both wind and thermal radiation extend the ET and are observed in the plate temperature where it is significantly below OAT for Test PG2-11 and just under OAT for Test PG2-28. These effects, to some degree, are also observed in the pictures of Test PG2-28 where the snowflakes are more within the fluid and form "mountains" as a result. The thickness at start of Test PG2-28 is obviously lower due to a below average rate and higher at the end due to the significant increase in rate and longer duration. When comparing both runs to each other, Test PG2-28 thickness at 5 minutes is greater than Test PG2-11, however, there is no evidence indicating that this is due to the initial fluid temperature. Alternatively, the comparative thickness at mid test is approximately the same.

The relatively low wind speed for Test PG2-11 along with some wet snow explains the snow on the bare plate. This also explains the snow on the top of the test plate prior to failure. The low wind speed and to a minor degree the cooler plate, allows the snow to rest on top of the fluid as shown in the pictures. A slightly higher final concentration for Test PG2-11 is thus the result of the latter. Another key observation from the available pictures shows Test PG2-28 to have snowflakes which resemble that of a powder whereas Test PG2-11 is more of a typical snowflake. It is possible that this powdery snow significantly affects the ET by extending it. However, the MVD obtained from the distrometer does not support this. It is possible that many snow particles were calculated as being one instead of individual flakes as it passed the sensors. However, since there is no direct evidence of this, it is only a speculation. The wind direction for each run is somewhat different but no significant effect is observed. The low barometric pressure for Test PG2-28 is also generally indicative of high wind speed during testing. In a nutshell, the rate variance (time below average) including last 15 minutes rate, high wind speeds, thermal radiation, bare plate, low barometric pressure and possible "powdery snow" are all variables to consider for the increased ET of Test PG2-28.

Point-to-Point Comparison – PG Type II Test PG2-7 vs. Test PG2-6

For this comparison, the OAT, rate variance, last 15-minute rate, snowflake size and possibly the wind speed and variance are the variables to consider.

The OAT for Test PG2-6 tends to be warming whereas Test PG2-7 is cooling. Although minor, this tends to a longer ET for Test PG2-6. The temperature gradients also follow in the same direction. Test PG2-6 plate temperature gradient is decreasing (warming) due to the near constant precipitation rate indicating less glycol available for phase change (thinning fluid). Test PG2-7, however, has an almost constant greater temperature gradient (cooler plate vs OAT). This is particularly due to the variance in rate (higher precipitation rate converts the available snow at a higher rate removing more heat from the fluid) and in some part due to the decreasing (cooling) OAT.

The high variance with a significant precipitation rate near the end of the test tends to decrease the ET for Test PG2-7. The high rate quickly saturates the plate causing the plate to fail at a lower ET. This is confirmed by the failure pictures and higher final concentration. The wind speed also varied significantly during Test PG2-7 whereas Test PG2-6 remained constant. Nevertheless, the average wind speed for both tests is approximately the same and indicates no significant impact on the tests.

Wind direction also changed during Test PG2-7 however, no impact was observed on any other variable. Snowflake size was significantly smaller for Test PG2-7 which tends to increase the ET however, this variable was not substantial enough to overcome the rate variance observed. Finally, the fluid thickness is thicker for Test PG2-6 than Test PG2-7, possibly due to the differences in snowflake size. When considering the initial temperature and gradients for these runs, Test PG2-6 should provide a thinner layer due to the warmer measured temperatures however, the thickness data indicates the opposite, a thicker layer for Test PG2-6. This obviously does not support the hypothesis where a cooler fluid results in a thicker fluid layer.

However, when considering the temperature profiles, Test PG2-6 begins to increase in temperature (warms up) during testing with a lower precipitation rate. Comparing this observation to Test PG2-7, the temperature profile remains cooler and does not increase in temperature while tested at higher rate. This indicates that run 15 may have started with a thinner fluid but the thickness data may have been masked by thicker data values due to the differences in snowflake size (greater snowflake gives rise to thicker fluid).

Point-to-Point Comparison – PG Type II Test PG2-7 vs. Test PG2-29

Please note, this conclusion was streamlined and put into bullet form. please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- Initial fluid temperature gradient is warmer for Test PG2-7 than Test PG2-29. There is no evidence that Test PG2-7 resulted in a thinner fluid application. Variable not to be considered.
- The OAT is slightly cooling for Test PG2-7 while Test PG2-29 is relatively constant. This may negatively impact the ET of Run 7 to a minor extent. Variable to be considered.
- Wind speed for Test PG2-29 is much greater than Test PG2-7 using both APS and NCAR data. Minute maximum is also much greater for Test PG2-29. Variable to be considered.
- Test PG2-29 was conducted during the day while Test PG2-7 was performed at night. Variable to be considered.
- Longer time below average rate may have played a role in the extended ET of Test PG2-29. The first half was below average for 30 minutes ≈ 55% of test time, while the second half was above average for 25 minutes ≈ 45%. Test PG2-7 was below average for 15 minutes which represents 44% of the test. Thus, Test PG2-29 was below average for 50% longer than Test PG2-7. The rate variance also suggests that the rate may have played a role when comparing Runs 7 and 29 (greater Test PG2-7 rate variance to Test PG2-29). Variable to be considered (rate variance).
- The rate during the last 15 minutes of Test PG2-7 may have contributed to ending the test since it is significantly greater than the average rate when compared to Test PG2-29. The rate in the last 15 minutes for Test PG2-29 is also above average but it is less than the rate in Test PG2-7 (rate of 50 vs 41). Variable to be considered.
- Test PG2-29 barometric pressure was significantly lower than Test PG2-7. This is indicative of high wind speeds during the storm and is supported by the NCAR minute maximum data. Variable to be considered.
- Test PG2-7 average plate temperature and gradient is cooler than Test PG2-29 due to overnight testing and lower wind speed including lower minute maximum.
- Test PG2-29 average plate temperature and gradient is warmer compared to Test PG2-7 due to daytime testing and higher wind speed including greater minute maximum.

- Test PG2-29 fluid thickness is greater throughout the test (except for 5 minutes thickness) compared to Test PG2-7 due to the higher wind speed with a lower variance including a greater minute maximum.
- The final concentration for Test PG2-29 is lower than Test PG2-7 due to the longer duration of the test provided by the daytime testing and wind speed.
- No effect of wind direction on ET of both runs is observed.

Point-to-Point Comparison – PG Type II Test PG2-4 vs. Test PG2-3

Upon reviewing the data packages, it was determined that the initial fluid temperature (fluid temperature gradient and cooler initial fluid temperature for Test PG2-3), wind speed (a possible contributor), and the rate variance (coupled with the initial fluid temperature) were the causes for different fail times. To begin, the rate throughout the test was as follows: Test PG2-3 started with a higher rate which decreased below average until proximity to the end of the test, where it increased again to a higher rate. The rate for Test PG2-4 started below average but then increased throughout the test and stayed above average until failure. The rate in the last 15 minutes (minor effect to end test) and the variance, thus, played a part in the extended ET of Test PG2-3.

The warmer initial fluid temperature also contributed to the quicker fail of Test PG2-4, as the starting rate was below average for the warmer initial fluid. It is, therefore, reasonable to assume that a thinner fluid thickness would not be greatly affected at this time. For Test PG2-3, the initial fluid temperature is cooler by 3.5°C compared to Run 4. Additionally, Test PG2-3 also has a 2°C cooler fluid temperature gradient. The thicker fluid, however, was precipitated on with a higher-than-average starting rate, which caused the fluid thickness to decrease and then remain constant as the rate began to decrease.

It is interesting to note the fluid thickness at the 5-minute mark; the thickness for Test PG2-3 & Test PG2-4 at the 5-minute mark is the same even with differing precipitation rates. Furthermore, Test PG2-3 never decreased throughout the test while Test PG2-4 decreased until finally increasing at failure. The APS wind speeds are higher for Test PG2-3 while the NCAR recorded speeds are similar for both runs. If wind speed is to be considered, then it would also contribute to the delayed ET of Test PG2-3.

Point-to-Point Comparison – PG Type II Test PG2-12 vs. Test PG2-8

For this comparison, there are a few variables to consider when determining how the ET is greater for Test PG2-8 than Test PG2-12. The main variables are the initial fluid temperatures, wind speed, variable rate including the rate the last 15 min, and the snowflake size and distribution. To begin, the initial fluid temperature gradient for Test PG2-8 is 1.5°C warmer than Test PG2-12. A warmer initial fluid tends to provide a thinner layer of protection on a plate when compared to a cooler fluid due to viscous changes. However, 1.5°C is not a substantial gradient to significantly decrease the fluid viscosity. Furthermore, there is no thickness data which supports the premise for this run, rendering this variable insignificant. The wind speeds for this comparison are comparably different. Test PG2-8 is significantly greater than Test PG2-12 when using either APS or NCAR data.

In addition, the barometric pressure for Test PG2-8 is significantly lower than Test PG2-12 indicating the presence of high wind speed during the storm. This suggests that the wind speed did play a role in providing convective heat transfer to the fluid and inducing some viscous drag. The high wind speed (and greater average minute maximum) also aids in reducing fluid run off from the plate, providing more protection. The precipitation rate during Test PG2-8 was highly variable whereas Test PG2-12 is relatively consistent. The higher-than-average rate for the first part of Test PG2-8 quickly reduces the concentration of glycol while maintaining the same thickness, indicating complete absorption of precipitation during this period. As the precipitation remains high, the fluid thickness begins to decrease indicating dilution and some fluid runoff. The rate then reduces to below average until the end of the test. Since the rate remained below average for the last 15 minutes (of 38 minutes total test time), it aided in prolonging the ET even though the rate was above average for the first part of this test.

The snowflake size and variance play a significant role in this comparison. As observed in the progression pictures, after the initial absorption phase where much of the precipitation has melted, the snowflakes for Test PG2-12 begin to remain on the top of the surface. The large snowflakes are absorbed at a lower rate (smaller overall area available with larger snow particles) compared to the smaller snowflakes seen in Test PG2-8 (support for smaller snowflakes is also seen in the statistical skewness and range). This is also illustrated in the plate temperature profiles. Test PG2-8 melts the precipitation (snow) reaching a max plate temperature gradient of -2.6°C. At this point, the amount of precipitation (snow) going through a phase change has reached the maximum conversion rate. As the glycol concentration decreases, the amount of glycol available for H-bonding begins to decrease. This effectively increases the temperature of the plate as less precipitation is converted to the liquid phase. The plate temperature continues to increase until ultimately the fluid ET is reached.

In the case for Test PG2-12, the larger snowflakes (including the small available snowflakes during the test), melt within the fluid during the initial phase. Although the larger snowflakes have an overall smaller surface area available, the large non-melted snowflakes occupy a greater area (greater absolute amount) on the plate (fluid surface area) at one time for conversion (phase change). This decreases the plate temperature by 3.5°C (below OAT) compared to 2.6°C for Test PG2-8. The wind speed, which can slightly warm the fluid, is accounted for when analyzing these temperature gradients. If the wind speed were to completely account for the differences in temperature gradients, then both runs would have a similar profile. Hence, a similar profile would be observed for both runs but with different temperature gradients. However, this is clearly not the case. The maximum conversion rate, therefore, also lasts for a longer period since less snow is converted per particle at one time (less surface area available per particle) from solid to liquid.

The limiting rate for this process is the surface area of large snow particles covering the plate compared to the amount of glycol available. The ET is thus shorter as the snow rests on the plate. To further the idea on Test PG2-12 having a smaller amount of surface area available for snow conversion per particle, the large flakes which rest on top of the plate may also prevent the smaller snowflakes from reaching the fluid, keeping the glycol concentration higher than expected as illustrated by the final brix.

Additional support is provided by the negative kurtosis which suggests a "square" distribution indicating a relatively equal number of small flakes compared to large flakes, rendering a higher final concentration. On another note, since the drop in plate temperature is so great for Test PG2-12, it might be possible to compare it to the next cooler temperature band as some tests in that band can possibly have a plate temperature equal to the testing OAT, rendering these tests possibly equivalent. The snow on bare plate is indicative of lower wind speeds and possibly some wet snow as indicated on the pad pictures.

Point-to-Point Comparison – EG Type III Test EG3-8 vs. Test EG3-7

The major variables in this analysis are the rate variance, snowflake distribution (not average size), fluid temperature gradient, and wind direction. The higher rate at the start of Test EG3-8 results in a constant decrease in fluid thickness, while Test EG3-7 starting at an average rate keeps the thickness consistent for the first five minutes of the test. Although the latter difference is observed, the rate variance has limited impact on the ET. The rate for the last 15 minutes is slightly higher for Test EG3-7 than Test EG3-8, although to a minor extent. Hence, no effect is observed for this variable.

The snowflake distribution for this comparison is significantly different. Although the average sizes are the same for both tests, the kurtosis for Test EG3-7 is significantly negative, while it is significantly positive for Test EG3-8. The negative kurtosis indicates a "square" distribution while the positive indicates more of a standard one. Therefore, a greater number of larger snowflakes are observed in Test EG3-7. This variance in snowflake distribution significantly impacts the concentration by keeping the brix high due to a lower absorption rate. As snowflakes fall on the plate, the larger flakes may also prevent the smaller flakes from being absorbed in the fluid. Consequently, although the average is the same for both runs giving a similar ET, the different snowflake distribution impacts the concentration of the fluid. This impact is primarily observed towards the end of the test as the fluid begins to fail and the snowflakes remain on the fluid/plate.

A fluid temperature gradient is also calculated for both tests and is warmer for Test EG3-7. Although it is different when compared by 1.5°C, no impact is seen in fluid thickness at the start of tests as demonstrated by the thickness graphs. The wind direction is also slightly different. Since no significant difference was observed in the HOT, no causal relationship may exist between wind direction and endurance time.

Point-to-Point Comparison – EG Type III Test EG3-2 vs. Test EG3-1

After analysis, rate variance for Test EG3-2 is slightly greater than Test EG3-1. The snowflake size for Test EG3-1 is also smaller than Test EG3-2 by 10%. A smaller snowflake size results in a higher ET and brix at fail for Test EG3-1. The higher wind speed (NCAR sensor) for Test EG3-1 also contributes to the extended fail time by providing more convective heat transfer and aids in retaining fluid on the plate, hindering fluid run off. This will also result in a thicker fluid layer throughout the test. The lower barometric pressure indicates more turbulent weather conditions and greater wind speeds. The plate temperature gradient for Test EG3-1 is cooler than Test EG3-2, possibly providing a thicker fluid throughout the test as indicated by the graphs and thickness at fail.

Another factor contributing to this test is the error associated with being the first of the testing session (specific to this testing event only). It appears that the test plates did not have sufficient time to temper to OAT, which would result in a warmer fluid temperature on the plate and thus reduce the fluid viscosity. This is observed in the initial lower fluid thickness for Test EG3-1. However, it does not account for the longer ET of the test. Wind direction has no effect on ET. Therefore, the variables that are most likely responsible for the extension of the ET for Test EG3-1 are the following:

- variance in rate (slight impact, if any);
- snowflake size;
- wind speed;
- plate temperature gradient; and
- barometric pressure.

Point-to-Point Comparison – EG Type III Test EG3-6 vs. Test EG3-10

For this comparison, the rate during the last 15 minutes, wind speed, snowflake size, time of testing (day/night), initial fluid temperature and gradient, the OAT, and bare plate are the variables to consider.

The rate during the last 15 minutes has a minimal impact, if at all, for this case since the rate is only marginally higher for Test EG3-6. The time of testing seems to play a major role for this comparison as Test EG3-6 was at sunset and Test EG3-10 was conducted during the day. This is supported by the plate temperature profile for Test EG3-10 which is above OAT indicating an external source of energy warming the plate, possibly increasing the ET. The OAT is also slightly warming for Test EG3-10 possibly contributing to the warmer plate. The opposite for the OAT is also observed for Test EG3-6.

The wind speed for Test EG3-10 plays a role in warming up the plate of Test EG3-10 compared to Test EG3-6. APS wind speed data suggests a much higher velocity for Test EG3-10 than Test EG3-6. However, NCAR data shows Test EG3-10 and Test EG3-6 with approximately the same average but with higher minute maximum data. The snowflake size also played a significant part. The snowflake size is much smaller for Test EG3-10 (48% smaller) which tends to decrease the concentration and increase the ET. The smaller thicknesses throughout the test and at fail for Test EG3-10 can be explained by the warmer plate (lower viscosity), smaller snowflake size, and to a minor extent the initial fluid temperature (warmer compared to Test EG3-6).

The bare plate may also indicate a minor impact on Test EG3-10 as it suggests some minor wet snow. The wet snow would decrease the ET by diluting the fluid quicker as the water does not need to go through a phase change, thus, easily bonding with the surrounding glycol molecules. As seen from the progression pictures, the fluid seems to dilute at a much higher rate compared to Test EG3-6. Due to the foregoing explanation and the smaller snowflakes which provide for a quicker absorption, Test EG3-10 fails by dilution failure. Again, this is due to the smaller snowflakes, wet snow, slightly warmer initial fluid temperature, and warmer plate caused by the daytime testing, slightly increasing OAT and possibly the higher wind speeds. Test EG3-6 plate temperature, however, is below OAT. The snow particles are also larger and readily accumulate on the top of the plate (to some extent). The kurtosis may also indicate that as the large snowflakes fall on the plate, the smaller flakes may be prevented from reaching the fluid thus resulting in a more typical visual representation of fluid failure and a higher final concentration.

Although Test EG3-6 initial fluid temperature and gradient are cooler by 1.4°C and 0.3°C, respectively, providing a minor impact at a higher thickness as seen from the thickness plots, it does not increase the ET in this comparison. The above-stated variables are no doubt significant to consider. However, the Type III fluid withstands all these variables and is shown to have no effect on the ET for this comparison. This data follows the trend of the regression curve.

Point-to-Point Comparison – EG Type III Test EG3-11 vs. Test EG3-23

Hypothesis for this comparison: The first variable to consider is the time of testing (day/night). Test EG3-11 was conducted during the day which raised the temperature of the plate as illustrated by the temperature gradient. Although the initial fluid temperature gradient and fluid temperature is cooler compared to Test EG3-23, which should theoretically lead to a greater thickness at the 5-minute mark, a 1°C and 2.3°C difference, respectively, did not substantially affect the fluid layer thickness for this test comparison. Test EG3-23 had a very high initial rate. This may have caused the fluid to have a greater thickness for Test EG3-23 as compared to Test EG3-11 which is not typical of EG fluids.

Next, the temperature of the plate during the test was above the OAT for Test EG3-11 whereas for Test EG3-23, the temperature was below OAT (see plate temperature gradients). At the same time, the rate variance (including the rate the last 15 min) plays a key factor. Test EG3-11 has a much smaller variance and was about average for most of the test. Test EG3-23, however, was very high and drops off to below average for the second half of the test. Furthermore, this snow was somewhat wet compared to Test EG3-11 (see pad pics and bare plate). Combining these variables results in the following: Test EG3-11 is mostly above OAT, fluid thins out due to a warmer plate and the constant snow fall results in dilution failure. Test EG3-23 plate temperature is below OAT, rate is high at first and results in a higher thickness, rate drops off, fluid remains more on plate (low rate & colder fluid) but also fails by dilution.

Thus, due to the cooler plate temperature gradient and wet snow, snow accumulates at the top of plate (see rate, pad pics and bare plate), results in higher thickness at fail, lower brix due to snow/wet snow accumulation, longer ET. Overall, although the ET is longer for Test EG3-23, it is not substantially longer than Test EG3-11. The Type III fluid seems to withstand the impacts of the significant variables resulting in the data following the regression curve.

Point-to-Point Comparison – EG Type III Test EG3-44 vs. Test EG3-12

For this comparison, there are 3 main variables which need to be considered. The first being the wind speed. The wind speed for Test EG3-12 is higher than Test EG3-44, which extends the ET of the fluid by providing convective heat transfer and decreases fluid run off. The convective heat transfer is not observed in the plate temperature profile of Test EG3-12 when comparing to Test EG3-44. However, when looking at Test EG3-12 plate progression pictures, the snow on the fluid seems to have mostly changed phases. It is possible that the convective heat transfer aids in the phase change of the snow particles by providing a minor amount of heat to the top layer of the fluid, essentially melting some of the snow.

The slowly warming OAT may also contribute to this melted top layer by providing additional thermal energy. Since it is difficult to observe the change in heat transfer from the temperature profile of Test EG3-12, the greater impact of high wind speeds (including higher minute maximum) may be attributed to the increase in fluid thickness on the plate. Test EG3-12 has a much greater fluid thickness compared to Test EG3-44. Although an initial higher rate is observed for Test EG3-12, EG fluids do not tend to increase in thickness with increased snow rates, further supporting the hypothesis that higher wind speeds result in greater fluid thickness.

It is possible the fluid temperature gradient and difference in OAT, being cooler for Test EG3-12 than Test EG3-44, provides a thicker fluid layer at start. If this is the case, the OAT would be the significant factor (not the fluid temperature gradient) as it could explain the greater thickness of Test EG3-12. The smaller snowflake size is also known to cause greater fluid absorption, extending the ET of the fluid as depicted in the progression pictures. The rate during the last 15 minutes may also extend the ET of Test EG3-12 since the rate is below average compared to Test EG3-44. Another factor which may be considered to a minor extent, but not included in this analysis, is the relative humidity. The relative humidity may contribute to decreasing the ET of a fluid by evaporative cooling. The process of higher energy molecules evaporating, causes the fluid to decrease in temperature for Test EG3-12.

Point-to-Point Comparison – EG Type III Test EG3-40 vs. Test EG3-20

This comparison has a few key variables to consider. However, they do not have a major impact on the difference in ET for this fluid. This may be due to the specific fluid characteristics of the EG Type III. A key factor of interest to note in this comparison is the mechanism of failure for these two tests. The two tests fail by means of similar mechanisms (dilution failure) at relatively the same ET. The main variables are the wind speed, time of testing (day or night), OAT, rate including rate variance, and barometric pressure.

The OAT for Test EG3-40 is constant while Test EG3-20 is slightly cooling. The cooling OAT has the tendance to decrease the ET of the fluid. The low wind speed and wet snow (see pad pictures) also allows for the accumulation of snow on the bare plate (Test EG3-20). It is possible that the snow density for this run is higher than the snow in Test EG3-40. For Test EG3-20, the lower wind speed and overnight testing causes the plate temperature to drop significantly below the OAT (by 3.1°C). This drop in temperature aids in causing the snow to form some slush when sufficiently diluted (still considered a dilution failure). Additional snow then accumulates on the plate and forms a snow layer.

The hypothesis is that the wet snow (the water content) already in liquid form, bonds to the glycol before the snow can change phases. The salvated glycol molecules within the vicinity of snow, therefore, prevent the phase change from occurring. Of course, this only occurs once the fluid is sufficiently diluted (water and snow diluted the fluid). This results in the snow layer observed and in the relatively simple visual failure depicted in the progression pictures. For Test EG3-40, however, the high wind speeds and daytime testing causes the plate temperature to approximate that of the OAT. The bare plate during this test is also bare indicating little wet snow (and possibly justifying the high wind speeds).

Overall, a similar failure mechanism is observed for this test to that of Test EG3-20. The additional energy transferred to the fluid allows the fluid to dilute further than expected. Hence, since the fluid has a plate temperature gradient close to 0°C and no wet snow exists, the snow particles can change phases and dilute the fluid until the fluid separates showing a bare plate (see progression photos). As the snow continues to fall on the plate, snow particles begin to accumulate in the crevices and a visual failure is obtained. The brix for Test EG3-40 would result in a lower final concentration as is the case. The fluid thickness is initially greater for Test EG3-20 and is possibly due to the higher precipitation rate at start and the cooler plate temperature, however, as the rate decreases, the fluid thickness for both Test EG3-20 and Test EG3-40 become similar.

The barometric pressure for Test EG3-40 is substantially lower than Test EG3-20 indicating much greater wind speeds during the storm and is illustrated in the wind speed plots. The wind speed minute maximum is also substantially greater indicating wind bursts which can aid in keeping fluid on the plate as well as transfer heat. Finally, the rate and rate variance for this comparison are different. Test EG3-20 rate and variance are greater than Test EG3-40. The rate alone does not seem to influence the ET (for this comparison only) as the higher rate for Test EG3-20 also has a higher ET. The opposite is also true for Test EG3-40. The variance, however, may possibly play a role in the extension of Test EG3-20 ET as it is greater. It is important to keep in mind that the failure mechanisms are considered equivalent even though the above-mentioned variables are at play. The rate and fail time still line up to the regression curve for this comparison indicating that the EG Type III fluid may be better at withstanding different environmental conditions in warm natural snow.

Point-to-Point Comparison – EG Type III Test EG3-45 vs. Test EG3-13

To begin, the OAT for Test EG3-13 is slightly warming during the test which may have a minor effect in extending the ET. The initial fluid temperature gradient is also cooler for Test EG3-13 when compared to Test EG3-45, which has the tendency to increase the thickness of the fluid on the plate. In this case, the fluid temperature gradient between these tests is approx. 1°C providing a minor increase in viscosity at best.

When considering the plate temperature profile for Test EG3-13, a dual effect may be observed. The initial plate temperature increases, indicating that the fluid is warmer than initially measured while also possibly warming due to convective effects. In summary, this warming is the effect of high wind speeds for Test EG3-13 compared to Test EG3-45 which may warm the plate due to convective heat transfer and aids in retaining the fluid on the plate. The thickness measurements indicated a significant thicker layer for Test EG3-13 compared to Test EG3-45, further supporting the hypothesis that high wind speed help retain deicing fluid on the plate. The wind speed minute maximum is also much greater for Test EG3-13 compared to Test EG3-45 which indicate wind bursts, also supporting the latter.

Upon initial inspection, the rate during the last 15 minutes was considered significant since Test EG3-13 is above average and Test EG3-45 is at average. However, Test EG3-13 is only slightly above average and the overall standard deviation for both tests are approximately the same rendering the rate for the last 15 minutes to have only a minor effect, if any. The variable which remains for this comparison is thus the snowflake size.

The smaller snowflake size has the tendency to prolong the ET of the fluid as seen for this comparison and as indicated by the final concentration of the fluid. The main theory supporting this hypothesis is the increased rate of absorption of small snowflakes compared to larger flakes due to the total surface area available. Another hypothesis stems from the statistical kurtosis. The negative kurtosis indicates a "square" distribution whereas a positive one indicates a more typical shape. It is possible that with a negative kurtosis, the larger snowflakes which remain on the plate near the end of a test prevent some smaller snowflakes from contacting the fluid. This, in turn, would aid in visual failure representation and keep the final concentration high compared to a test with a smaller snowflake. The statistical skewness and range also support Test EG3-13 snowflake size being smaller than Test EG3-45.

In addition, the final thickness for Test EG3-45 is greater than Test EG3-13 due to the large amount of snow on the plate driven by the larger snowflakes. To summarize, the greater fluid temperature gradient, slightly warming OAT, high wind speeds, and small snowflakes drive the fluid to prolong the ET for Test EG3-13. The slightly higher rate during the last 15 minutes of Test EG3-13 may have a minor effect to oppose the latter, however, the effect is almost negligible.

Point-to-Point Comparison – EG Type III Test EG3-47 vs. Test EG3-14

This conclusion was streamlined and put into bullet form; please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- Initial fluid temperature gradient is cooler for Test EG3-14 than Test EG3-47, however, the fluid temperature is the same for both runs. Therefore, the resultant fluid layer should be approximately the same for both. Variable not to be considered.
- The OAT is slightly warming for Test EG3-47 (1.4°C) but relatively constant for Test EG3-14. This may positively impact the ET of Test EG3-47 to a minor extent. Variable to be considered.
- Wind speed for Test EG3-14 is greater than Test EG3-47 using both APS and NCAR data. Minute maximum is also greater for Test EG3-14. Variable to be considered.
- Test EG3-47 was conducted during the day while Test EG3-14 was performed at night. Variable to be considered.
- The snowflake size for Test EG3-14 is significantly smaller (31%) than Test EG3-47. This generally has the tendency to extend the ET of the fluid, however, this is not the case here. The kurtosis can help explain the flakes on top of other flakes during visual failure (hypothesis). The skewness and range are evidence in support of Test EG3-14 having a smaller snowflake. Variable to be considered.
- The bare plate shows some sign of accumulation on Test EG3-47. This may indicate the presence of wet snow in the form of snow pellets/graupel (see pad pictures) and/or low wind speed. If wet snow is indeed present, the snow pellets/graupel will melt at a slower rate compared to crystalized snow. In this case, a linear decrease in concentration is observed for both Test EG3-14 and Test EG3-47 with a greater concentration for Test EG3-47 throughout when directly compared. With this information, it is not possible to determine if the higher concentrations for Test EG3-47 is due to the snow pellets/graupel and/or particle size. Conclusively, one or both parameters tend to influence the concentration (greater for Test EG3-47 than Test EG3-14). The larger wet snow pellets/graupel particles of Test EG3-47 also seem to accumulate more readily on the fluid as fluid dilution progresses until failure is reached. Variable to be considered.
- In Test EG3-47, the starting plate temperature is cooler (1°C) than in Test EG3-14 due to the lower (cooler) OAT. The average plate temperature is also very slightly cooler (0.2°C) due to the lower OAT and possibly the lower wind speed, despite being conducted in the day. This is also evidenced by the lower minute maximum

of Test EG3-47. The plate temperature gradient for Test EG3-14 is slightly cooler than Test EG3-47, however, as previously stated, the differences are very small and not significant.

- In Test EG3-14, the starting plate temperature is warmer (1°C) than in Test EG3-47 due to the warmer OAT. The average plate temperature is also very slightly warmer (0.2°C) due to the warmer OAT & possibly the higher wind speed, despite being conducted at night. This is also evidenced by the greater minute maximum of Test EG3-14. The plate temperature gradient for Test EG3-47 is slightly warmer than Test EG3-14, however, as previously stated, the differences are very small and not significant.
- Test EG3-14 fluid thickness is greater at the 5-minute mark and 15-minute mark compared to Test EG3-47 due to the higher wind speed and possibly, though unlikely, the greater average precipitation rate for the period leading up to this time (first 15 minutes). The thickness at fail is not available for Test EG3-14 but has significantly increased for Test EG3-47. This is most likely due to the large snowflakes resting on top of the plate, further influenced by the slightly elevated precipitation rate and lower wind speed (thermal effects).
- No effect of wind direction on ET of both runs is observed.

Point-to-Point Comparison – EG Type III Test EG3-14 vs. Test EG3-5

Overall, this comparison has three independent variables which can influence the outcome; these variables are the wind speed, snowflake size and distribution, and time of testing (day/night). Upon further review, the wind speed is approximately the same according to NCAR data and, therefore, the wind speed can be neglected.

The fluid temperature gradient is cooler for Test EG3-14 then Test EG3-5 by 1.4°C which should theoretically lead to a thicker fluid on the plate. However, this is not observed for this comparison. When comparing the day/night testing, the average plate temperature gradients for both tests are approximately the same and, therefore, no significant thermal radiation is transferred to the plate.

The only variable which remains is the snowflake size and distribution. They are significantly different with Test EG3-5 being approximately 40 % larger than Test EG3-14. However, the Type III fluid significantly withstands the impact of this variable on the ET hence, there is only a minor difference. The major impacts observed from the snowflake size are the final brix and thicknesses. The brix is higher for Test EG3-5 due to the slower absorption of the bigger snowflake. The snowflake distribution may also play a role in a greater brix at failure due to small snowflakes resting on top of larger snowflakes.

This hypothesis is also supported by the statistical kurtosis. Test EG3-5 kurtosis is negative implying a "square" distribution while Test EG3-14 is positive implying a more typical form. The thicknesses are greater for Test EG3-5 due to the larger snowflakes being absorbed at a slower rate as seen by the progression photos.

Point-to-Point Comparison – EG Type III Test EG3-41 vs. Test EG3-16

This conclusion was streamlined and put into bullet form; please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- The rate for Test EG3-16 is slightly greater compared to Test EG3-41. However, no effect is observed.
- Initial fluid temperature and gradient is cooler for Test EG3-16 than Test EG3-41. EG fluids usually do not increase in thickness due to higher rates. In this comparison, the rates, during which the thicknesses were measured, are approximately equal. Evidence thus suggests that Test EG3-16 resulted in a thicker fluid application due to temperature differentials. Variable to be considered.
- The OAT is slightly cooling for Test EG3-16 while Test EG3-41 is constant. This may negatively impact the ET of Test EG3-16 to a minor extent. Variable to be considered.
- Wind speed for Test EG3-41 is much greater than Test EG3-16 using both APS and NCAR data. Minute maximum is also greater for Test EG3-41. Variable to be considered.
- Test EG3-14 was conducted during the day while Test EG3-16 was performed at night. Variable to be considered.
- Test EG3-41 barometric pressure was significantly lower than Test EG3-16. This is indicative of high wind speeds during the storm and is supported by the NCAR minute maximum data. Variable to be considered.
- The snowflake size is much greater for Test EG3-41 than Test EG3-16. This has the tendency to decrease the ET of the fluid as is the case. Variable to be considered.
- The variance for Test EG3-16 is greater than Test EG3-41. The variance does not seem to influence the ET of Test EG3-16.
- The rate during the last 15 minutes of Test EG3-16 may have contributed to ending the test since it is significantly greater than the average rate. Rate last 15 minutes for Test EG3-41 is at average. Variable to be considered.
- Test EG3-16 average plate temperature and gradient is cooler than Test EG3-41 due to overnight testing and lower wind speed including lower minute maximum.
- Test EG3-41 average plate temperature and gradient is warmer compared to Test EG3-16 due to daytime testing and higher wind speed including greater minute maximum.

- Test EG3-16 fluid thickness is greater throughout the test compared to Test EG3-41 and is possibly due to the fluid and plate temperature differentials.
- The final concentration for Test EG3-41 is lower than Test EG3-16 and may be due to the thicker fluid layer present throughout the test for Test EG3-16.
- No effect of wind direction on ET of both runs is observed.

Point-to-Point Comparison – EG Type III Test EG3-16 vs. Test EG3-15

For this comparison, the rate variance, rate last 15 min, initial fluid temperature and gradient, wind speed and wind speed variance and snowflake size are the variables to consider. The rate variance explains the steep drop in fluid concentration at the beginning of Test EG3-15. Test EG3-15 was high above average at the start of this test while Test EG3-16 was approx. at average or below. The rate during the last 15 minutes and the initial fluid temperature and gradient had no significant impact on the ET.

The non effects of initial fluid temperature and gradient are also seen on the thickness graphs for both runs as they start with the same thickness. Furthermore, it is not a common occurrence for EG fluids to initially increase in thickness with an increased precipitation rate, further supporting the latter. In fact, the only time a difference in thickness is observed between these runs is during mid-test and can be explained by the rate variance up to that point in time.

The wind speeds are significantly different according to APS data (EC data) with Test EG3-16 being much higher (with a greater variance according to NCAR data). However, NCAR weather sensor show ap. same wind speeds. If wind speed is to be considered, it would aid in prolonging the ET of Test EG3-16 by providing thermal energy to the fluid and prevent some fluid runoff. When comparing snowflake size, Test EG3-16 also had a smaller snowflake compared to Test EG3-15 (15% smaller). These last 2 variables (wind speed and/or snowflake size) may seem to change the fluid failure characteristics (see photos) however in general, the Type III fluid seems to maintain its integrity since the same ET is obtained for this comparison.

Point-to-Point Comparison – PG Type IV Test PG4-6 vs. Test PG4-3

For this comparison, the main variables are the snowflake size including variance in distribution, the variance in rate (extended time below the average rate) including the rate the last 15 min, the day/night testing, the fluid temperature gradient including the difference in initial fluid temperature in direct test comparison, and the OAT to a minor extent. The OAT is slightly cooling during Test PG4-6 which may very slightly reduce the ET, if at all. The opposite also holds true for Test PG4-3 as it is very slightly warming up during the test. The fluid temperature gradient was 0.8°C above OAT while the initial fluid temperature difference shows a 2.6°C (cooler) in a direct comparison for Test PG4-6 and Test PG4-3, respectively.

When considering the fluid temperature gradient, although it is above the OAT, it is only marginally higher which results in a very small impact, if any, on the relative fluid thickness. The actual fluid temperature difference between tests, however, can result in greater fluid thickness at the start of test. Although PG fluids usually experience an increase in fluid thickness during initial precipitation, this is not supported from the thickness plots in this comparison. The thickness for Test PG4-3 is greater at a lower rate while Test PG4-6 has a lower thickness at a rate which is above average. This may support the hypothesis of a thicker fluid for Test PG4-3.

The thickness at 5 minutes, mid test and at failure is lower for Test PG4-6 and may be explained by both the variance in the rate throughout the test and starting fluid thickness. The rate started higher at first, decreased to below average, and then increased towards the end of the test, and still resulted in a lower thickness compared to Test PG4-3. For Test PG4-6, the brix is much higher due to the larger average snowflake size and variance in distribution. The large snowflakes have an overall smaller surface area for absorption when considering water equivalents to the small snowflakes of Test PG4-3.

The distribution in snowflakes may also have an impact on the failure time and final concentration. As Test PG4-6 progresses, the large snowflakes which rest on the plate (on the fluid) may prevent the smaller snowflakes from reaching the fluid; this may enhance the visual failure with more snow resting on top of the plate. The kurtosis for Test PG4-6 is -1.2 which indicates a "square" distribution supporting the latter hypothesis.

It is interesting to note that the very slightly cooling OAT, warmer fluid temperature gradient and direct fluid temperature comparison, extended lower than average rate during the test (for 38 min), the increase in rate at the end of the test, the larger snowflake size and night-time testing for Test PG4-6 reached failure at the same time as Test PG4-3. The difference, however, is that Test PG4-3 had a slightly warming OAT, a cooler initial fluid temperature gradient and direct fluid temperature comparison, a relatively consistent rate throughout the test, a smaller snowflake and day-time testing. Furthermore, the regression curve also suggests that Test PG4-6 could have under-failed, and should have recorded an ET of 90 minutes instead of 75 minutes compared to Test PG4-3 which failed directly on the curve. The variables associated with Test PG4-6 are also all directly related to the under-failing, except for the extended lower than average rate, of Test PG4-6.

Point-to-Point Comparison – PG Type IV Test PG4-6 vs. Test PG4-10

This comparison consists of many variables which have the effect of prolonging the ET of Test PG4-10. The snowflake size and distribution, amount of time under the average rate (to some extent), initial fluid temperature, day/night testing and the OAT are the main variables for this comparison. The wind speeds may also have contributed however, to a minor extent.

The average snowflake size for Test PG4-10 is significantly smaller than Test PG4-6. This effects the performance by extending the ET; having a greater absorption compared to larger snowflakes. The smaller flakes can dilute the fluid to a greater extent over time while still provide adequate protection. The final concentration, consequently, will be lower for Test PG4-10 than Test PG4-6 as is illustrated in the concentration chart (Brix). The snowflake distribution may also play a role in decreasing the ET of Test PG4-6. As larger snowflakes rest on top of the plate, the smaller flakes are hindered from reaching the fluid as they stay on the larger flakes. This would ultimately result in an increased visual representation of fluid failure and end with a higher final concentration as less snow is absorbed. The negative kurtosis suggests a "square" distribution and may support this hypothesis. The rate may also affect the ET of Test PG4-10.

The total amount of time under the average for Test PG4-10 was 62% (81 minutes) of the test. Comparably, Test PG4-6 was under average for 53% (38 minutes) of the time. The 10% longer time under average may contribute to the ET by withstanding a longer time frame due to a lower rate. The initial fluid temperature for Test PG4-10 was recorded to be 3°C cooler than the OAT. This may result in a thicker fluid layer due to higher viscosity at lower temperatures. As illustrated on the thickness graphs, Test PG4-10 at 5 minutes is thicker than Test PG4-6. Furthermore, the thickness throughout the test for Test PG4-10 is consistently higher with a below average rate than Test PG4-6. This indicates the strong possibility of a thicker fluid layer for Test PG4-10, extending the ET.

Test PG4-10 was also performed during the daytime compared to Test PG4-6 which was conducted at night. During the day, thermal radiation may contribute as a source of energy by supplying heat to the fluid and thus extending the ET. The plate temperature for Test PG4-10 shows a temperature consistently above that of the OAT. The OAT for Test PG4-10 is also slightly warming throughout the test run. Test PG4-6 shows the opposite effect for the OAT without any information on the plate temperature. It is possible that the thermal radiation and warming OAT for this test was substantial enough to cause the warmer plate temperatures recorded, thereby extending the ET. The wind speed may also have contributed to the prolonged ET of Test PG4-10 by supplying thermal energy by convection and viscous drag. If this is the case, it was to a minor extent as illustrated by the wind speed graphs. It is also possible that the wind may have contributed to the warmer than OAT plate temperature, however, to a minor extent.

Point-to-Point Comparison – PG Type IV Test PG4-28 vs. Test PG4-45

For this comparison, there are many variables at play which ultimately produce the obtained result. To begin, the variance in rate (below average rate) and rate during the last 15 minutes influences the ET of Test PG4-45. As seen from the precipitation rate graph, the rate is below average for the first 58% of the test and then above average for the remainder. This has the effect of increasing the ET since the rate is much lower for the 1st part of the test. The opposite effect can also be observed when the rate is elevated for the last 15 minutes of the test run, however, in this case, the ET is extended due to the long duration below average.

The initial fluid temperature for Test PG4-28 is slightly cooler than Test PG4-45 which may provide a thicker fluid layer upon pouring, however this is not observed due to the marginal difference in temperature (0.8°C). The fluid thickness at 5 minutes is greater for Test PG4-28 primarily because of the greater precipitation rate. The above freezing OAT, wind speed (mostly from the minute maximum), smaller snow particle size, and low starting precipitation rate for Test PG4-45 all contribute to the extended ET.

As can be seen from the plate temperature profile, at approximately 18:22, the temperature is seen to reach 0°C for 20 min. The precipitation rate at that time was effectively 0 g/dm^2/hr (very low). This is due to the lack of snow particles going through a phase change (solid to liquid) which is an endothermic process. The convective heat transfer above the freeze point also contributes to this plate temperature. At this point, some snow on top of the plate begins to melt while some stay as a solid particle. It is important to note that at 17 minutes, where no precipitation is observed, the fluid thickness on the plate remains constant. As the precipitation rate increases through the test and in particular the end of the test, the plate ultimately fails. The smaller snow particles have an overall greater surface area to penetrate the fluid, lowering the final measured concentration.

The negative kurtosis of Test PG4-28 may also explain the easier visual failure and greater final concentration. The fluid thickness at 5 minutes and mid test are lower for Test PG4-45 than 28 due to the lower precipitation rate, warmer plate temp and above freezing OAT during testing. The higher rate during the last 15 minutes of Test PG4-45 had no effect on increasing the thickness due to above freezing OAT, convective heat transfer and fluid thinning failure. The below freezing OAT and variable wind speed for Test PG4-28 causes the fluid to fail with snow on the plate. This is also observed in the graph showing the driving force for nucleation. The bare plate also supports the varying wind speeds (low speeds at end of test) as snow remains on the plate.

Point-to-Point Comparison – PG Type IV Test PG4-11 vs. Test PG4-23

For this comparison, the initial fluid temperature gradient is above OAT for Test PG4-11 and vise versa for Test PG4-23.

The cooler fluid seems to leave a thicker fluid layer on the plate for Test PG4-23 (observed at start and throughout the test). Furthermore, since this test is taking place at night with slightly lower wind speeds compared to Test PG4-11, the negative plate temperature gradient obtained may help retain this added thickness (greater viscosity). For Test PG4-11 by contrast, this test is taking place during the day with slightly higher wind speeds. In addition, the initial fluid temperature is above OAT resulting in a thinner fluid layer application (observed at start and throughout the test). The former variables (day testing and slightly higher wind speeds) aid in keeping the plate temperature above or at OAT for the duration of the test. Although the fluid is slightly warmer and could theoretically provide longer protection compared to Test PG4-23, the added "benefit" from the warmer plate temperature gradient does not overcome the combined variable effect of Test PG4-23 which includes the added fluid layer thickness, slightly smaller snowflake (minor effect) and slightly greater variable rate (minor effect) including the below average rate during the last 15 minutes (minor effect).

The fluid concentration for Test PG4-23 also decreases at a slightly slower rate due to the variance in rate and has a lower final value due to the extended duration of the test (smaller snowflake size, below average rate during last 15, thicker fluid layer).

The bare plate including the pad pictures illustrate some evidence of wet snow during Test PG4-23. This may also have a slight effect in decreasing the thickness of the fluid as the added water can dilute the fluid at a faster rate however, this is not evidenced to be substantial for this test. The added water is therefore seen in the rate and in the morphology of the fluid failure. Test PG4-23 may also have been over-failed according to the APS test manager. Nevertheless, removal of some time still results in a longer ET when compared to Test PG4-11. The change in wind direction does not seem to have any effect on Test PG4-23.

Point-to-Point Comparison – PG Type IV Test PG4-20 vs. Test PG4-37

This conclusion was streamlined and put into bullet form; please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- Initial fluid temperature and gradient is cooler for Test PG4-20 than Test PG4-37. There is no evidence that Test PG4-20 resulted in a thicker fluid application. Variable not to be considered.
- Wind speed for Test PG4-37 is much greater than Test PG4-20 using both APS and NCAR data. Minute maximum is also much greater for Test PG4-37. Variable to be considered.
- Test PG4-37 was conducted during the day while Test PG4-20 was performed at night. Variable to be considered.
- Longer time below average rate may have played a role in the extended ET of Test PG4-37. The first half was below average (33 minutes ≈ 56% of test time) while the second half was above average. Test PG4-20 varied somewhat but was more along the average. Variable to be considered (rate variance).
- The rate during the last 15 minutes of Test PG4-37 may have contributed to ending the test since it is significantly greater than the average rate. Last 15 minutes for Test PG4-20 is at average. Variable to be considered.
- Test PG4-37 barometric pressure was significantly lower than Test PG4-20. This is indicative of high wind speeds during the storm and is supported by the NCAR minute maximum data. Variable to be considered.
- Test PG4-20 plate temperature gradient is much cooler than Test PG4-37 due to nighttime testing and lower wind speed including lower minute maximum.
- Test PG4-37 plate temperature gradient is warmer compared to Test PG4-20 due to daytime testing and higher wind speed including greater minute maximum.
- Test PG4-37 fluid thickness is greater throughout the test compared to Test PG4-20 due to the higher wind speed and greater minute maximum.
- The final concentration for Test PG4-37 is lower than Test PG4-20 due to the longer duration of the test provided by the daytime testing and higher wind speed.
- No effect of wind direction on ET of both runs is observed.

Point-to-Point Comparison – PG Type IV Test PG4-44 vs. Test PG4-14

This conclusion was streamlined and put into bullet form; please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- Initial fluid temperature and gradient is cooler for Test PG4-44 than Test PG4-14. Data suggests that Test PG4-44 may have resulted in a thicker fluid application. Test PG4-44 experiences a lower precipitation rate during the first 5 minutes of testing, however, the data shows a slightly thicker or similar fluid thickness. Variable to be considered.
- The OAT is slightly warming for Test PG4-44 (1.5°C) and Test PG4-14 (0.6°C); however, Test PG4-44 is warming at a slightly higher rate. This may positively impact the ET of both Runs (greater for Test PG4-44) to a minor extent. Variable to be considered.
- Wind speed for Test PG4-14 is greater than Test PG4-44 using both APS and NCAR data. Minute maximum is also greater for Run 14. Variable to be considered.
- Test PG4-44 was conducted during the day while Test PG4-14 was performed at night. Variable to be considered.
- The rate during the last 15 minutes of Test PG4-44 is slightly greater than the average rate, however, it is not significant enough to be considered as a variable. The rate in the last 15 minutes for Test PG4-14 is at average. Variable not to be considered.
- Test PG4-14 barometric pressure was lower than Test PG4-44. This is indicative of high wind speeds during the storm and is supported by the NCAR minute maximum data. Variable to be considered.
- The snowflake size for Test PG4-14 is significantly smaller (27%) than Test PG4-44. This has the tendency to extend the ET of the fluid, as is the case. The kurtosis can help explain the flakes on top of other flakes during visual failure (hypothesis). The skewness and range are evidence in support of Test PG4-14 having a smaller snowflake. Variable to be considered.
- The bare plate shows some sign of accumulation on Test PG4-44. This may indicate the presence of wet snow in the form of snow pellets/graupel (see pad pictures) and/or low wind speed. If this wet snow is indeed present, the snow pellets/graupel will melt at a slower rate compared to crystalized snow. This may also explain the linear decrease in concentration of Test PG4-44 compared to the likely parabolic for Test PG4-14. The larger wet snow pellets/graupel particles melt at a slower rate and accumulate more readily on the fluid until failure is reached, decreasing the ET. Variable to be considered.

- Test PG4-44 starting plate temperature is slightly cooler (0.5°C) than Test PG4-14 due to the lower OAT and cooler fluid application. The average plate temperature is also cooler due to the lower OAT & possibly the lower wind speed despite being conducted in the day. This is also evidenced by the lower minute maximum of Test PG4-44. The plate temperature gradient for both runs is approximately the same.
- Test PG4-14 starting plate temperature is slightly warmer (0.5°C) than Test PG4-44 due to both the warmer OAT and fluid application. The average plate temperature is also warmer due to the warmer OAT & possibly the higher wind speed despite being conducted at night. This is also evidenced by the greater minute maximum of Test PG4-14. The plate temperature gradient for both runs is approximately the same.
- Test PG4-14 fluid thickness is greater at the 15 minutes mark compared to Test PG4-44 due to the higher wind speed and greater average precipitation rate during the period leading up to this time (first 15 min). The thickness at fail is NA for Test PG4-14 but has significantly increased for Test PG4-44. This is most likely due to the large snowflakes resting on top of the plate, further influenced by the slightly elevated precipitation rate and lower wind speed (thermal effects).
- No effect of wind direction on ET of both runs is observed.

Point-to-Point Comparison – PG Type IV Test PG4-16 vs. Test PG4-15

For this comparison, the initial fluid temperature gradient is cooler for Test PG4-15 than Test PG4-16. This has the tendency to increase the fluid viscosity on the plate. Therefore, the colder fluid may leave a thicker fluid layer on the plate for Test PG4-15. The high initial rate for Test PG4-15 also contributes to the greater thickness at 5 minutes and this greater thickness is also observed throughout the comparison.

The OAT for Test PG4-15 seems to be slowly warming compared to Test PG4-16 where it is slightly cooling. This also has a minor effect in prolonging the ET for Test PG4-15. The variance in wind speed for Test PG4-16 may slightly contribute to the earlier fail compared to Test PG4-15. The lull in wind speed during the test prevents convective heat transfer to the plate and, therefore, the plate temperature remains cooler for Test PG4-16 than Test PG4-15. This may provide a minor contribution to the earlier fail of Test PG4-16.

The snowflake size also has a minor contribution for this test as Test PG4-16 is approximately 13% smaller than Test PG4-15 which should make the fluid last a longer time however, this is not the case. The rate for the last 15 minutes also plays a factor for the earlier failure of Test PG4-16 (see failure pics). Test PG4-16 has a higher last 15 minutes rate compared to Test PG4-15 which is only slightly above average. This can also be verified with the higher final concentration for Test PG4-16. Hence, the initial warmer fluid temp, wind speed variance, plate temperature gradient, slightly cooling OAT and last 15 minutes rate all contribute to the earlier fail call which the smaller snowflake size can not overcome for Test PG4-16, and by contrast Test PG4-15.

Point-to-Point Comparison – PG Type IV Test PG4-5 vs. Test PG4-14

To begin this comparison, the initial fluid temperature gradient and the available temperature plot for Test PG4-14 indicates that the fluid thicknesses at start are similar. This is also observed in the fluid thickness measurements as they are equal. The day/night testing also shows no significant impact for this test since Test PG4-5 should have a longer ET than Test PG4-14, which is not the case. The rates for both tests (variance) are approximately the same including the rate during the last 15 minutes. Hence, no significant impact is observed from the influence of rate. The variables which remain are the wind speed and snowflake size.

The APS wind speed data suggests that the wind speed may be playing a significant factor for the extended ET of Test PG4-14. However, NCAR sensor data positioned close to the test stands indicate a small difference in the wind speed. This smaller difference in the wind speed does have an impact on the ET however, not as the major contributing factor, but one nonetheless as the minute maximum is considerably much higher than Test PG4-5.

The snowflake size for this comparison is, thus, the major impact factor. Test PG4-14 has a snowflake size approximately 35% smaller than Test PG4-5 (the skewness and range is also to some extent representative of this). A smaller snowflake size tends to extend the ET of the fluid (greater absorption). This is observed in the final comparison pictures where, in this case, the smaller snowflakes impact more of the fluid (greater absorption) and thus for a longer duration resulting in a larger amount of slush on the plate. Due to the latter, the final concentration is also lower when compared to Test PG4-5.

In addition, the negative kurtosis may also suggest that the larger flakes on the fluid nearing the end of a test can prevent the smaller flakes from being absorbed. This hypothesis is difficult to observe in the progression pictures, however, remains plausible especially with such a large difference in snowflake size. The mid fluid thickness is also slightly greater for Test PG4-14 than Test PG4-5 and is also due to the greater amount of slush present. Hence, snowflake size is the greatest contributing factor for the difference in ET while the wind speed is also considered to provide a smaller impact.

Point-to-Point Comparison – PG Type IV Test PG4-16 vs. Test PG4-38

This conclusion was streamlined and put into bullet form; please see other detailed comparisons within this appendix for key hypotheses and theories regarding this project.

- Initial fluid temperature and gradient is cooler for Test PG4-16 than Test PG4-38. There is no evidence that Test PG4-16 resulted in a thicker fluid application. Variable not to be considered.
- The OAT is slightly cooling for Test PG4-16 while Test PG4-38 is constant. This may negatively impact the ET of Run 16 to a minor extent. Variable to be considered.
- Wind speed for Test PG4-38 is much greater than Test PG4-16 using both APS and NCAR data. Minute maximum is also much greater for Test PG4-38. Variable to be considered.
- Test PG4-38 was conducted during the day while Test PG4-16 was performed at night. Variable to be considered.
- Longer time below average rate may have played a role in the extended ET of Test PG4-38. The first half was below average for 20 minutes ≈ 46% of test time, while the second half was above average for 14 minutes ≈ 32%. Test PG4-16 varied somewhat but was more along the average. Variable to be considered (rate variance).
- The rate during the last 15 minutes of Test PG4-38 may have contributed to ending the test since it is significantly greater than the average rate. The rate in last 15 minutes for Test PG4-16 is at average. Variable to be considered.
- Test PG4-38 barometric pressure was significantly lower than Test PG4-16. This is indicative of high wind speeds during the storm and is supported by the NCAR minute maximum data. Variable to be considered.
- Test PG4-16 average plate temperature and gradient is cooler than Test PG4-38 due to nighttime testing and lower wind speed including lower minute maximum.
- Test PG4-38 average plate temperature and gradient is warmer compared to Test PG4-16 due to daytime testing and higher wind speed including greater minute maximum.
- Test PG4-38 fluid thickness is greater throughout the test compared to Test PG4-16 due to the higher wind speed with a lower variance including a greater minute maximum and greater precipitation rate during the last 15 minutes.
- The final concentration for Test PG4-38 is lower than Test PG4-16 due to the longer duration of the test provided by the daytime testing and wind speed.
- No effect of wind direction on ET of both runs is observed.

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