

QUALIFICATION TEST REPORT
FP-13-48
LARGE TRANSPORT TYPE JET
AIRCRAFT AERODYNAMIC TESTING
OF THE CANDIDATE TYPE I FLUID

Arctica DG91 Concentrate
lot # 11

Produced at Tatarstan, Russia

for
ARCTON LTD.
P.O. Box 1079
GO 11, Nizhnekamsk
423570, Tatarstan, Russia

by
Diane Paradis
Marc Mario Tremblay



QUALIFICATION

This report presents results of high speed ramp aerodynamic acceptance tests, using Boundary Layer Displacement Thickness (BLDT) values, performed on samples of the candidate Type I fluid **ARCTON LTD. Arctica DG91 Concentrate lot # 11**, produced at **Tatarstan, Russia**, evaluated diluted with ASTM D1193 TYPE IV water according to the latest revisions of the SAE AMS 1424K specification and AS5900B standard [1-3]. The tests were performed between 0°C and -32.1°C within a $\pm 2^\circ\text{C}$ range, using the flat plate set-up in the Luan Phan refrigerated wind tunnel at the Anti-icing Materials International Laboratory (AMIL) research laboratory. AMIL is independent of fluid manufacturers and was found qualified on September 11, 1997 (reconfirmed September 13, 2012) by the Performance Review Institute according to PRI document AC3001, “audit criteria for compliance to SAE AMS 1424 and AMS 1428”.

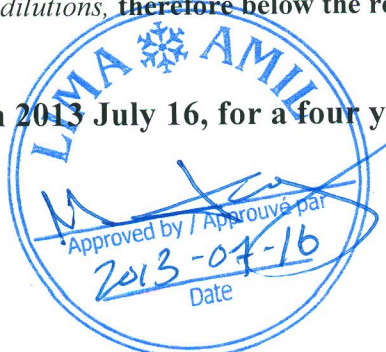
On the basis of the acceptance criteria, the candidate Type I fluid ARCTON LTD. Arctica DG91 Concentrate lot # 11 qualifies according to AMS 1424K specification for use on large transport type jet aircraft in the following temperature ranges:

- above -31.5°C in the case of the 75/25 dilution,
- above -20°C in the case of the 50/50 dilution.

Final Fluid Thickness (paragraph 3.5.3.1)

The final fluid thickness, based on an initial thickness of 2000 μm , was measured to be from 33 μm to 211 μm for all dilutions, therefore below the required 400 μm .

This fluid is qualified from 2013 July 16, for a four year period.



This page left blank.

TABLE OF CONTENTS

QUALIFICATION	i
LIST OF TABLES	iv
LIST OF FIGURES	iv
LIST OF SYMBOLS.....	v
TEST RESULTS	1
TEST DESCRIPTION.....	21
1. INTRODUCTION.....	23
2. TEST DESCRIPTION	23
2.1 Flat Plate Elimination Test	23
2.2 Measurements.....	25
2.3 Calibration and Acceptance Criteria	25
3. TEST RESULTS	26
3.1 Test Presentation	26
3.2 Calculation of the Calibration and Acceptance Criteria.....	27
3.3 Flat Plate Elimination Tests.....	32
4. REFERENCES	32
ATTACHMENT 1.....	33
ATTACHMENT 2.....	37
ACCREDITATION.....	99

LIST OF TABLES

Table 1 - Fluid Identification.....	3
Table 2 - Apparent Surface Tension, pH and Refractive Index	3
Table 3 - Brookfield Viscosity (mPa·s).....	5
Table 4 - Aerodynamic Performance Test Data: 75/25 Dilution	7
Table 5 - Aerodynamic Performance Test Data: 50/50 Dilution	9
Table 6 - Refractive Index Data and Water Change: 75/25 Dilution.....	17
Table 7 - Refractive Index Data and Water Change: 50/50 Dilution.....	17
Table 8 - Viscosity Measurement Details	26
Table 9 - Dry Test Data	28
Table 10 - Aerodynamic Performance Test Data : Reference Fluid	29
Table 11 - Refractive Index Data and Water Change: Reference Fluid.....	30

LIST OF FIGURES

Figure 1 - Aerodynamic Test Results.....	11
Figure 2 - Fluid Elimination	13
Figure 3 - Relative Humidity.....	15
Figure 4 - Refractive Index versus Water Content.....	19
Figure 5 - FPET Set-up.....	24
Figure 6 - Take-off Ground Acceleration Simulation	24
Figure 7 - Acceptance Criteria	31

LIST OF SYMBOLS

δ_{ave}^*	average Boundary Layer Displacement Thickness (BLDT) over the test section perimeter at cross-section 3 (Figure 5) evaluated by the equation 2 in Attachment 1, (mm)
δ^*	Boundary Layer Displacement Thickness (BLDT) over the test section perimeter at cross-section 3 (Figure 5) evaluated by the equation 3 in Attachment 1 (mm)
AIR	Aerospace Information Report
AMIL	Anti-icing Materials International Laboratory
AMS	Aerospace Material Specification
AS	Aerospace Standard
FE	Fluid Elimination during the test (%)
FP	Flat Plate elimination test identification number
FPC	Flat Plate Calibration test identification number
FPD	Flat Plate elimination test Dry (without fluid)
FPET	Flat Plate Elimination Test
P	Static Pressure as measured by gauges positioned at points # 1, 2 and 3 in the set-up (Figure 5) (mPa)
Rh	Relative humidity (%)
SAE	Society of Automotive Engineers
t	Thickness of the film fluid on the plate (μm)
T_a	Air Temperature as recorded at the top of the cross-section 2 in the set up (Figure 5) ($^{\circ}\text{C}$)
T_f	Fluid Temperature as recorded in the fluid film at the bottom of the cross-section 3 (Figure 5) ($^{\circ}\text{C}$)
UQAC	University of Quebec at Chicoutimi
V	Air Velocity derived from the measurement of the pressure difference $P_1 - P_2$ using the equation (1) in Attachment 1 (m/s)
WC	Water Change (% w/w)

This page left blank.

TEST RESULTS

This page left blank.

Table 1 - Fluid Identification

Company Name	Product	Color	Manufacture Location	Manuf. Date	AMIL Label	Recep. Date
ARCTON LTD.	Arctica DG91 Concentrate lot # 11 NEAT	Orange	Tatarstan, Russia	March 2013	J159	13-06-10
ARCTON LTD.	Arctica DG91 Concentrate lot # 11 75/25	Orange	Tatarstan, Russia	March 2013	J160	13-06-10
ARCTON LTD.	Arctica DG91 Concentrate lot # 11 50/50	Orange	Tatarstan, Russia	March 2013	J161	13-06-10
AMIL	Reference Fluid* lot # 20130703	Colorless	Saguenay, Quebec (Canada)	13-07-03	M116	13-07-03

Table 2 - Apparent Surface Tension, pH and Refractive Index

**DEICING FLUID ARCTON LTD.
Arctica DG91 Concentrate, lot # 11**

Fluid	Apparent Surface Tension (± 0.5)		pH (± 0.1)		Refractive Index (± 0.0002)	
	T (°C)	dynes/cm	T (°C)	Value	T (°C)	Value
<i>J160</i>	22	39.1	22	8.8	20	1.4131
<i>J161</i>	22	36.5	22	8.3	20	1.3884
<i>M116</i>	not measured	not measured	not measured	not measured	20	1.4278

* For the reference fluid formulation, refer to AS5900B paragraph 2.1.3 for the high speed ramp tests.

This page left blank.

Table 3 - Brookfield Viscosity (mPa·s)

**DEICING FLUID ARCTON LTD.
Arctica DG91 Concentrate, lot # 11**

Fluid	Temp (°C)	0.3 RPM			6 RPM			30 RPM		
		Viscosity	Accuracy	Spindle #	Viscosity	Accuracy	Spindle #	Viscosity	Accuracy	Spindle #
J160	20	< 20	200	1	11	10	1	11.0	2	1
	0	40	200	1	30	10	1	30.0	2	1
	-10	60	200	1	53	10	1	53.2	2	1
	-20	120	200	1	116	10	1	116.2	2	1
	-30	300	1000	2	275	50	2	276	10	2

Fluid	Temp (°C)	0.3 RPM			6 RPM			30 RPM		
		Viscosity	Accuracy	Spindle #	Viscosity	Accuracy	Spindle #	Viscosity	Accuracy	Spindle #
J161	20	< 20	200	1	5	10	1	5.0	2	1
	0	< 20	200	1	11	10	1	11.0	2	1
	-10	20	200	1	18	10	1	18.0	2	1
	-20	40	200	1	30	10	1	30.0	2	1

Fluid	Temp (°C)	0.3 RPM			6 RPM			30 RPM		
		Viscosity	Accuracy	Spindle #	Viscosity	Accuracy	Spindle #	Viscosity	Accuracy	Spindle #
M116	20	40	200	1	34	10	1	34.0	2	1
	0	160	200	1	155	10	1	155.0	2	1
	-10	400	200	1	398	10	1	398	10	2
	-20	1 600	1000	2	1 590	50	2	1 584	40	3
	-30	3 900	1000	2	3 985	50	2	3 968	40	3

For additional viscosity details, see Table 8.

This page left blank.

Table 4 - Aerodynamic Performance Test Data: 75/25 Dilution

DEICING FLUID ARCTON LTD.
Arctica DG91 Concentrate, lot # 11

HIGH SPEED RAMP

TEST CODE	T _a °C	T _f °C	Rh %	t ₀ ⁽¹⁾ μm	t _{end} ⁽²⁾ μm	FE ⁽³⁾ %	WC ⁽⁴⁾ %	V ⁽⁵⁾ m/s	δ* mm
J160A117	-0.6	0.3	88.2	2000	84	95.8	9.77*	67.3	3.88
J160A116	-0.7	0.1	87.3	2000	76	96.2	9.11*	67.0	3.92
J160A118	-0.9	0.1	87.5	2000	76	96.2	9.24*	67.3	3.83
J160C134	-10.6	-9.6	72.7	1933	119	93.8	2.99*	66.9	4.51
J160C135	-10.8	-10.1	72.5	2000	127	93.5	3.39*	66.9	4.37
J160C136	-11.2	-10.5	71.5	2000	135	93.2	3.39*	67.2	4.71
J160E144	-21.5	-21.5	62.5	1800	170	90.5	24.87*	66.8	5.90
J160E145	-22.0	-21.7	60.0	1800	178	90.1	1.30	67.8	5.96
J160E146	-22.4	-21.9	58.7	1800	160	91.1	0.91	67.4	6.01
J160G161	-33.1	-31.2	52.2	1800	203	88.7	0.52	67.6	8.41
J160G162	-33.7	-31.5	53.2	1800	211	88.3	0.52	67.1	8.76
J160G160	-33.9	-32.1	49.6	1800	196	89.1	0.52	67.5	8.59

*caution : value outside the ± 2% range

Acceptance Criteria :

D₀ = 8.51 mm D₋₁₀ = 9.30 mm D₋₁₅ = 9.70 mm D₋₂₀ = 10.09 mm

(1) Thickness of the fluid measured at the beginning of the test.

(2) Thickness of the fluid measured at the end of the test.

(3) Fluid Elimination.

(4) Water Change.

(5) Air velocity 30 seconds after the beginning of the test.

This page left blank.

Table 5 - Aerodynamic Performance Test Data: 50/50 Dilution**DEICING FLUID ARCTON LTD.****Arctica DG91 Concentrate, lot # 11****HIGH SPEED RAMP**

TEST CODE	T _a °C	T _f °C	Rh %	t ₀ ⁽¹⁾ μm	t _{end} ⁽²⁾ μm	FE ⁽³⁾ %	WC ⁽⁴⁾ %	V ⁽⁵⁾ m/s	δ* mm
J161A119	-0.6	-0.2	88.5	2000	43	97.8	11.05*	66.1	3.36
J161A121	-0.6	-0.3	88.9	2000	43	97.8	10.88*	66.6	3.28
J161A120	-0.8	-0.4	87.8	2000	33	98.3	9.84*	66.4	3.33
J161C137	-10.7	-10.6	73.4	2067	51	97.5	2.07*	66.8	3.43
J161C138	-10.8	-10.6	73.4	2067	51	97.5	2.25*	66.3	3.44
J161C139	-11.2	-10.8	72.3	2067	69	96.7	2.25*	66.8	3.42
J161E149	-21.8	-19.7	60.4	2000	102	94.9	-0.35	66.7	3.90
J161E148	-21.6	-20.1	61.2	2000	102	94.9	0.00	67.6	3.82
J161E147	-22.6	-20.9	58.6	2067	135	93.5	-0.35	66.9	3.81

*caution : value outside the ± 2% range

Acceptance Criteria :D₀ = 8.51 mm D₋₁₀ = 9.30 mm D₋₁₅ = 9.70 mm D₋₂₀ = 10.09 mm

(1) Thickness of the fluid measured at the beginning of the test.

(2) Thickness of the fluid measured at the end of the test.

(3) Fluid Elimination.

(4) Water Change.

(5) Air velocity 30 seconds after the beginning of the test.

This page left blank.

ARCTON LTD.
Arctica DG91 Concentrate, lot # 11

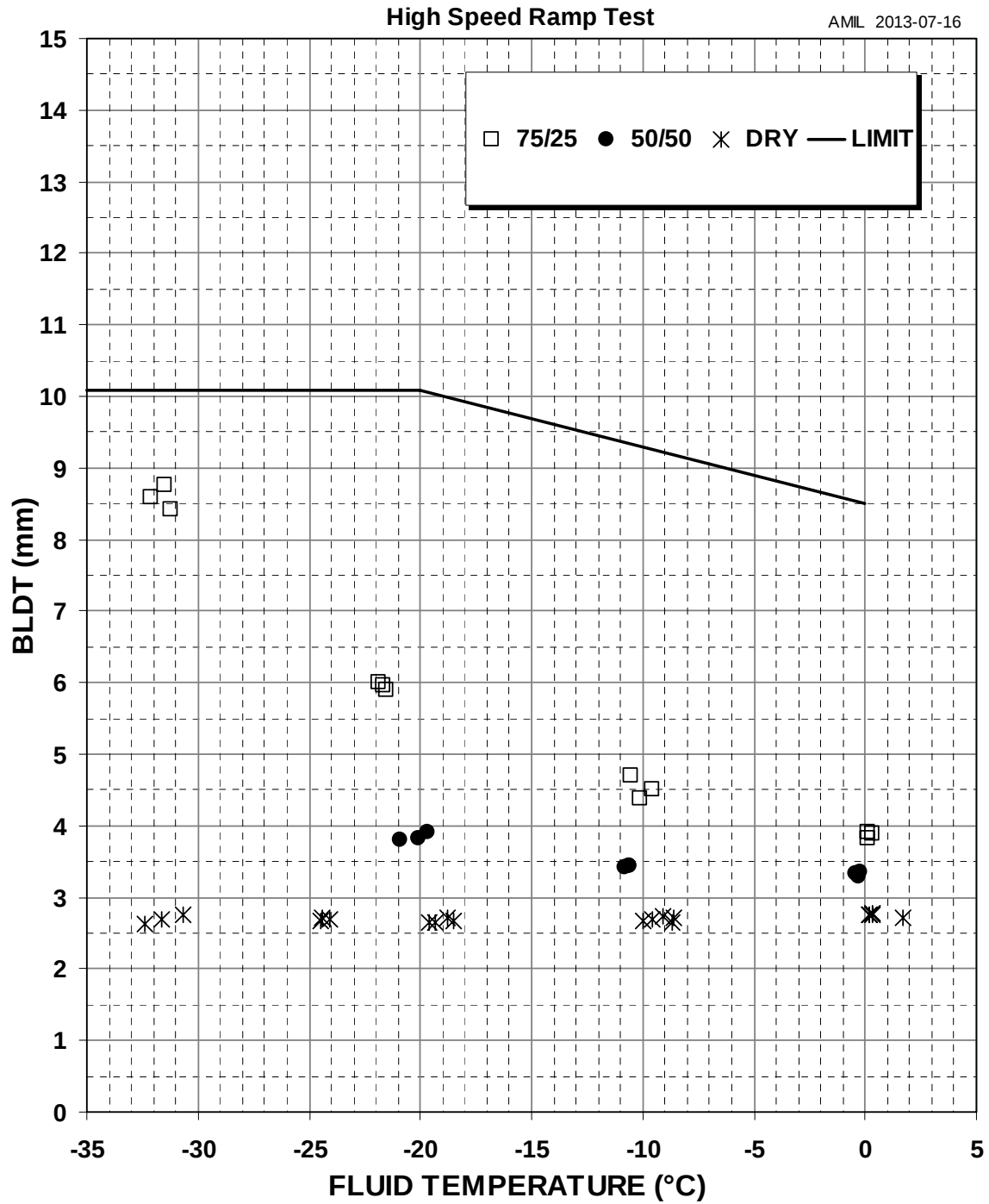


Figure 1 - Aerodynamic Test Results

This page left blank.

ARCTON LTD.
Arctica DG91 Concentrate, lot # 11

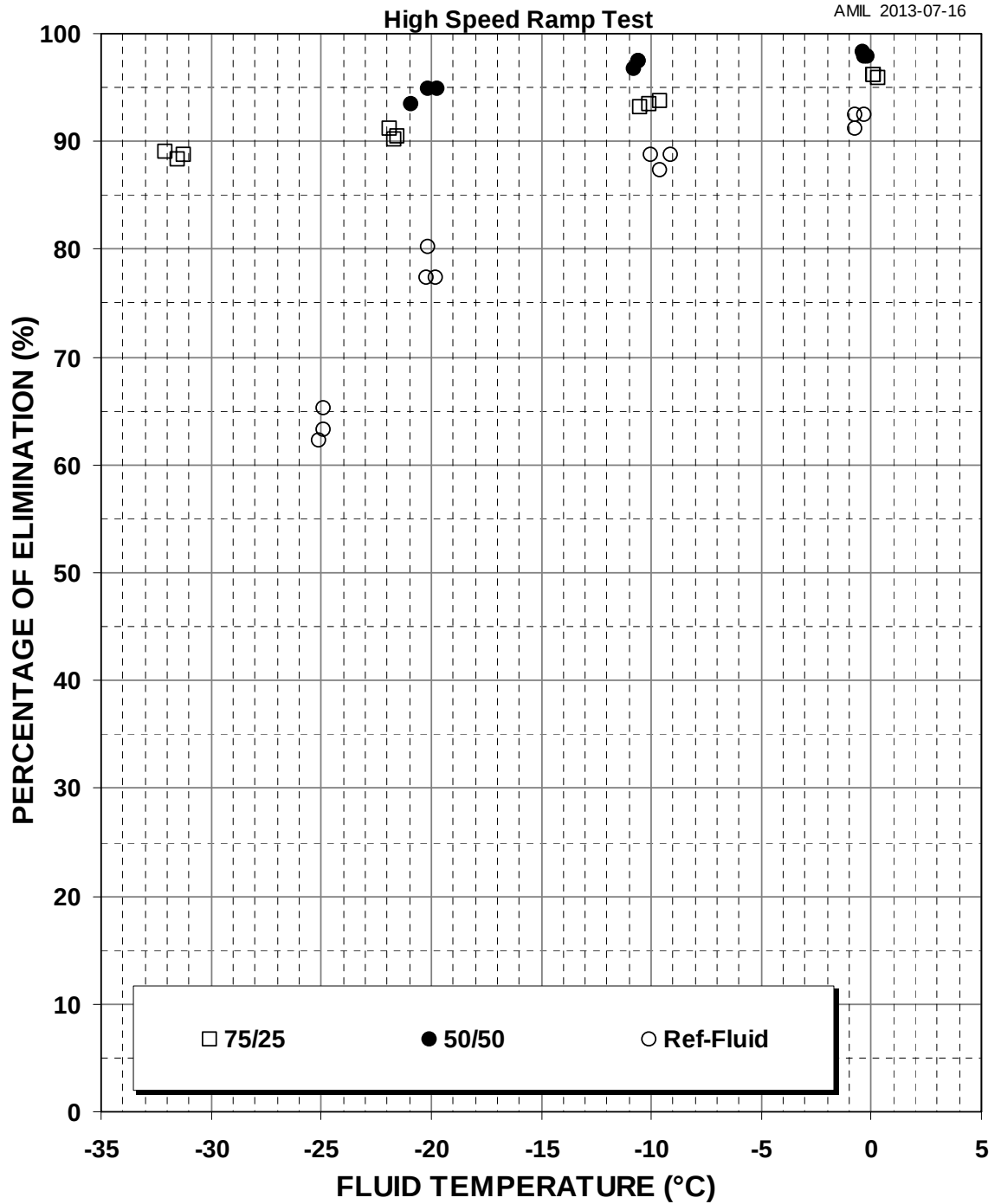


Figure 2 - Fluid Elimination

This page left blank.

ARCTON LTD.

Arctica DG91 Concentrate, lot # 11

High Speed Ramp Test

AMIL 2013-07-16

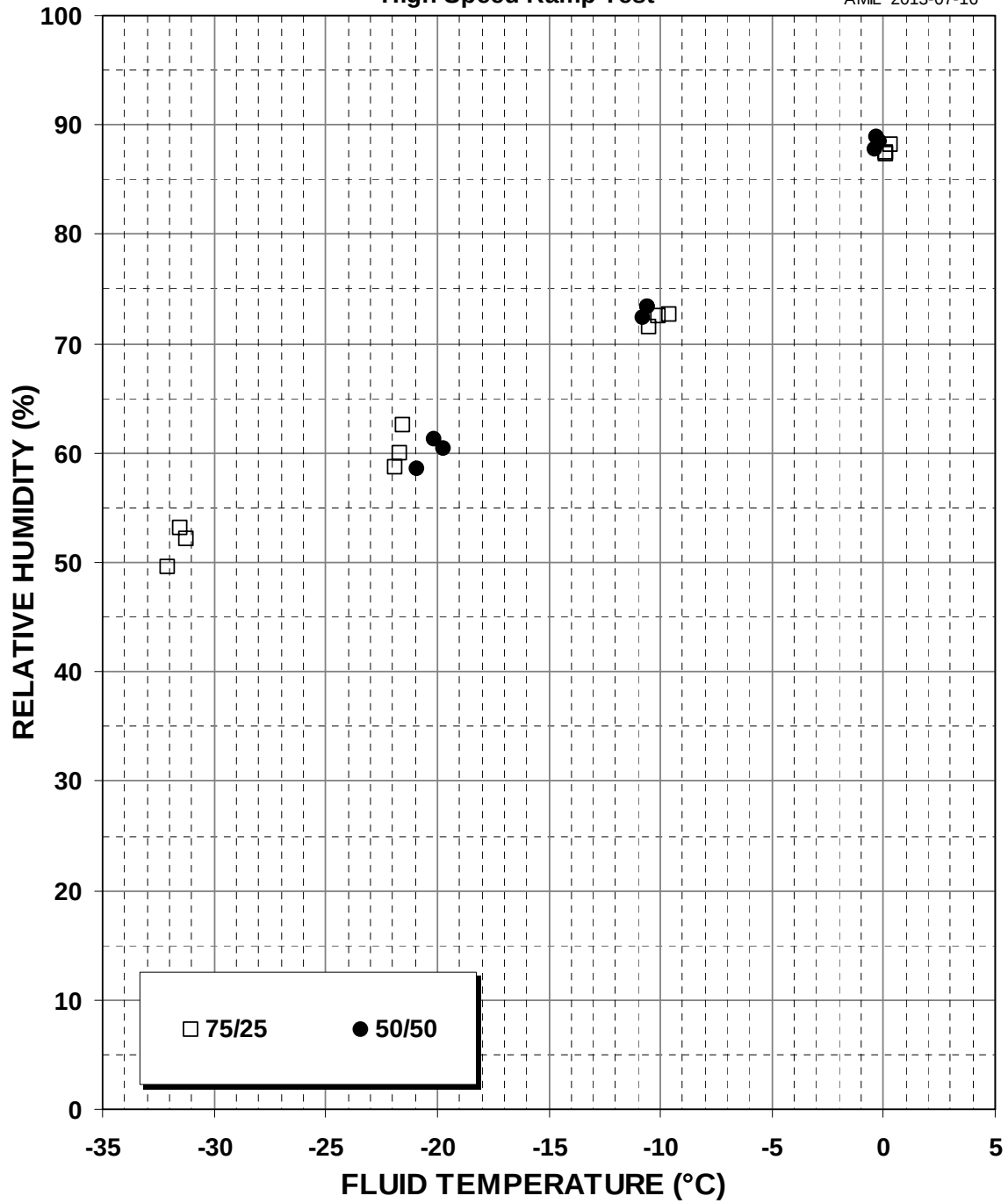


Figure 3 - Relative Humidity

This page left blank.

Table 6 - Refractive Index Data and Water Change: 75/25 Dilution**DEICING FLUID ARCTON LTD.
Arctica DG91 Concentrate, lot # 11**

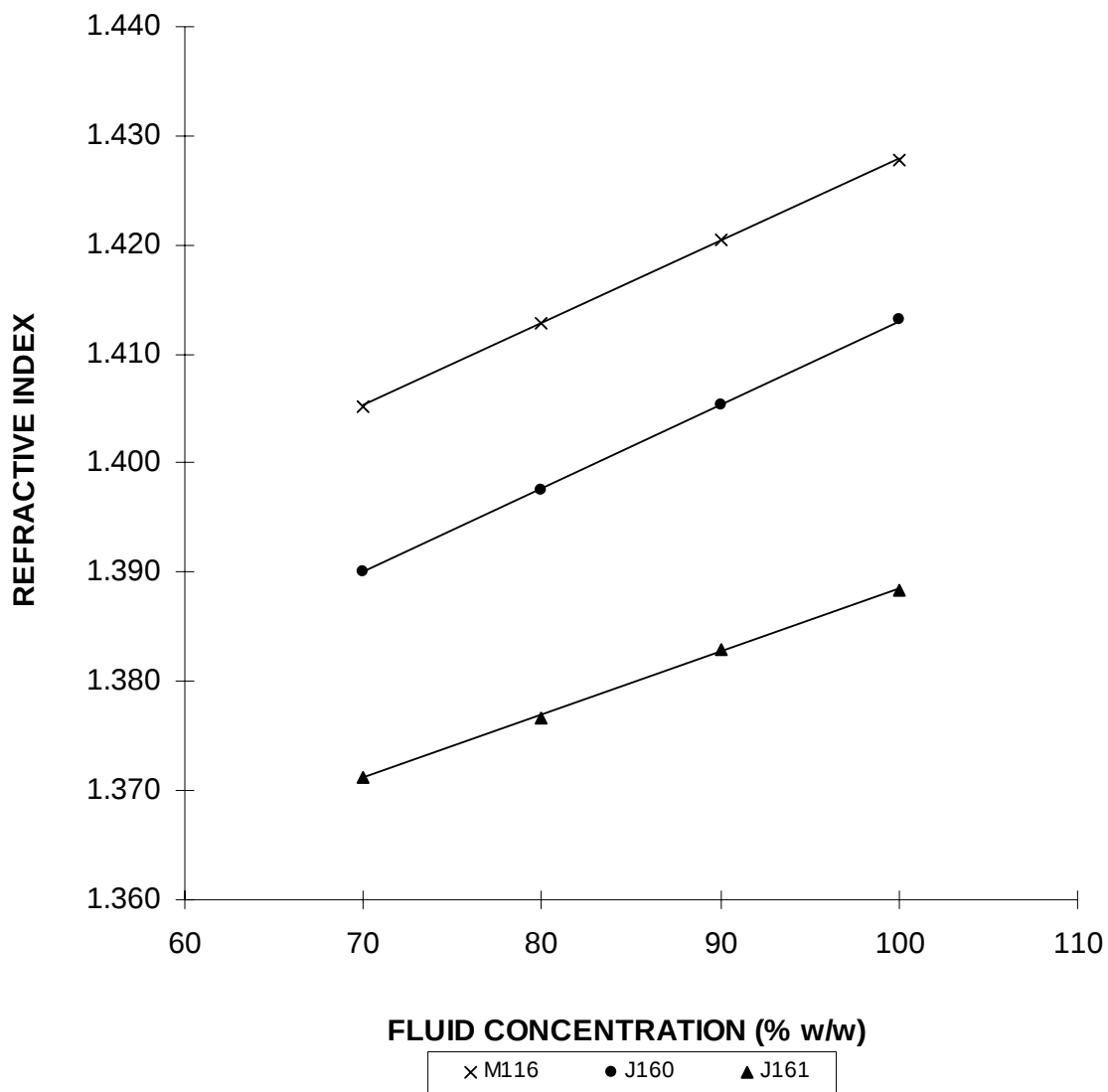
TEST CODE	RI Initial	RI Final	Δ RI	WC % W/W	Rh %
J160A117	1.4148	1.4073	-0.0075	9.77*	88.2
J160A116	1.4149	1.4079	-0.0070	9.11*	87.3
J160A118	1.4147	1.4076	-0.0071	9.24*	87.5
J160C134	1.4147	1.4124	-0.0023	2.99*	72.7
J160C135	1.4148	1.4122	-0.0026	3.39*	72.5
J160C136	1.4148	1.4122	-0.0026	3.39*	71.5
J160E144	1.4148	1.3957	-0.0191	24.87*	62.5
J160E145	1.4147	1.4137	-0.0010	1.30	60.0
J160E146	1.4145	1.4138	-0.0007	0.91	58.7
J160G161	1.4146	1.4142	-0.0004	0.52	52.2
J160G162	1.4147	1.4143	-0.0004	0.52	53.2
J160G160	1.4148	1.4144	-0.0004	0.52	49.6

*caution : value outside the $\pm 2\%$ range**Table 7 - Refractive Index Data and Water Change: 50/50 Dilution****DEICING FLUID ARCTON LTD.
Arctica DG91 Concentrate, lot # 11**

TEST CODE	RI Initial	RI Final	Δ RI	WC % W/W	Rh %
J161A119	1.3890	1.3826	-0.0064	11.05*	88.5
J161A121	1.3887	1.3824	-0.0063	10.88*	88.9
J161A120	1.3887	1.3830	-0.0057	9.84*	87.8
J161C137	1.3887	1.3875	-0.0012	2.07*	73.4
J161C138	1.3887	1.3874	-0.0013	2.25*	73.4
J161C139	1.3887	1.3874	-0.0013	2.25*	72.3
J161E149	1.3886	1.3888	0.0002	-0.35	60.4
J161E148	1.3886	1.3886	0.0000	0.00	61.2
J161E147	1.3886	1.3888	0.0002	-0.35	58.6

*caution : value outside the $\pm 2\%$ range

This page left blank.



M116: RI = 0.000754 % w/w + 1.352510

J160 : RI = 0.000768 % w/w + 1.336270

J161 : RI = 0.000579 % w/w + 1.330610

BASIS : 100% w/w corresponds to NEAT fluid

Figure 4 - Refractive Index versus Water Content

This page left blank.

TEST DESCRIPTION

This page left blank.

1. INTRODUCTION

This report details the performance of fluid samples, identified in Table 1, when subjected to the Flat Plate Elimination Test, denoted FPET hereafter. The FPET procedure follows the SAE Aerospace Material Specifications, AMS 1424K [2] and Aerospace Standard AS5900B [3] for deicing fluid on the high speed ramp. The tests were carried out in the Luan Phan refrigerated wind tunnel of the "Anti-icing Materials International Laboratory" (AMIL) at the "Université du Québec à Chicoutimi" (UQAC) [4]. UQAC facility is operated independently from fluid manufacturers and meets the requirements of the aerodynamic acceptance testing standards. It was found qualified on September 11, 1997 (reconfirmed September 13, 2012) by the Performance Review Institute according to PRI document AC3001, "audit criteria for compliance to SAE AMS 1424 and AMS 1428".

2. TEST DESCRIPTION

2.1 Flat Plate Elimination Test

This test is designed to measure the Boundary Layer Displacement Thickness, BLDT, which is related to lift loss [5]. The flat plate set-up consists of a duct inserted in the test section of AMIL refrigerated wind tunnel. In this tunnel, the airflow and the fluid can be maintained at a constant temperature, between $5^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and $-45^{\circ}\text{C} \pm 2^{\circ}\text{C}$. A set-up sketch is given in Figure 5.

The FPET procedure consists in submitting a 2 mm thick layer of deicing product covering the duct floor to an accelerating air flow of 2.6 m/s^2 , simulating a large transport-type aircraft take-off (Figure 6). The BLDT on the flat plate is measured at pressure tap location # 3 (Figure 5), thirty seconds after the beginning of the simulated take-off. A detailed description of this test is presented in AS5900B [3].

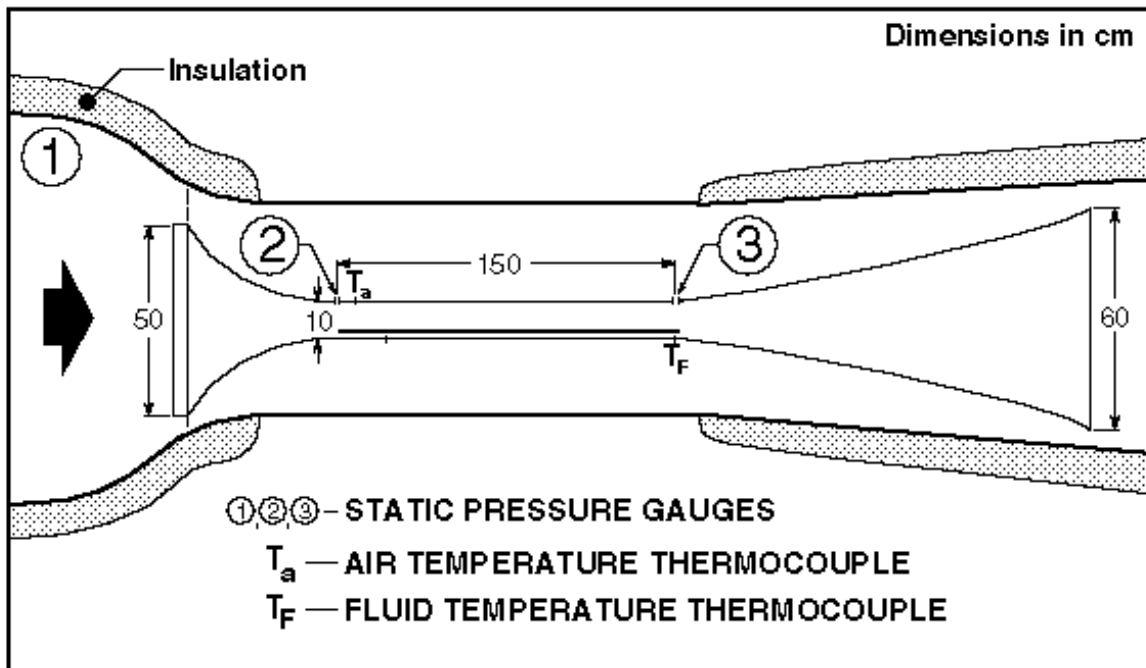


Figure 5 - FPET Set-up

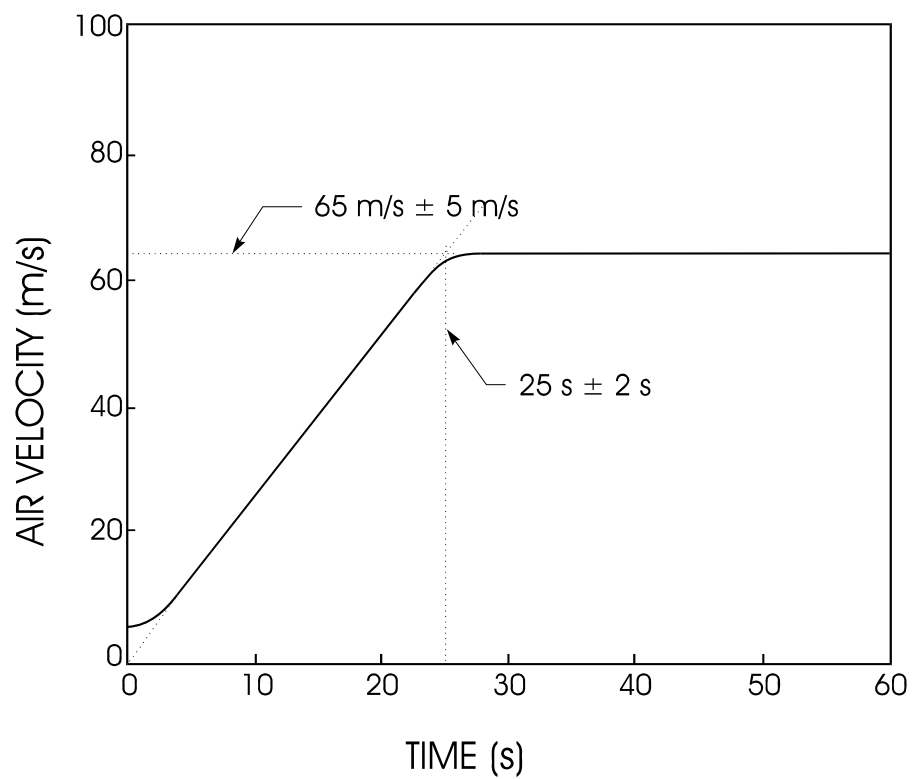


Figure 6 - Take-off Ground Acceleration Simulation

2.2 Measurements

In a FPET, the fluid performance is evaluated from BLDT measurements. The BLDT value used for the fluid evaluation is the average of the BLDT measured between the 27th and the 33rd seconds after the beginning of the test. The starting time ($t = 0$) is evaluated by extrapolating the straight line of the acceleration ramp to the point where $V = 0$ m/s.

In addition, the following parameters are measured:

1. **apparent surface tension at room temperature (dynes/cm)**

Apparent Surface Tension measured with a DuNouy precision tensiometer, CSC Scientific Company Inc., model No. 70535, using a 5.992 cm pulling ring.

2. **pH at room temperature**

pH values measured with a Fisher Accumet pHmeter, Fisher Scientific Company, model 925, using a pHRESH, Flow-On-Demand Epoxy Body Combination pH Electrode, Beckman, model 511110.

3. **refractive index which is used to determine the water change (%)**

Refractive Index measured with a REICHERT AR7 SERIES Refractometer, Reichert, Inc., model AR70.

4. **viscosity at room and test temperatures (mPa . s)**

5. **fluid film thickness (μm) at the beginning and at the end of the FPET to compute fluid elimination (%)**

2.3 Calibration and Acceptance Criteria

The calibration is obtained from dry tests, performed without fluid, and Reference Fluid tests (as described in AS5900B paragraph 2.1.3), for which BLDT results are well documented. The BLDT values obtained from a dry test should be $2.5 \text{ mm} \pm 0.4 \text{ mm}$. For dry and calibration tests, the BLDT values are recorded at four temperatures: 0°C , -10°C , -20°C and -25°C . Reference Fluid BLDT values and dry BLDT values are used to calculate the acceptance criteria required for certification. A candidate fluid is acceptable at a test temperature if none of the independent BLDT measurements is greater than the acceptance criteria. This test temperature is the average of the three lowest temperatures of the acceptable data points.

3. TEST RESULTS

3.1 Test Presentation

The fluid identification is presented in Table 1 and the fluid physical properties in the following tables : Apparent surface tension, pH and refractive index values are given in Table 2 and Brookfield viscosity values in Table 3. FPET results are presented in Table 4 and Table 5. Calibration data from dry tests and tests with the reference fluid are reproduced in Table 9 and Table 10 respectively. Finally, Table 6 and Table 7 present refractive index data and water change calculations. Figure 4 shows the refractive index as a function of water change. Fluid elimination and relative humidity are presented as a function of test temperature in Figure 2 and Figure 3 respectively.

Table 8 - Viscosity Measurement Details

Fluid Type	Measurement Device	Spindle #	Container Description	Sample Volume (ml)	Rotation Duration (min)		
					0.3 RPM	6 RPM	30 RPM
I	LV	1	600 ml Beaker	600	5	5	5
		2		600	5	5	5
		3		550	5	5	5
		4		550	5	5	5
II	SSA	31	13 R (P)	10	30	5	5
III		34	13 R (P)	10	30	5	5
IV		16	8 R (P)	4.2	30	5	5
		18	13 R (P)	8	30	5	5

The viscometers are calibrated yearly by the accredited laboratory CAN-AM Instruments, Ltd. The NIST traceable calibration certificate is available upon request.

3.2 Calculation of the Calibration and Acceptance Criteria

Calibration tests, as defined in section 2.3, consist of dry tests and tests with the Reference Fluid. The dry test results are presented in Table 9. According to specifications [2], the AMIL system is considered adequately calibrated, since the dry test BLDT value (δ^*) varies within the standard range of $2.5 \text{ mm} \pm 0.4 \text{ mm}$. The Reference Fluid results are presented in Table 10. These results are also in agreement with known values. As mentioned in section 2.3, dry and Reference Fluid BLDT values are used to compute the criteria of acceptance, presented below and in Figure 7. Below -20°C , the acceptance envelope is a constant straight line with a BLDT equal to the value D20. Between -20°C and 0°C , the acceptance envelope is a straight line from D20, at -20°C , to D0, at 0°C . The D20 and D0 are calculated accordingly to the AS5900B standard for the high speed ramp:

Calculation of acceptance level at -20°C:	Calculation of acceptance level at 0°C:
$D20 = \delta_{ref}^* - 0.18 \left(\delta_{ref}^* - \delta_{dry}^* \right)_{-20}$	$D0 = \delta_{ref}^* + 0.71 \left(\delta_{ref}^* - \delta_{dry}^* \right)_0$
$D20 = 11.71 - 0.18 \times (11.71 - 2.71) = 10.09 \text{ mm}$	$D0 = 6.10 + 0.71 \times (6.10 - 2.71) = 8.51 \text{ mm}$

Table 9 - Dry Test Data

TEST CODE	T _a (°C)	T _f (°C)	Rh (%)	V ⁽¹⁾ (m/s)	δ_{dry}^* (mm)
DRY_A338	-1.2	1.7	75.2	65.1	2.71
DRY_A339	-0.5	0.3	83.0	65.7	2.77
DRY_A341	-0.5	0.3	87.0	66.4	2.76
DRY_A340	-0.5	0.2	85.2	66.5	2.75
DRY_A342	-0.8	0.2	86.7	66.3	2.75
DRY_C350	-10.5	-8.6	67.5	66.3	2.72
DRY_C352	-10.9	-8.7	69.6	66.5	2.65
DRY_C351	-10.4	-9.1	70.0	65.3	2.73
DRY_C349	-12.0	-9.6	63.3	65.3	2.70
DRY_C353	-11.0	-10.0	73.2	66.2	2.67
DRY_E355	-20.4	-18.5	55.6	65.6	2.68
DRY_E356	-20.8	-18.8	58.3	66.0	2.72
DRY_E357	-22.1	-19.3	62.0	65.8	2.66
DRY_E354	-21.4	-19.6	59.6	65.8	2.66
DRY_F346	-25.4	-24.5	56.3	66.0	2.67
DRY_F348	-27.2	-24.1	54.1	66.2	2.70
DRY_F347	-25.8	-24.4	55.7	65.8	2.72
DRY_G367	-33.7	-30.7	60.3	66.4	2.75
DRY_G366	-33.8	-31.6	53.8	65.8	2.70
DRY_G365	-34.1	-32.4	48.4	66.1	2.62

⁽¹⁾ Air velocity 30 seconds after the beginning of the test

**Table 10 - Aerodynamic Performance Test Data :
Reference Fluid**

TEST CODE	T _a °C	T _f °C	Rh %	t _o ⁽¹⁾ μm	t _{end} ⁽²⁾ μm	FE ⁽³⁾ %	WC ⁽⁴⁾ %	V ⁽⁵⁾ m/s	δ* mm
M116A259	-1.5	-0.3	77.9	1800	135	92.5	7.43*	67.0	6.48
M116A260	-0.7	-0.7	82.4	1800	160	91.1	7.43*	67.2	6.25
M116A261	-0.6	-0.7	87.7	1800	135	92.5	7.96*	67.4	6.34
M116C267	-10.8	-9.1	71.5	1800	203	88.7	2.92*	67.1	8.53
M116C266	-10.6	-9.6	67.4	1800	229	87.3	3.05*	67.3	8.72
M116C265	-11.3	-10.0	65.2	1800	203	88.7	2.52*	67.2	8.65
M116E269	-20.2	-19.8	57.1	1800	406	77.4	0.80	66.1	11.70
M116E268	-20.6	-20.1	57.8	1800	356	80.2	0.80	65.9	11.62
M116E270	-20.9	-20.2	55.4	1800	406	77.4	1.06	66.0	11.79
M116F262	-26.1	-24.9	51.6	1800	627	65.2	0.66	64.9	13.37
M116F263	-26.4	-24.9	50.4	1800	660	63.3	1.59	65.6	13.10
M116F264	-27.0	-25.1	50.8	1800	678	62.3	0.93	65.3	13.08

*caution value outside the ± 2% range

-
- (1) Thickness of the fluid measured at the beginning of the test.
(2) Thickness of the fluid measured at the end of the test.
(3) Fluid Elimination.
(4) Water Change.
(5) Air velocity 30 seconds after the beginning of the test.

**Table 11 - Refractive Index Data and Water Change:
Reference Fluid**

TEST CODE	RI Initial	RI Final	Δ RI	WC % W/W	Rh %
M116A259	1.4277	1.4221	-0.0056	7.43*	77.9
M116A260	1.4276	1.4220	-0.0056	7.43*	82.4
M116A261	1.4277	1.4217	-0.0060	7.96*	87.7
M116C267	1.4276	1.4254	-0.0022	2.92*	71.5
M116C266	1.4277	1.4254	-0.0023	3.05*	67.4
M116C265	1.4275	1.4256	-0.0019	2.52*	65.2
M116E269	1.4275	1.4269	-0.0006	0.80	57.1
M116E268	1.4276	1.4270	-0.0006	0.80	57.8
M116E270	1.4277	1.4269	-0.0008	1.06	55.4
M116F262	1.4277	1.4272	-0.0005	0.66	51.6
M116F263	1.4277	1.4265	-0.0012	1.59	50.4
M116F264	1.4275	1.4268	-0.0007	0.93	50.8

*caution value outside the $\pm 2\%$ range

ARCTON LTD.

Arctica DG91 Concentrate, lot # 11

High Speed Ramp Test

AMIL 2013-07-16

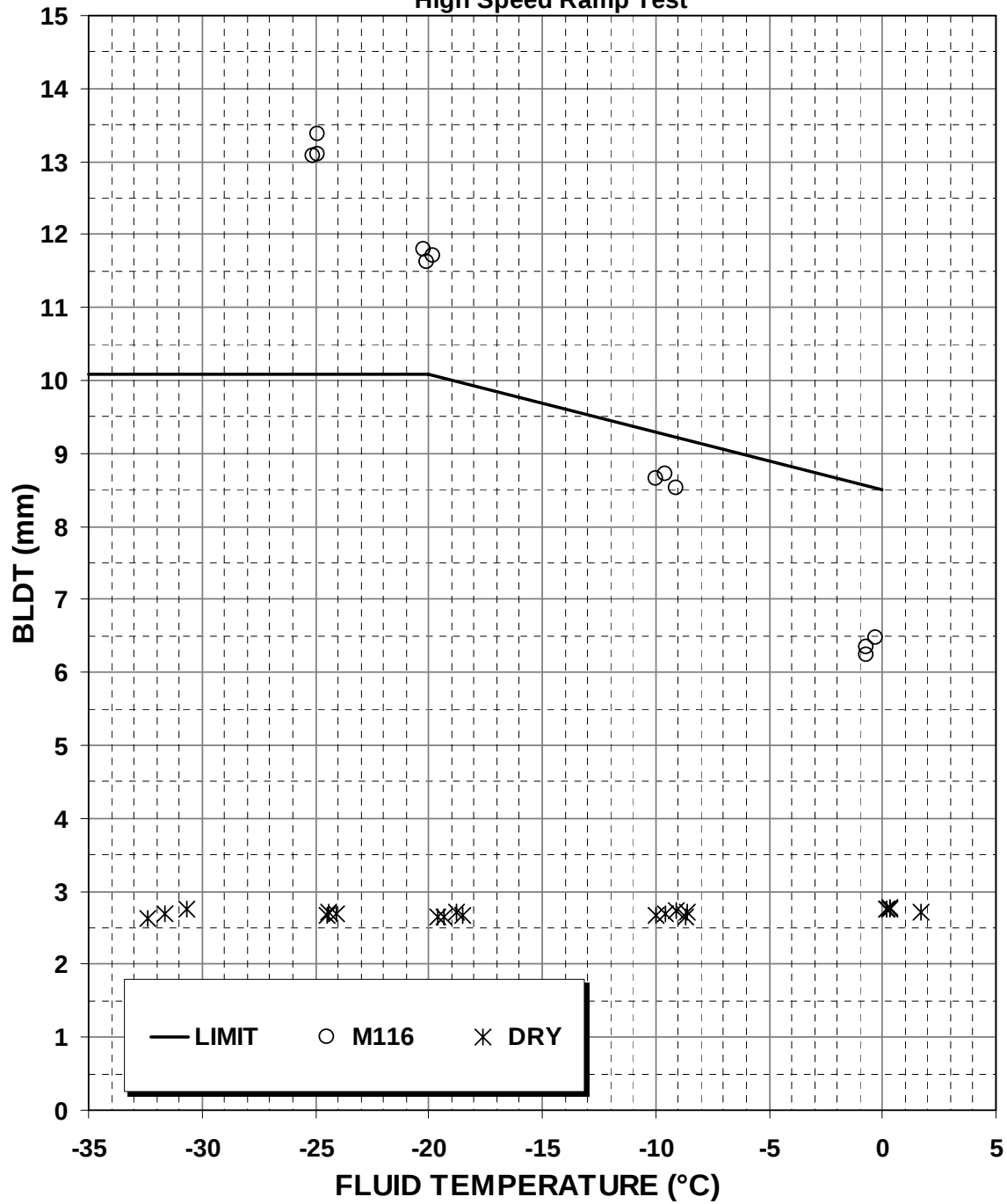


Figure 7 - Acceptance Criteria

3.3 Flat Plate Elimination Tests

BLDT, fluid elimination and water change values are listed in Table 4 and Table 5 for each test. In Figure 1, BLDT values are presented in comparison with the acceptance criteria. This figure shows that the candidate fluid **ARCTON LTD. Arctica DG91 Concentrate lot # 11** is acceptable with the high speed ramp above -31.5°C in the case of the 75/25 dilution, and above -20°C in the case of the 50/50 dilution.

4. REFERENCES

1. *American Society for Testing and Materials "Standard Specification for Reagent Water", ASTM D 1193-06, 2011.*
2. *SAE International Aerospace Material Specification, "Deicing/Anti-icing Fluid, Aircraft, SAE Type I", AMS 1424, revision K, March 2012.*
3. *SAE International Aerospace Standard, "Standard Test Method for Aerodynamic Acceptance of SAE AMS 1424 and SAE AMS 1428 Aircraft Deicing/Anti-icing Fluids", AS5900, revision B, July 1, 2007.*
4. *Laforte, J.-L., P. Louchez, G. Bouchard, and M. Farzaneh, "A Facility to Evaluate Performance of Aircraft Ground De/Anti-Icing Fluids Subjected to Freezing Rain". Cold Regions Science and Technology, 1990. 18: p. 161-171.*
5. *Laforte, J.-L., P. Louchez, and G. Bouchard, "Experimental Evaluation of Flat Plate Boundary Layer Growth over an Anti-Icing Fluid Film". Canadian Aeronautics and Space Journal, 1993. 39(2): p. 96-104.*

ATTACHMENT 1

Measurement Principle*

The time varying velocity at the inlet of the test section will be derived from the measurement of the pressure difference $P_1 - P_2$, recorded as a function of time during all test runs. For such purpose, the following relation, obtained from application of Bernoulli and continuity equations according to usual wind tunnel practice, will be used:

$$V = \sqrt{\frac{2(P_1 - P_2)}{\rho} \left/ \left(1 - \left[\frac{S_2}{S_1} \right]^2 \right) \right.} \quad (1)$$

where ρ is the mass per unit volume of the test gas at the test conditions, and S_1/S_2 is the area ratio of the wind tunnel contraction.

The boundary layer displacement thickness (BLDT) on the bottom flat plate, at the location of the pressure tap P_3 (cross-section 3), will be evaluated from the measurement of the two pressure differences $P_1 - P_2$ and $P_1 - P_3$ recorded as functions of time during all the test runs.

Indeed, an increase in BLDT from inlet to outlet of the test section causes a restriction of the net cross-sectional area, thus producing an increase in the air velocity along the test section, which in turn causes a decrease of static pressure from cross-section 2 to 3.

* This text reproduces Appendix B of DOCUMENT NO D6-55573: "Aerodynamic Acceptance Test for Aircraft Ground Deicing/Anti-icing Fluids". BOEING Commercial Airplane Company.

More precisely, the average BLDT δ_{ave}^* over the test section perimeter, at cross-section 3, will be evaluated using following relation, obtained from application of mass conservation and Bernouilli equations:

$$\delta_{ave}^* = \frac{1}{c} \left[S_3 - S_2 \sqrt{\frac{P_1 - P_2}{(P_1 - P_2) + (P_2 - P_3)}} \right] \quad (2)$$

where c is the test section perimeter at cross-section 3, and S_2 and S_3 are the areas of cross-sections 2 and 3 respectively.

When no fluid is present on the bottom flat plate, all four test section walls are in the same dry state, and the previous expression (2) yields the value of the BLDT on a dry wall:

$$\delta_{dry}^* = \delta_{ave}^* \quad (\text{with no fluid})$$

On the other hand, when the bottom plate of the test section is covered with a layer of de/anti-icing fluid, and the top and sides are not, the BLDT is not constant over the perimeter of the cross-section 3. Indeed, it assumes a value δ^* on the bottom plate and another value on the sides and top wall. Expressing the previously determined δ_{ave}^* as a perimeter-weighted average of δ_{dry}^* and δ^* , the following relation can be obtained:

$$\delta^* = \frac{c}{b} \left[\delta_{ave}^* - \frac{c-b}{c} \delta_{dry}^* \right] \quad (3)$$

where b is the width of the bottom flat plate. This relation will be used to derive the BLDT over a wet surface, δ^* , from the measurement of δ_{ave}^* carried out as explained with fluid on the bottom test section wall, provided an expression for

δ_{dry}^* has been previously determined by a number of "dry" runs, carried out without any fluid in the test section. More precisely, these dry runs, to be made during the setting up and calibration of the facility, will yield the value of δ_{dry}^* and they will be used to determine the constant in the following empirical formula:

$$\delta_{dry}^* = const \times \left[\frac{V}{n} \right]^{-1/5} \quad (4)$$

where V is the tunnel air velocity at cross-section 2 and n is the cinematic viscosity of the test gas at the test conditions. For data reduction of a test with fluid in the test section, this last expression (4) will be used to evaluate, as function of the instantaneous velocity determined by (1), the value of δ_{dry}^* to be used in expression (3).

This page left blank.

ATTACHMENT 2

TEST DATA SHEETS

DRY RUNS 39

RUNS WITH REFERENCE FLUID M116..... 61

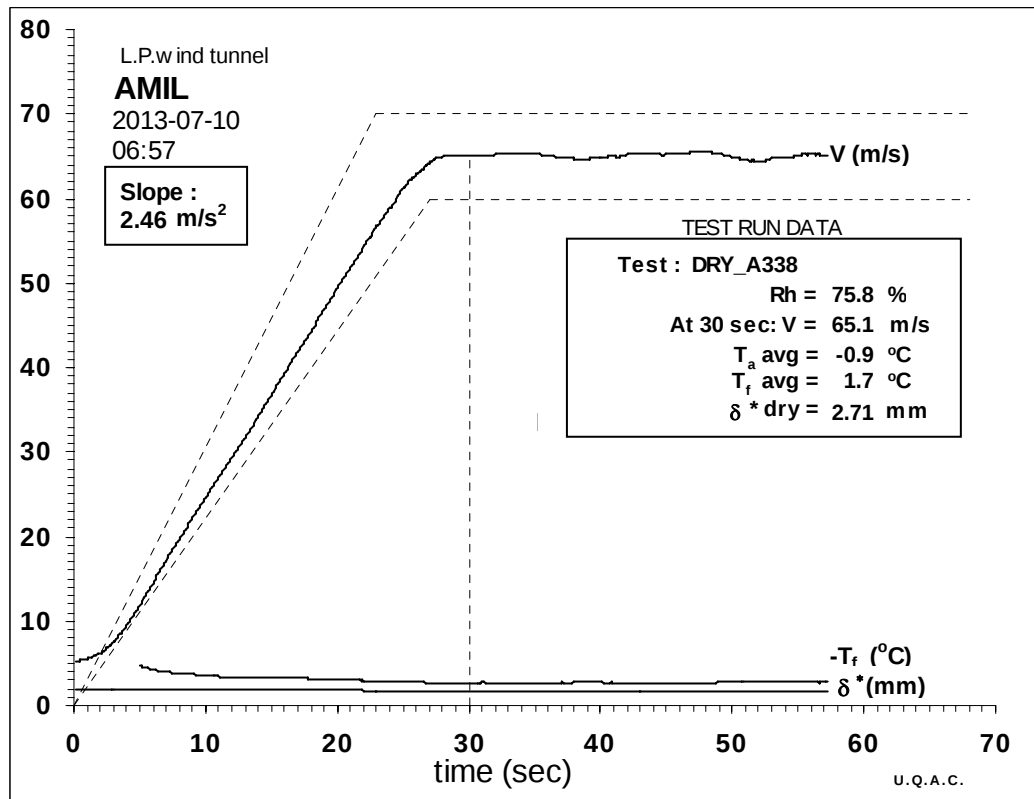
Arctica DG91 Concentrate lot # 11, 75/25 Dilution J-160 75

Arctica DG91 Concentrate lot # 11, 50/50 Dilution J-161 89

This page left blank.

DRY RUNS

DRY_A338



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-1.2	1.7	74.7	10.92	65.2	-0.19	2.62
28	-1.2	1.7	74.7	10.70	64.5	-0.12	2.74
29	-1.2	1.7	75.2	11.15	65.8	-0.17	2.66
30	-1.2	1.7	75.2	10.80	64.8	-0.09	2.79
31	-1.2	1.7	75.1	10.90	65.1	-0.18	2.64
32	-1.1	1.7	75.7	10.83	64.9	-0.13	2.72
33	-1.2	1.7	75.5	10.98	65.3	-0.11	2.76

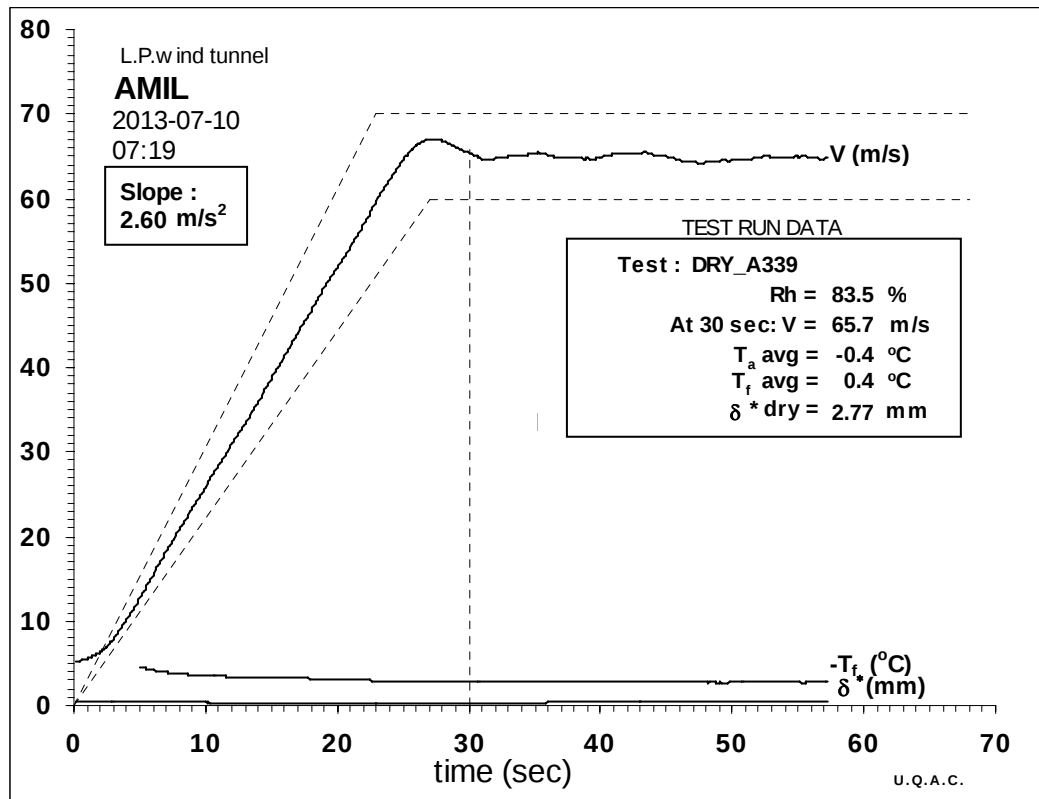
Averages between 27 and 33 seconds:

30	-1.2	1.7	75.2	10.89	65.1	-0.14	2.71
----	------	------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_A339



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.5	0.4	83.1	11.91	68.1	-0.13	2.74
28	-0.5	0.3	82.9	11.79	67.8	-0.14	2.72
29	-0.5	0.3	83.0	11.24	66.2	-0.09	2.80
30	-0.5	0.3	83.1	10.69	64.5	-0.08	2.80
31	-0.5	0.4	83.2	10.67	64.5	-0.12	2.73
32	-0.5	0.3	83.1	10.85	65.0	-0.11	2.75
33	-0.5	0.4	83.0	10.62	64.3	-0.03	2.88

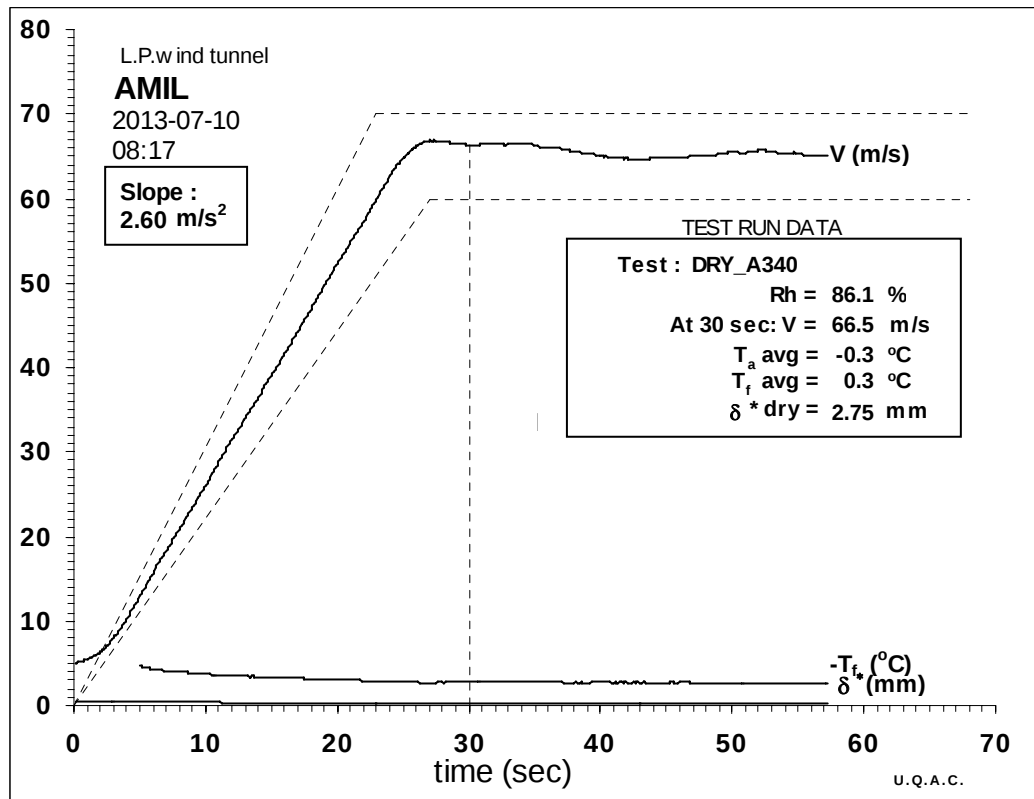
Averages between 27 and 33 seconds:

30	-0.5	0.3	83.0	11.08	65.7	-0.10	2.77
----	------	------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_A340



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.6	0.2	85.0	11.33	66.4	-0.10	2.77
28	-0.6	0.2	84.9	11.49	66.9	-0.16	2.68
29	-0.5	0.2	85.1	11.23	66.2	-0.10	2.77
30	-0.5	0.2	85.5	11.33	66.4	-0.11	2.76
31	-0.5	0.2	85.3	11.36	66.5	-0.11	2.76
32	-0.5	0.2	85.4	11.24	66.2	-0.11	2.77
33	-0.5	0.2	85.3	11.41	66.7	-0.12	2.74

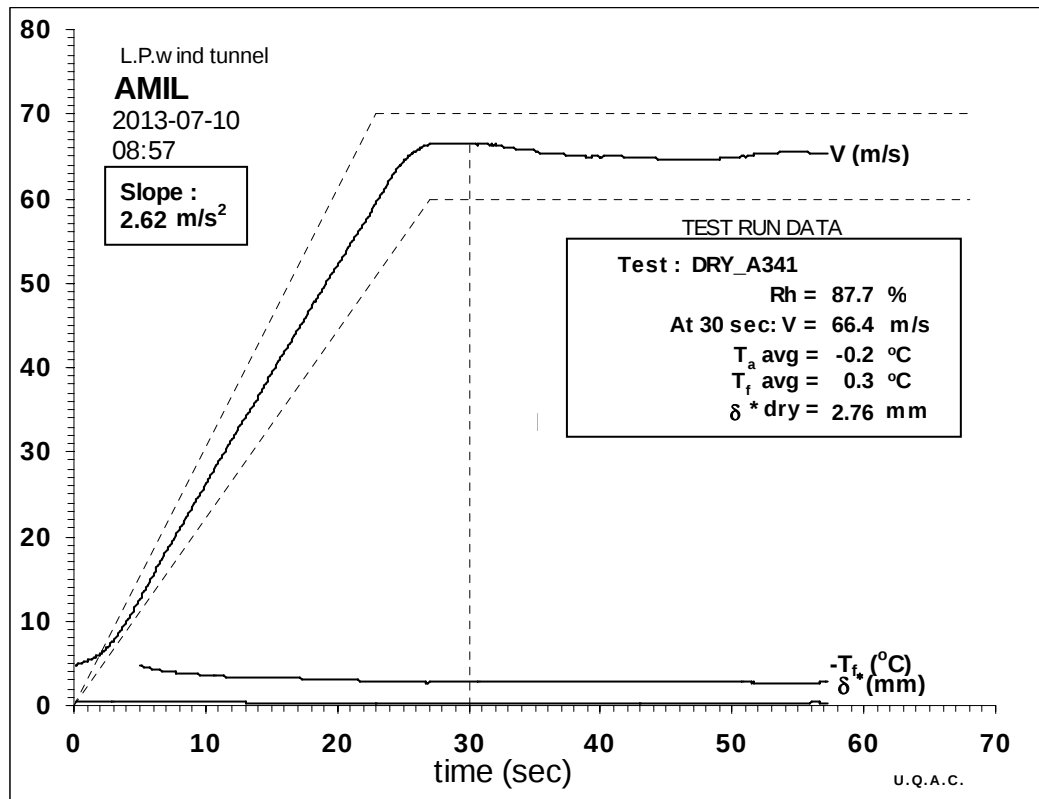
Averages between 27 and 33 seconds:

30	-0.5	0.2	85.2	11.34	66.5	-0.12	2.75
----	------	------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_A341



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ * mm
27	-0.5	0.3	86.5	11.29	66.3	-0.12	2.75
28	-0.5	0.3	86.6	11.23	66.1	-0.13	2.73
29	-0.5	0.3	87.0	11.40	66.6	-0.09	2.79
30	-0.5	0.3	87.0	11.32	66.4	-0.08	2.82
31	-0.5	0.3	87.2	11.42	66.7	-0.11	2.76
32	-0.5	0.4	87.2	11.12	65.8	-0.14	2.72
33	-0.4	0.3	87.1	11.42	66.7	-0.11	2.76

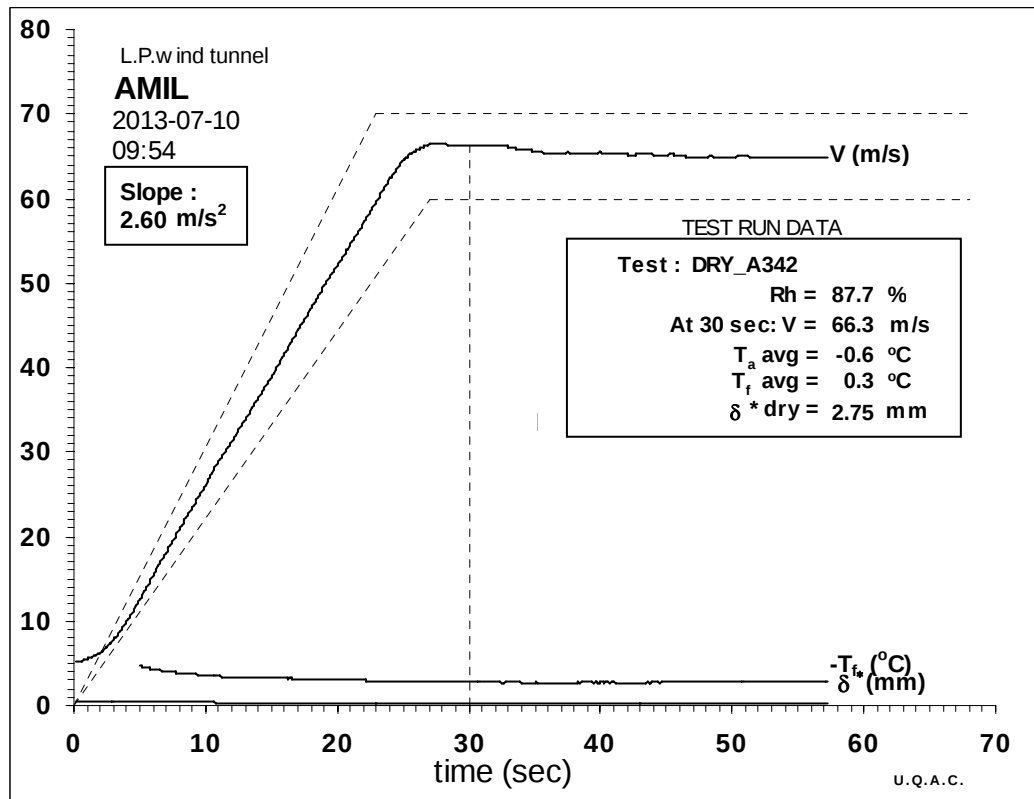
Averages between 27 and 33 seconds:

30	-0.5	0.3	87.0	11.31	66.4	-0.11	2.76
----	------	------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_A342



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ * mm
27	-0.9	0.2	86.4	11.18	66.0	-0.02	2.91
28	-0.9	0.2	86.4	11.28	66.2	-0.14	2.71
29	-0.8	0.2	86.5	11.26	66.2	-0.12	2.75
30	-0.8	0.2	86.7	11.24	66.1	-0.07	2.83
31	-0.8	0.2	86.9	11.36	66.5	-0.13	2.72
32	-0.8	0.2	87.0	11.32	66.4	-0.13	2.72
33	-0.8	0.2	87.3	11.35	66.5	-0.16	2.68

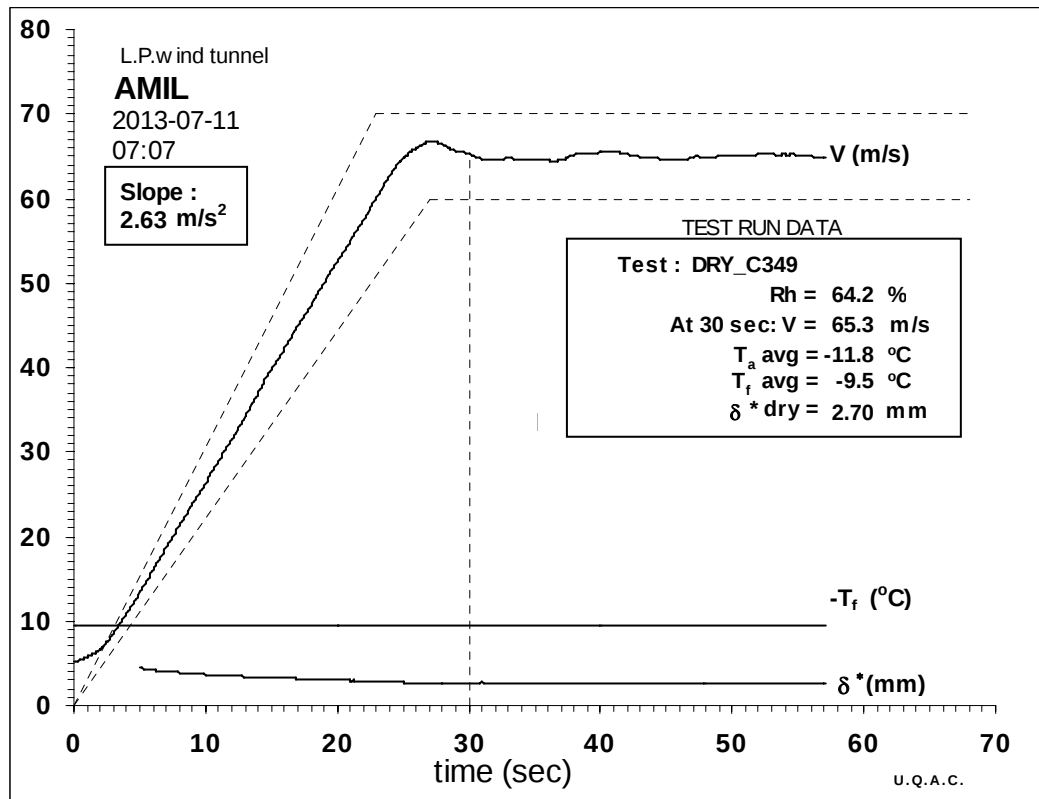
Averages between 27 and 33 seconds:

30	-0.8	0.2	86.7	11.29	66.3	-0.12	2.75
----	------	------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_C349



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-12.1	-9.5	63.0	11.76	66.2	-0.19	2.64
28	-12.1	-9.6	63.3	11.92	66.7	-0.17	2.68
29	-12.0	-9.6	62.9	11.88	66.6	-0.21	2.60
30	-12.0	-9.6	63.4	11.27	64.9	-0.11	2.77
31	-12.0	-9.6	63.2	10.99	64.0	-0.15	2.70
32	-11.9	-9.6	63.5	11.08	64.3	-0.10	2.77
33	-11.9	-9.6	63.8	11.30	64.9	-0.15	2.69

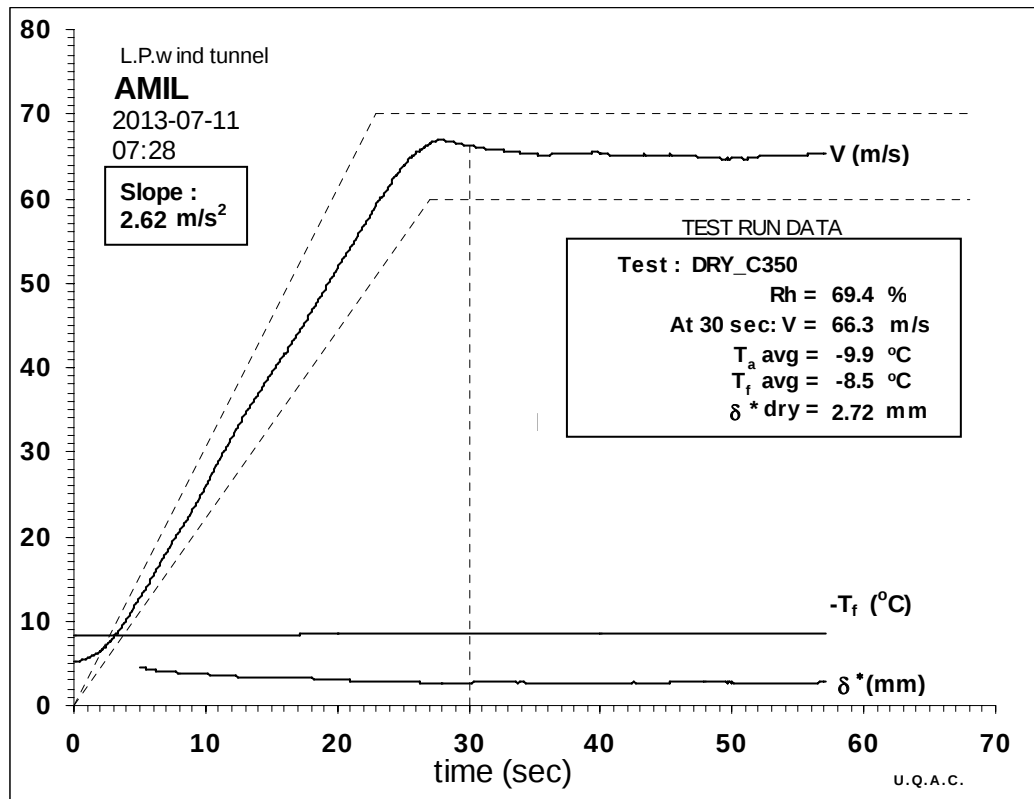
Averages between 27 and 33 seconds:

30	-12.0	-9.6	63.3	11.44	65.3	-0.15	2.70
----	-------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_C350



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-10.5	-8.5	67.5	12.04	67.2	-0.16	2.70
28	-10.5	-8.5	67.5	11.95	67.0	-0.20	2.63
29	-10.5	-8.5	67.5	12.01	67.1	-0.16	2.70
30	-10.5	-8.5	67.3	11.66	66.1	-0.15	2.71
31	-10.5	-8.6	67.5	11.46	65.6	-0.12	2.75
32	-10.4	-8.6	67.5	11.54	65.8	-0.11	2.77
33	-10.4	-8.6	68.0	11.38	65.4	-0.07	2.84

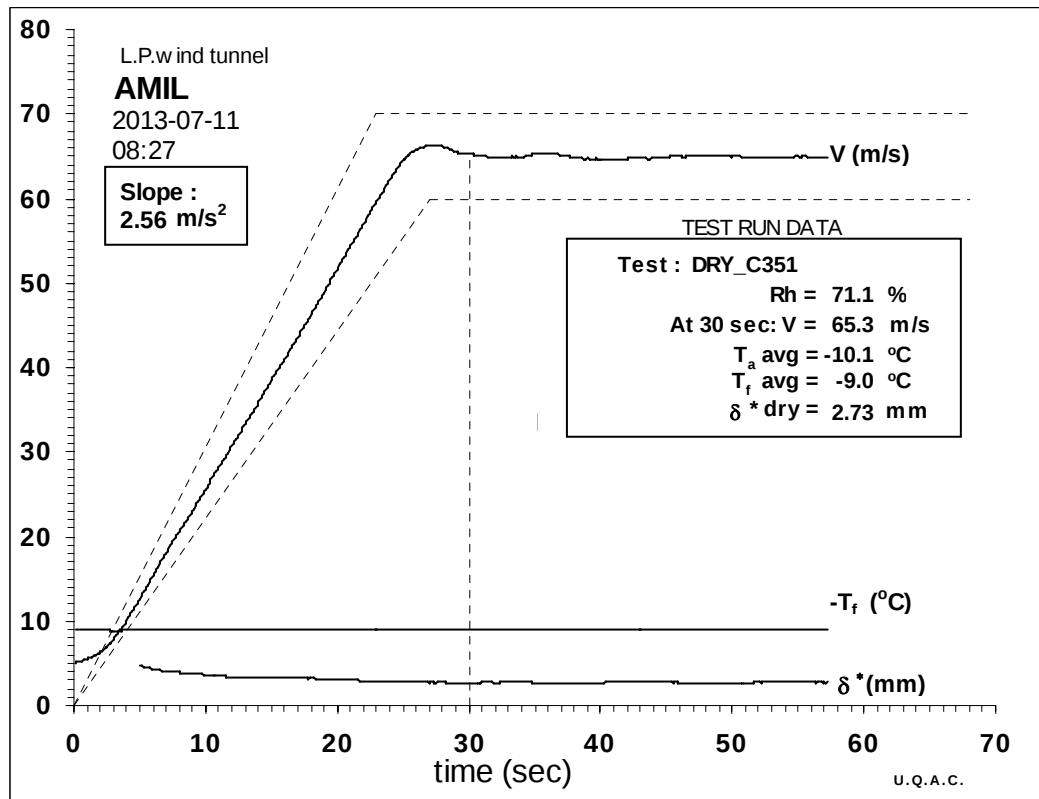
Averages between 27 and 33 seconds:

30	-10.5	-8.6	67.5	11.72	66.3	-0.14	2.72
----	-------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_C351



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-10.4	-9.1	69.4	11.90	66.8	-0.15	2.71
28	-10.4	-9.1	69.9	11.44	65.5	-0.10	2.78
29	-10.4	-9.1	69.6	11.36	65.3	-0.19	2.63
30	-10.4	-9.1	69.9	11.35	65.3	-0.09	2.79
31	-10.3	-9.1	70.3	11.34	65.3	-0.18	2.64
32	-10.3	-9.1	70.2	11.16	64.7	-0.12	2.74
33	-10.3	-9.1	70.4	11.07	64.5	-0.06	2.84

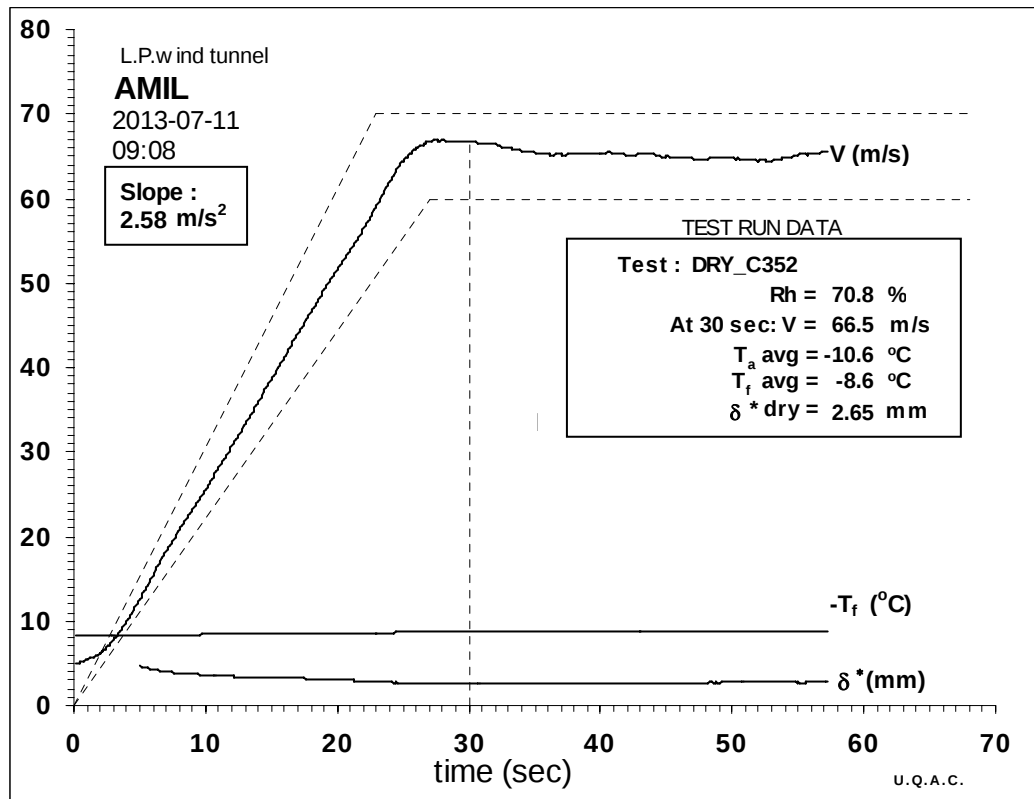
Averages between 27 and 33 seconds:

30	-10.4	-9.1	70.0	11.35	65.3	-0.13	2.73
----	-------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_C352



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-11.0	-8.6	69.0	11.47	65.6	-0.17	2.67
28	-11.0	-8.7	69.3	11.94	66.9	-0.22	2.59
29	-11.0	-8.7	69.5	11.94	66.9	-0.18	2.67
30	-10.9	-8.7	69.6	11.86	66.7	-0.21	2.61
31	-10.9	-8.7	69.7	11.91	66.8	-0.15	2.71
32	-10.9	-8.7	69.6	11.72	66.3	-0.17	2.68
33	-10.8	-8.7	70.1	11.65	66.1	-0.18	2.66

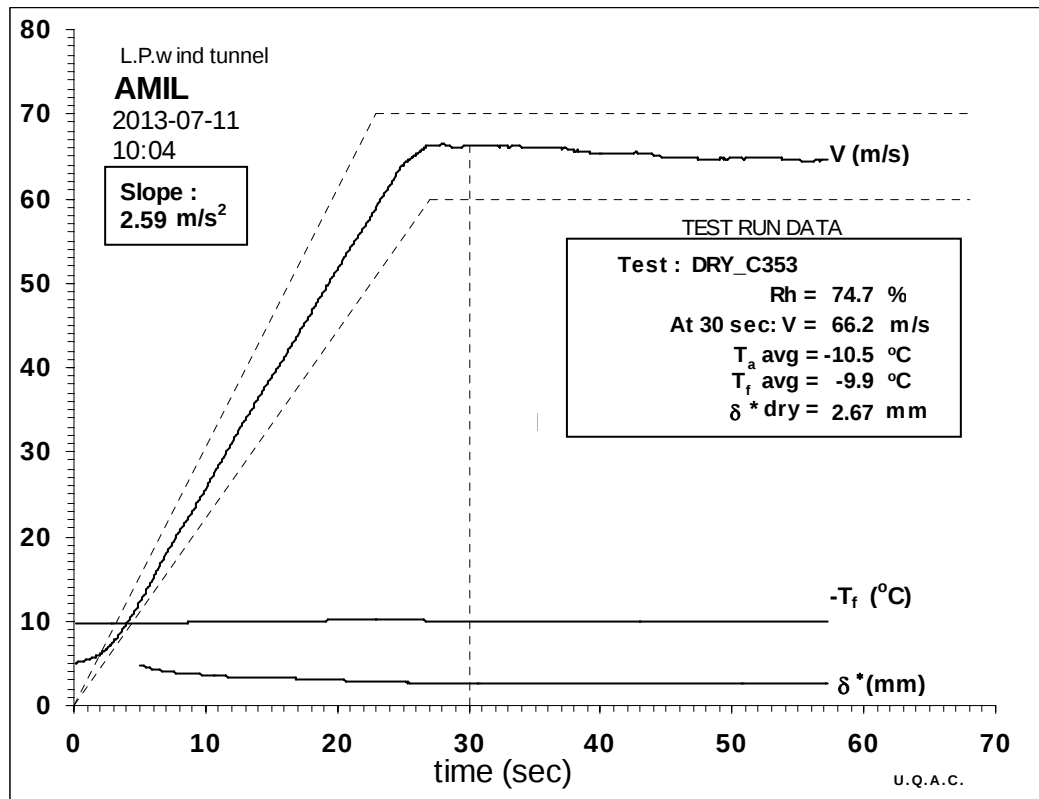
Averages between 27 and 33 seconds:

30	-10.9	-8.7	69.6	11.82	66.5	-0.18	2.65
----	-------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_C353



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-11.1	-10.1	73.0	11.57	65.8	-0.12	2.75
28	-11.0	-10.0	73.0	11.51	65.6	-0.15	2.69
29	-11.0	-10.0	73.2	11.79	66.4	-0.16	2.68
30	-11.0	-10.1	73.0	11.62	66.0	-0.21	2.60
31	-11.0	-10.0	73.3	11.71	66.2	-0.11	2.78
32	-10.9	-10.0	73.3	11.93	66.9	-0.23	2.58
33	-10.9	-10.0	73.5	11.78	66.4	-0.19	2.63

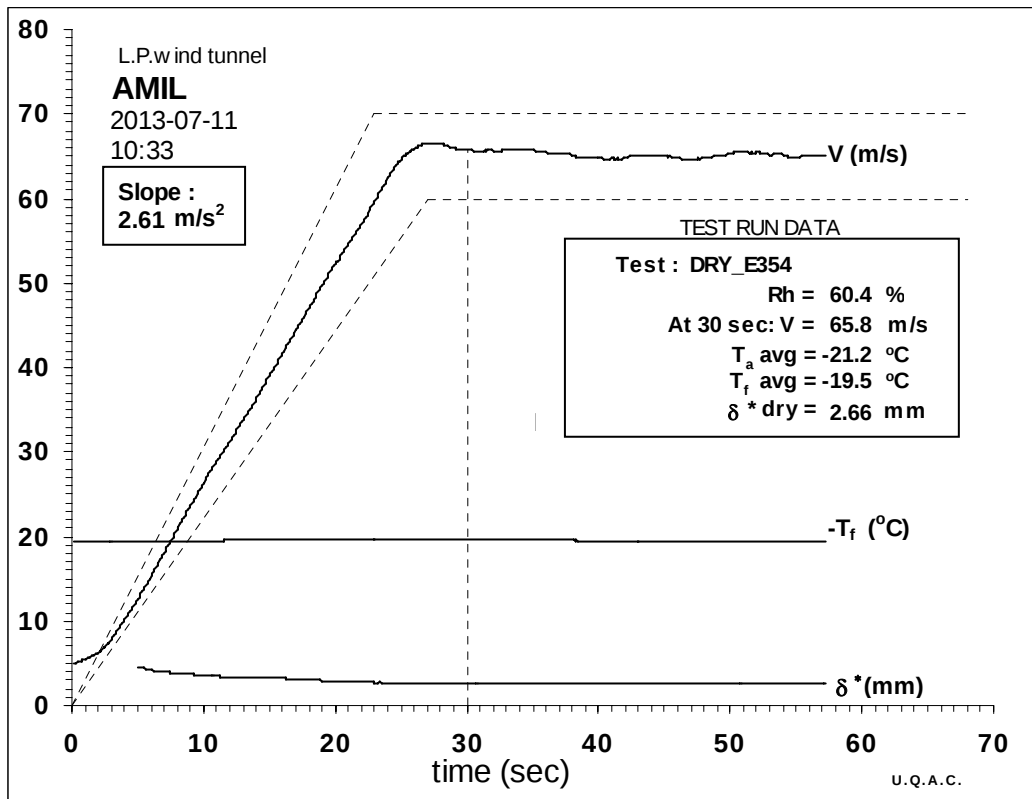
Averages between 27 and 33 seconds:

30	-11.0	-10.0	73.2	11.71	66.2	-0.17	2.67
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_E354



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-21.5	-19.6	59.4	12.38	66.7	-0.18	2.67
28	-21.5	-19.6	59.5	12.05	65.8	-0.21	2.61
29	-21.5	-19.6	59.7	12.09	65.9	-0.24	2.56
30	-21.4	-19.6	59.5	12.21	66.3	-0.12	2.76
31	-21.4	-19.6	59.6	11.85	65.3	-0.21	2.61
32	-21.3	-19.6	59.6	11.83	65.2	-0.13	2.74
33	-21.3	-19.6	59.7	11.97	65.6	-0.17	2.67

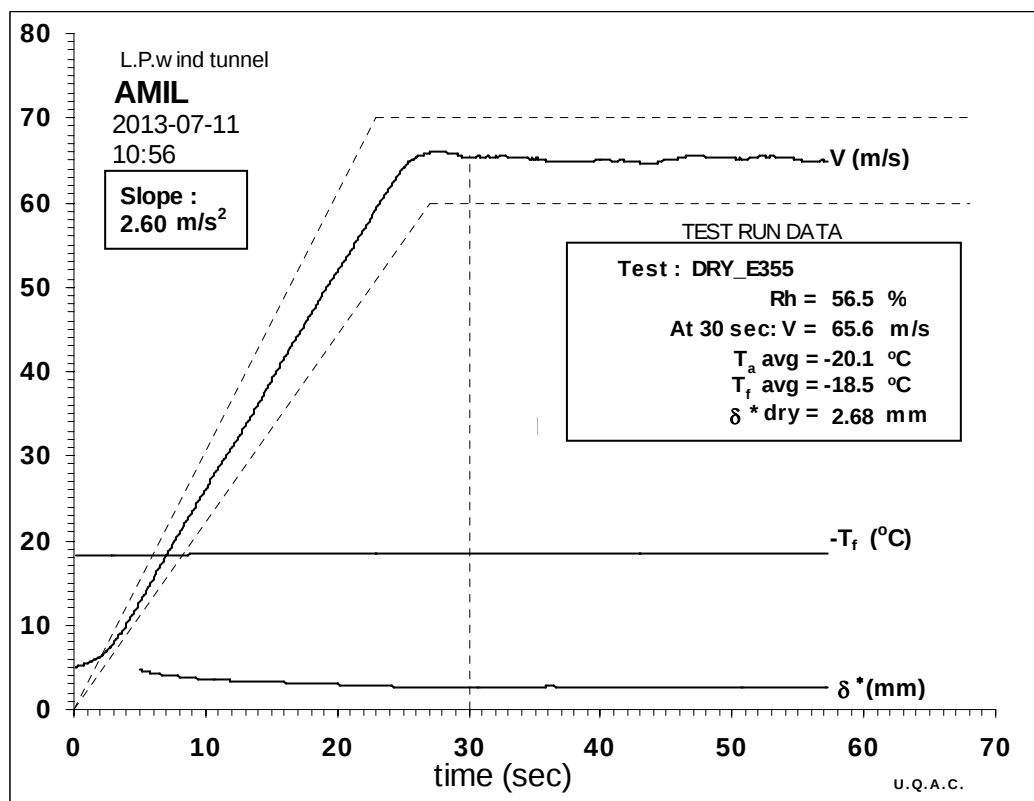
Averages between 27 and 33 seconds:

30	-21.4	-19.6	59.6	12.03	65.8	-0.18	2.66
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_E355



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-20.5	-18.6	55.3	12.64	67.6	-0.22	2.61
28	-20.5	-18.5	55.5	11.86	65.4	-0.16	2.69
29	-20.5	-18.5	55.2	11.84	65.4	-0.15	2.70
30	-20.4	-18.6	55.9	11.82	65.3	-0.13	2.74
31	-20.4	-18.5	55.7	11.95	65.7	-0.22	2.59
32	-20.4	-18.6	56.1	11.82	65.3	-0.15	2.70
33	-20.4	-18.6	55.6	11.69	65.0	-0.16	2.69

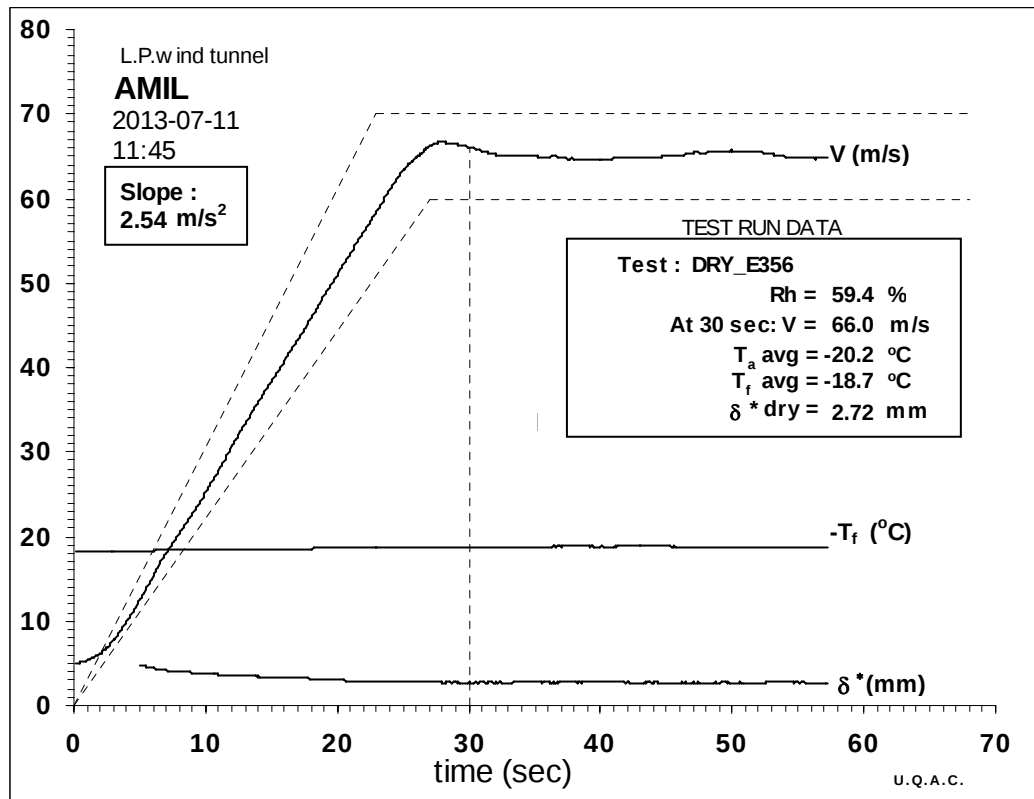
Averages between 27 and 33 seconds:

30	-20.4	-18.5	55.6	11.91	65.6	-0.17	2.68
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_E356



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-20.9	-18.7	58.5	12.28	66.5	-0.16	2.70
28	-20.8	-18.8	58.6	12.19	66.3	-0.17	2.69
29	-20.9	-18.8	58.6	12.54	67.2	-0.15	2.73
30	-20.8	-18.8	58.2	12.16	66.2	-0.11	2.78
31	-20.8	-18.8	58.2	11.90	65.5	-0.17	2.68
32	-20.8	-18.8	58.1	11.65	64.8	-0.16	2.69
33	-20.8	-18.8	58.0	11.73	65.0	-0.11	2.77

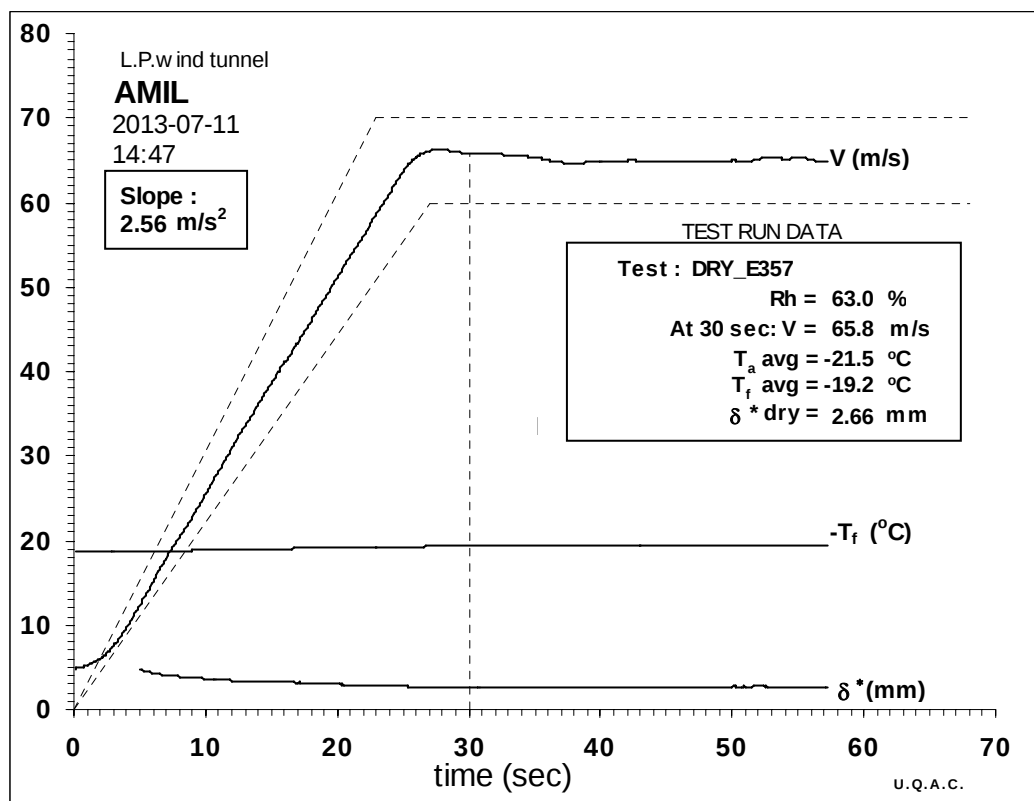
Averages between 27 and 33 seconds:

30	-20.8	-18.8	58.3	12.07	66.0	-0.15	2.72
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_E357



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-22.1	-19.3	62.1	12.54	67.1	-0.15	2.72
28	-22.1	-19.3	62.3	12.02	65.7	-0.22	2.60
29	-22.1	-19.3	62.1	12.03	65.7	-0.19	2.64
30	-22.1	-19.4	62.0	12.12	65.9	-0.20	2.63
31	-22.0	-19.4	62.0	12.22	66.2	-0.17	2.68
32	-22.0	-19.4	61.7	11.97	65.5	-0.17	2.68
33	-22.0	-19.4	61.8	11.83	65.1	-0.11	2.77

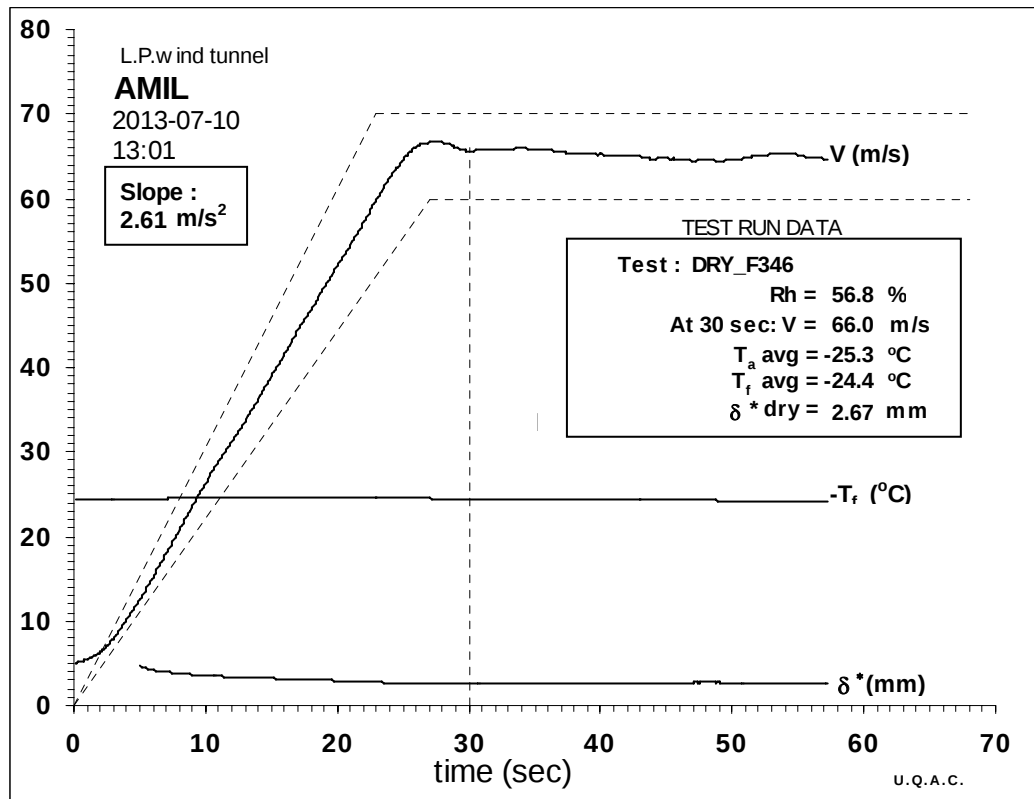
Averages between 27 and 33 seconds:

30	-22.1	-19.3	62.0	12.09	65.8	-0.18	2.66
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_F346



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ * mm
27	-25.5	-24.5	56.5	13.04	67.9	-0.22	2.62
28	-25.5	-24.5	56.2	12.44	66.4	-0.20	2.63
29	-25.5	-24.5	56.2	12.12	65.5	-0.14	2.73
30	-25.4	-24.4	56.4	12.37	66.2	-0.13	2.75
31	-25.3	-24.5	56.5	11.96	65.1	-0.16	2.68
32	-25.3	-24.4	56.3	12.25	65.9	-0.19	2.65
33	-25.3	-24.4	56.4	12.49	66.5	-0.29	2.51

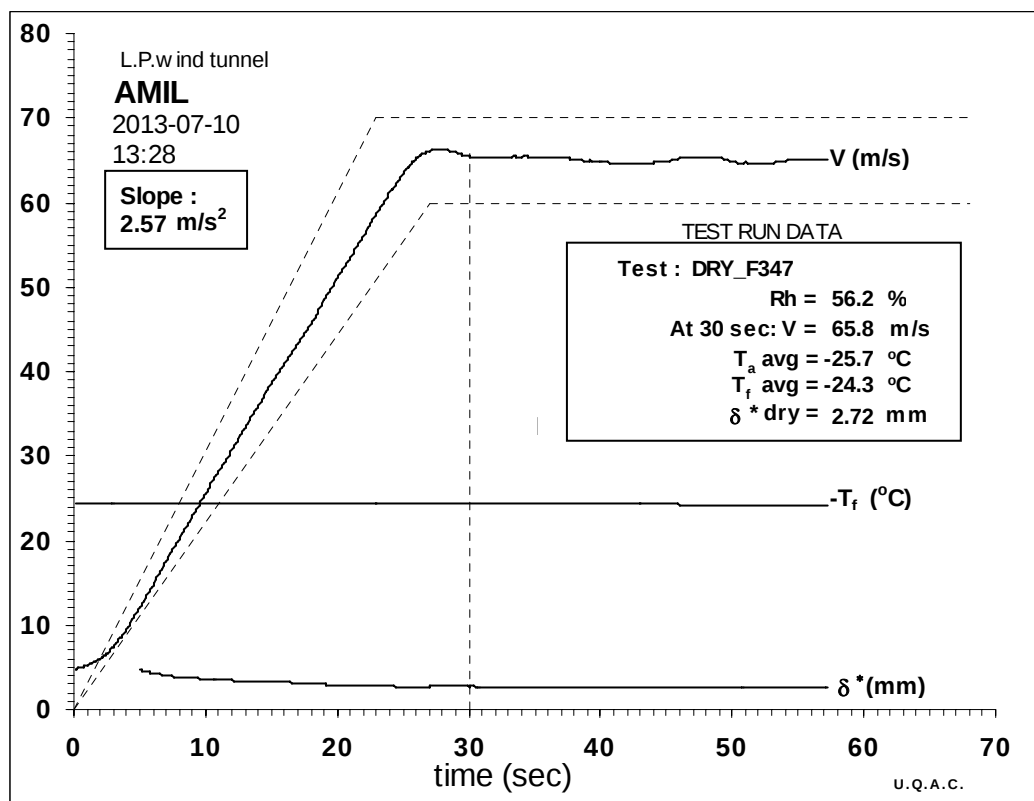
Averages between 27 and 33 seconds:

30	-25.4	-24.5	56.3	12.32	66.0	-0.18	2.67
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_F347



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ * mm
27	-25.9	-24.4	55.4	13.04	67.9	-0.24	2.59
28	-25.8	-24.4	55.6	12.62	66.8	-0.12	2.77
29	-25.9	-24.4	55.6	12.28	65.9	-0.11	2.78
30	-25.8	-24.4	55.7	12.00	65.1	-0.13	2.74
31	-25.8	-24.4	55.8	11.87	64.8	-0.17	2.67
32	-25.7	-24.4	55.8	12.15	65.5	-0.16	2.69
33	-25.7	-24.4	55.9	12.22	65.7	-0.15	2.72

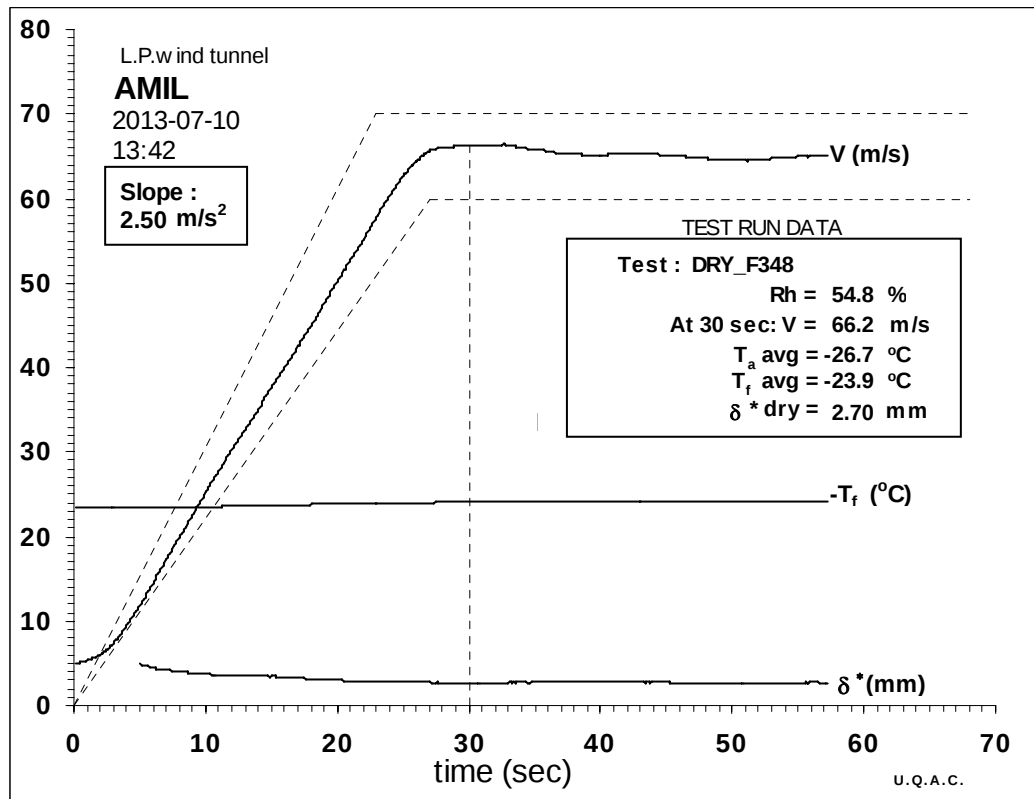
Averages between 27 and 33 seconds:

30	-25.8	-24.4	55.7	12.26	65.8	-0.15	2.72
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

$$S2 = 30845.149 \text{ mm}^2 \quad S3 = 33276.211 \text{ mm}^2 \quad B3 = 302.374 \text{ mm} \quad C3 = 825.221 \text{ mm}$$

DRY_F348



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-27.3	-24.0	54.3	12.51	66.3	-0.10	2.80
28	-27.3	-24.0	54.5	12.52	66.3	-0.16	2.70
29	-27.2	-24.1	54.0	12.42	66.1	-0.18	2.68
30	-27.1	-24.1	54.0	12.33	65.8	-0.16	2.69
31	-27.1	-24.1	53.9	12.57	66.5	-0.15	2.72
32	-27.0	-24.1	53.8	12.51	66.3	-0.17	2.69
33	-27.0	-24.1	53.9	12.50	66.3	-0.21	2.63

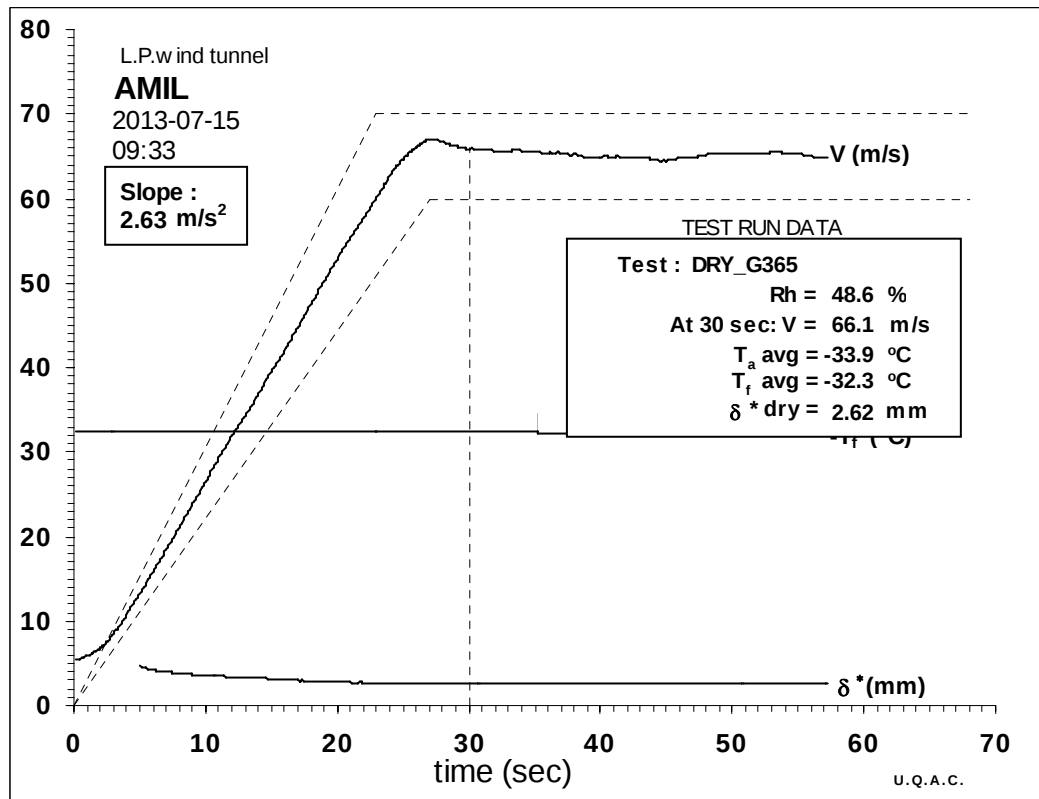
Averages between 27 and 33 seconds:

30	-27.2	-24.1	54.1	12.48	66.2	-0.16	2.70
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_G365



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-34.2	-32.4	48.5	12.98	66.6	-0.23	2.62
28	-34.2	-32.4	48.2	13.03	66.7	-0.21	2.64
29	-34.1	-32.4	48.3	12.94	66.5	-0.24	2.60
30	-34.1	-32.4	48.5	12.72	65.9	-0.18	2.67
31	-34.0	-32.4	48.4	12.46	65.2	-0.20	2.64
32	-34.0	-32.4	48.4	12.73	66.0	-0.25	2.58
33	-34.0	-32.4	48.2	12.73	66.0	-0.27	2.54

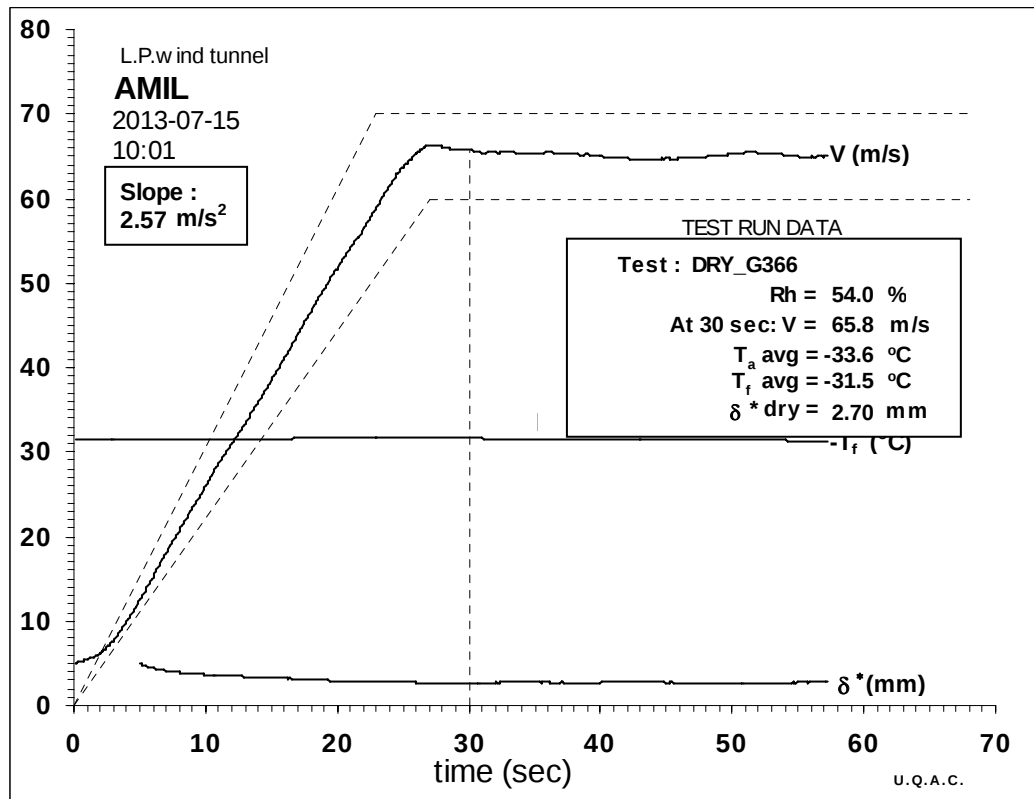
Averages between 27 and 33 seconds:

30	-34.1	-32.4	48.4	12.79	66.1	-0.22	2.62
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_G366



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-33.9	-31.6	54.1	12.73	66.0	-0.19	2.67
28	-33.9	-31.6	53.9	13.13	67.0	-0.18	2.68
29	-33.8	-31.6	53.8	12.57	65.6	-0.14	2.74
30	-33.7	-31.6	53.8	12.43	65.2	-0.21	2.62
31	-33.7	-31.6	53.6	12.61	65.7	-0.18	2.67
32	-33.6	-31.6	53.7	12.70	65.9	-0.11	2.78
33	-33.6	-31.6	53.8	12.46	65.3	-0.14	2.74

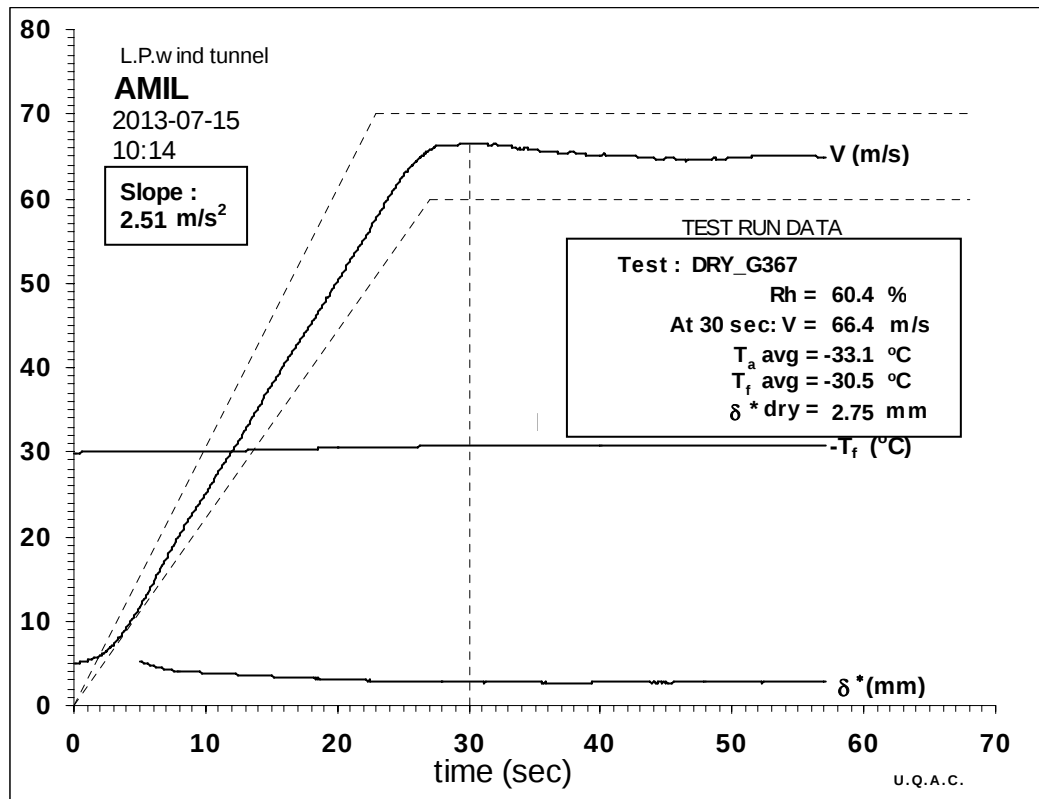
Averages between 27 and 33 seconds:

30	-33.8	-31.6	53.8	12.67	65.8	-0.16	2.70
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

DRY_G367



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-33.9	-30.7	60.3	12.84	66.3	-0.11	2.79
28	-33.8	-30.7	60.5	12.85	66.3	-0.15	2.73
29	-33.8	-30.7	60.5	13.01	66.7	-0.11	2.79
30	-33.7	-30.7	60.4	12.70	65.9	-0.15	2.73
31	-33.7	-30.7	60.2	13.05	66.8	-0.17	2.70
32	-33.6	-30.7	60.1	12.83	66.3	-0.11	2.79
33	-33.6	-30.8	60.1	12.91	66.5	-0.13	2.76

Averages between 27 and 33 seconds:

30	-33.7	-30.7	60.3	12.89	66.4	-0.13	2.75
----	-------	--------------	------	-------	------	-------	-------------

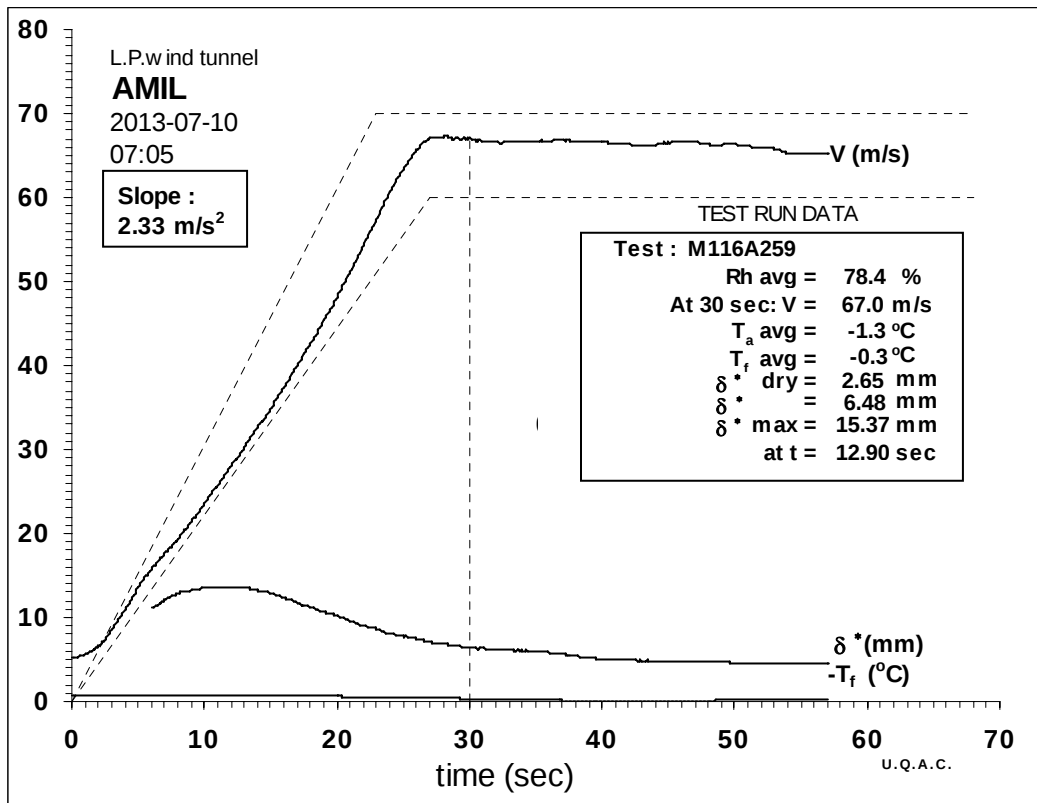
Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

This page left blank.

RUNS WITH REFERENCE FLUID M116

M116A259



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-1.5	-0.5	77.4	11.62	67.1	0.94	7.38
28	-1.5	-0.4	77.5	11.99	68.2	0.77	6.58
29	-1.5	-0.4	77.5	11.35	66.3	0.73	6.57
30	-1.5	-0.3	78.0	11.47	66.7	0.69	6.38
31	-1.4	-0.3	77.9	11.44	66.6	0.70	6.42
32	-1.4	-0.3	78.6	11.72	67.5	0.60	5.96
33	-1.4	-0.2	78.9	11.45	66.7	0.72	6.51

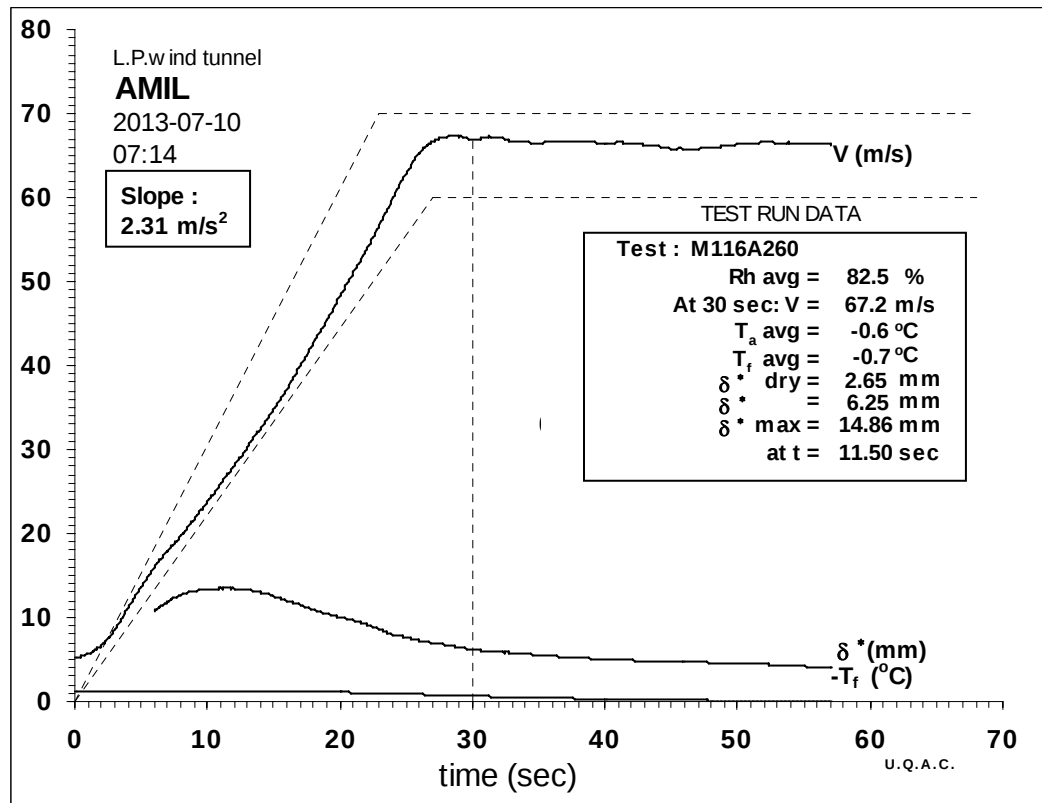
Averages between 27 and 33 seconds:

30	-1.5	-0.3	77.9	11.58	67.0	0.72	6.48
----	------	-------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116A260



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.7	-0.8	81.7	11.67	67.4	0.84	6.93
28	-0.7	-0.8	82.0	11.63	67.3	0.83	6.89
29	-0.7	-0.7	82.1	11.44	66.7	0.67	6.32
30	-0.7	-0.7	82.4	11.83	67.8	0.63	6.09
31	-0.7	-0.6	82.6	11.43	66.7	0.57	5.92
32	-0.7	-0.6	82.7	11.43	66.7	0.56	5.87
33	-0.7	-0.5	83.0	11.85	67.9	0.60	5.94

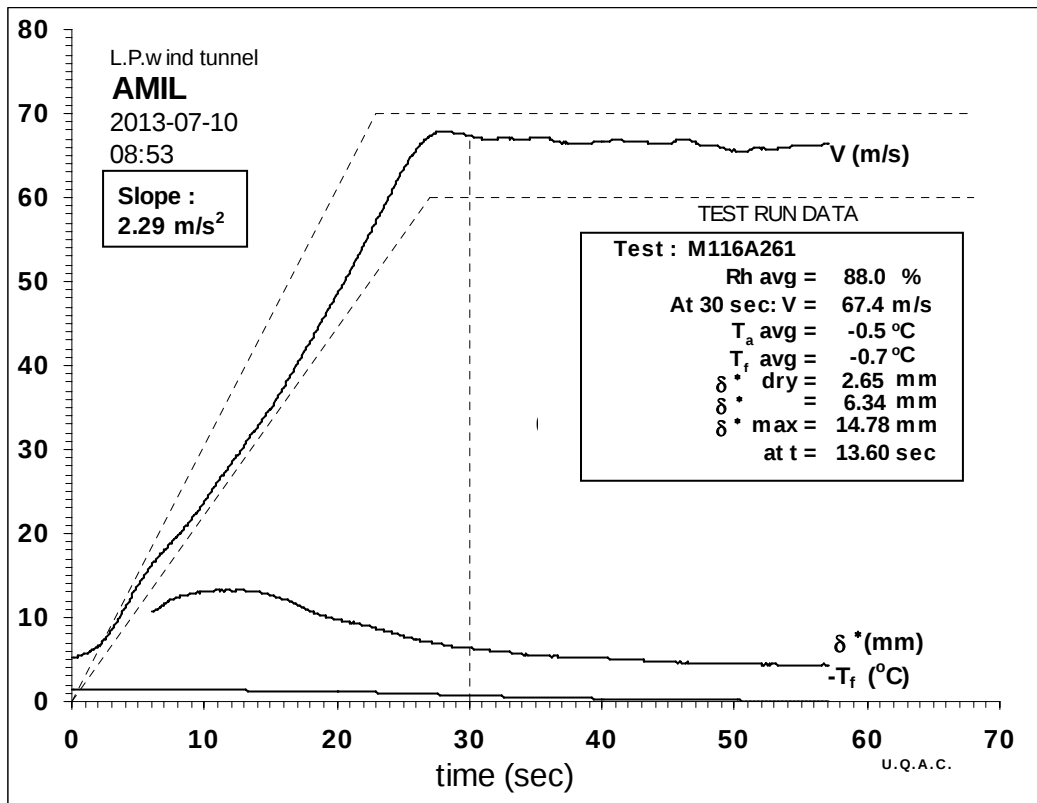
Averages between 27 and 33 seconds:

30	-0.7	-0.7	82.4	11.59	67.2	0.66	6.25
----	------	-------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116A261



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.6	-0.9	86.9	12.06	68.5	0.93	7.14
28	-0.6	-0.8	87.4	11.99	68.3	0.76	6.54
29	-0.6	-0.8	87.6	11.70	67.5	0.74	6.54
30	-0.6	-0.7	87.6	11.45	66.8	0.63	6.12
31	-0.5	-0.7	88.1	11.71	67.5	0.68	6.29
32	-0.5	-0.6	88.0	11.46	66.8	0.63	6.14
33	-0.5	-0.6	87.7	11.24	66.2	0.54	5.81

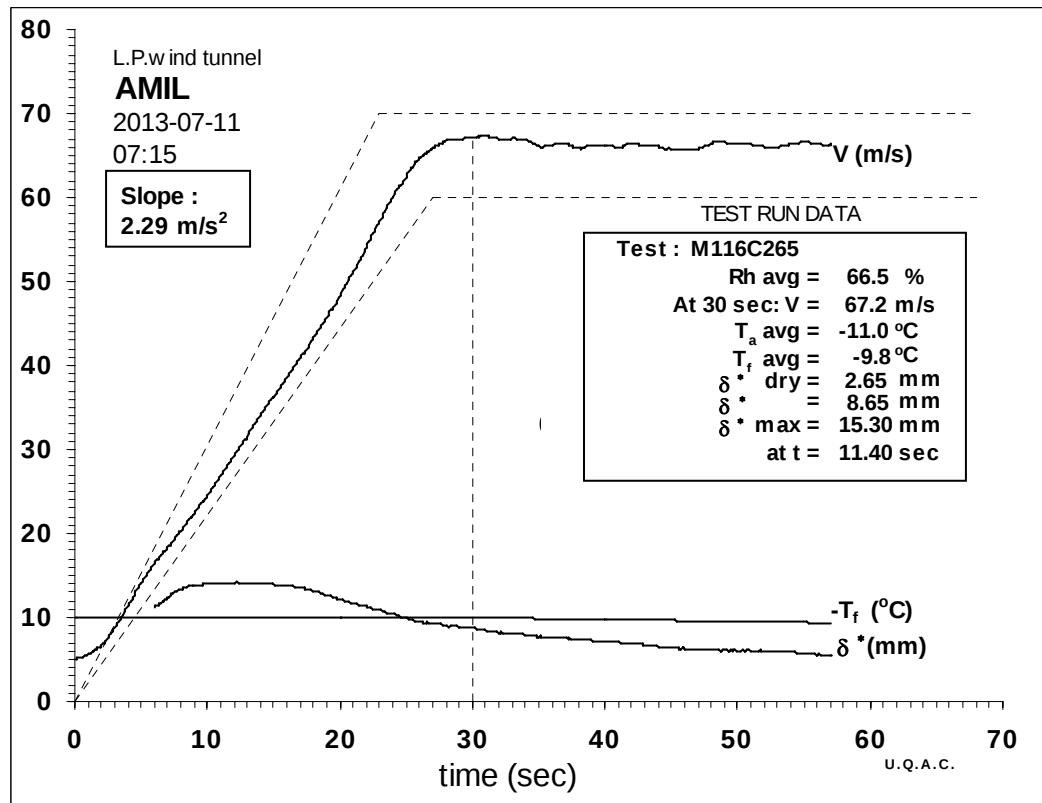
Averages between 27 and 33 seconds:

30	-0.6	-0.7	87.7	11.65	67.4	0.69	6.34
----	------	-------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116C265



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-11.4	-10.0	64.7	11.71	66.2	1.28	8.58
28	-11.4	-10.0	64.5	12.14	67.4	1.48	9.14
29	-11.3	-10.0	64.9	12.05	67.1	1.42	8.98
30	-11.3	-10.0	65.1	11.95	66.9	1.36	8.79
31	-11.2	-9.9	65.4	12.04	67.1	1.30	8.56
32	-11.2	-9.9	65.5	12.38	68.1	1.28	8.33
33	-11.1	-9.9	66.4	12.09	67.3	1.09	7.79

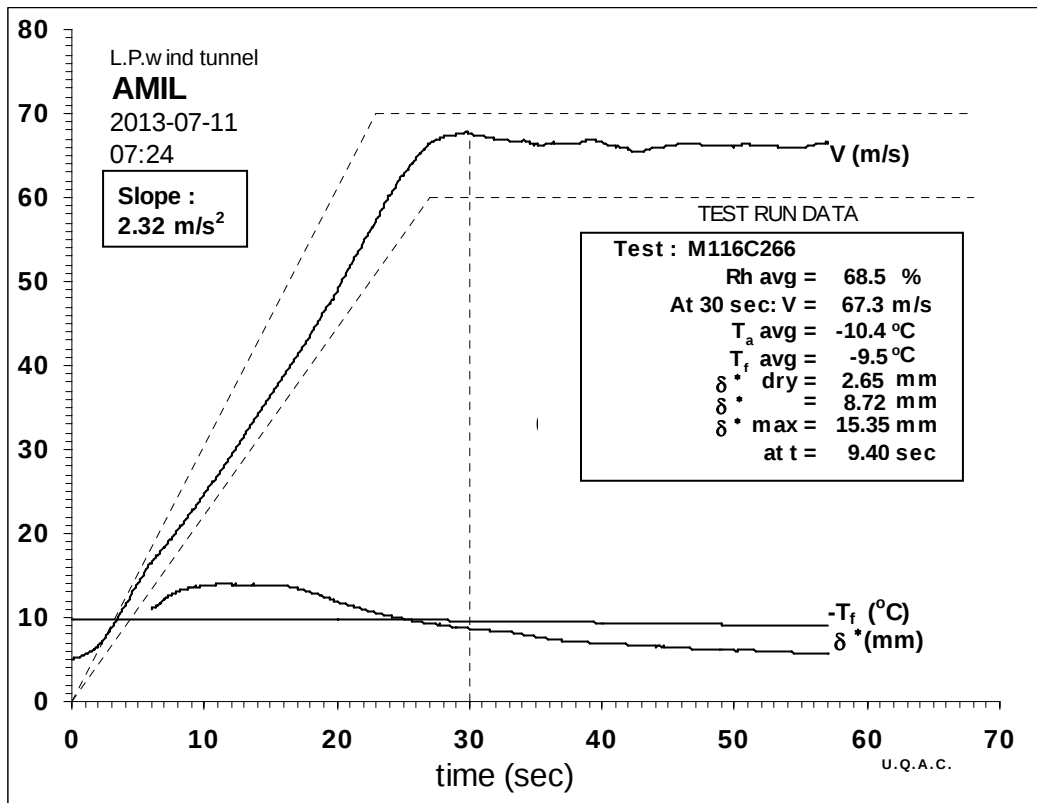
Averages between 27 and 33 seconds:

30	-11.3	-10.0	65.2	12.08	67.2	1.33	8.65
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116C266



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-10.8	-9.6	66.8	11.49	65.6	1.33	8.88
28	-10.7	-9.6	66.7	12.25	67.8	1.48	9.11
29	-10.7	-9.6	66.9	12.38	68.1	1.42	8.84
30	-10.6	-9.6	67.4	12.06	67.2	1.29	8.53
31	-10.6	-9.6	67.7	12.26	67.8	1.41	8.84
32	-10.5	-9.6	67.9	11.86	66.7	1.20	8.27
33	-10.5	-9.6	68.3	11.90	66.8	1.29	8.60

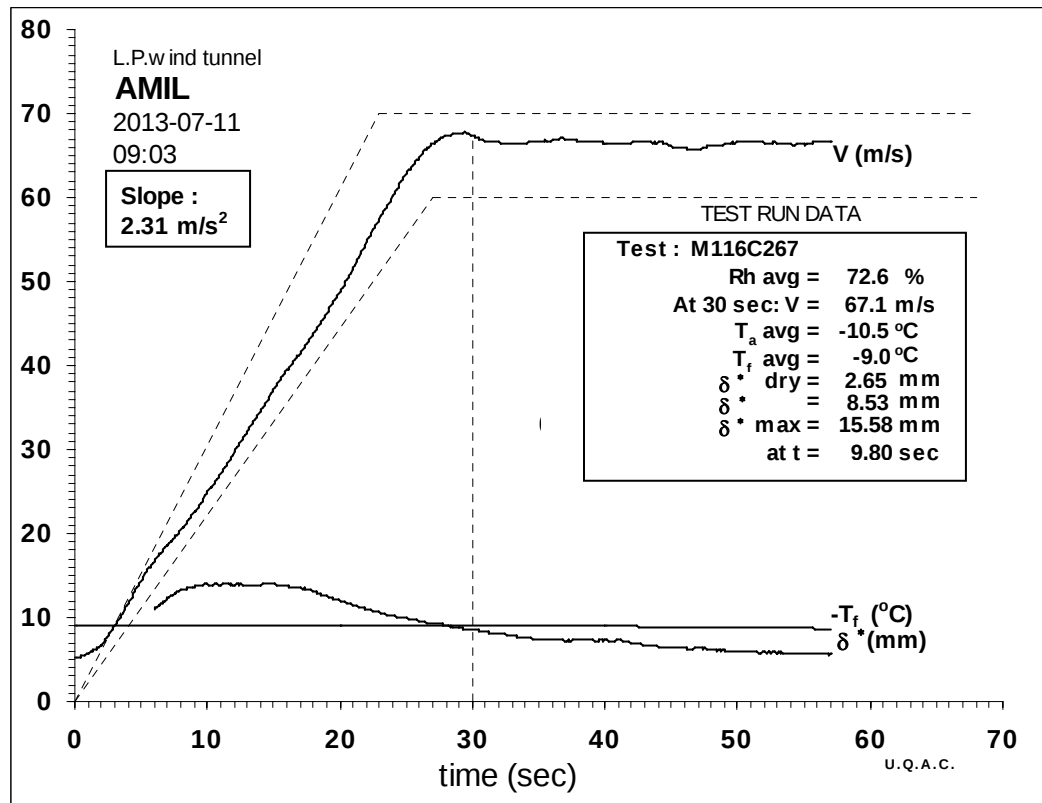
Averages between 27 and 33 seconds:

30	-10.6	-9.6	67.4	12.08	67.3	1.35	8.72
----	-------	-------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116C267



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-11.0	-9.1	70.8	12.04	67.1	1.56	9.49
28	-10.9	-9.1	70.9	12.37	68.1	1.45	8.93
29	-10.9	-9.1	71.1	12.30	67.9	1.38	8.76
30	-10.8	-9.1	71.6	12.04	67.2	1.24	8.36
31	-10.8	-9.1	71.7	12.26	67.8	1.28	8.41
32	-10.7	-9.1	72.0	11.37	65.3	1.15	8.26
33	-10.7	-9.1	72.1	11.64	66.1	1.02	7.64

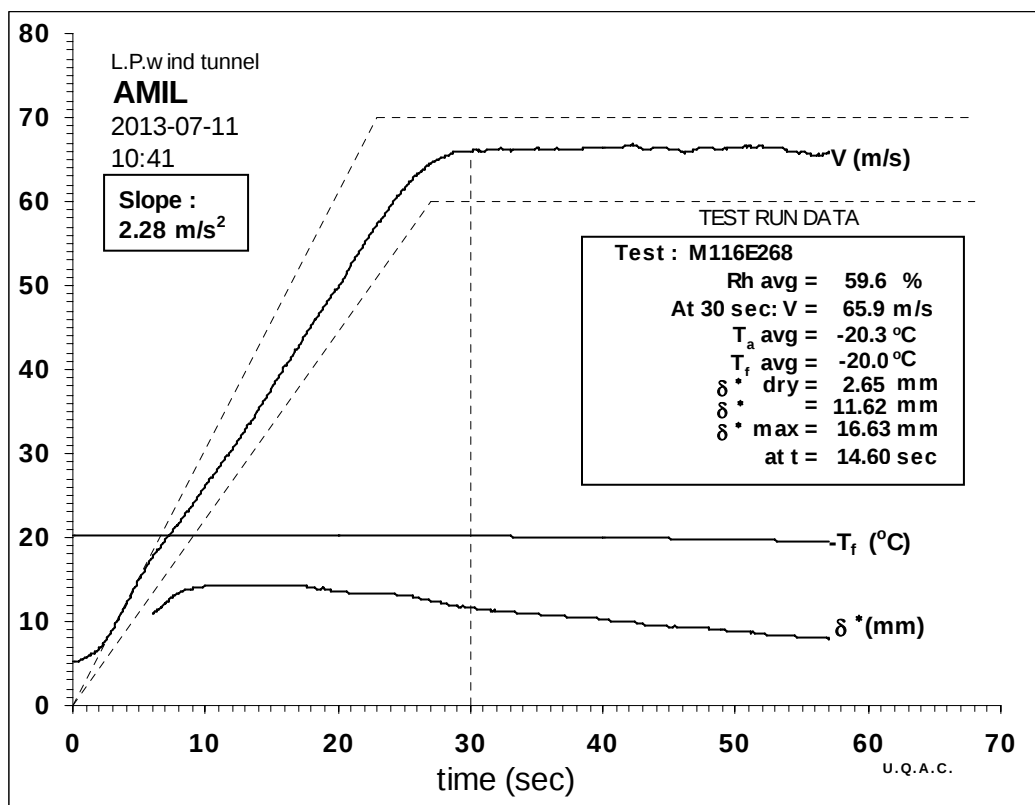
Averages between 27 and 33 seconds:

30	-10.8	-9.1	71.5	12.02	67.1	1.30	8.53
----	-------	-------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116E268



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-20.8	-20.1	57.4	12.04	65.9	2.30	12.00
28	-20.7	-20.1	57.6	11.79	65.2	2.31	12.18
29	-20.6	-20.2	57.5	11.99	65.8	2.23	11.77
30	-20.6	-20.2	58.0	12.10	66.1	2.15	11.47
31	-20.5	-20.1	58.1	12.35	66.8	2.26	11.67
32	-20.4	-20.1	58.0	12.08	66.0	2.03	11.08
33	-20.4	-20.1	58.2	11.75	65.1	2.02	11.23

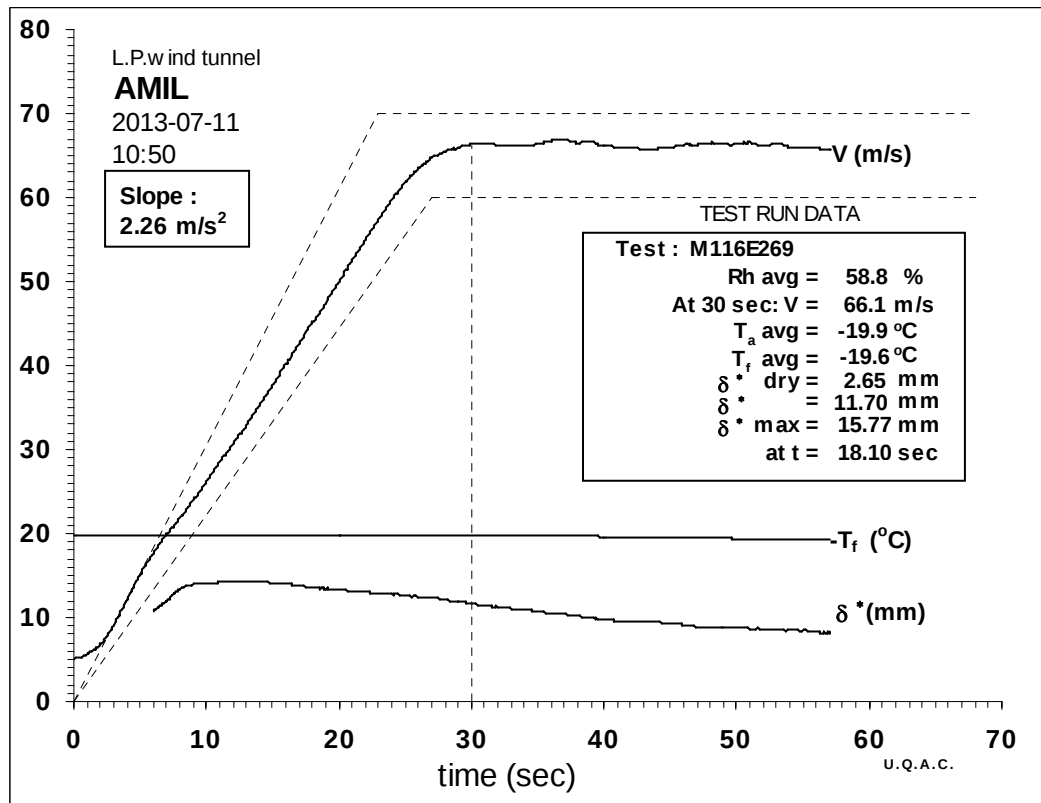
Averages between 27 and 33 seconds:

30	-20.6	-20.1	57.8	12.03	65.9	2.19	11.62
----	-------	--------------	------	-------	------	------	--------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116E269



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-20.4	-19.8	56.4	11.67	64.9	2.21	11.91
28	-20.4	-19.8	56.9	11.90	65.6	2.45	12.58
29	-20.3	-19.8	56.9	12.02	65.9	2.35	12.17
30	-20.2	-19.8	57.2	12.23	66.5	2.13	11.33
31	-20.1	-19.8	57.3	12.35	66.8	2.14	11.31
32	-20.1	-19.7	57.4	12.33	66.8	2.11	11.20
33	-20.1	-19.8	57.4	11.84	65.4	2.09	11.40

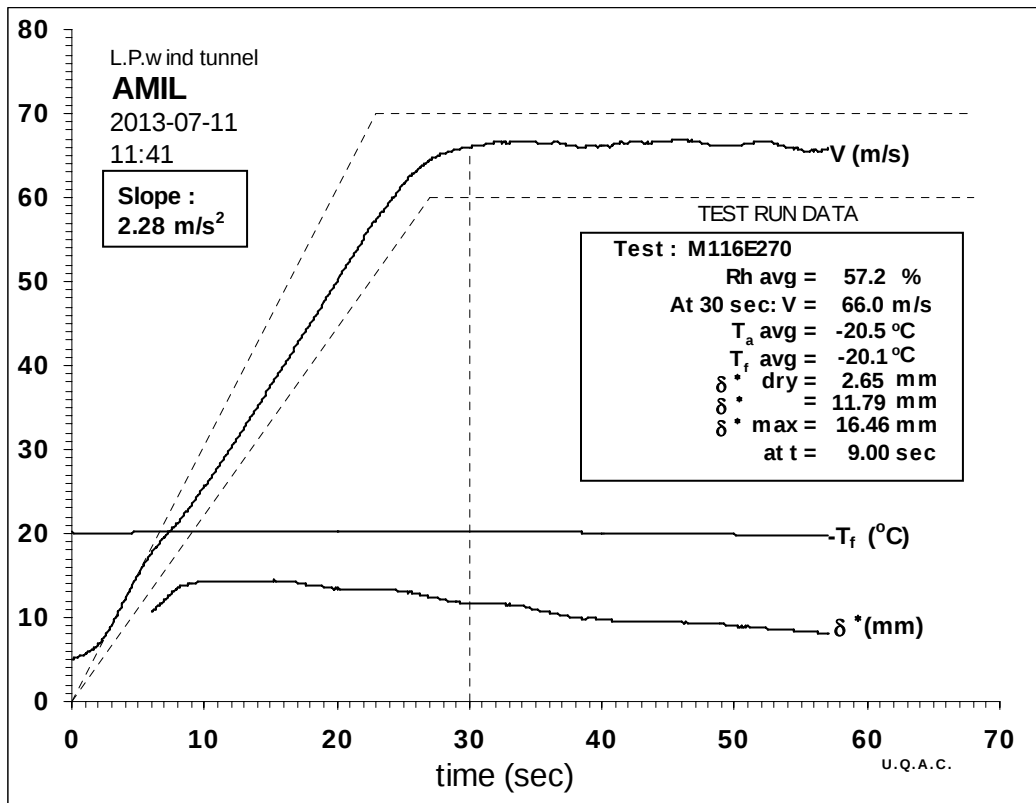
Averages between 27 and 33 seconds:

30	-20.2	-19.8	57.1	12.09	66.1	2.22	11.70
----	-------	--------------	------	-------	------	------	--------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116E270



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-21.1	-20.2	54.9	11.67	64.8	2.26	12.10
28	-21.0	-20.2	55.3	11.93	65.5	2.34	12.19
29	-20.9	-20.2	55.1	11.94	65.6	2.21	11.73
30	-20.9	-20.2	55.2	12.08	66.0	2.18	11.57
31	-20.8	-20.2	55.7	12.21	66.3	2.12	11.29
32	-20.7	-20.2	55.8	12.27	66.5	2.37	12.09
33	-20.7	-20.2	55.7	12.29	66.6	2.24	11.66

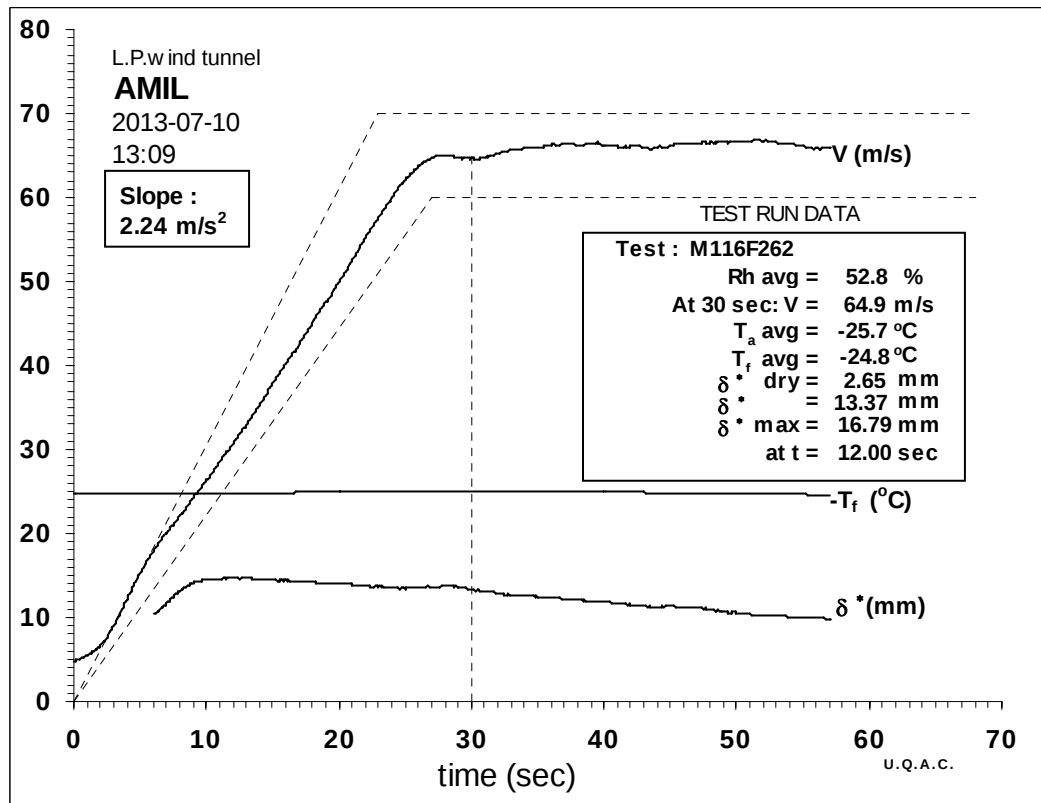
Averages between 27 and 33 seconds:

30	-20.9	-20.2	55.4	12.07	66.0	2.25	11.79
----	-------	--------------	------	-------	------	------	--------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116F262



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-26.3	-25.0	51.7	11.91	64.8	2.84	13.81
28	-26.2	-24.9	51.3	12.16	65.5	2.97	13.99
29	-26.2	-24.9	51.8	11.98	65.0	2.80	13.64
30	-26.1	-25.0	51.5	11.58	63.9	2.65	13.43
31	-26.0	-25.0	51.6	11.71	64.3	2.55	13.05
32	-26.0	-25.0	51.6	12.04	65.2	2.57	12.83
33	-25.9	-25.0	51.6	12.29	65.9	2.65	12.91

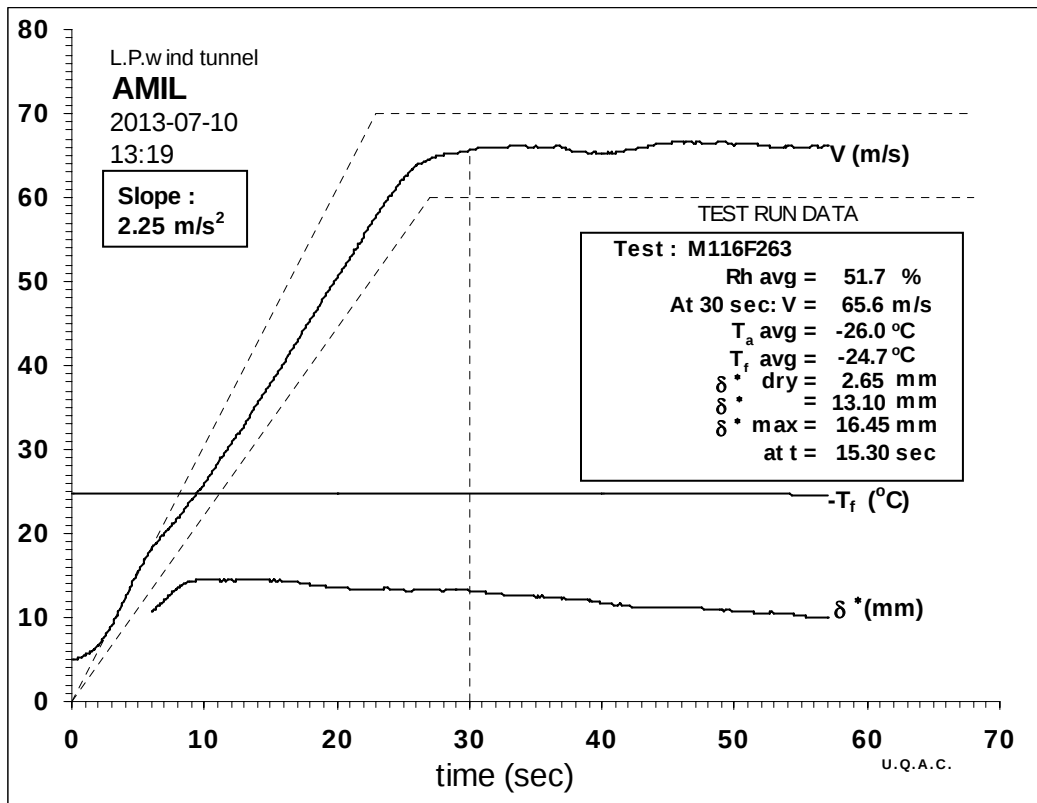
Averages between 27 and 33 seconds:

30	-26.1	-24.9	51.6	11.93	64.9	2.71	13.37
----	-------	--------------	------	-------	------	------	--------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116F263



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-26.7	-24.8	50.2	11.95	64.9	2.52	12.77
28	-26.6	-24.8	50.2	12.03	65.1	2.74	13.41
29	-26.5	-24.9	50.3	12.00	65.0	2.80	13.62
30	-26.5	-24.9	50.3	12.15	65.4	2.75	13.35
31	-26.4	-24.9	50.4	12.48	66.3	2.68	12.92
32	-26.3	-24.9	50.5	12.56	66.6	2.61	12.65
33	-26.2	-24.9	50.7	12.28	65.8	2.55	12.65

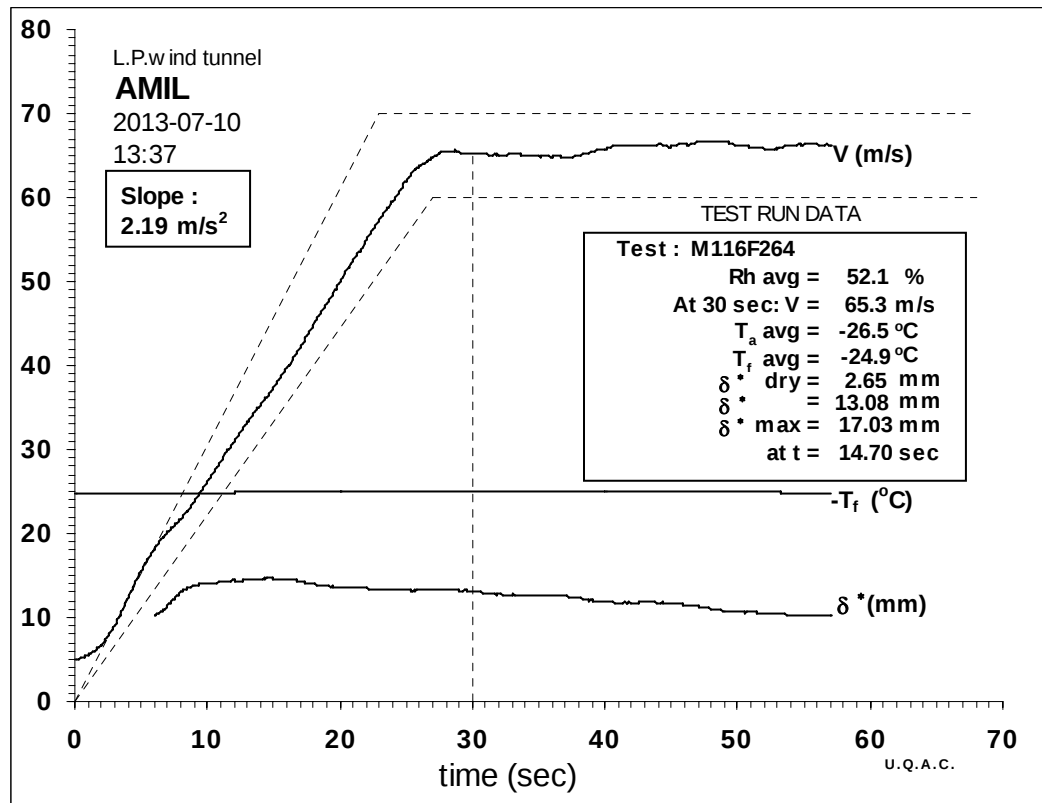
Averages between 27 and 33 seconds:

30	-26.4	-24.9	50.4	12.22	65.6	2.69	13.10
----	-------	--------------	------	-------	------	------	--------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

M116F264



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-27.2	-25.0	50.9	12.34	65.9	2.74	13.21
28	-27.1	-25.1	50.5	12.21	65.5	2.83	13.56
29	-27.0	-25.1	50.7	12.13	65.3	2.77	13.39
30	-27.0	-25.0	50.8	12.21	65.5	2.65	12.97
31	-26.9	-25.1	50.8	11.94	64.8	2.60	13.02
32	-26.8	-25.1	50.9	12.14	65.4	2.57	12.78
33	-26.7	-25.1	50.8	11.97	64.9	2.44	12.47

Averages between 27 and 33 seconds:

30	-27.0	-25.1	50.8	12.13	65.3	2.66	13.08
----	-------	--------------	------	-------	------	------	--------------

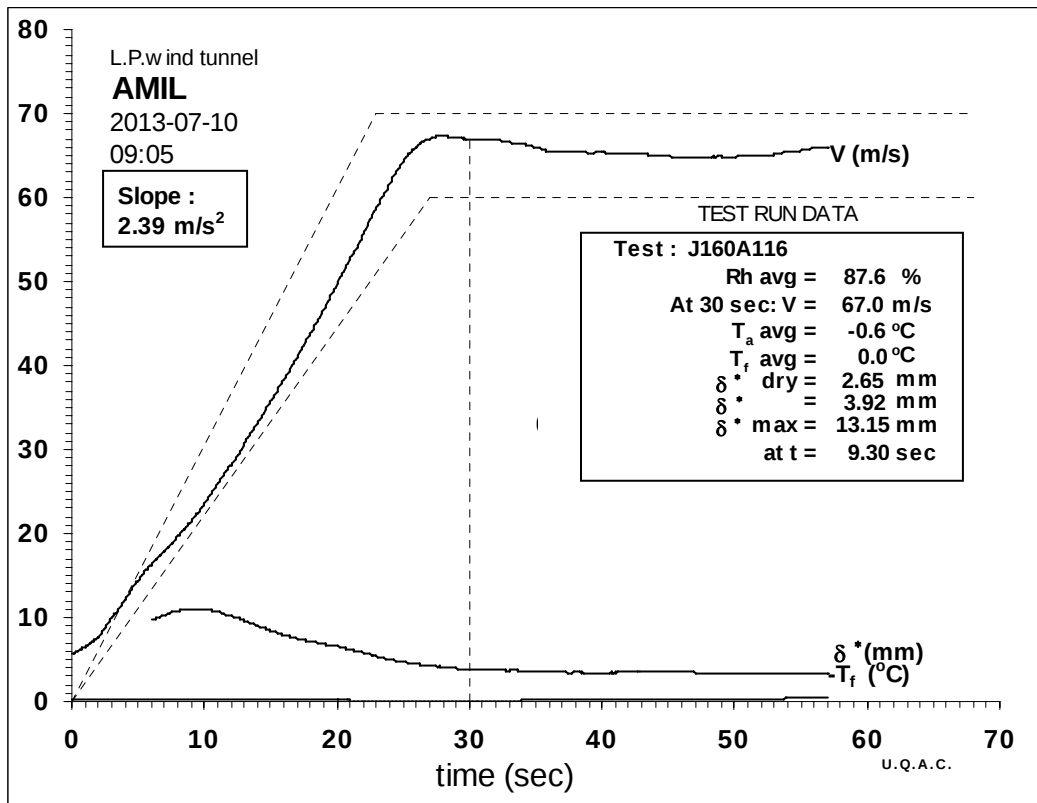
Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

This page left blank.

ARCTON LTD. DEICING FLUID
Arctica DG91 Concentrate lot # 11,
75/25 Dilution J-160

J160A116



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.8	0.0	86.6	11.62	67.2	0.23	4.43
28	-0.8	0.0	86.8	11.66	67.4	0.15	4.11
29	-0.7	0.1	87.2	11.53	67.0	0.09	3.85
30	-0.7	0.1	87.4	11.59	67.2	0.09	3.83
31	-0.7	0.1	87.6	11.40	66.6	0.06	3.73
32	-0.7	0.1	87.6	11.45	66.8	0.11	3.93
33	-0.7	0.1	87.9	11.40	66.6	0.07	3.76

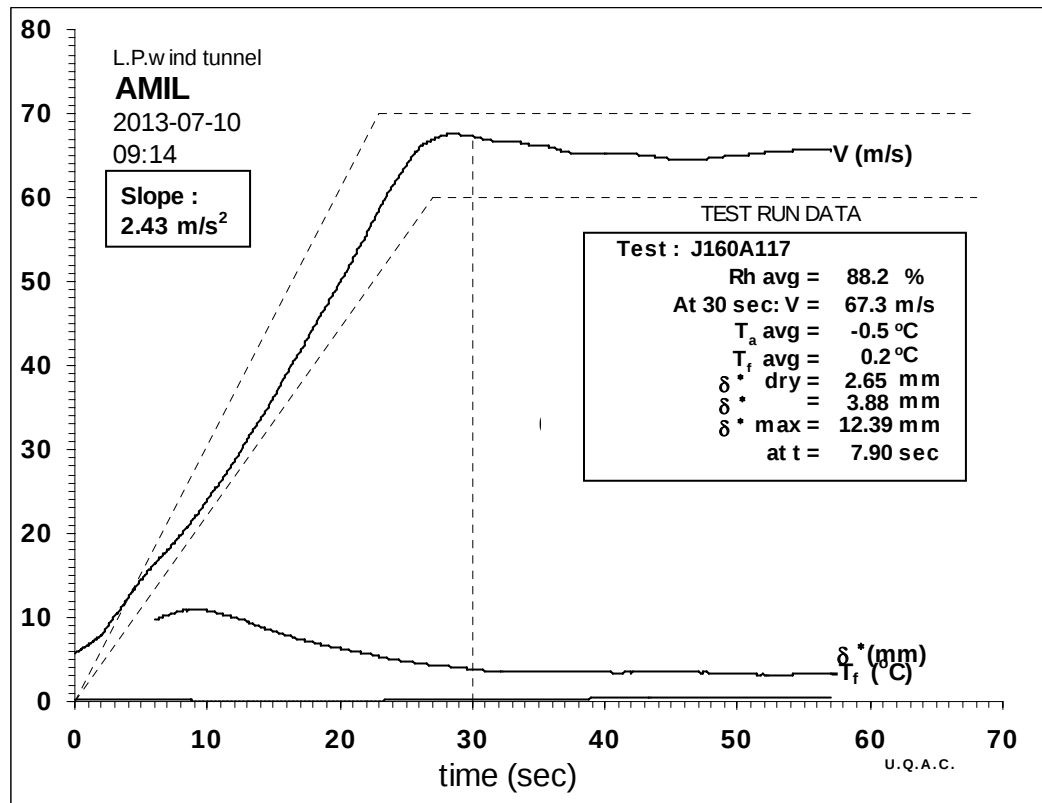
Averages between 27 and 33 seconds:

30	-0.7	0.1	87.3	11.52	67.0	0.11	3.92
----	------	------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160A117



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.6	0.2	87.9	11.76	67.7	0.20	4.29
28	-0.6	0.2	87.8	11.96	68.2	0.22	4.39
29	-0.6	0.3	88.2	11.70	67.5	0.14	4.05
30	-0.6	0.2	88.1	11.55	67.1	0.04	3.64
31	-0.6	0.3	88.2	11.49	66.9	0.07	3.75
32	-0.5	0.3	88.4	11.56	67.1	0.02	3.56
33	-0.5	0.3	88.7	11.17	66.0	0.01	3.52

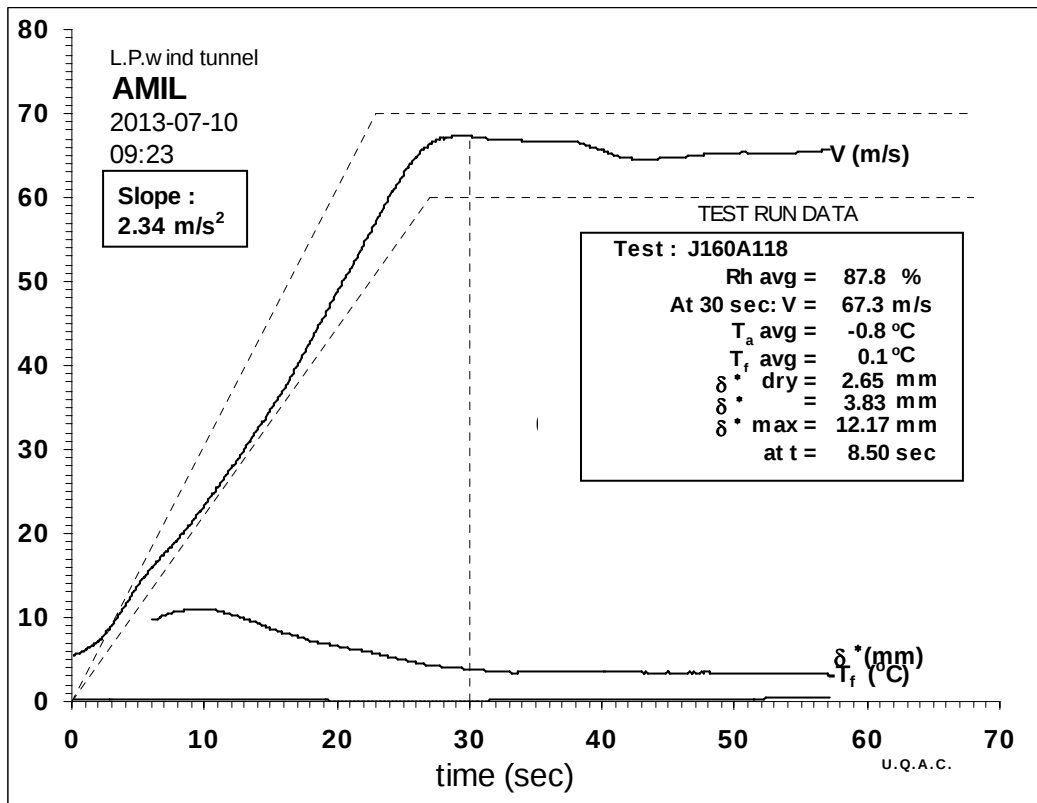
Averages between 27 and 33 seconds:

30	-0.6	0.3	88.2	11.61	67.3	0.10	3.88
----	------	------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160A118



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a $^\circ\text{C}$	T_f $^\circ\text{C}$	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-0.9	0.1	86.9	11.50	66.9	0.21	4.38
28	-0.9	0.1	86.9	12.06	68.5	0.13	4.01
29	-0.9	0.1	87.3	11.65	67.3	0.12	3.96
30	-0.9	0.1	87.6	11.58	67.1	0.09	3.83
31	-0.8	0.1	87.7	11.36	66.5	0.10	3.92
32	-0.8	0.1	87.6	11.79	67.7	-0.02	3.35
33	-0.8	0.1	88.2	11.42	66.7	0.01	3.49

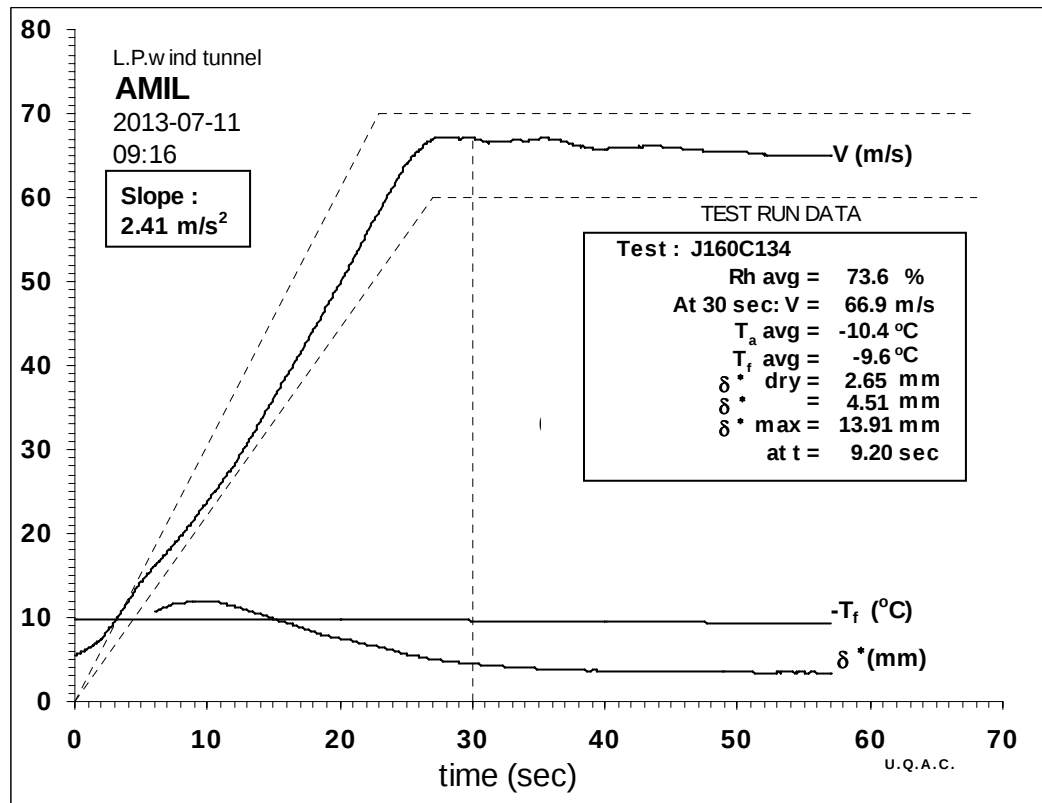
Averages between 27 and 33 seconds:

30	-0.9	0.1	87.5	11.64	67.3	0.09	3.83
----	------	------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160C134



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-10.7	-9.7	72.1	12.13	67.4	0.40	5.11
28	-10.7	-9.7	72.3	12.33	68.0	0.30	4.68
29	-10.6	-9.6	72.6	11.87	66.7	0.28	4.62
30	-10.6	-9.6	72.6	11.76	66.4	0.24	4.48
31	-10.6	-9.6	72.7	11.99	67.1	0.22	4.37
32	-10.5	-9.6	73.2	12.01	67.1	0.20	4.30
33	-10.5	-9.6	73.3	11.45	65.6	0.16	4.16

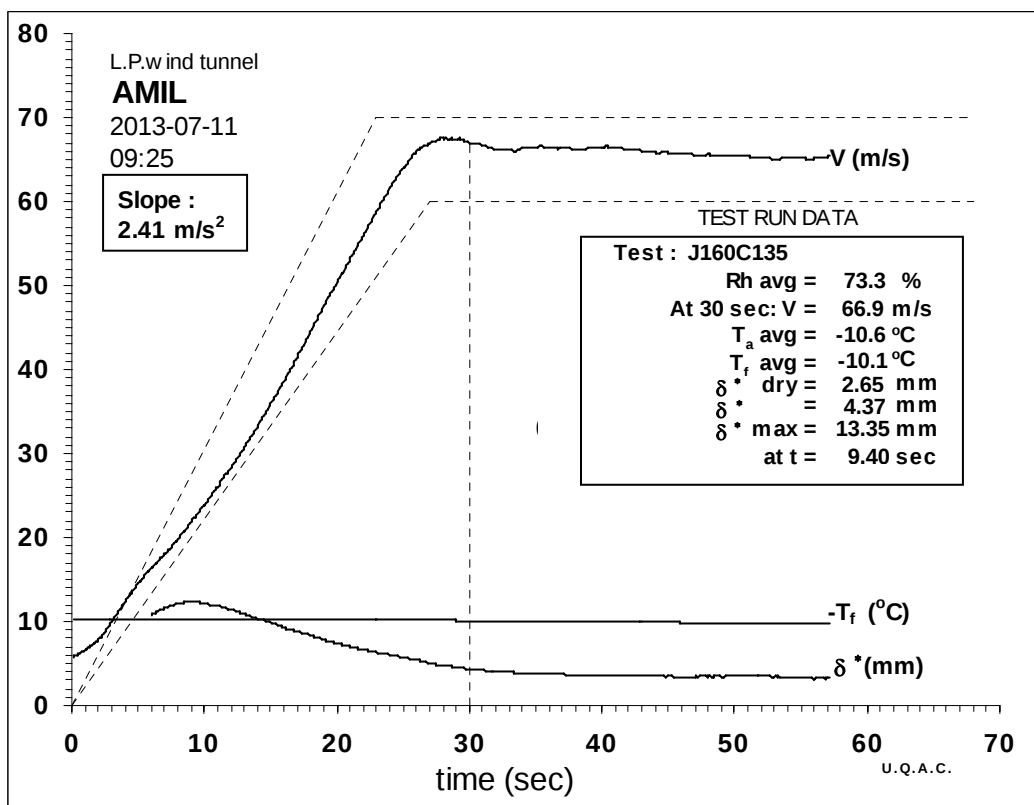
Averages between 27 and 33 seconds:

30	-10.6	-9.6	72.7	11.95	66.9	0.25	4.51
----	-------	-------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160C135



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-10.9	-10.1	72.1	12.12	67.4	0.38	5.01
28	-10.9	-10.1	72.0	12.23	67.7	0.30	4.71
29	-10.9	-10.1	72.2	12.14	67.4	0.21	4.32
30	-10.9	-10.1	72.4	12.08	67.3	0.23	4.39
31	-10.8	-10.1	72.7	12.06	67.2	0.22	4.36
32	-10.8	-10.1	72.8	11.50	65.7	0.13	4.03
33	-10.7	-10.1	73.1	11.44	65.5	0.11	3.93

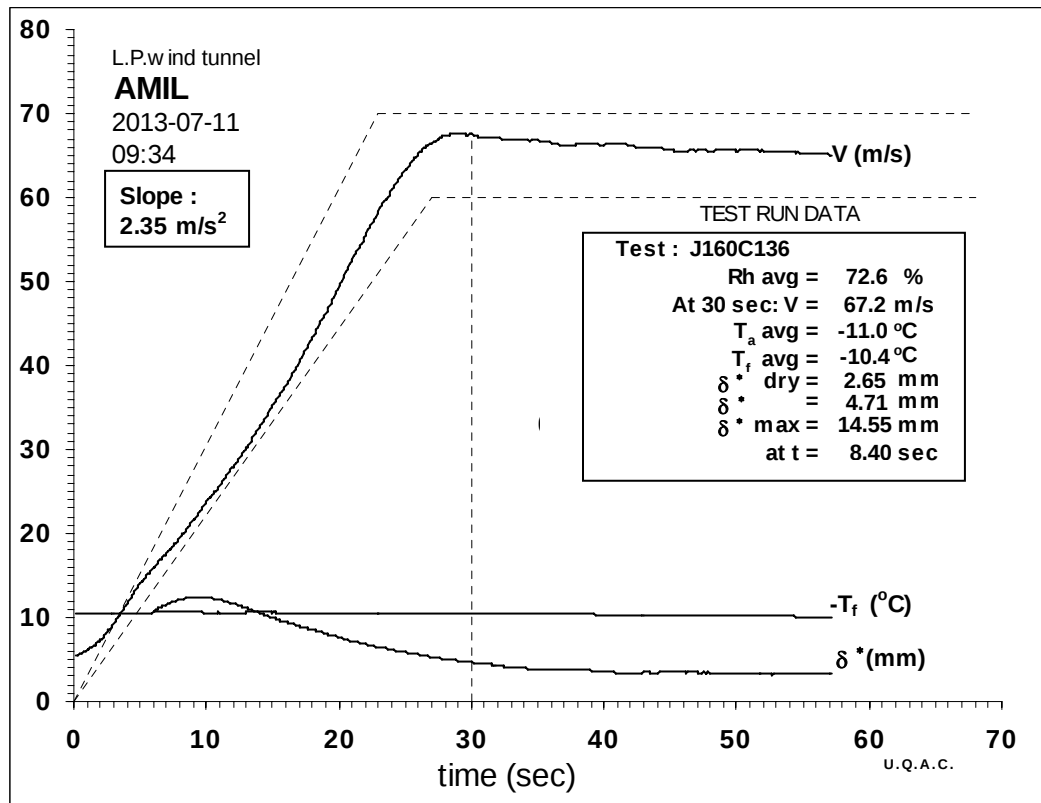
Averages between 27 and 33 seconds:

30	-10.8	-10.1	72.5	11.96	66.9	0.22	4.37
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160C136



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-11.3	-10.5	71.2	12.18	67.5	0.54	5.65
28	-11.3	-10.5	71.1	12.19	67.5	0.36	4.92
29	-11.3	-10.5	71.5	12.11	67.3	0.33	4.81
30	-11.2	-10.5	71.3	12.39	68.1	0.28	4.61
31	-11.2	-10.5	71.6	12.09	67.3	0.28	4.61
32	-11.1	-10.5	72.3	11.75	66.3	0.20	4.29
33	-11.1	-10.5	71.8	11.71	66.2	0.22	4.40

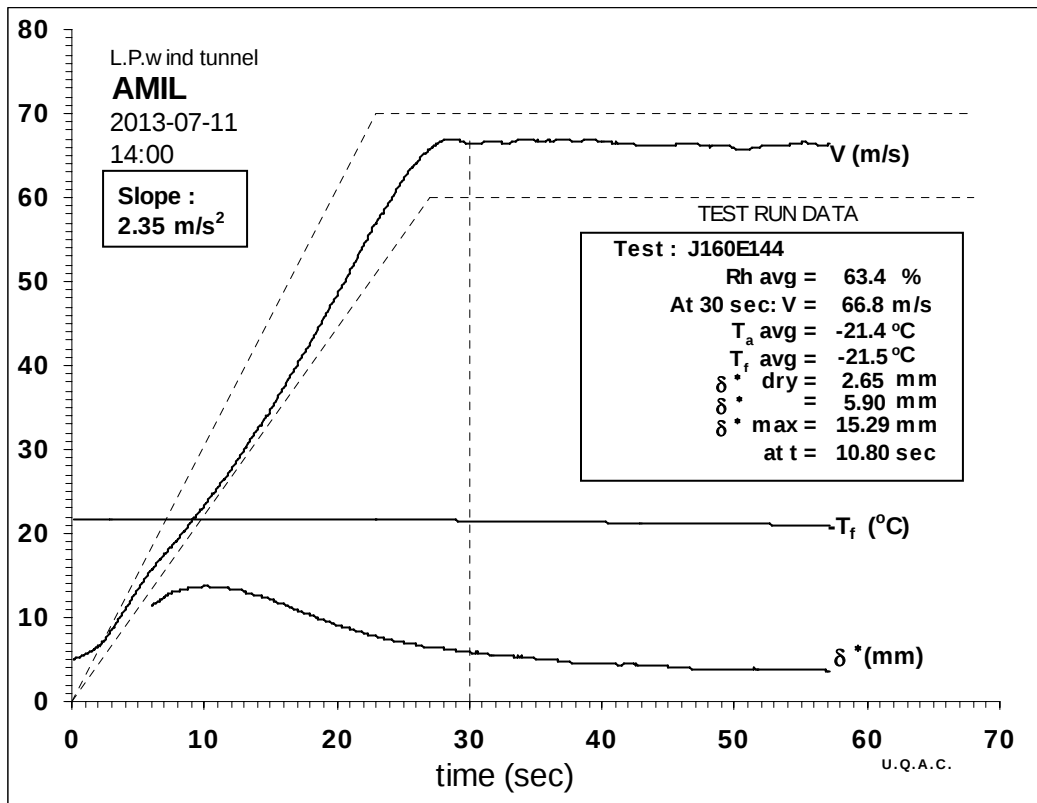
Averages between 27 and 33 seconds:

30	-11.2	-10.5	71.5	12.07	67.2	0.30	4.71
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160E144



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-21.6	-21.6	62.0	12.77	67.8	0.80	6.50
28	-21.6	-21.6	62.1	12.65	67.4	0.62	5.87
29	-21.6	-21.6	62.1	12.39	66.7	0.80	6.59
30	-21.5	-21.5	62.7	12.38	66.7	0.59	5.80
31	-21.5	-21.5	62.7	12.07	65.9	0.55	5.69
32	-21.5	-21.5	62.6	12.17	66.1	0.44	5.26
33	-21.4	-21.5	62.9	12.69	67.6	0.62	5.85

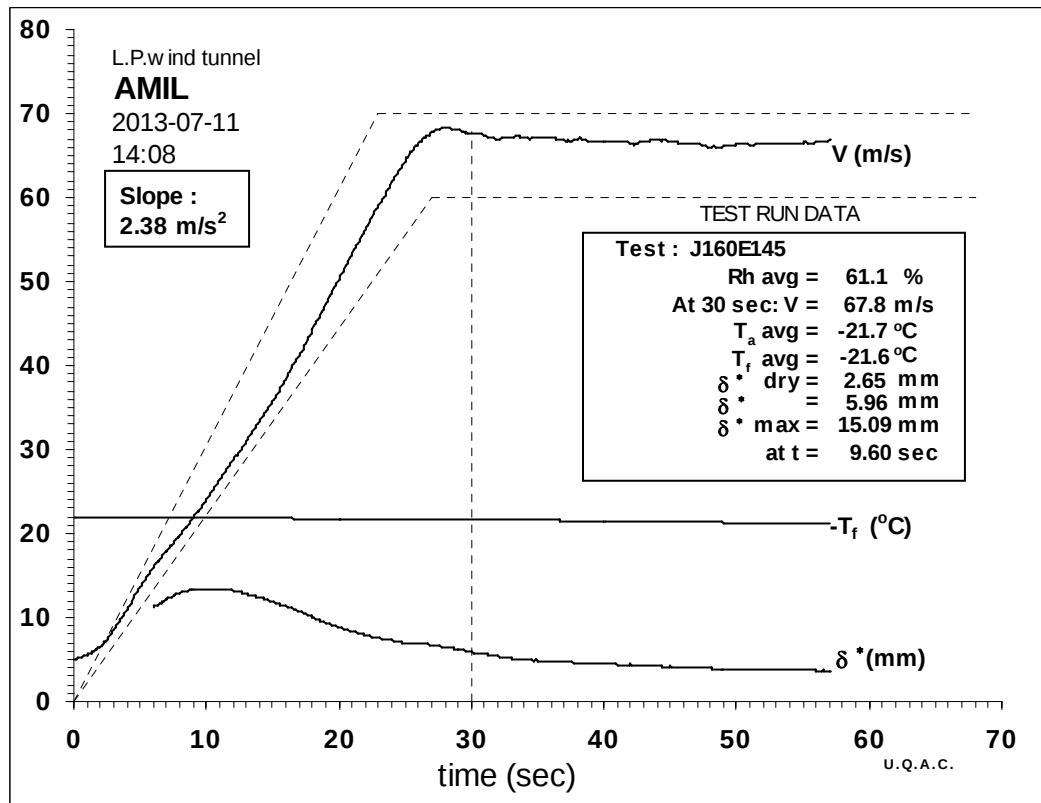
Averages between 27 and 33 seconds:

30	-21.5	-21.5	62.5	12.40	66.8	0.62	5.90
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160E145



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-22.1	-21.7	59.8	13.21	68.9	1.01	7.15
28	-22.1	-21.7	59.8	12.93	68.1	0.85	6.63
29	-22.0	-21.7	60.0	13.04	68.4	0.70	6.09
30	-22.0	-21.7	60.0	12.86	67.9	0.65	5.92
31	-21.9	-21.7	60.1	12.32	66.5	0.52	5.56
32	-21.9	-21.6	60.3	12.86	67.9	0.47	5.28
33	-21.8	-21.6	60.4	12.40	66.7	0.52	5.51

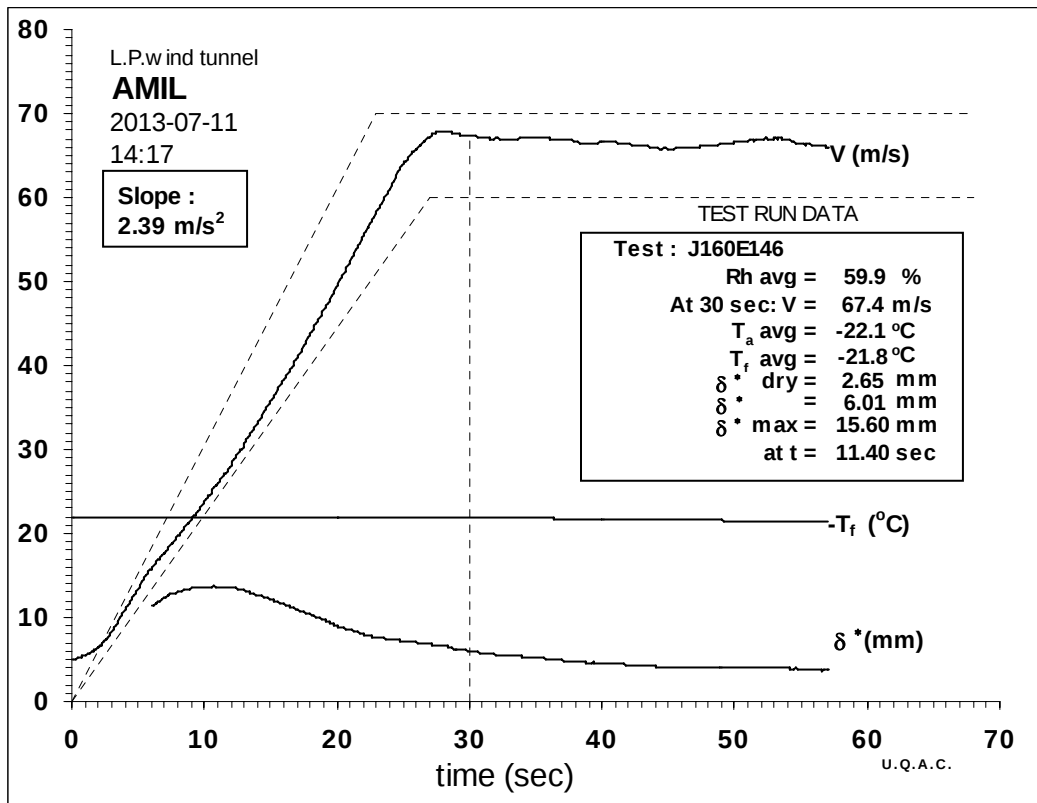
Averages between 27 and 33 seconds:

30	-22.0	-21.7	60.0	12.80	67.8	0.66	5.96
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160E146



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-22.5	-21.9	58.4	12.74	67.5	0.90	6.87
28	-22.5	-21.9	58.5	12.82	67.7	0.78	6.40
29	-22.4	-21.9	58.6	12.89	68.0	0.79	6.44
30	-22.4	-21.9	58.6	12.52	67.0	0.72	6.27
31	-22.4	-21.9	58.7	12.51	66.9	0.51	5.49
32	-22.3	-21.9	58.9	12.64	67.3	0.51	5.46
33	-22.3	-21.9	59.1	12.56	67.1	0.47	5.31

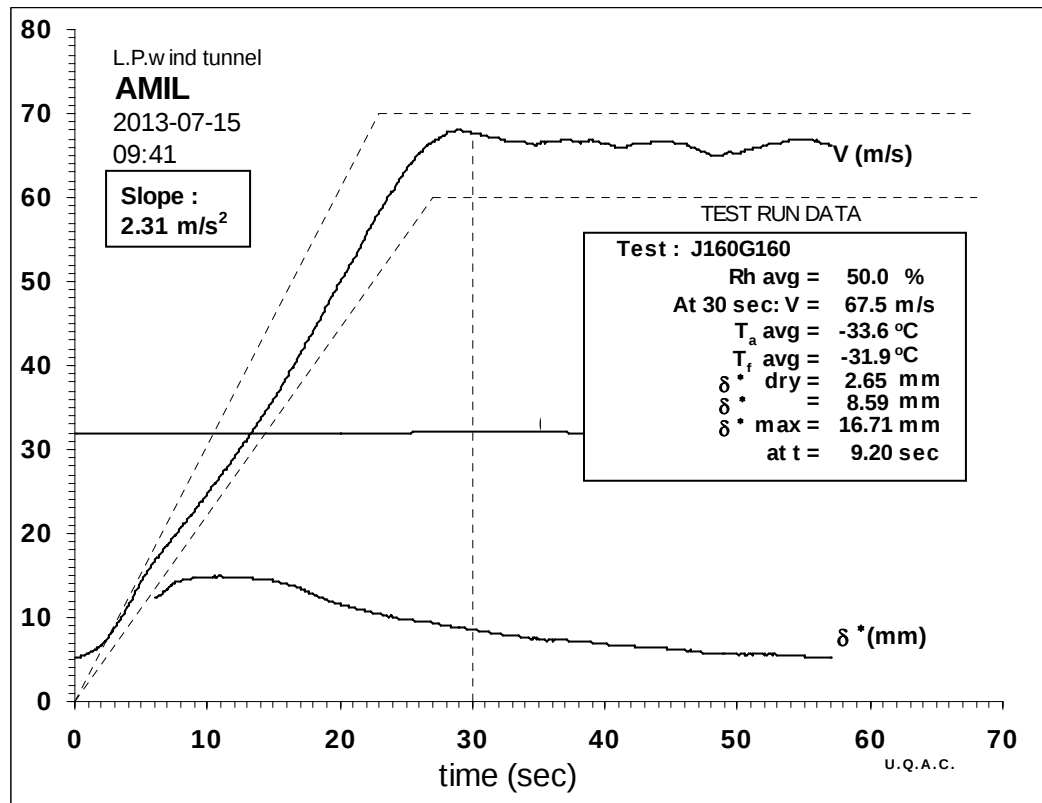
Averages between 27 and 33 seconds:

30	-22.4	-21.9	58.7	12.67	67.4	0.66	6.01
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160G160



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-34.1	-32.1	49.5	13.01	66.7	1.72	9.62
28	-34.1	-32.1	49.7	13.83	68.7	1.70	9.19
29	-34.0	-32.1	49.6	13.43	67.7	1.48	8.66
30	-33.9	-32.1	49.6	13.75	68.6	1.43	8.38
31	-33.8	-32.1	49.3	13.11	66.9	1.39	8.47
32	-33.7	-32.1	49.5	13.27	67.4	1.34	8.25
33	-33.6	-32.1	50.0	12.56	65.6	1.12	7.71

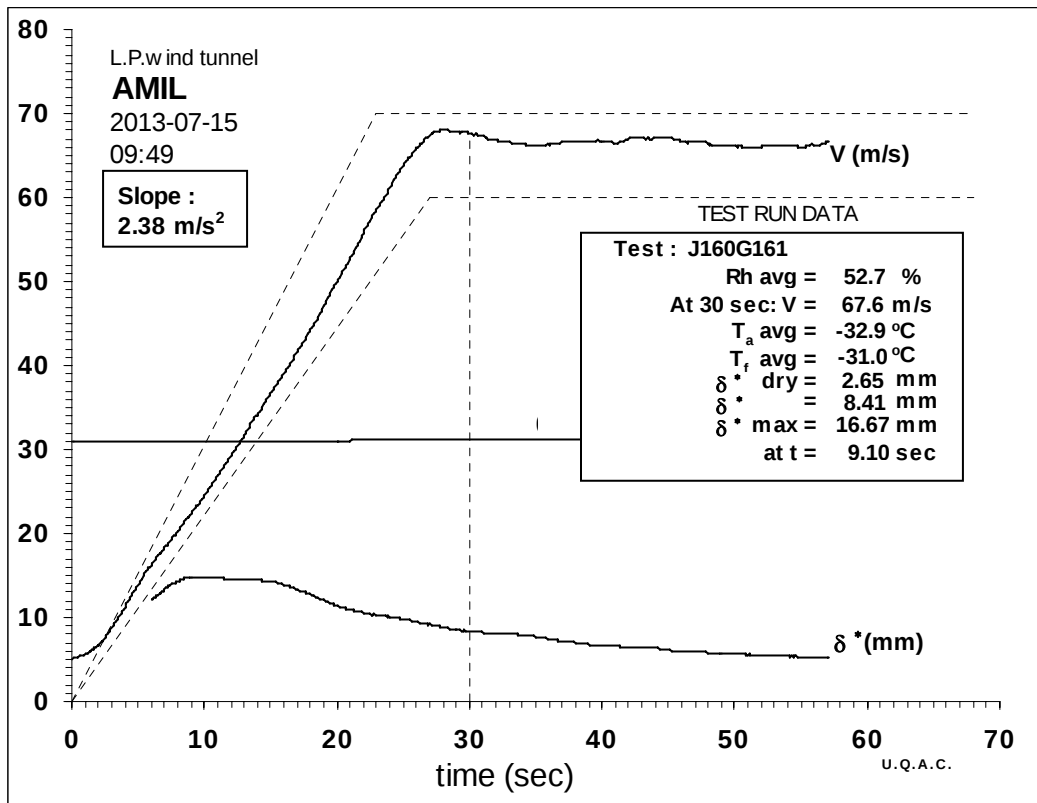
Averages between 27 and 33 seconds:

30	-33.9	-32.1	49.6	13.35	67.5	1.46	8.59
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160G161



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-33.4	-31.2	52.3	13.11	67.0	1.57	9.08
28	-33.3	-31.2	52.2	13.62	68.3	1.47	8.55
29	-33.2	-31.2	52.2	13.85	68.9	1.58	8.82
30	-33.1	-31.2	52.1	13.17	67.2	1.32	8.20
31	-33.0	-31.2	52.2	13.04	66.9	1.26	8.03
32	-32.9	-31.2	52.3	13.13	67.1	1.26	8.02
33	-32.9	-31.2	52.2	13.35	67.7	1.44	8.56

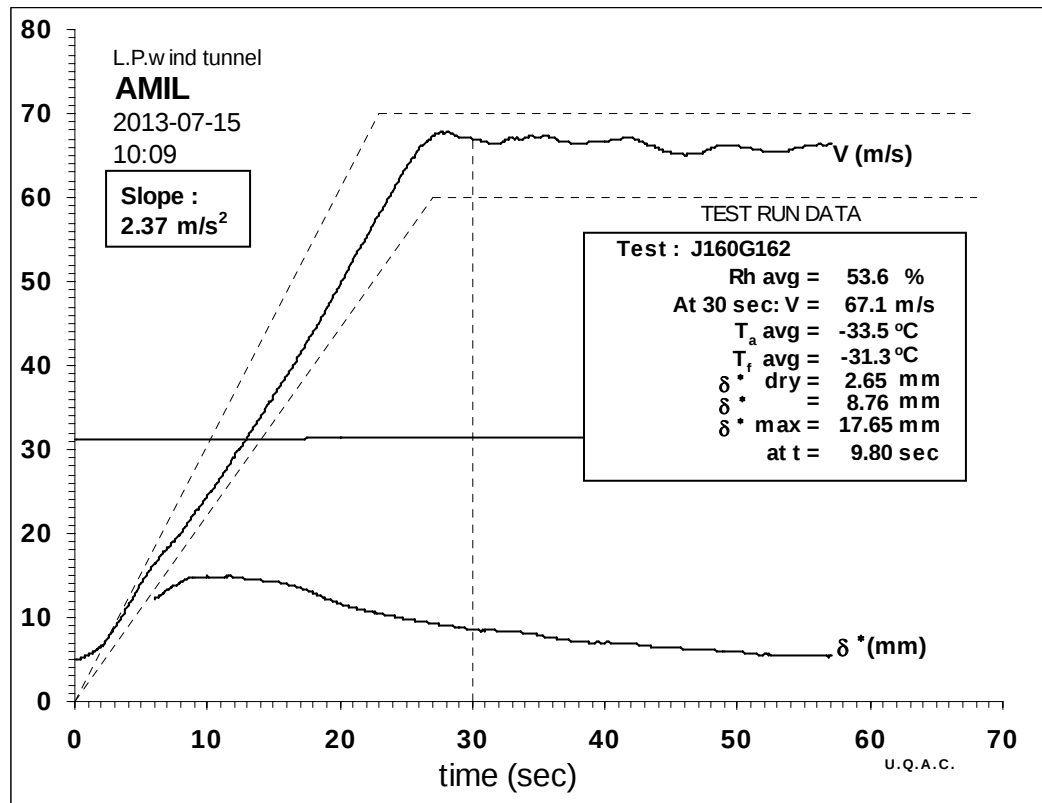
Averages between 27 and 33 seconds:

30	-33.1	-31.2	52.2	13.34	67.6	1.40	8.41
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J160G162



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a °C	T_f °C	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-34.0	-31.5	53.3	13.20	67.2	1.80	9.78
28	-33.9	-31.5	53.2	13.49	67.9	1.69	9.28
29	-33.8	-31.5	53.1	13.66	68.3	1.52	8.66
30	-33.7	-31.5	53.4	12.89	66.4	1.41	8.60
31	-33.6	-31.5	53.3	12.81	66.2	1.25	8.11
32	-33.5	-31.5	53.1	12.85	66.3	1.39	8.56
33	-33.4	-31.5	53.2	13.28	67.4	1.52	8.84

Averages between 27 and 33 seconds:

30	-33.7	-31.5	53.2	13.16	67.1	1.49	8.76
----	-------	--------------	------	-------	------	------	-------------

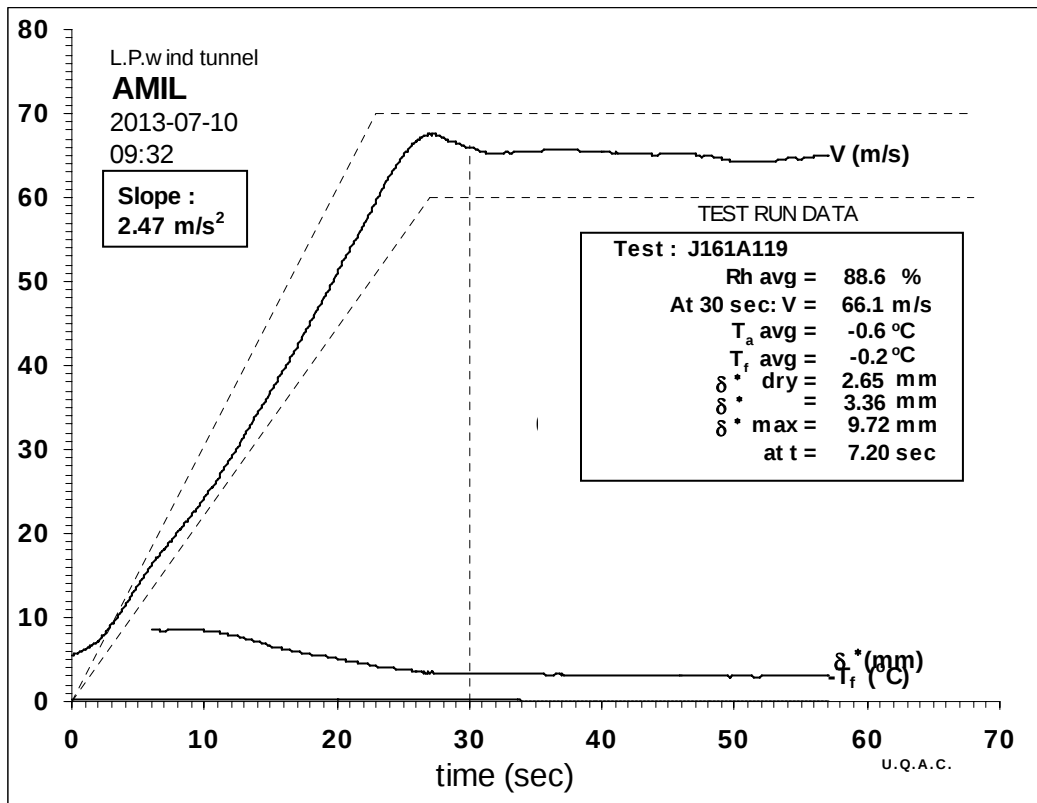
Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

This page left blank.

ARCTON LTD. DEICING FLUID
Arctica DG91 Concentrate lot # 11,
50/50 Dilution J-161

J161A119



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.7	-0.2	87.7	11.80	67.8	0.06	3.72
28	-0.6	-0.2	88.5	11.70	67.5	-0.05	3.25
29	-0.7	-0.2	88.4	11.53	67.0	0.00	3.44
30	-0.6	-0.2	88.5	10.85	65.0	-0.04	3.25
31	-0.6	-0.2	88.7	10.96	65.3	-0.05	3.24
32	-0.6	-0.1	88.6	11.12	65.8	-0.04	3.28
33	-0.6	-0.1	88.5	10.80	64.9	0.03	3.58

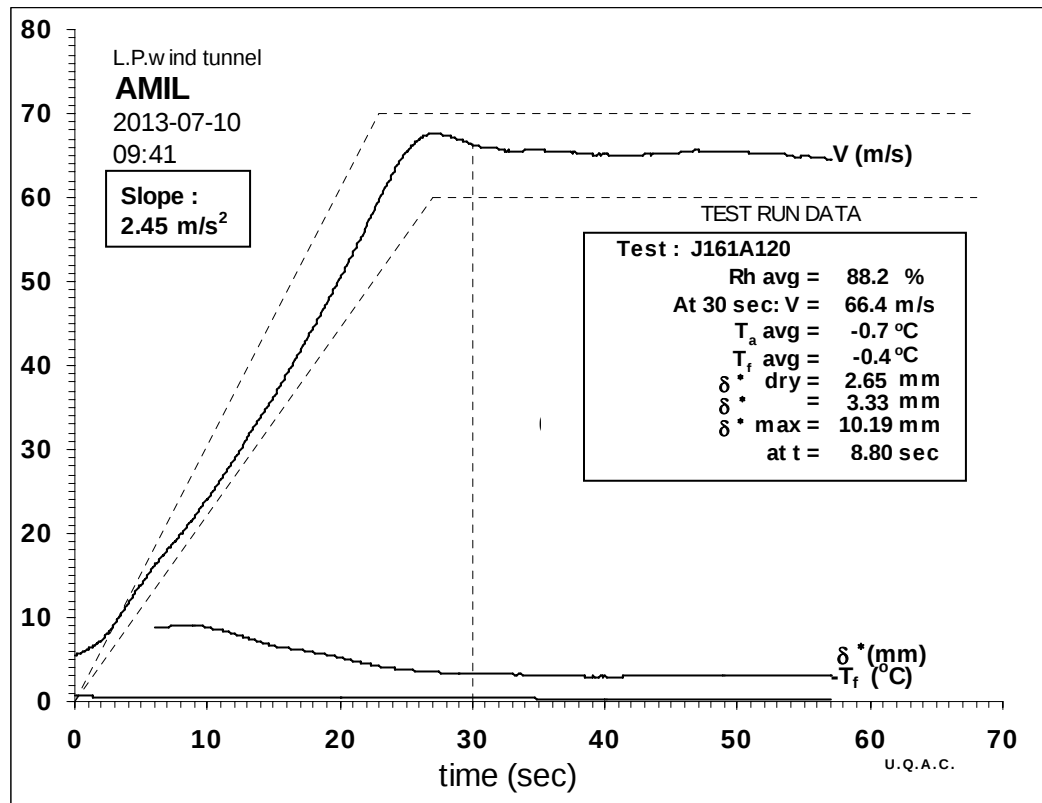
Averages between 27 and 33 seconds:

30	-0.6	-0.2	88.5	11.24	66.1	-0.02	3.36
----	------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161A120



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-0.9	-0.4	87.5	11.81	67.8	0.03	3.59
28	-0.9	-0.4	87.4	11.66	67.4	-0.04	3.27
29	-0.8	-0.4	87.7	11.35	66.5	-0.01	3.40
30	-0.8	-0.4	87.9	11.60	67.2	-0.08	3.12
31	-0.8	-0.4	88.1	11.14	65.8	-0.04	3.28
32	-0.8	-0.4	88.2	10.86	65.0	0.01	3.49
33	-0.8	-0.4	87.8	10.96	65.3	-0.05	3.21

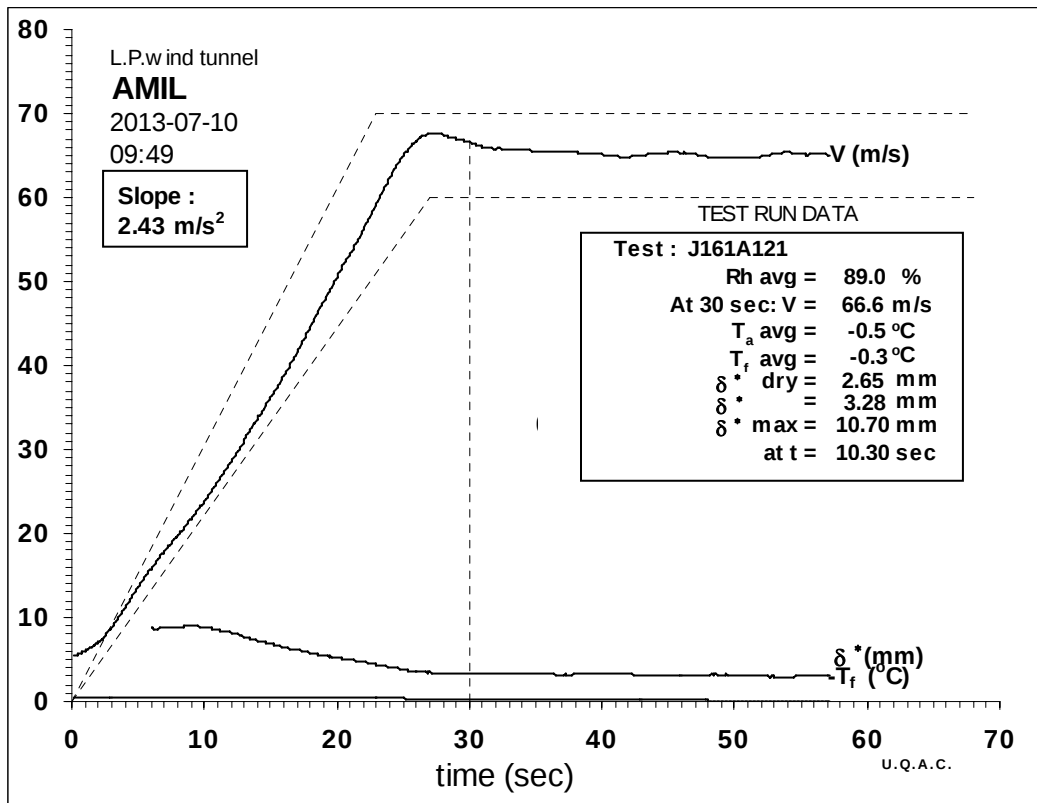
Averages between 27 and 33 seconds:

30	-0.8	-0.4	87.8	11.33	66.4	-0.03	3.33
----	------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161A121



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T_a $^\circ\text{C}$	T_f $^\circ\text{C}$	Rh %	P_1-P_2 "H ₂ O	V m/s	P_2-P_3 "H ₂ O	δ^* mm
27	-0.6	-0.3	88.7	11.80	67.8	-0.07	3.15
28	-0.6	-0.3	88.5	11.94	68.2	-0.03	3.31
29	-0.6	-0.3	88.9	11.52	67.0	-0.02	3.36
30	-0.6	-0.3	88.8	11.18	66.0	-0.07	3.15
31	-0.5	-0.3	89.0	11.24	66.2	-0.04	3.26
32	-0.6	-0.3	89.3	11.18	66.0	-0.02	3.36
33	-0.5	-0.3	89.1	10.94	65.3	-0.02	3.35

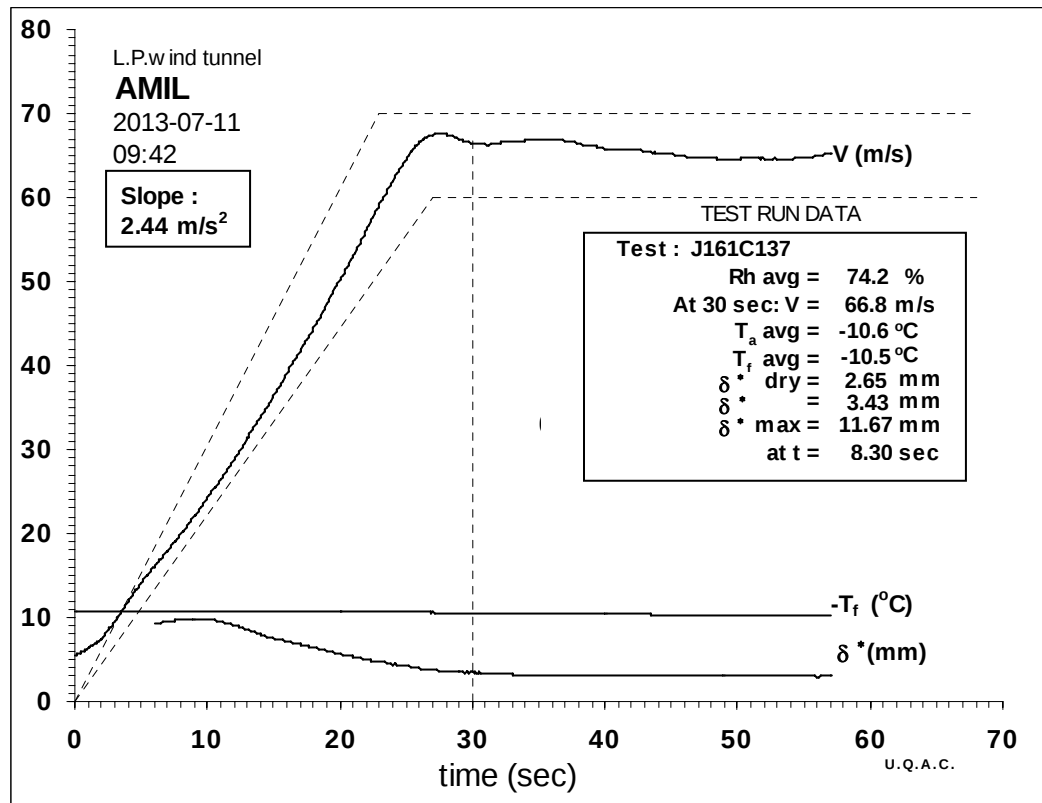
Averages between 27 and 33 seconds:

30	-0.6	-0.3	88.9	11.40	66.6	-0.04	3.28
----	------	-------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161C137



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-10.8	-10.6	72.6	12.53	68.5	0.05	3.65
28	-10.8	-10.6	72.8	12.19	67.6	-0.01	3.40
29	-10.8	-10.6	73.4	11.94	66.9	0.02	3.53
30	-10.7	-10.6	73.4	11.70	66.2	0.00	3.46
31	-10.7	-10.6	73.8	11.58	65.9	-0.03	3.34
32	-10.7	-10.5	73.8	11.82	66.6	0.01	3.48
33	-10.7	-10.5	74.0	11.76	66.4	-0.08	3.10

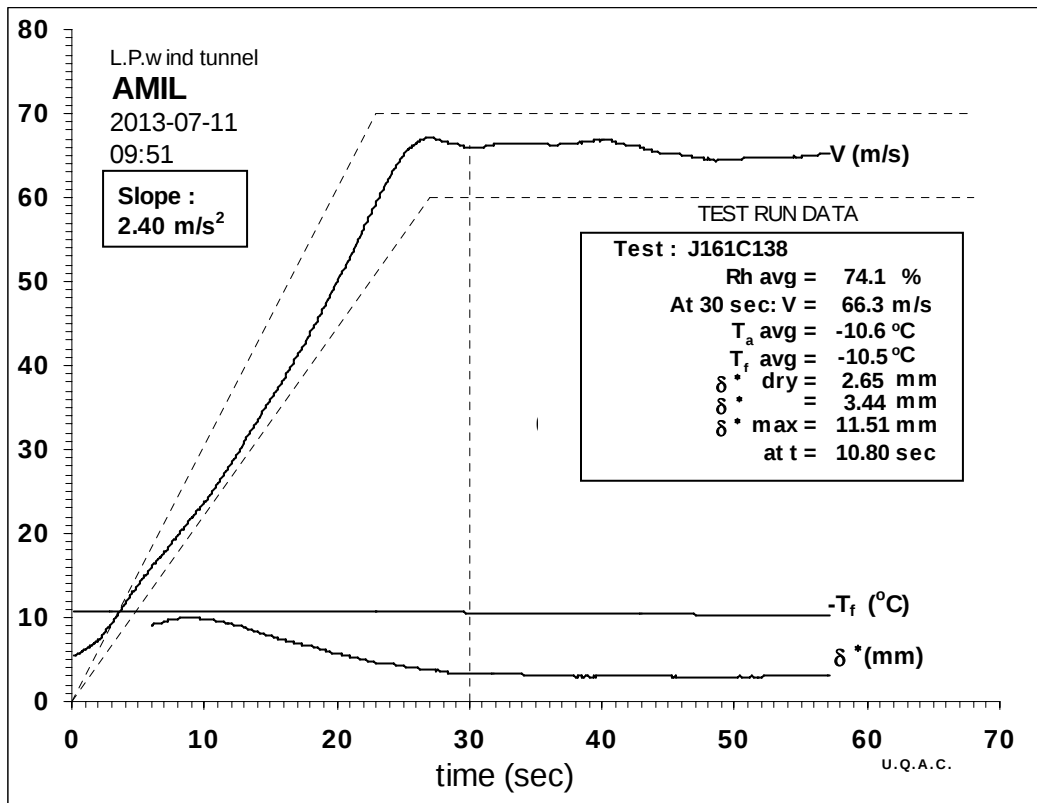
Averages between 27 and 33 seconds:

30	-10.7	-10.6	73.4	11.89	66.8	-0.01	3.43
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161C138



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-10.9	-10.6	72.7	12.31	67.9	0.01	3.51
28	-10.8	-10.6	72.9	11.89	66.8	0.00	3.45
29	-10.8	-10.6	73.2	11.55	65.8	-0.03	3.35
30	-10.8	-10.6	73.5	11.58	65.9	-0.06	3.21
31	-10.8	-10.6	73.7	11.61	66.0	0.06	3.72
32	-10.7	-10.6	74.0	11.72	66.3	0.00	3.45
33	-10.7	-10.6	74.1	11.66	66.1	-0.02	3.37

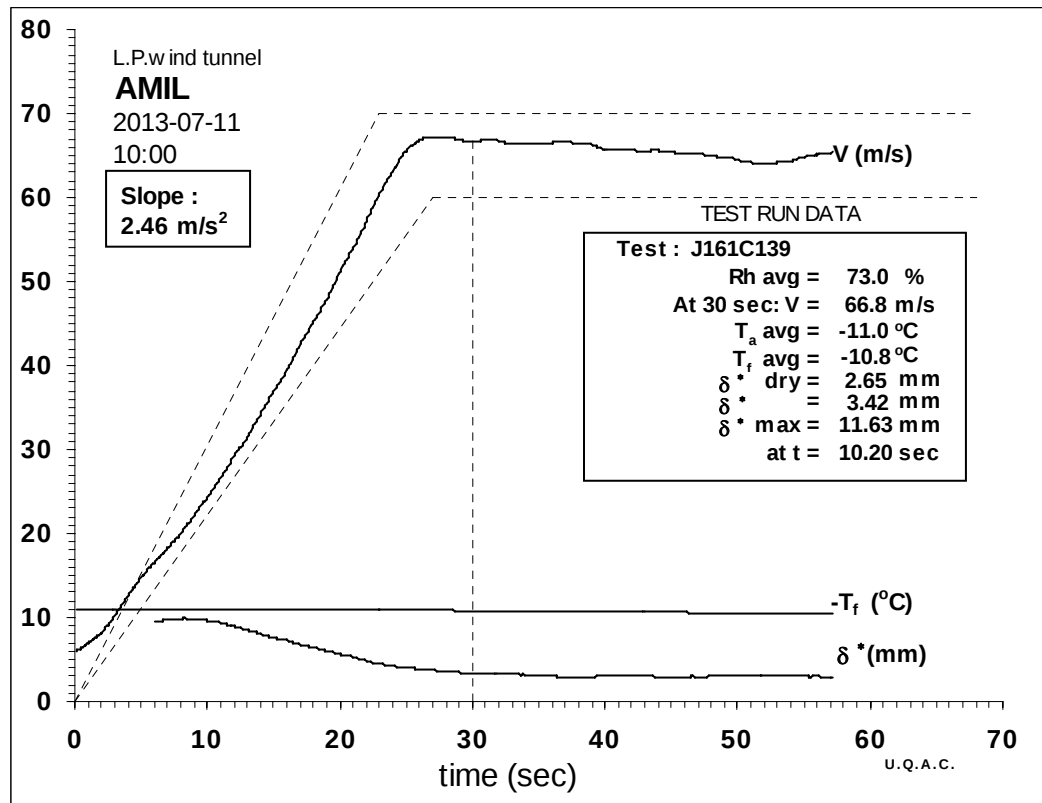
Averages between 27 and 33 seconds:

30	-10.8	-10.6	73.4	11.72	66.3	0.00	3.44
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161C139



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-11.3	-10.9	72.2	11.93	66.8	0.05	3.65
28	-11.3	-10.8	71.9	11.96	66.9	0.03	3.60
29	-11.2	-10.8	72.0	11.69	66.2	-0.01	3.42
30	-11.2	-10.8	72.2	12.13	67.4	-0.02	3.38
31	-11.2	-10.8	72.5	11.92	66.8	-0.03	3.34
32	-11.1	-10.8	72.7	11.83	66.6	0.01	3.48
33	-11.1	-10.8	73.0	12.05	67.2	-0.09	3.05

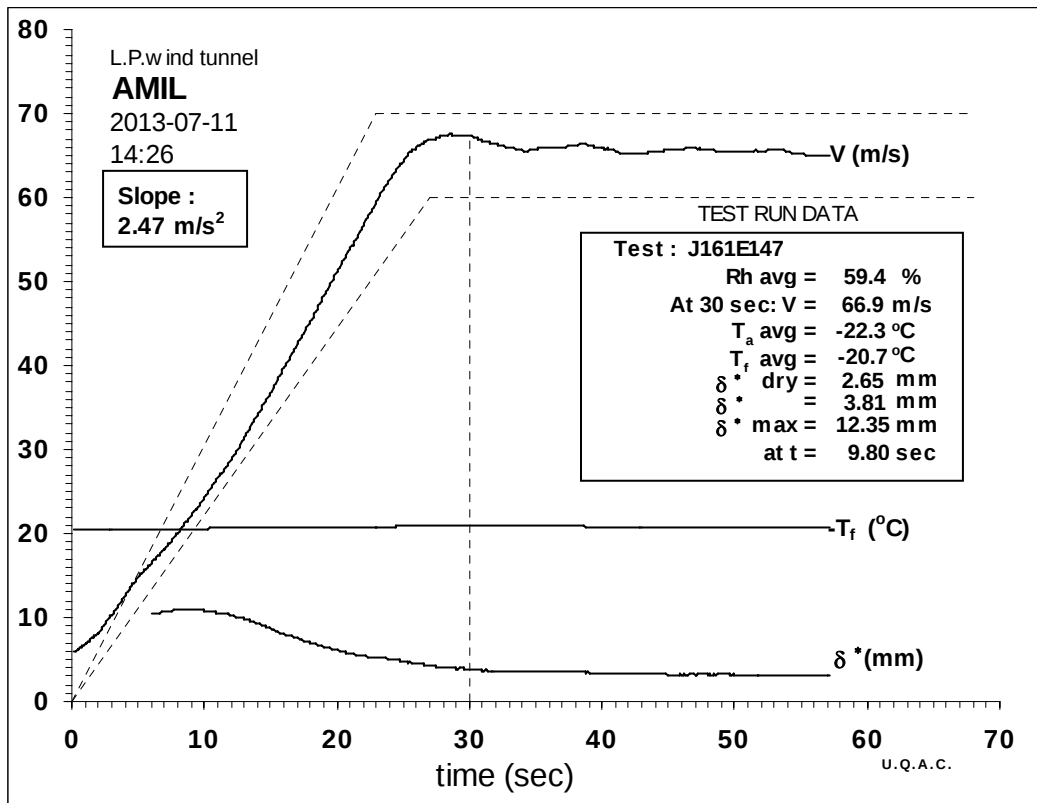
Averages between 27 and 33 seconds:

30	-11.2	-10.8	72.3	11.92	66.8	-0.01	3.42
----	-------	--------------	------	-------	------	-------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161E147



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-22.7	-20.9	58.1	12.80	67.7	0.02	3.54
28	-22.7	-20.9	58.6	12.36	66.5	0.21	4.28
29	-22.6	-20.9	58.5	12.89	67.9	0.15	4.06
30	-22.6	-20.9	58.4	12.80	67.7	0.10	3.86
31	-22.6	-20.9	58.6	12.61	67.2	0.04	3.63
32	-22.5	-20.9	58.9	12.14	65.9	-0.02	3.35
33	-22.5	-20.9	58.7	11.81	65.1	0.09	3.83

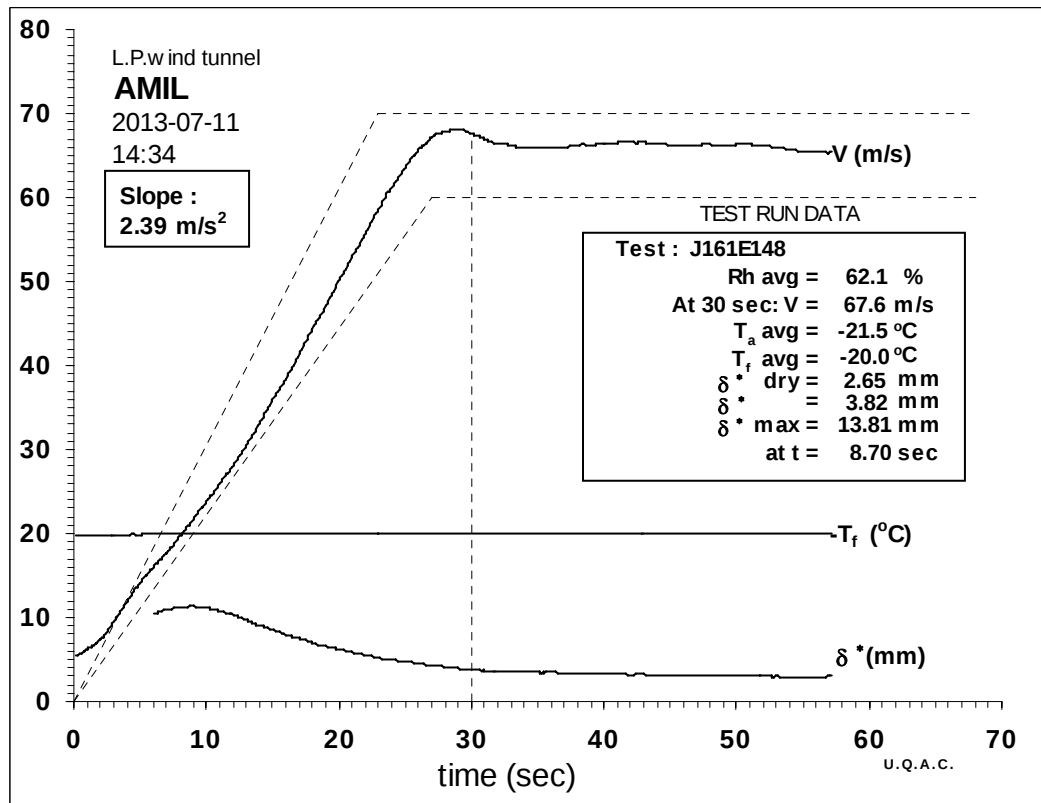
Averages between 27 and 33 seconds:

30	-22.6	-20.9	58.6	12.51	66.9	0.09	3.81
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161E148



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-21.7	-20.1	60.9	13.14	68.7	0.28	4.53
28	-21.7	-20.1	61.0	13.18	68.8	0.15	4.01
29	-21.7	-20.1	61.1	13.16	68.8	0.10	3.81
30	-21.6	-20.1	61.0	12.54	67.1	0.10	3.85
31	-21.6	-20.1	61.4	12.58	67.2	0.01	3.51
32	-21.6	-20.1	61.5	12.24	66.3	0.08	3.77
33	-21.5	-20.1	61.5	12.18	66.2	0.01	3.49

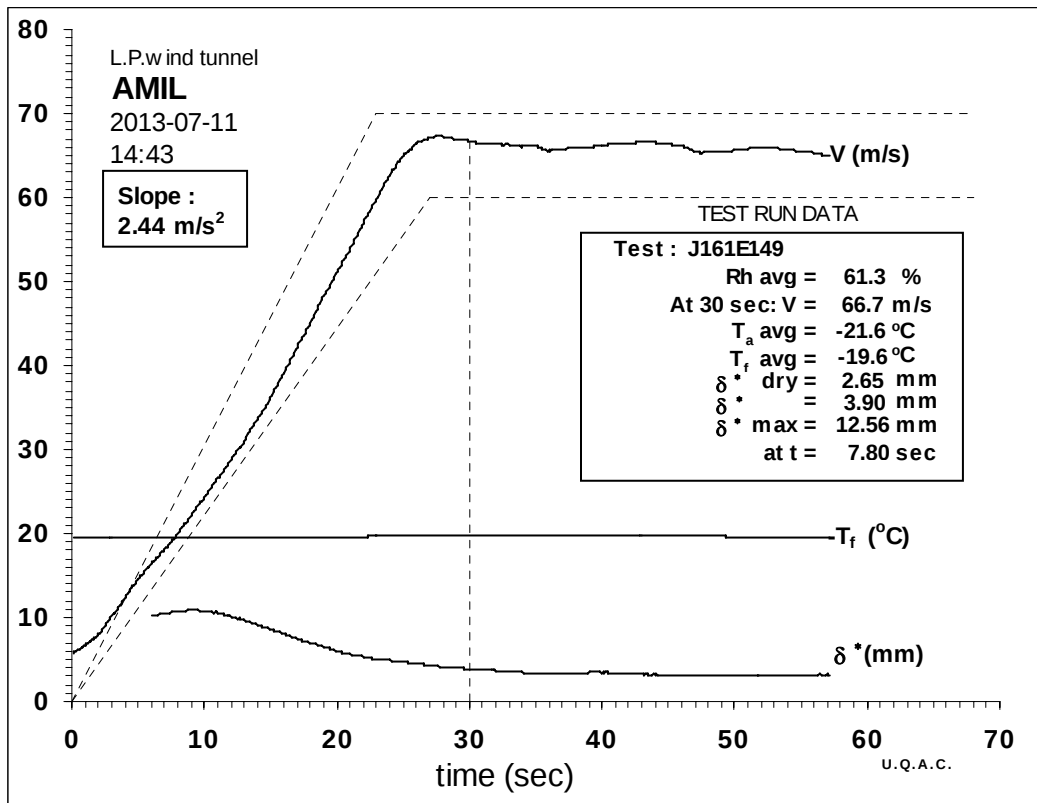
Averages between 27 and 33 seconds:

30	-21.6	-20.1	61.2	12.72	67.6	0.09	3.82
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

J161E149



CRITICAL TIME TEST DATA AVERAGED OVER ONE SECOND

time Sec	T _a °C	T _f °C	Rh %	P ₁ -P ₂ "H ₂ O	V m/s	P ₂ -P ₃ "H ₂ O	δ* mm
27	-21.9	-19.7	60.1	12.52	67.0	0.15	4.05
28	-21.8	-19.7	60.4	12.62	67.3	0.21	4.30
29	-21.8	-19.7	60.3	12.52	67.1	0.07	3.74
30	-21.8	-19.7	60.3	12.51	67.0	0.14	4.04
31	-21.7	-19.7	60.5	12.23	66.3	0.07	3.75
32	-21.6	-19.7	60.8	12.00	65.7	0.10	3.90
33	-21.6	-19.7	60.6	12.29	66.5	-0.02	3.37

Averages between 27 and 33 seconds:

30	-21.8	-19.7	60.4	12.38	66.7	0.11	3.90
----	-------	--------------	------	-------	------	------	-------------

Test Duct Dimensions :

S2 = 30845.149 mm² S3 = 33276.211 mm² B3 = 302.374 mm C3 = 825.221 mm

ACCREDITATION

This page left blank.



In accordance with PRI Program Document AC3001, Audit Criteria for compliance to SAE AMS 1424 and AMS 1428:

Anti-Icing Materials International Laboratory (AMIL)

Universite du Quebec a Chicoutimi
Department des Sciences Appliquees
555, Boulevard de l'Universite
Chicoutimi Quebec, Canada G7H 2B1

Has had its facilities examined and approved through continuing audit procedures as established by the Commercial Aviation Accreditation conformance to the applicable specification requirements for the Aircraft Ground Deicing/Anti-Icing Aerodynamic acceptance test facilities.

This certificate is granted by authority of the Performance Review Institute for:

Testing of Deicing/Anti-Icing Fluids

Certificate Number: 0001 – C
Expiration Date: 31 October 2017
Issue Date: 13 September 2012

Joseph G. Pinto, Vice President and Chief Operating Officer

Performance Review Institute (PRI) 161 Thorn Hill Road Warrendale, PA 15086-7527