RUNWAY DEICER PERFORMANCE TEST
FOR SAE AMS1431/1435
RUNWAY AND TAXIWAY DEICING CHEMICALS
EVALUATION TEST REPORT

2011-MT-30

According to AIR6170 and AIR6172 Test Methods

PURE CMA 30/70 (Generic) and
Yeatz Runway De-icing Fluid, lot # 1

for

Drago
Ambarli Dolum Tesisleri Yolu
Sehit Zafer Kiziltas Sokak No: 5
Ambarli Avcilar İstanbul
Turkey

by

Caroline Blackburn
Diane Paradis
Marc Mario Tremblay

Laboratoire international des matériaux antigivre LIMA AMIL Anti-icing Materials International Laboratory

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1 INTRODUCTION

This report presents results of runway deicing performance tests, performed on two samples of liquid runway deicers provided by **Drago**.

2 PROCEDURE

The runway deicer was tested in accordance with the following test methods;

AIR6170 [1]; Ice Melting Test Method* for Runways and Taxiways Deicing/Anti-icing Chemicals (proposed method, Feb. 2011).

AIR6172 [2]; Ice Undercutting Test Method* for Runways and Taxiways Deicing/Anti-icing Chemicals (proposed method, Feb. 2011).

** These test methods were submitted for ballot to the G-12 fluids committee in May 2011, currently waiting to be published.*

3 TEST RESULTS SUMMARY

Ice melting test results are presented in Table 2 and Table 3. The ice undercutting test results are presented in Table 4 and Table 5.

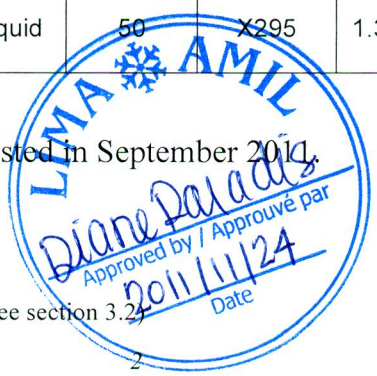
3.1 Runway Deicer Identification

Deicing performance evaluation tests were performed on the deicers described in Table 1.

Table 1 - Runway Deicer Identification

Company	Runway Deicer			AMIL Label	RI[1] (20°C)	Manuf. Date	Manuf. Location	Recep. Date
	Name	Form	Conc.[2] % w/w					
AMIL	**K Acetate Solution**	Liquid	50	REF001	1.3932	11-05-27	Saguenay, PQ, Can.	11-05-27
-	**PURE CMA 30/70 (Generic)**	Liquid	30	X297	1.3776	-	Shanghai, China	11-07-07
Drago	**Yeatz Runway De-icing Fluid, lot # 1**	Liquid	50	X295	1.3926	11-09-12	Istambul, Turkey	11-09-19

These runway deicers were tested in September 2011.



[1] Refractive Index
[2] Concentration of active ingredient (see section 3.2)

3.2 Performance Tests Description

3.2.1 Ice Melting

This test was designed to evaluate the laboratory ice melting performance of SAE AMS 1431 [3] and SAE AMS 1435 [4] Runways and Taxiways Deicing/Anti-icing Chemicals. The test utilizes a sheet of ice of uniform thickness frozen in a flat circular polystyrene petri dish. After equilibration to the desired temperature, a weighed quantity of the deicing chemical is distributed over the surface of the ice (see Figure 1). At specified time intervals, generated brines are removed and the mass difference is calculated in order to obtain the mass of melted ice. Testing temperatures shall be within 1 °C (2 °F) of the stated values and tests are performed within a cold chamber.

Figure 1 - Example of Ice Melting Test Set-Up

3.2.2 Ice Undercutting

This test was designed to evaluate the laboratory ice undercutting capability by SAE AMS 1431 [3] and SAE AMS 1435 [4] Runways and Taxiways Deicing/Anti-icing Chemicals. The test utilizes small cylindrical cavities in a sheet of fabricated ice of uniform thickness frozen in a flat circular modified polystyrene petri dish having an average standardized surface roughness of 120 grit (see Figure 2). The bottoms of the cavities are essentially free of ice. After equilibration to the desired temperature, a known volume of dyed-liquid deicer is placed in the cavities, and undercutting

commences (see Figure 2). Undercutting is evidenced by the formation of essentially circular undercut patterns. At specified time intervals, the dimensions of the observed undercut patterns are measured. The undercut pattern reflects the net result of melting on the walls of the ice cavity and melting at the ice/substrate interface. The undercut is relatively thick near the center and relatively thin at the extremities. The undercut area is defined as the total area of the circular undercut pattern minus the area of the original cavity. Testing temperatures shall be within 1 °C (2 °F) of the stated values and tests are performed within a cold chamber.

Figure 2 - Adapted Polystyrene Petri Dish with Dyed Chemical

3.3 Ice Melting Test Results (AIR6170)

Tests were conducted according to Ice Melting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals (proposed method, Feb. 2011) [1].

Table 2 - Ice Melting Results at -2°C

AMIL #	Refractive Index at 20°C	Time Interval (minutes)	Amount of Ice Melted (Average of three tests) (g)
REF001	1.3932	5	6.10 ± 0.95
		10	7.58 ± 0.18
		30	13.42 ± 1.12
PURE CMA 30/70 (Generic)	1.3776	5	1.32 ± 0.23
		10	2.06 ± 0.18
		30	3.37 ± 0.12
Yeatz Runway De-icing Fluid, Lot # 1	1.3926	5	5.94 ± 0.12
		10	7.64 ± 0.16
		30	10.91 ± 0.29

Table 3 - Ice Melting Results at -10°C

AMIL #	Refractive Index at 20°C	Time Interval (minutes)	Amount of Ice Melted (Average of three tests) (g)
REF001	1.3932	5	3.77 ± 0.17
		10	4.48 ± 0.27
		30	6.06 ± 0.12
PURE CMA 30/70 (Generic)	1.3776	5	0.00 ± 0.00
		10	0.00 ± 0.00
		30	0.00 ± 0.00
Yeatz Runway De-icing Fluid, Lot # 1	1.3926	5	3.60 ± 0.20
		10	4.53 ± 0.24
		30	5.55 ± 0.51

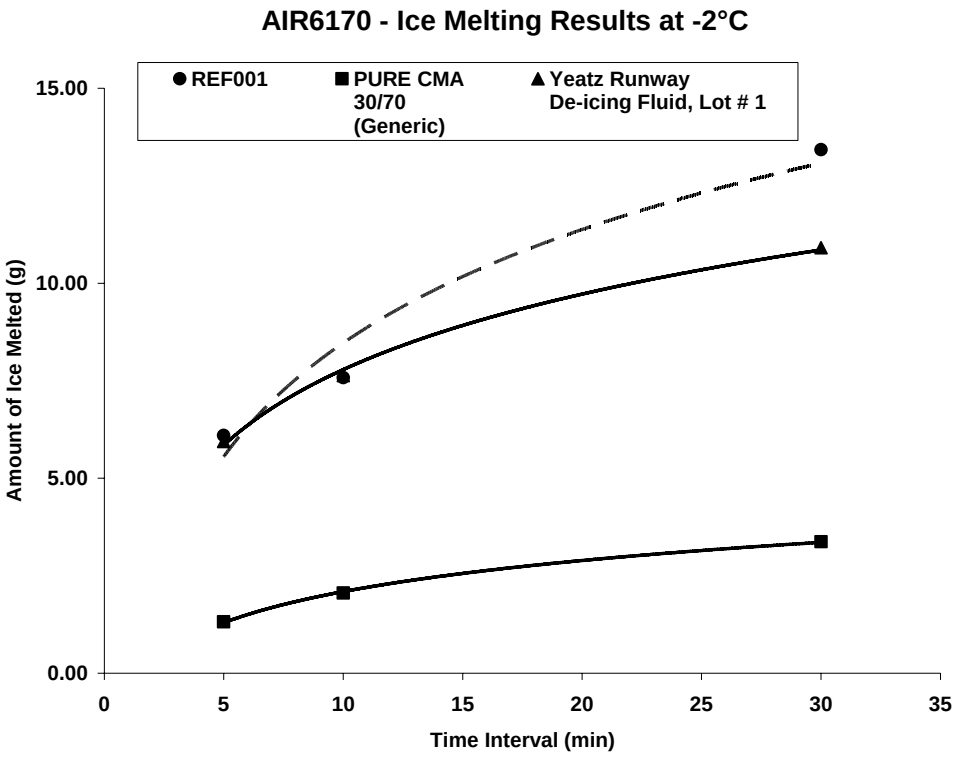


Figure 3 - Ice Melting as a Function of Time at -2°C

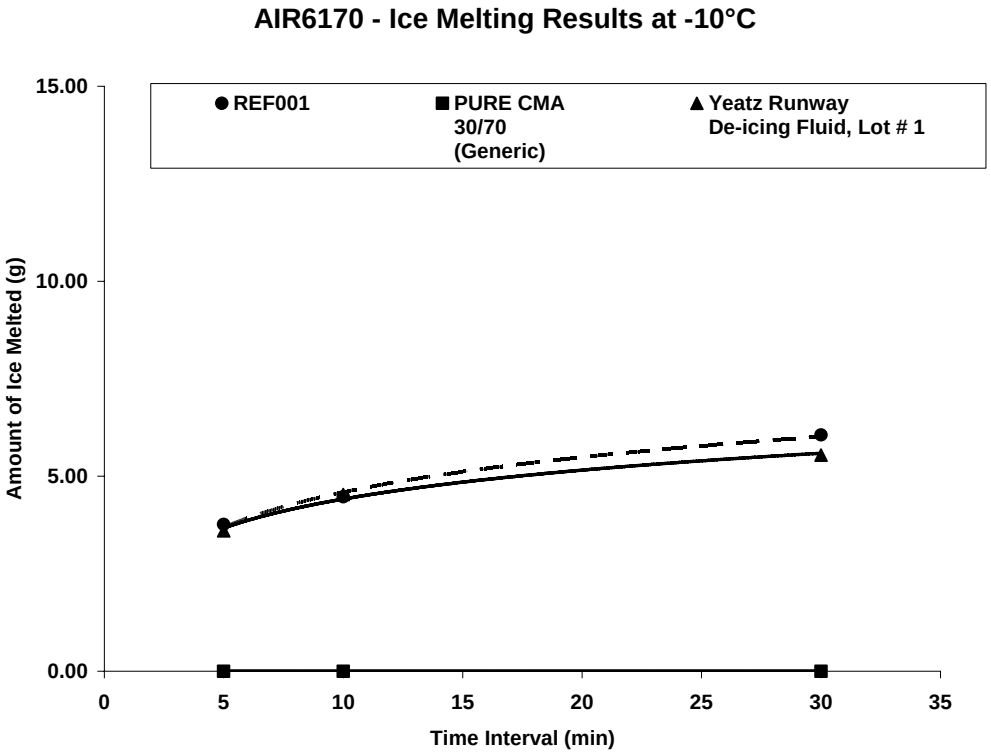


Figure 4 - Ice Melting as a Function of Time at -10°C

3.4 Ice Undercutting Test Results (AIR6172)

Tests were conducted according to Ice Undercutting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals (proposed method, Feb. 2011) [2].

Table 4 - Ice Undercutting Results at -2°C

AMIL #	RI at 20°C	Time Interval (minutes)	Ice Undercutting IU (mm^2)
REF001	1.3932	5	50.2 ± 5.7
		10	90.9 ± 16.4
		30	136.0 ± 9.9
PURE CMA 30/70 (Generic)	1.3776	5	7.6 ± 1.4
		10	9.6 ± 1.2
		30	17.6 ± 2.2
Yeatz Runway De-Icing Fluid, Lot # 1	1.3926	5	78.4 ± 8.4
		10	111.9 ± 8.7
		30	152.1 ± 9.7

Table 5 - Ice Undercutting Results at -10°C

AMIL #	RI at 20°C	Time Interval (minutes)	Ice Undercutting IU (mm^2)
REF001	1.3932	5	13.4 ± 2.1
		10	28.0 ± 3.5
		30	36.6 ± 5.9
PURE CMA 30/70 (Generic)	1.3776	5	5.5 ± 0.2
		10	5.5 ± 0.2
		30	5.5 ± 0.2
Yeatz Runway De-Icing Fluid, Lot # 1	1.3926	5	35.4 ± 3.3
		10	51.9 ± 3.3
		30	59.1 ± 1.9

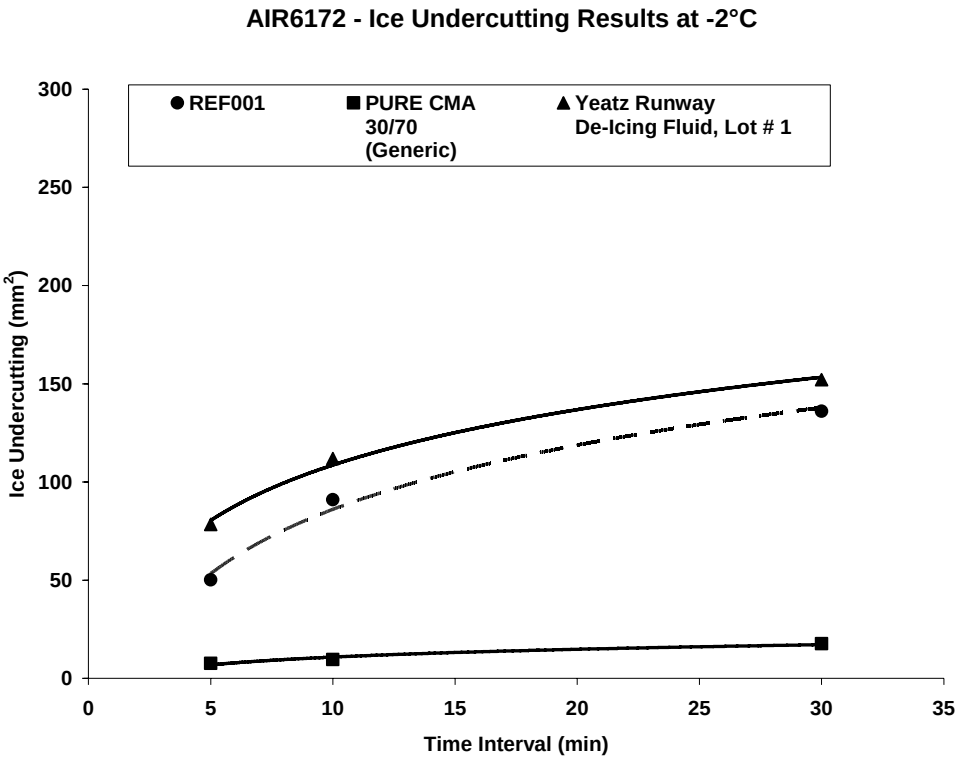


Figure 5 - Ice Undercutting as a Function of Time at -2°C

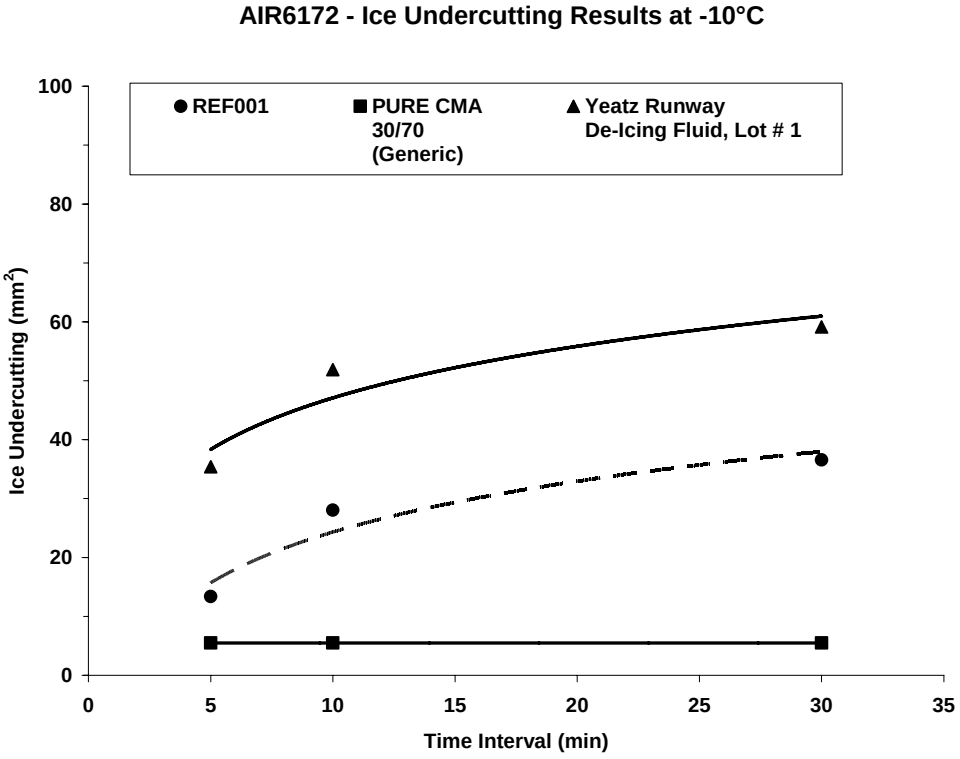


Figure 6 - Ice Undercutting as a Function of Time at -10°C

4 REFERENCES

1. SAE International Aerospace Information Report, "Ice Melting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals", AIR6170, proposed draft 2011-02.
2. SAE International Aerospace Information Report, "Ice Undercutting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals", AIR6172, proposed draft 2011-02.
3. SAE International Aerospace Material Specification, "Compound, Solid Runway and Taxiway Deicing/Anti-icing", AMS 1431, revision C, September 2010.
4. SAE International Aerospace Material Specification, "Fluid, Generic, Deicing/Anti-icing Runways and Taxiways", AMS 1435, revision B, September 2010.

Appendix 1 – Ice Melting (detailed tests)

AIR6170 - Ice Melting at -2°C

LIMA AMIL

FOR-FR024

Ice Melting
AIR6170

Deicer Utilized: Reference Control Solution

AMIL #: REF001

Report #: 2011-MT-30

Test Date: 2011-09-13

IR at 20°C: 1.3932

Test Temperature: -2 (°C)

Time* (minute)	Amount of Ice Melted m_{im} (g)				
	Test #1	Test #2	Test #3	Average	Standard deviation
5	6.25	6.96	5.08	6.10	0.95
10	7.52	7.78	7.44	7.58	0.18
30	13.85	14.27	12.15	13.42	1.12

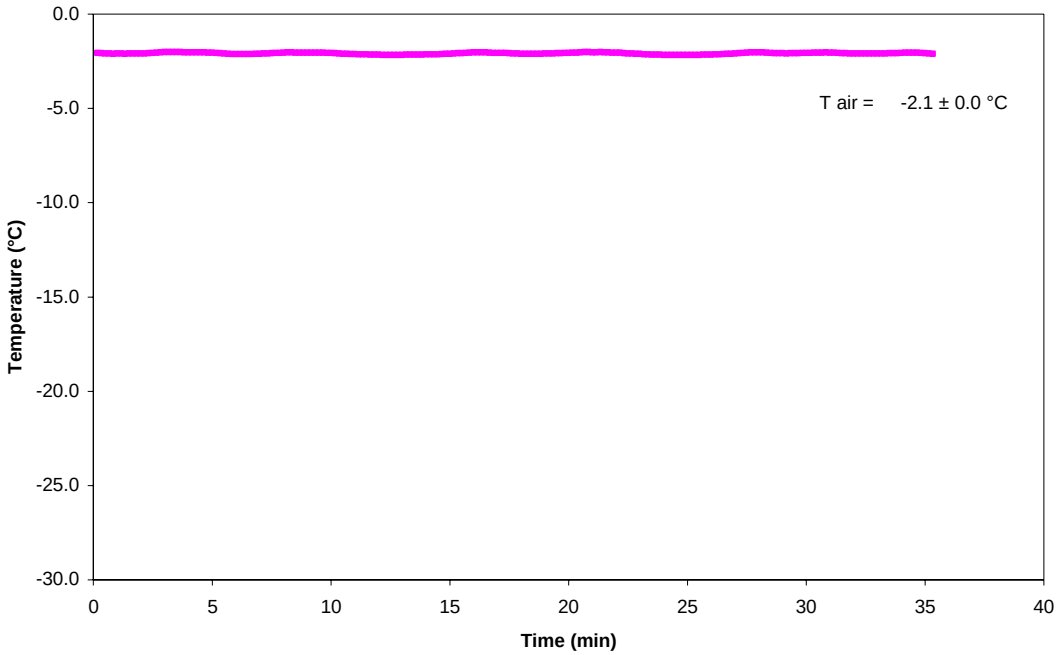
Time* (minute)	Ice Melting Capacity g ice/g deicer
5	1.22
10	1.52
30	2.68

Time* (minute)	Amount of Deicer Applied g			
	Test #1	Test #2	Test #3	Average
5	5.00	5.00	5.00	5.00
10	5.00	5.00	5.00	5.00
30	5.00	5.00	5.00	5.00

AIR TEMPERATURE RECORDING

ICE MELTING TEST -2 °C: REF001

DATE:2011-09-13



LIMA AMIL

Ice Melting
AIR6170

Deicer Utilized: PURE CMA 30/70 (Generic)

AMIL #: X297

Report #: 2011-MT-30

Test Date: 2011-09-30

IR at 20°C: 1.3776

Test Temperature: -2 (°C)

Time* (minute)	Amount of Ice Melted m_{im} (g)				
	Test #1	Test #2	Test #3	Average	Standard deviation
5	1.39	1.51	1.06	1.32	0.23
10	2.16	1.85	2.16	2.06	0.18
30	3.49	3.37	3.26	3.37	0.12

Time* (minute)	Ice Melting Capacity g ice/g deicer
5	0.26
10	0.41
30	0.67

Time* (minute)	Amount of Deicer Applied g			
	Test #1	Test #2	Test #3	Average
5	5.00	5.00	5.00	5.00
10	5.00	5.00	5.00	5.00
30	5.00	5.00	5.00	5.00

LIMA AMIL

Ice Melting
AIR6170

Deicer Utilized: Yeatz Runway De-icing Fluid, Lot # 1

AMIL #: X295

Report #: 2011-MT-30

Test Date: 2011-09-30

IR at 20°C: 1.3926

Test Temperature: -2 (°C)

Time* (minute)	Amount of Ice Melted m_{im} (g)				
	Test #1	Test #2	Test #3	Average	Standard deviation
5	6.08	5.89	5.86	5.94	0.12
10	7.75	7.70	7.46	7.64	0.16
30	10.70	11.24	10.80	10.91	0.29

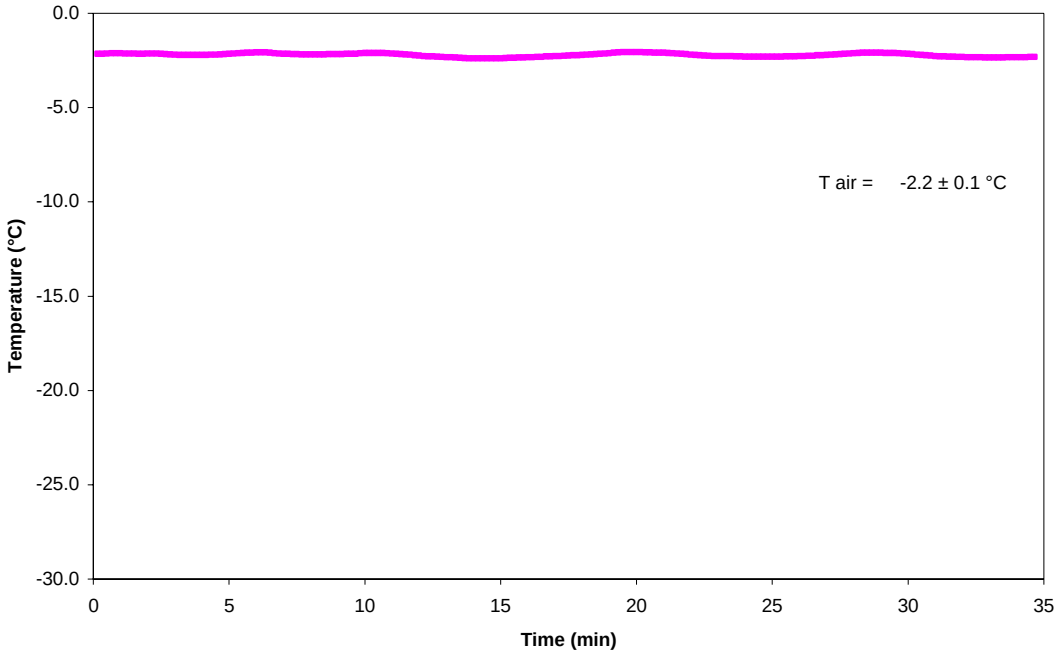
Time* (minute)	Ice Melting Capacity g ice/g deicer
5	1.19
10	1.53
30	2.18

Time* (minute)	Amount of Deicer Applied g			
	Test #1	Test #2	Test #3	Average
5	5.00	5.00	5.00	5.00
10	5.00	5.00	5.00	5.00
30	5.00	4.99	5.00	5.00

AIR TEMPERATURE RECORDING

ICE MELTING TEST -2 °C: X297

DATE:2011-09-30



AIR TEMPERATURE RECORDING

ICE MELTING TEST -2 °C: X295

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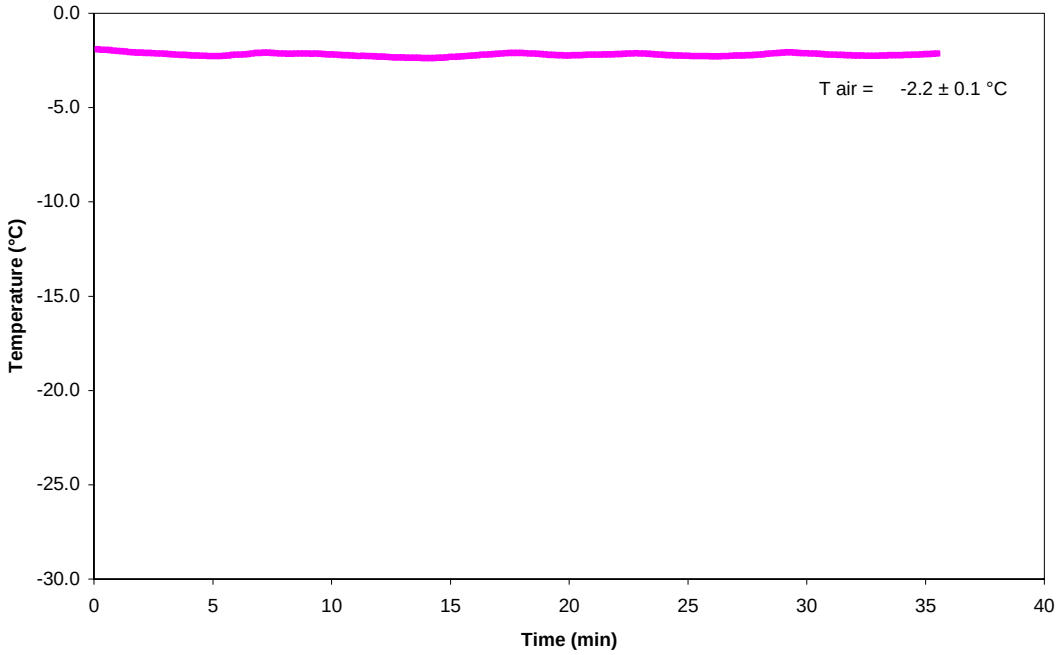


AIR6170 - Ice Melting at -10°C

LIMA AMIL

FOR-FR024

Ice Melting
AIR6170

Deicer Utilized: Reference Control Solution

AMIL #: REF001

Report #: 2011-MT-30

Test Date: 2011-08-30

IR at 20°C: 1.3932

Test Temperature: **-10** **(°C)**

Time* (minute)	Amount of Ice Melted m_{im} (g)				
	Test #1	Test #2	Test #3	Average	Standard deviation
5	3.96	3.68	3.66	3.77	0.17
10	4.57	4.69	4.17	4.48	0.27
30	6.18	5.95	6.05	6.06	0.12

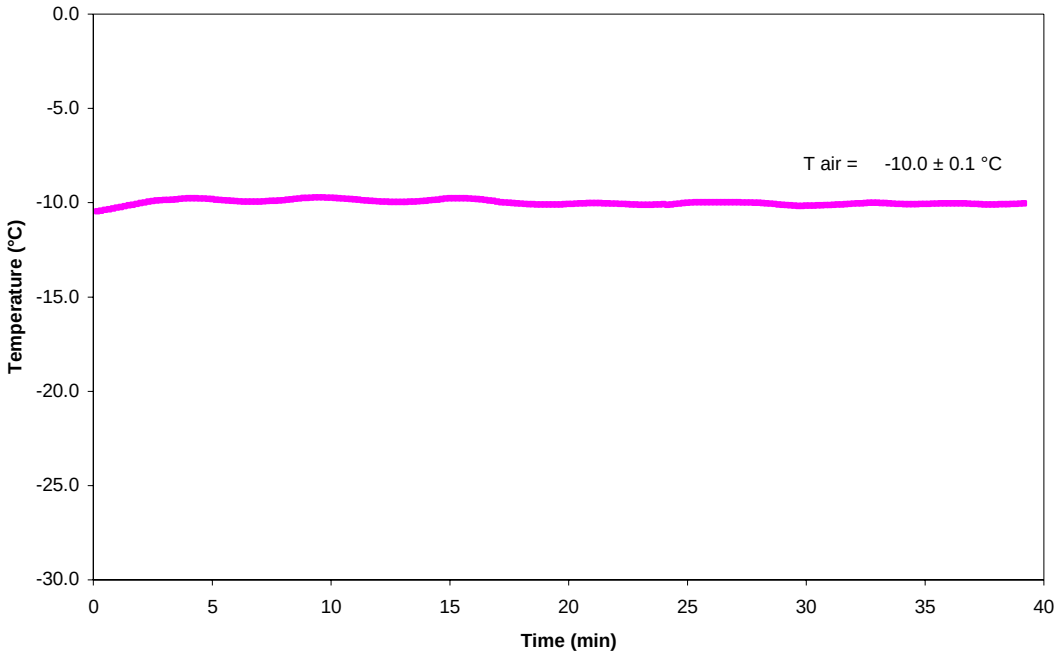
Time* (minute)	Ice Melting Capacity g ice/g deicer
5	0.75
10	0.90
30	1.21

Time* (minute)	Amount of Deicer Applied g			
	Test #1	Test #2	Test #3	Average
5	5.00	5.00	4.99	5.00
10	5.00	5.00	5.00	5.00
30	5.00	5.00	5.00	5.00

AIR TEMPERATURE RECORDING

ICE MELTING TEST -10 °C: REF001

DATE:2011-08-30



LIMA AMIL

Ice Melting
AIR6170

Deicer Utilized: PURE CMA 30/70 (Generic)

AMIL #: X297

Report #: 2011-MT-30

Test Date: 2011-09-28

IR at 20°C: 1.3776

Test Temperature: **-10** **(°C)**

Time* (minute)	Amount of Ice Melted m_{im} (g)				
	Test #1	Test #2	Test #3	Average	Standard deviation
5	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00

Time* (minute)	Ice Melting Capacity g ice/g deicer
5	0.00
10	0.00
30	0.00

Time* (minute)	Amount of Deicer Applied g			
	Test #1	Test #2	Test #3	Average
5	5.00	5.00	5.00	5.00
10	5.00	5.00	4.99	5.00
30	5.00	5.00	5.00	5.00

LIMA AMIL

Ice Melting
AIR6170

Deicer Utilized: Yeatz Runway De-icing Fluid, Lot # 1

AMIL #: X295

Report #: 2011-MT-30

Test Date: 2011-09-28

IR at 20°C: 1.3926

Test Temperature: **-10** **(°C)**

Time* (minute)	Amount of Ice Melted m_{im} (g)				
	Test #1	Test #2	Test #3	Average	Standard deviation
5	3.64	3.78	3.39	3.60	0.20
10	4.79	4.49	4.32	4.53	0.24
30	5.87	5.81	4.96	5.55	0.51

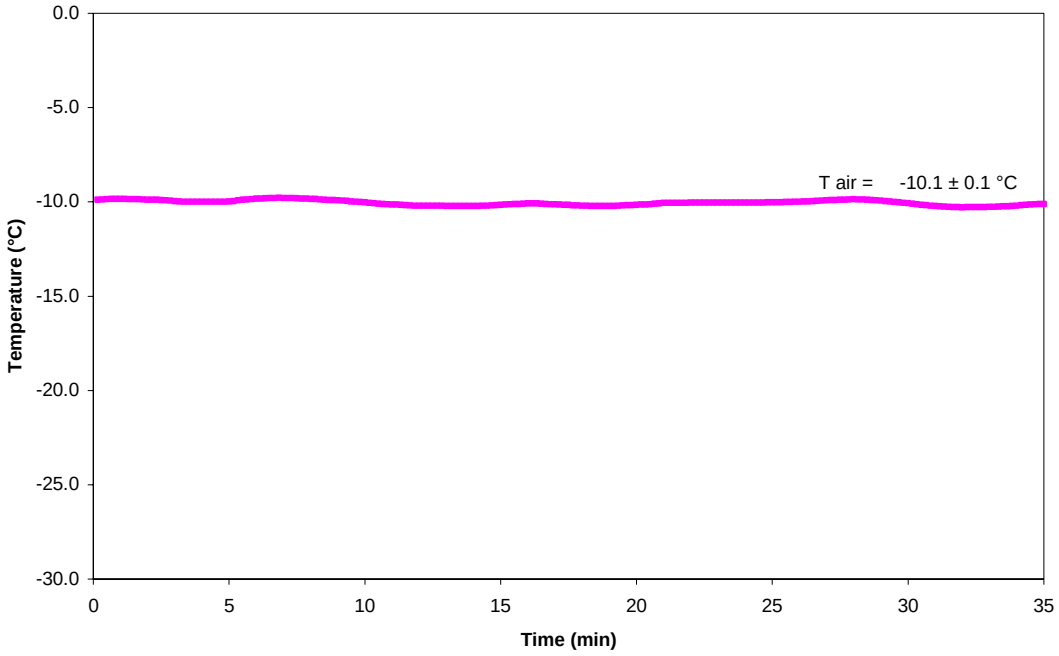
Time* (minute)	Ice Melting Capacity g ice/g deicer
5	0.72
10	0.91
30	1.11

Time* (minute)	Amount of Deicer Applied g			
	Test #1	Test #2	Test #3	Average
5	5.00	5.00	5.00	5.00
10	5.00	5.00	5.00	5.00
30	4.99	5.00	5.00	5.00

AIR TEMPERATURE RECORDING

ICE MELTING TEST -10 °C: X297

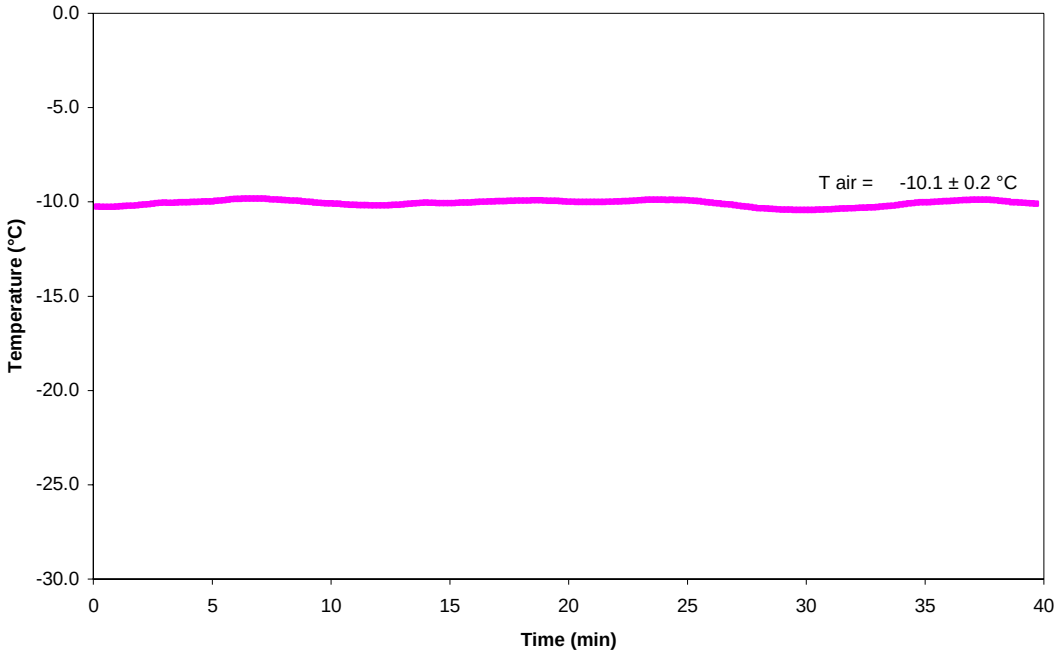
DATE:2011-09-28



AIR TEMPERATURE RECORDING

ICE MELTING TEST -10 °C: X295

DATE:2011-09-28



Appendix 2 – Ice Undercutting (detailed tests)

AIR6172 - Ice Undercutting at -2°C and -10°C

LIMA AMIL

FOR-EN102

Ice Undercutting
AIR6172

Product Name: Reference Control Solution
AMIL #: REF001
Report #: 2011-MT-30

IR at 20°C as is: 1.3932

Test Date: 2011-09-07 **Test Temperature:** -2.2 ± 0.1
File name: IU20C

Results at -2°C

Time (minutes)	Cavity #	Undercut Cavity Diameter (± 0.5 mm)		Mean Undercut Cavity Diameter (mm)	Total Area IU_e (mm^2)	Ice Undercutting IU (mm^2)	Average IU (mm^2)	Standard deviation (mm^2)
		Vertical	Horizontal					
5	1	9.6	8.6	9.1	65.0	58.0	50.2	5.7
	2	8.3	7.7	8.0	50.3	43.2		
	3	8.7	7.8	8.3	53.5	46.4		
	4	8.7	8.7	8.7	59.4	52.4		
	5	8.9	8.3	8.6	58.1	51.0		
10	1	13.2	11.8	12.5	122.7	115.6	90.9	16.4
	2	11.1	10.2	10.7	89.1	82.0		
	3	11.2	11.9	11.6	104.8	97.7		
	4	11.2	10.6	10.9	93.3	86.2		
	5	10.0	10.2	10.1	80.1	73.0		
30	1	15.0	13.1	14.1	155.0	148.0	136.0	9.9
	2	13.6	13.4	13.5	143.1	136.1		
	3	12.3	13.4	12.9	129.7	122.6		
	4	13.8	13.8	13.8	149.6	142.5		
	5	13.3	13.2	13.3	137.9	130.8		

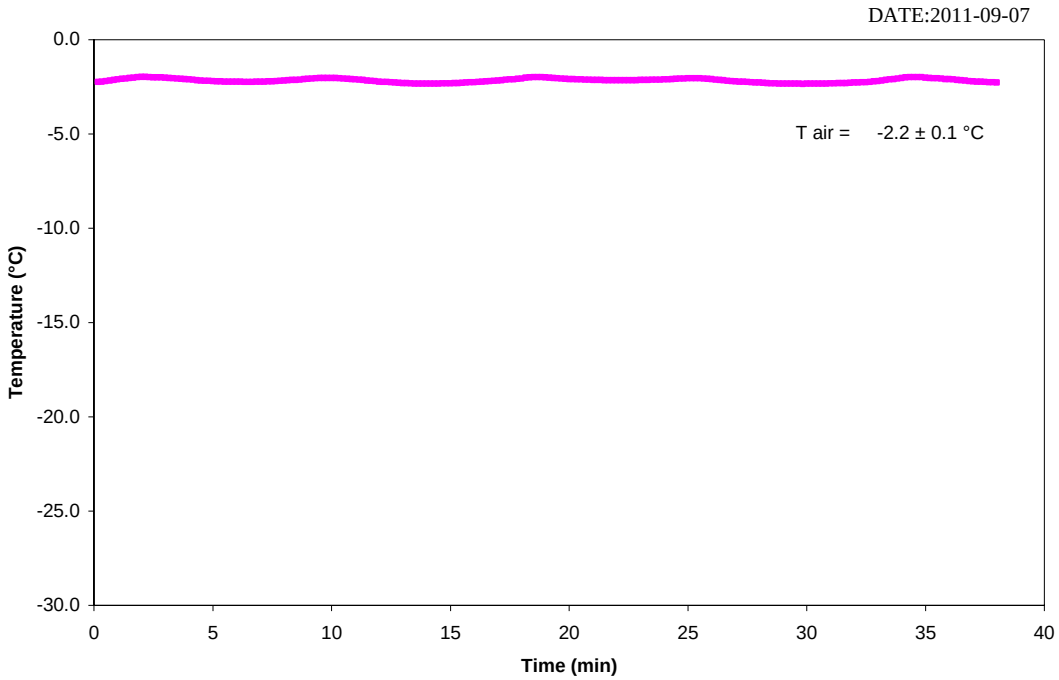
Test Date: 2011-09-01 **Test Temperature:** -10.1 ± 0.3
File name: IU20A

Results at -10°C

Time (minutes)	Cavity #	Undercut Cavity Diameter (± 0.5 mm)		Mean Undercut Cavity Diameter (mm)	Total Area IU_e (mm^2)	Ice Undercutting IU (mm^2)	Average IU (mm^2)	Standard deviation (mm^2)
		Vertical	Horizontal					
5	1	4.7	5.1	4.9	18.9	11.8	13.4	2.1
	2	5.4	5.5	5.5	23.3	16.3		
	3	6.1	4.3	5.2	21.2	14.2		
	4	5.2	4.4	4.8	18.1	11.0		
	5	5.8	4.5	5.2	20.8	13.8		
10	1	6.6	6.7	6.7	34.7	27.7	28.0	3.5
	2	6.2	6.2	6.2	30.2	23.1		
	3	6.8	6.6	6.7	35.3	28.2		
	4	8.2	6.1	7.2	40.2	33.1		
	5	7.6	5.8	6.7	35.3	28.2		
30	1	7.4	7.4	7.4	43.0	35.9	36.6	5.9
	2	6.7	7.7	7.2	40.7	33.6		
	3	7.4	6.5	7.0	37.9	30.9		
	4	9.0	7.5	8.3	53.5	46.4		
	5	8.7	6.1	7.4	43.0	35.9		

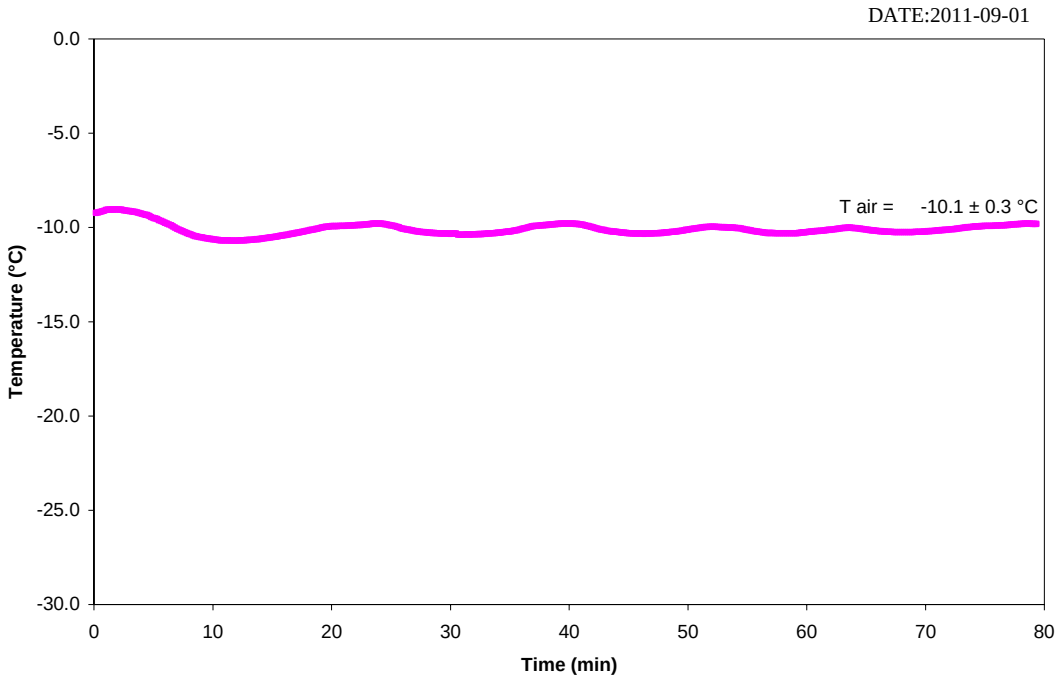
AIR TEMPERATURE

ICE UNDERCUTTING TEST -2 °C: REF001



AIR TEMPERATURE

ICE UNDERCUTTING TEST -10 °C: REF001



LIMA AMIL

Ice Undercutting
AIR6172

PURE CMA
30/70
Product Name: (Generic)
AMIL #: X297
Report #: 2011-MT-30

IR at 20°C as is: 1.3776

Test Date: 2011-09-30 **Test Temperature:** -2.2 ± 0.1
File name: IU30A2

Results at -2°C

Time (minutes)	Cavity #	Undercut Cavity Diameter (± 0.5 mm)		Mean Undercut Cavity Diameter (mm)	Total Area IU_e (mm^2)	Ice Undercutting IU (mm^2)	Average IU (mm^2)	Standard deviation (mm^2)
		Vertical	Horizontal					
5	1	4.4	4.6	4.5	15.9	8.8	7.6	1.4
	2	4.6	4.4	4.5	15.9	8.8		
	3	4.6	4.2	4.4	15.2	8.1		
	4	4.1	4.1	4.1	13.2	6.1		
	5	4.3	3.9	4.1	13.2	6.1		
10	1	4.9	4.8	4.9	18.5	11.4	9.6	1.2
	2	4.7	4.4	4.6	16.3	9.2		
	3	4.7	4.7	4.7	17.3	10.3		
	4	4.4	4.7	4.6	16.3	9.2		
	5	4.5	4.3	4.4	15.2	8.1		
30	1	5.5	5.5	5.5	23.8	16.7	17.6	2.2
	2	6.0	5.6	5.8	26.4	19.4		
	3	5.8	5.6	5.7	25.5	18.4		
	4	5.8	5.8	5.8	26.4	19.4		
	5	5.4	5.0	5.2	21.2	14.2		

Test Date: 2011-09-28 **Test Temperature:**
File name: IU30A

Results at -10°C

Time (minutes)	Cavity #	Undercut Cavity Diameter (± 0.5 mm)		Mean Undercut Cavity Diameter (mm)	Total Area IU_e (mm^2)	Ice Undercutting IU (mm^2)	Average IU (mm^2)	Standard deviation (mm^2)
		Vertical	Horizontal					
5	1	4.0	4.0	4.0	12.6	5.5	5.5	0.2
	2	4.3	3.7	4.0	12.6	5.5		
	3	4.1	3.8	4.0	12.3	5.2		
	4	4.0	4.0	4.0	12.6	5.5		
	5	4.1	4.0	4.1	12.9	5.8		
10	1	4.0	4.0	4.0	12.6	5.5	5.5	0.2
	2	4.3	3.7	4.0	12.6	5.5		
	3	4.1	3.8	4.0	12.3	5.2		
	4	4.0	4.0	4.0	12.6	5.5		
	5	4.1	4.0	4.1	12.9	5.8		
30	1	4.0	4.0	4.0	12.6	5.5	5.5	0.2
	2	4.3	3.7	4.0	12.6	5.5		
	3	4.1	3.8	4.0	12.3	5.2		
	4	4.0	4.0	4.0	12.6	5.5		
	5	4.1	4.0	4.1	12.9	5.8		

LIMA AMIL

Ice Undercutting
AIR6172

Yeatz Runway

Product Name: De-Icing Fluid, Lot # 1
AMIL #: X295
Report #: 2011-MT-30

IR at 20°C as is: 1.3926

Test Date: 2011-09-30 **Test Temperature:** -2.2 ± 0.1
File name: IU30B2

Results at -2°C

Time (minutes)	Cavity #	Undercut Cavity Diameter (± 0.5 mm)		Mean Undercut Cavity Diameter (mm)	Total Area IU_e (mm^2)	Ice Undercutting IU (mm^2)	Average IU (mm^2)	Standard deviation (mm^2)
		Vertical	Horizontal					
5	1	10.6	11.0	10.8	91.6	84.5	78.4	8.4
	2	10.8	10.8	10.8	91.6	84.5		
	3	10.7	9.5	10.1	80.1	73.0		
	4	9.7	9.6	9.7	73.1	66.1		
	5	10.1	11.4	10.8	90.8	83.7		
10	1	12.1	12.5	12.3	118.8	111.8	111.9	8.7
	2	12.7	13.0	12.9	129.7	122.6		
	3	12.3	11.8	12.1	114.0	107.0		
	4	11.7	11.7	11.7	107.5	100.4		
	5	12.4	12.8	12.6	124.7	117.6		
30	1	14.1	14.9	14.5	165.1	158.1	152.1	9.7
	2	14.1	14.6	14.4	161.7	154.7		
	3	14.0	14.0	14.0	153.9	146.9		
	4	14.1	13.1	13.6	145.3	138.2		
	5	14.1	15.3	14.7	169.7	162.6		

Test Date: 2011-09-28 **Test Temperature:** -10.2 ± 0.1
File name: IU30B

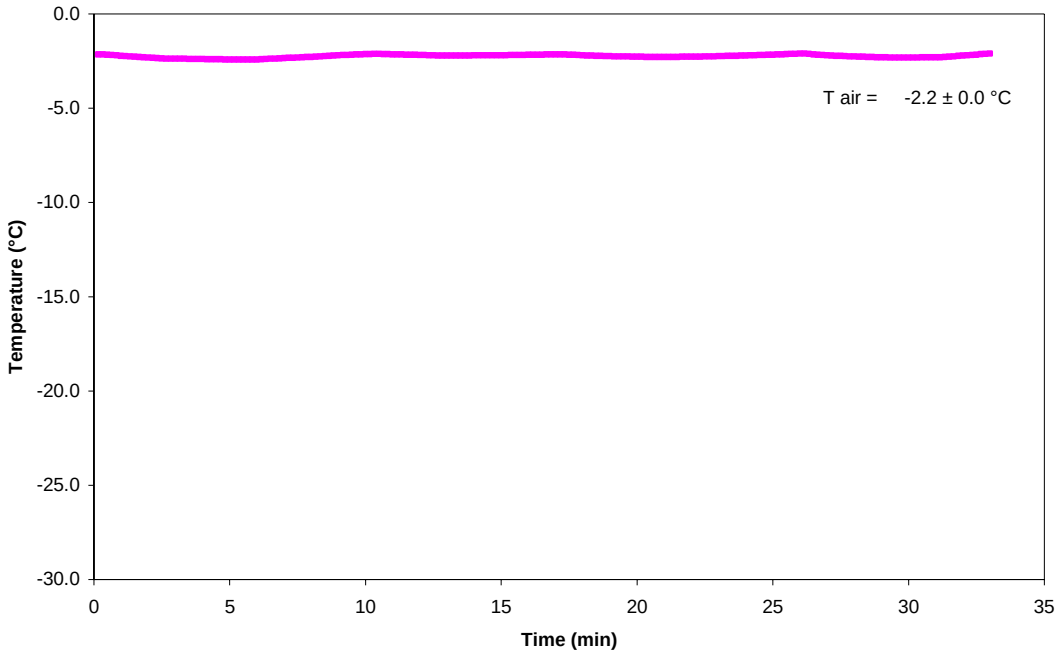
Results at -10°C

Time (minutes)	Cavity #	Undercut Cavity Diameter (± 0.5 mm)		Mean Undercut Cavity Diameter (mm)	Total Area IU_e (mm^2)	Ice Undercutting IU (mm^2)	Average IU (mm^2)	Standard deviation (mm^2)
		Vertical	Horizontal					
5	1	7.0	7.3	7.2	40.2	33.1	35.4	3.3
	2	7.1	7.4	7.3	41.3	34.2		
	3	7.3	7.6	7.5	43.6	36.5		
	4	7.1	7.1	7.1	39.6	32.5		
	5	7.8	7.8	7.8	47.8	40.7		
10	1	8.8	8.8	8.8	60.8	53.8	51.9	3.3
	2	8.5	8.8	8.7	58.8	51.7		
	3	8.7	8.7	8.7	59.4	52.4		
	4	8.1	8.4	8.3	53.5	46.4		
	5	8.9	8.9	8.9	62.2	55.1		
30	1	9.3	9.3	9.3	67.9	60.9	59.1	1.9
	2	9.0	9.0	9.0	63.6	56.5		
	3	9.2	9.2	9.2	66.5	59.4		
	4	9.1	9.1	9.1	65.0	58.0		
	5	9.3	9.3	9.3	67.9	60.9		

AIR TEMPERATURE RECORDING

ICE UNDERCUTTING TEST -2 °C: X297

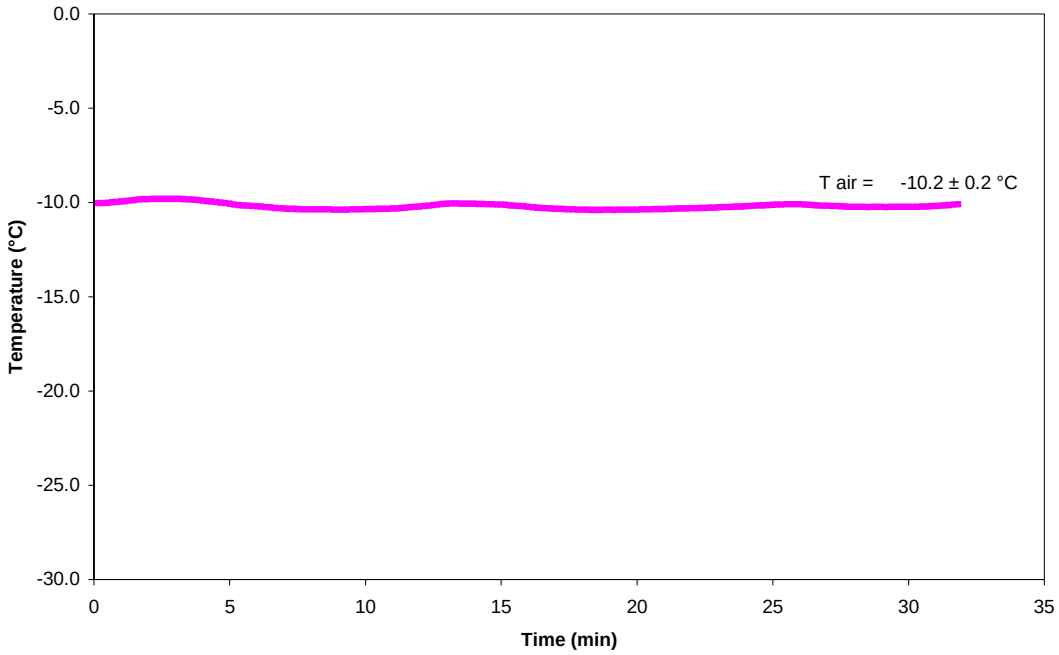
DATE:2011-09-30



AIR TEMPERATURE RECORDING

ICE UNDERCUTTING TEST -10 °C: X297

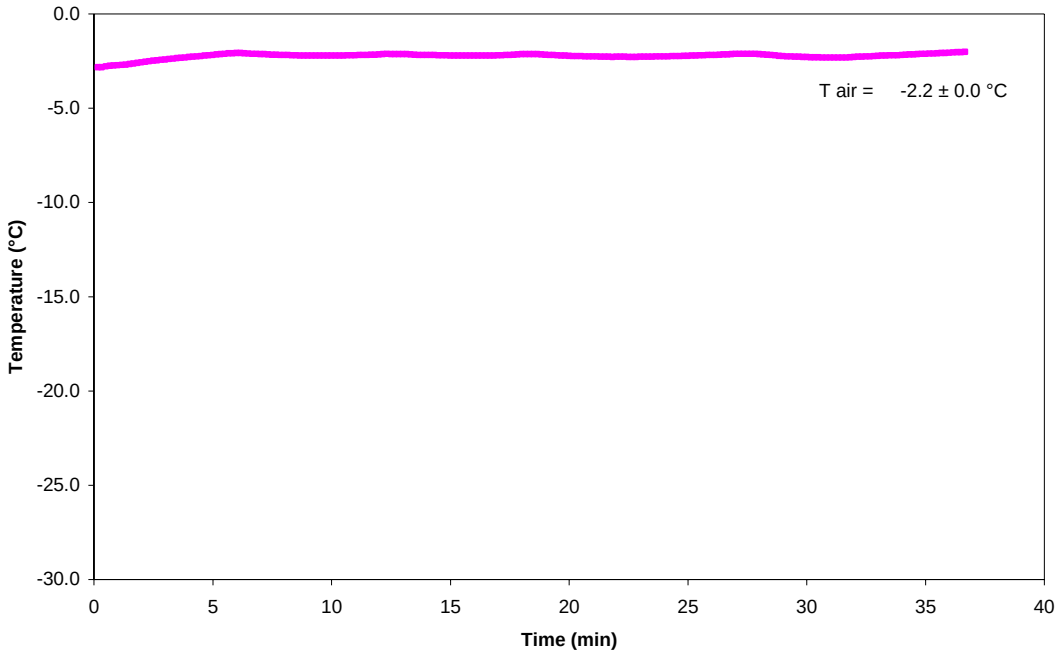
DATE:2011-09-28



AIR TEMPERATURE RECORDING

ICE UNDERCUTTING TEST -2 °C: X295

DATE:2011-09-30



AIR TEMPERATURE RECORDING

ICE UNDERCUTTING TEST -10 °C: X295

DATE:2011-09-28