

Attn: Sergey Salo
Nordix Chemicals Factory d.o.o.
Radnička cesta 173L
10000, Zagreb Croatia

Date: 03-Aug-2022

SMI/REF: 2204-461

Product: **D-ICE NF (SOLID DEICING REAGENT)** (received 25-Apr-2022)

Dilution: Per specification

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Partial testing in accordance with:

AMS 1431E

SOLID RUNWAY DEICING/ANTI-ICING PRODUCT

3.1 Material

3.1.1	Environmental Information	
3.1.1.1	Biochemical Oxygen Demand	Informational
3.1.1.2	Chemical Oxygen Demand	Informational
3.1.1.3	Percent Biodegradation	Informational
3.1.1.4	Aquatic Toxicity	Informational
3.1.2	Trace Contaminants	Informational
3.1.3	Water Content	Informational
3.1.4	Freezing Point	Informational
3.1.5	Appearance	Conforms

3.2 PHYSICAL PROPERTIES

3.2.1	pH	Informational
3.2.2	Flash Point	Conforms
3.2.3	Chloride Content	Conforms
3.2.4	Storage Stability	Not performed
3.2.5	Effect on Transparent Plastics	Conforms
3.2.6	Effect on Painted Surfaces	Conforms
3.2.7	Effect on Unpainted Surfaces	Conforms
3.2.8	Effect on Runway Pavements	
3.2.8.1	Runway Concrete Surface Scaling Resistance	Conforms
3.2.8.2	Asphalt Concrete Degradation Resistance	¹ Not performed
3.2.9	Effect on Aircraft Metals:	
3.2.9.1	Sandwich Corrosion	Conforms
3.2.9.2	Total Immersion Corrosion	Conforms
3.2.9.3	Low Embrittling Cadmium Plate	Conforms
3.2.9.3.1	Cyclic Immersion Corrosion of Cadmium Plate	Informational
3.2.9.4	Hydrogen Embrittlement	Conforms
3.2.9.5	Stress Corrosion Resistance	
	AMS 4911	Conforms
	AMS 4916	Informational

¹Testing required for deicer /anti-icer products used in Europe. This test is not performed by SMI.

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3.2 PROPERTIES (continued)

3.2.10 Performance

Ice Melting Effectiveness
Ice Undercutting Effectiveness
Ice Penetration Effectiveness

Informational

Informational

Informational

3.2.11 Effect on Carbon-Brake Systems

²Not performed

² This test is not performed by SMI.



Jeff Nottebaum, SMI Inc.
Director

Respectfully submitted,



Rae-anne Nottebaum, SMI Inc.
Chemist

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3.1 Material: The composition of the product may contain additives, such as corrosion inhibitors, coating agents, etc., as required to produce a product meeting the requirements of this specification.

3.1.1 Environmental Information: Product shall be tested in accordance with APHA "Standard Methods for Examination of Water and Waste Water". The manufacturer shall provide not less than the following information:

3.1.1.1 Biochemical Oxygen Demand (BOD) of the product for 5-, 15-, and 20-day incubation periods. The test solutions shall be incubated at 68°F (20°C).

5 day BOD: < 0.01 kg O₂/kg solid

15 day BOD: < 0.01 kg O₂/kg solid

20 day BOD: < 0.01 kg O₂/kg solid

Result Informational

3.1.1.2 Total Oxygen Demand (TOD) or Chemical Oxygen Demand (COD) of the product, expressed in kilograms of oxygen per kilograms of product.

COD: 0.28 kg O₂/kg solid

Result Informational

3.1.1.3 Percent biodegradation of product for 5-, 15-, and 20 day incubation periods. Percent biodegradation can be approximated by dividing BODx100 by either TOD or COD.

5 day = ($< 0.01 \times 100$) / 0.28) = < 3.6%

15 day = ($< 0.01 \times 100$) / 0.28) = < 3.6%

20 day = ($< 0.01 \times 100$) / 0.28) = < 3.6%

Result Informational

3.1.1.4 Aquatic Toxicity: Product shall be tested in accordance with EPA (40 Code of Federal Regulations (CFR) Parts 797.1300 and 797.1400) or OECD (Organization for Economic Cooperation and Development Guidelines for Testing of Chemicals, Methods 202 and 203) procedures using test species required by regulatory agencies for permitted discharges. Examples include: fathead minnows, daphnia magna and rainbow trout. The LC50 concentration, the highest concentration at which 50% of the test species survive, shall be given in milligrams per liter.

EPA 40 CFR 797.1300 DAPHNID ACUTE TOXICITY TEST

Daphnia magna, static system

48 hour LC₅₀: 4,225 mg/L

EPA 40 CFR 797.1400 FISH ACUTE TOXICITY TEST

Pimephales promelas, static system

96 hour LC₅₀: 4,150 mg/L

Result Informational

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- 3.1.2 Trace Contaminants: Report the presence, in percentage by weight, of sulfur, halogens, phosphate, nitrate, and heavy metals (lead, chromium, cadmium, and mercury).

	<i>ppm</i>	<i>%</i>
Sulfur	13	0.0051
Halogens	93	0.0093
Phosphorus (as P_2O_5)	< 1	< 0.0001
Nitrate (as NO_3)	< 2	< 0.0002
Heavy Metals:		
Lead (Pb)	< 1	< 0.0001
Chromium (Cr)	< 1	< 0.0001
Cadmium (Cd)	< 1	< 0.0001
Mercury (Hg)	< 1	< 0.0001

Result Informational

- 3.1.3 Vendor shall report the product chemical analysis, determined in accordance with a recognized method acceptable to purchaser; and total water content shall be determined in accordance with ASTM E203.

Water Content: 0.7%

Result Informational

- 3.1.4 Vendor shall provide a phase diagram relating product dilution to freezing point. Delivered product shall be within +7°F (+4°C) of the preproduction value.

Freezing point (5% solution): - 2°C
Freezing point (10% solution): - 4°C
Freezing point (15% solution): - 7°C

Result Informational

- 3.1.5 Appearance: The product, as received by purchaser, shall be uniform, free-flowing, and free from foreign material detrimental to usage of the product.

Compound is uniform and free from foreign material.

Result Conforms

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3.2 Physical Properties: The product, as supplied by vendor, shall conform to the following requirements: tests shall be performed in accordance with specified test on the product as delivered by vendor, unless otherwise specified herein.

3.2.1 pH: The product, diluted with ASTM D1193, Type IV water, to 15% by weight of solids taking into account water contained in the product, shall be within ± 0.5 of the preproduction value established in 4.2.3, determined in accordance with ASTM E70.

15%: pH = 9.2

Result Informational

3.2.2 Flash Point: The product on a dry basis shall be not lower than 200°F (93°C), determined in accordance with ASTM D56.

As received (dry basis): No flash to 212°F

Result Conforms

3.2.3 Chloride Content: The level of soluble chloride on a dry basis shall not exceed 250 ppm, determined in accordance with APHA Standard Methods for the Examination of Water and Waste Water, Method 4500-CL or equivalent.

As received (dry basis): Chloride content = 93 ppm

Result Conforms

3.2.4 Storage Stability: The product, when stored in a closed container for at least 1 year in accordance with ASTM F1104 shall not deliquesce or otherwise deteriorate.

Result Not performed

3.2.5 Effect on Transparent Plastics:

3.2.5.1 The product, diluted with ASTM D1193, Type IV, water to 15% by weight of solids taking into account water contained in the product shall not craze, stain or discolor Type C stretched acrylic plastic conforming to MIL-PRF-25690, determined in accordance with ASTM F484.

15%: Type C – no crazing, staining or discoloration

Result Conforms

3.2.5 Effect on Transparent Plastics (continued):

3.2.5.2 The product, diluted with ASTM D1193, Type IV, water to 15% by weight of solids taking into account water contained in the product, shall not craze, stain, or discolor AMS-P-83310 polycarbonate plastic, determined in accordance with ASTM F484, except that the specimens shall be stressed for 30 minutes ± 2 minutes to an outer fiber stress of 2000 psi (13.8 Mpa).

15%: AMS-P-83310 – no crazing, staining or discoloration

Result Conforms

3.2.6 Effect on Painted Surfaces: Product, diluted with ASTM D1193, Type IV, water to 15% by weight of solids taking into account water contained in the product, shall neither decrease the paint film hardness by more than two pencil hardness levels nor shall it produce any streaking, discoloration, or blistering of the paint film, determined in accordance with ASTM F502.

15%: No hardness change; no streaking, discoloration or blistering

Result Conforms

3.2.7 Effect on Unpainted Surfaces: Product, diluted with ASTM D1193, Type IV, water to 15% by weight of solids taking into account water contained in the product, shall neither produce streaking nor leave any stains which require polishing to remove, determined in accordance with ASTM F485.

15%: No streaking, no staining

Result Conforms

3.2.8 Effect on Runway Pavements

3.2.8.1 Runway Concrete Surface Scaling Resistance: The condition of the runway concrete surface shall have a rating not greater than 1 for 50 freeze-thaw cycles, determined in accordance with ASTM C672, except that concrete shall:

- a. Be air-entrained with an air content as specified in ASTM C672.
- b. Have a minimum cement content of $510 \text{ lb/yd}^3 \pm 10 \text{ lb/yd}^3$ ($302 \text{ kg/m}^3 \pm 6 \text{ kg/m}^3$).
- c. Have a slump, 1.5 inches ± 0.5 inch (38 mm ± 13 mm).

A 25% by volume solution of the deicing/anti-icing product as supplied by the manufacturer in commercial concentration in tap water shall be substituted for calcium chloride. Performing more than one freeze-thaw cycle per day is acceptable.

Note: a 25% by weight saturated solution was utilized for testing

Rating after 50 cycles: 1

Result Conforms

3.2.8.2 Asphalt Concrete Degradation Resistance (Appendix A, valid for runway deicing/anti-icing products used in Europe)

Result ¹Not performed by SMI

¹Testing required for deicer /anti-icer products used in Europe. This test is not performed by SMI.

3.2.9 Effect on Aircraft Metals: Product, diluted with ASTM D1193, Type IV, water to 5% and 15% by weight solids taking into account water contained in the product, shall meet the following requirements:

3.2.9.1 Sandwich Corrosion: Specimens, after testing in accordance with ASTM F1110, shall not have a rating greater (worse) than 1.

	2024-T3 Bare Anodized	2024-T3 Alclad	7075-T6 Bare Anodized	7075-T6 Alclad
5 PERCENT	1	1	1	1
15 PERCENT	1	1	1	1
CONTROL	1	1	1	1

Result Conforms

3.2.9.2 Total Immersion Corrosion: The product, tested in accordance with ASTM F483, except that panels shall be AMS4376 tested for 24 hours, shall neither cause corrosion of test panels nor a weight change of any test panel greater than shown in Table I.

ALLOY	WEIGHT LOSS mg/cm ² /24hrs		
	Allowed	5 %	15 %
AMS 4037 Aluminum anodized per AMS 2470	0.3	0.04	0.02
AMS 4041 Aluminum	0.3	0.05	0.03
AMS 4049 Aluminum	0.3	0.04	0.03
AMS 4376 Magnesium, dichromate (AMS 2475)	0.2	0.03	+ 0.01
AMS 4911 Titanium	0.1	0.03	0.02
AMS 5045 Carbon Steel	0.8	0.13	0.12

“+” indicates weight gain

Result Conforms

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3.2.9.3 Low-Embrittling Cadmium Plate: Test panels, coated with low-embrittling cadmium plate, shall not show a weight change greater than 0.3 mg/cm² per 24 hours, determined in accordance with ASTM F1111.

5%: **0.06 mg/cm²/24 hrs**

15%: **0.11 mg/cm²/24 hrs**

Result Conforms

3.2.9.3.1 The product shall be tested for cyclic immersion corrosion of cadmium plate in accordance with AIR6130 and the results reported as specified in Section 6 of AIR6130.

Cadmium Plate Cyclic Corrosion Test

Initial pH of solution: 9.2

Final pH of solution: 8.2

Note: Solution tested = 15% w/w

The weight loss shall be no more than 0.3 mg/cm².

Tested in accordance with AIR6130A (Revision A 2017-05)

PANEL WEIGHTS	REPLICATE #	Weight (g)		
		Initial	Final	Weight change
	1	16.0182	16.0111	0.0071
	2	16.2541	16.2476	0.0065
	3	16.3295	16.3231	0.0064
Average weight change = 0.0067 g (0.24 mg/cm²) Note: "+" indicates weight gain				
<i>AIR6130A: A runway deicing fluid or solid compound tested in accordance with this document that exhibits a weight loss of more than 0.3 mg/cm² may cause undesirable corrosion effects to airplane equipment and/or airport equipment.</i>				
Result: <u>*Informational</u>				
See separate report for complete data tables				

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3.2.9.4 Hydrogen Embrittlement: The diluted product shall be non-embrittling, determined in accordance with ASTM F 519, Type 1a, 1c, or 2a specimens, cadmium plated in accordance with MIL-STD-870, Class 1 Type I. Type 1a and Type 1c specimens shall be loaded to 45% of the predetermined notch fracture strength and the 2a specimens loaded to 80% of the yield strength. The entire 2a stressed specimen or just the notched area of the 1a and 1c stressed specimen shall be immersed continuously in the solution under test for 150 hours at a temperature of 77°F ± 9°F (25°C ± 5°C)

*Specimens: Four Type 1c, cadmium plated per MIL-STD-870 Class 1 Type I.
Load: 45%, immersed for duration, 150 hours, temperature 25°C ± 5°C.*

Type 1c @ 5%: No failures occurred within 150 hours.
Type 1c @ 15%: No failures occurred within 150 hours.

Result Conforms

3.2.9.5 Stress-Corrosion Resistance: The diluted product shall not cause cracks in AMS4911 titanium alloy specimens, determined in accordance with ASTM F945, Method A.

	AMS 4911
CONTROL, BLANK:	No cracking evident
CONTROL, 3% ppm SALT:	Cracking evident
5%	No cracking evident
15%	No cracking evident

Result Conforms

3.2.9.5.1 Stress Corrosion Resistance: The diluted product shall be tested in accordance with ASTM F945, Method A using AMS4916 specimens. The results obtained from AMS 4916 shall be reported for informational purposes only.

	AMS 4916
CONTROL, BLANK:	No cracking evident
CONTROL, 100 ppm SALT:	Cracking evident
5%	Cracking evident
15%	Cracking evident

Result Informational

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3.2.10 **Performance:** The product, used in accordance with manufacturer's recommendation, shall remove accumulated frozen deposits of frost and ice from aircraft maneuvering areas, such as airport aprons, runways and taxiways. The product shall be tested in accordance with AIR6170 for ice melting effectiveness, with AIR6172 for ice undercutting effectiveness and with AIR6211 for ice penetration effectiveness. Acceptance criteria shall be agreed upon by purchaser and vendor

~~SAE AIR6170A (2017-02)~~

~~Ice Melting Test Method for Runways and Taxiways Deicing / Anti-icing Chemicals~~

SAE AS6170 (2021-10)

Ice Melting Test Method for AMS1431 and AMS1435 Runway Deicing/Anti-Icing Products

Note: AIR6170A has been superseded with AS6170 "Ice Melting Test Method for AMS 1431 and AMS 1435 Runway Deicing/Anti-Icing Products". This SAE Aerospace Standard (AS) document is redefinition of Aerospace Information Report AIR6170A as an AS document. Additional information includes clarification on the preparation of the reference control solutions, and some editorial changes.

See separate report for complete data results

ICE MELTING TEST RESULTS

As received (solid):

Test Temperature: -10°C (+14°F)			
Time (minutes)	Mean Mass of Deicing/Anti-icing Product applied m_d (g)	Mean Mass of Ice Melted M_{im} (g)	Ice Melting Capacity (m_{im}/m_d)
5	5.00	3.4	0.7
10	5.00	3.7	0.7
30	5.00	6.4	1.3

Test Temperature: -2°C (+28°F)			
Time (minutes)	Mean Mass of Deicing/Anti-icing Product applied m_d (g)	Mean Mass of Ice Melted M_{im} (g)	Ice Melting Capacity (m_{im}/m_d)
5	5.00	6.2	1.3
10	5.00	7.7	1.5
30	5.00	10.7	2.1

3.2.10 Performance (continued):

SAE AIR6170A (2017-02)

~~Ice Melting Test Method for Runways and Taxiways Deicing / Anti-icing Chemicals~~

SAE AS6170 (2021-10)

Ice Melting Test Method for AMS1431 and AMS1435 Runway Deicing/Anti-Icing Products

Note: AIR6170A has been superseded with AS6170 "Ice Melting Test Method for AMS 1431 and AMS 1435 Runway Deicing/Anti-Icing Products". This SAE Aerospace Standard (AS) document is redefinition of Aerospace Information Report AIR6170A as an AS document. Additional information includes clarification on the preparation of the reference control solutions, and some editorial changes.

See separate report for complete data results

ICE MELTING TEST RESULTS

25% w/w:

Test Temperature: -10°C (+14°F)			
Time (minutes)	Mean Mass of Deicing/Anti-icing Product applied m_d (g)	Mean Mass of Ice Melted M_{im} (g)	Ice Melting Capacity* (m_{im}/m_d)
5	5.00	2.1	0.4
10	5.00	2.8	0.6
30	5.00	3.4	0.7

Test Temperature: -2°C (+28°F)			
Time (minutes)	Mean Mass of Deicing/Anti-icing Product applied m_d (g)	Mean Mass of Ice Melted M_{im} (g)	Ice Melting Capacity* (m_{im}/m_d)
5	5.00	4.3	0.9
10	5.00	5.2	1.0
30	5.00	6.5	1.3

3.2.10 Performance (continued):

SAE AIR6172A (2017-03)

~~Ice Undercutting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals~~

SAE AS6172 (2021-10)

Ice Undercutting Test Method for AMS1431 and AMS1435 Runway Deicing/Anti-Icing Products

Note: AIR6172A has been superseded with AS6172 "Ice Undercutting Test Method for AMS 1431 and AMS 1435 Runway Deicing/Anti-Icing Products". This SAE Aerospace Standard (AS) document is redefinition of Aerospace Information Report AIR6172A as an AS document. Additional information includes clarification on the preparation of the reference control solutions, and some editorial changes.

See separate report for complete data results

ICE UNDERCUTTING TEST RESULTS

25% w/w:

Test Temperature: -10°C (+14°F)				
Time (minutes)	Mean Undercut Cavity Diameter (mm)	Total Area IU _e (mm ²)	Area Original Cavity A _s (mm ²)	Ice Undercutting IU (mm ²)
5	4.4	15.2	7.1	8.1
10	5.0	19.6	7.1	12.6
30	5.2	21.2	7.1	14.2

Test Temperature: -2°C (+28°F)				
Time (minutes)	Mean Undercut Cavity Diameter (mm)	Total Area IU _e (mm ²)	Area Original Cavity A _s (mm ²)	Ice Undercutting IU (mm ²)
5	7.9	49.0	7.1	41.9
10	9.8	75.4	7.1	68.3
30	12.0	113.0	7.1	105.9

3.2.10 Performance (continued):

~~SAE AIR6211A (2017-05)~~
~~Ice Penetration test Method for Runways and Taxiways Deicing/Anti-icing Chemicals~~
SAE AS6211 (2021-11)

Ice Penetration Test Method for AMS1431 and AMS1435 Runway Deicing/Anti-Icing Products

Note: AIR6211A has been superseded with AS6211 "Ice Penetration Test Method for AMS 1431 and AMS 1435 Runway Deicing/Anti-Icing Products". This SAE Aerospace Standard (AS) document is redefinition of Aerospace Information Report AIR6211A as an AS document. Additional information includes clarification on the preparation of the reference control solutions, and some editorial changes.

See separate report for complete data results

ICE PENETRATION TEST RESULTS

25% w/w:

Test Temperature -10°C (+14°F):		
Time (minutes)	Penetration Depth Average (mm)	Standard Deviation
5	1.5 mm	< 0.5
10	1.5 mm	< 0.5
30	2.0 mm	< 0.5

Test Temperature -2°C (+28°F):		
Time (minutes)	Penetration Depth Average (mm)	Standard Deviation
5	2.0 mm	< 0.5
10	2.5 mm	< 0.5
30	6.0 mm	< 0.5

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3.2.11 Effect on Carbon-Brake Systems: The product shall be tested for catalytic oxidation of carbon in accordance with AIR5567 and the results shall be reported as shown in section 4.2 of AIR5567. The results shall be reported for informational purposes only. Per AIR5567 the lower the percentage weight loss, the lower the risk of the carbon-carbon heat sink being damaged through catalytic oxidation.

Result ²Not performed

² *This test is not performed by SMI.*