

EVALUATION TEST REPORT
CBDO-16-02/2
CATALYTIC CARBON BRAKE DISK OXIDATION TEST

For SAE AMS1431/1435
Runway and Taxiway Deicing Chemicals

Runway Guard SF, lot # 03/16
Produced at Kyiv, Ukraine

for
DR ENERGY GROUP LTD.
1, Zavokzalnaya lane, Borispil, Kyiv Region
Kyiv, Ukraine

by

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ГЕНЕРАЛЬНИЙ ДИРЕКТОР
ЄЖОВ С.В. 28.08.17



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Laboratoire international
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International Laboratory

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1. INTRODUCTION

This report presents results of Catalytic Carbon Brake Disk Oxidation test, performed on a sample of **Runway Guard SF Runway Deicing Chemical**, provided by **DR ENERGY GROUP LTD.** The anti-oxidant coated coupons used for performing the tests were in accordance with the SAE AIR5567A requirements, and were provided by Honeywell Aerospace, 3520 Westmoor Street, South Bend, IN 46628 USA.

The Catalytic Carbon Brake Disk Oxidation Test results, as per the AIR5567A Method, are reported for informational purpose only.

2. PROCEDURE

The Runway Deicing Chemical was tested in accordance with the SAE AIR5567A[1] “Test Method for Catalytic Carbon Brake Disk Oxidation” as per the latest revision of the SAE AMS1431[2] and AMS1435[3] specifications. This simple test method was designed to assess the relative effect of runway deicing chemicals on carbon brake systems by measuring the mass change of contaminated carbon brake anti-oxidant (AO) coated coupons when submitted to an oxidation tests at high temperature according to the AIR5567A test method.

The carbon/carbon composite brake material CARBENIX® 4000 (C4000®) test coupons (*section 3.1) are treated with a generic anti-oxidant coating (*section 3.3) and then immersed in a runway deicer (25% w/w concentration) for 10 minutes. Deicer contaminated coupons are then dried at 150°C for 2 hours and transferred to a desiccator and cooled for a minimum of 30 minutes (*section 3.4). After the cooling period, the test coupons are heated in a still air muffle furnace at 550°C for 24 hours. After the heating period, the coupons are cooled and the normalized oxidation weight loss is calculated by means of the % weight loss (*section 3.5).

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* Refer to AIR5567A

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3. RESULTS

3.1 Runway Deicer Identification

СТАНУ ОРИГІНАЛОМ

The Catalytic Carbon Brake Disk Oxidation Test was performed on the runway deicer 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. % w/w | | | | | |
| DR ENERGY GROUP LTD | Runway Guard SF, lot # 03/16 | Solid | As is | X562 | n.a. | 16-03-03 | Kyiv, Ukraine | 16-03-2 |
| | | | 25 ² | X563 | 1.3664 | | | |

3.2 Test Results Summary

Table 2 presents the Catalytic Carbon Brake Oxidation test results. Figure 1 presents oxidation weight losses. The details of the test results are presented in Table 3 and the experimental data sheets are presented in Annexe A.

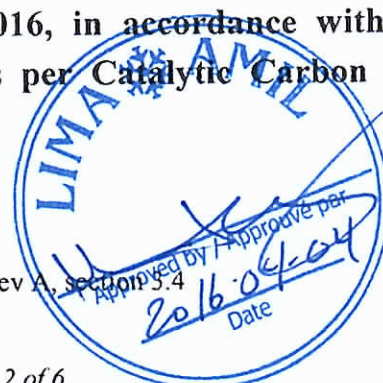
Table 2 - Summary of Catalytic Carbon Brake Disk Oxidation Test Results

| Company | Runway Deicer Name | Mean Oxidation Weight Loss (%) (3.5 h) | Mean Normalized Weight Loss (%) (3.5 k) |
|---------------------|------------------------------|--|---|
| DR ENERGY GROUP LTD | Runway Guard SF, lot # 03/16 | 20.5 ± 4.3 | 33.7 ± 5.1 |
| Honeywell Aerospace | Control Coupon | 0.4 ± 0.1 | n.a |

The runway deicer DR ENERGY GROUP LTD. Runway Guard SF, lot # 03/16, was tested in March 2016, in accordance with paragraph paragraph 3.2.11 of AMS 1431D as per Catalytic Carbon Brake Disk Oxidation Test (AIR5567).

¹ Refractive Index

² 25% w/w (active ingredient); refer to AIR5567-Rev A, section 3.4



CATALYTIC CARBON BRAKE DISK OXIDATION TEST
550°C, 24 hours

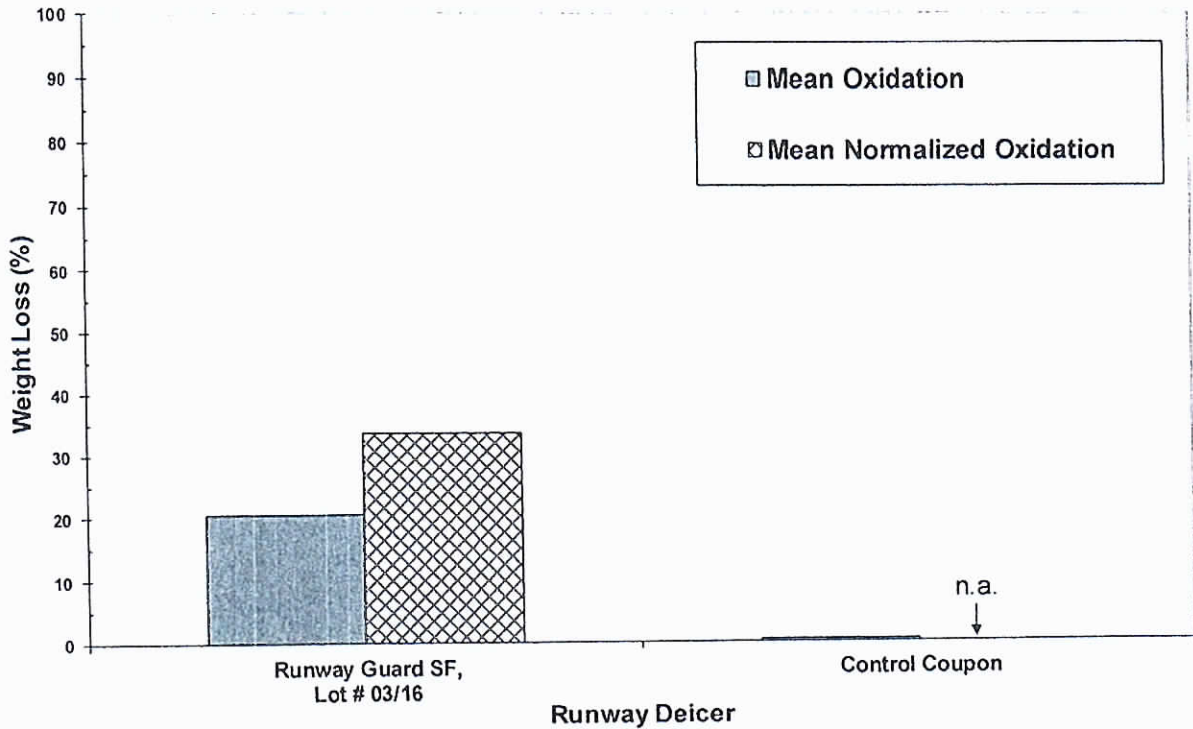


Figure 1 - Mean Weight Loss (%)

**Table 3 - Oxidation Test Result - Runway Deicer
Runway Guard SF, lot # 03/16**

| Test Parameters | AIR5567 Section ref. | Results |
|---|----------------------|---------|
| Deicer Concentration | - | 25% w/w |
| Mean pick up of deicer in coupon (%) | 3.4 j | 1.06 |
| Mean pick up of AO in coupons (%) | 3.3 k | 1.74 |
| Mean ratio deicer pick up (%) / AO pick up (%) | 3.5 i | 0.61 |
| Furnace temperature (oxidation test) | Min (°C) | - |
| | Max (°C) | - |
| | Mean (°C) | - |
| Oxidation test time (minutes) | - | 1440 |
| Mean oxidation weight loss deicer contaminated coupons (%) | 3.5 h | 20.5 |
| Standard deviation oxidation weight loss deicer contaminated coupons (%) | 3.5 h | 4.3 |
| Mean normalized weight loss deicer contaminated coupons (%) | 3.5 k | 33.7 |
| Standard deviation normalized oxidation weight loss deicer contaminated coupons (%) | 3.5 k | 5.1 |

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Table 4 - Oxidation Test Result - Control Coupons

| Test Parameters | | AIR5567 Section ref. | Results |
|--|-----------|----------------------------|-------------|
| Mean pick up of AO in coupons (%) | | 3.3 k | 1.60 |
| Furnace temperature (oxidation test) | Min (°C) | - | 550.0 |
| | Max (°C) | - | 550.8 |
| | Mean (°C) | - | 550.3 ± 0.2 |
| Oxidation test time (minutes) | | - | 1440 |
| Mean weight loss control coupons (%) | | 3.5 h | 0.4 |
| Standard deviation weight loss control coupons (%) | | 3.5 h | 0.1 |

4. REFERENCES

1. *SAE International Aerospace Information Report, "Test Method for Catalytic Carbon Brake Disk Oxidation", AIR5567, revision A, June 2010.*
2. *SAE International Aerospace Material Specification, "Compound, Solid Runway and Taxiway Deicing/Anti-icing", AMS 1431, revision D, June 2012.*
3. *SAE International Aerospace Material Specification, "Fluid, Generic, Deicing/Anti-icing Runways and Taxiways", AMS 1435, revision C, June 2012.*

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Annexe A

TEST DATA SHEETS

Oxidation Test Results

Runway Guard SF, lot # 03/16 (X563) p. 6

Control Coupon p. 6

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OXIDATION TEST RESULTS

REPORT #: CBDO-16-02/2 FURNACE TEMP (°C): 549.5 min 551.7 max 550.0 ± 0.4 mean ± std. dev. TEST DATE: 2016-03-31 GROUP COUPON #: 150

DEICER NAME: Runway Guard SF, Lot # 03/16

| FLUID AMIL # | Initial Weights (g) | | | Contamination (g) | | | Oxidation (g) | | Results | |
|--------------|---------------------|--------------------------------|-------------------------------------|--|---------------|---------------------------|-------------------------------|-----------------------|-----------------------------------|--|
| | Coupon # | Bare Coupon Initial Weight (a) | AO Coated Coupon Initial Weight (b) | Contaminated Coupon Initial Weight (c) | Weight Change | 3.4 j % Weight DI Pick Up | 24 h @ 550°C Final Weight (d) | 3.5 h % Weight Change | 3.5 i Ratio DI Pick Up/AO Pick Up | 3.5 k Normalized Oxidation Weight Loss |
| X563 | 1740 | 20.273 | 20.619 | 20.795 | 0.176 | 0.868 | 17.372 | 16.016 | 0.509 | 31.487 |
| | 1739 | 20.179 | 20.492 | 20.647 | 0.155 | 0.768 | 17.628 | 14.193 | 0.495 | 28.661 |
| | 1731 | 20.037 | 20.364 | 20.549 | 0.185 | 0.923 | 16.375 | 19.908 | 0.566 | 35.189 |
| | 1720 | 19.828 | 20.189 | 20.434 | 0.245 | 1.236 | 14.935 | 26.498 | 0.679 | 39.044 |
| | 1734 | 19.733 | 20.043 | 20.309 | 0.266 | 1.348 | 15.090 | 25.100 | 0.858 | 29.252 |
| | 1717 | 19.622 | 20.047 | 20.260 | 0.213 | 1.086 | 16.020 | 20.523 | 0.501 | 40.949 |
| | 1721 | 19.716 | 20.063 | 20.282 | 0.219 | 1.111 | 15.396 | 23.671 | 0.631 | 37.506 |
| | 1741 | 19.518 | 19.857 | 20.082 | 0.225 | 1.153 | 16.272 | 18.368 | 0.664 | 27.674 |
| AVERAGE | | | | | 0.211 | 1.062 | | 20.535 | 0.613 | 33.720 |
| STD DEV | | | | | 0.037 | 0.195 | | 4.342 | 0.124 | 5.130 |

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DEICER NAME: N.A. FURNACE TEMP (°C): 550.0 min 550.8 max 550.3 ± 0.2 mean ± std. dev. TEST DATE: 2015-02-05

| Reference Control Coupon | Initial Weight (g) | | | Contamination (g) | | | Oxidation (g) | | Results | |
|--------------------------|--------------------|--------------------------------|-------------------------------------|--|---------------|---------------------------|-------------------------------|-----------------------|-----------------------------------|--|
| | Coupon # | Bare Coupon Initial Weight (a) | AO Coated Coupon Initial Weight (b) | Contaminated Coupon Initial Weight (c) | Weight Change | 3.4 j % Weight DI Pick Up | 24 h @ 550°C Final Weight (d) | 3.5 h % Weight Change | 3.5 i Ratio DI Pick Up/AO Pick Up | 3.5 k Normalized Oxidation Weight Loss |
| Reference Control Coupon | 1094 | 19.716 | 20.088 | n/a | n/a | n/a | 20.027 | 0.309 | n/a | n/a |
| | 1233 | 19.581 | 19.975 | n/a | n/a | n/a | 19.881 | 0.480 | n/a | n/a |
| | 1161 | 19.584 | 19.902 | n/a | n/a | n/a | 19.846 | 0.286 | n/a | n/a |
| | 1241 | 19.899 | 20.185 | n/a | n/a | n/a | 20.135 | 0.251 | n/a | n/a |
| | 1243 | 19.890 | 20.153 | n/a | n/a | n/a | 20.061 | 0.463 | n/a | n/a |
| | 1245 | 19.976 | 20.245 | n/a | n/a | n/a | 20.168 | 0.385 | n/a | n/a |
| | 1226 | 20.088 | 20.378 | n/a | n/a | n/a | 20.319 | 0.294 | n/a | n/a |
| 1235 | 19.714 | 20.050 | n/a | n/a | n/a | 19.979 | 0.360 | n/a | n/a | |
| AVERAGE | | | | | | | | 0.354 | | |
| STD DEV | | | | | | | | 0.084 | | |



CATALYTIC CARBON BRAKE DISK OXIDATION TEST SUMMARY (AIR 5567A)

FOR SAE AMS1431D DEICING/ANTI-ICING CHEMICALS

| | | |
|--|---|--|
| Company Name Deicer Name Lot # Manufacture Location | DR ENERGY GROUP LTD. Runway Guard SF 03/16 Kyiv, Ukraine | Honeywell Aerospace Control Coupon N/A IN (USA) |
| Initial Deicer Concentration (% w/w) | As is | N/A |
| Test Solution Deicer Concentration (% w/w) | 25 | N/A |
| Mean Pickup of Deicer in Coupons (%) | 1.06 | N/A |
| Mean Pickup of Antioxidant in Coupons (%) | 1.74 | 1.60 |
| Mean Ratio: DI Pickup (%) / AO Pickup (%) | 0.61 | N/A |
| Min Test Temperature (°C) | 549.5 | 550.0 |
| Max Test Temperature (°C) | 551.7 | 550.8 |
| Mean Test Temperature (°C) | 550.0 ± 0.4 | 550.3 ± 0.2 |
| Test Duration (min) | 1440 | 1440 |
| Mean Oxidation Weight Loss (%) | 20.5 | 0.4 |
| Standard Deviation (%) | 4.3 | 0.1 |
| Mean Normalized Weight Loss (%) | 33.7 | N/A |
| Standard Deviation (%) | 5.1 | N/A |

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