



## Test Report

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Date: May 16<sup>th</sup>, 2016

### NanoShine Group Corp.

Product Description: Non-coating Cylinder and Coating Cylinder

Product Submitted By: NanoShine Group Corp

Date of Sample Received: February 16<sup>th</sup>, 2016

Date of Testing: April 14<sup>th</sup>, 2016

Test Required: Surface coating on the drag for a PVC cylinder

Reference Method: ASCE Standard ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures

Test Equipment: Atmospheric Boundary Layer Wind Tunnel

Anemometer

Force-moment sensor

Experimental Setup: The experimental setup is shown in Figure 1. The leading edge of the test models was located at 2.8 m from the inlet of test section. The testing models were installed on the force-moment sensor. Two side acrylic boards were installed. The distance between the edge of the cylinder and acrylic was 2.5 diameter of the PVC cylinder.



Figure 1. Experiment setup

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Test Result:

The result is shown in Table 1.

Table 1 Drag for a PVC cylinder with and without surface coating

Wind speed (m/s)	Drag (N)		Drag reduction (%)
	Non-coating cylinder	Coating cylinder	
8.1	5.87	5.69	3.0
10.4	9.68	9.47	2.1
14	17.68	17.35	1.8
16	23.11	22.79	1.4
18.1	29.16	28.76	1.4

End of Report

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# Appendix 1

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## 1. Summary

This wind tunnel tests addressed the surface coating on the drag for a PVC cylinder, provided by NanoShine Group Corp. The test was conducted at the Atmospheric Boundary Layer Wind Tunnel (ABLWT), Architecture and Building Research Institute. The PVC cylinders were installed on the force-moment sensor in order to acquire the wind load at five constant wind speeds, namely 8.1 m/s, 10.4 m/s, 14 m/s, 16 m/s, and 18.1 m/s. Five repeated runs were conducted for a given wind speed. The results indicate that there is a 3.0% reduction for the drag of a PVC cylinder with surface coating at the speed of 8.1 m/s, in comparison with that of a non surface coating PVC cylinder.

## 2. Testing Model

The diameter and height of the PVC cylinder were 0.232 m and 0.8 m, respectively. In order to prevent the wind from flowing into the cylinder, the top cross-section of the cylinder was tightly covered by acrylic.

## 3. Facility and Instrumentation

### 3.1 Wind tunnel

The tests were conducted at Atmospheric Boundary Layer Wind Tunnel (ABLWT), Architecture and Building Research Institute. There are a honeycomb and three screens, and the contraction ratio is 4.71. The constant-area test section is 2.6 m in height, 4 m in width and 36.5 m long. Turbulence intensity is approximately 0.3%.

### 3.2 Anemometer

The wind speed was measured by rotating vane anemometer (OMEGA HHF 141). The calibration certificate is shown in Appendix 2.

### 3.3 Force-moment sensor

The wind load was measure by force-moment sensor (JR3-75E20). The calibration certificate is shown in Appendix 3.

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# Appendix 1

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## 4. Experimental Setup

The experimental setup is shown in Figure 1. The leading edge of the test models was located at 2.8 m from the inlet of test section. In Figure 2, the testing models were installed on the force-moment sensor. Two side acrylic boards were installed. The distance between the edge of the cylinder and acrylic was 2.5 diameter of the PVC cylinder.



Figure A1 Installation of PVC cylinder

## 5. Results

The results are summarized in Table A1. It can be seen that the drag for a PVC cylinder with surface coating is lower than that for a PVC cylinder without surface coating. The most drag reduction is 3.0% at the wind speed of 8.1 m/s.

Table A1 Drag for a PVC cylinder with and without surface coating

Wind speed (m/s)	Drag (N)		Drag reduction (%)
	Non-coating cylinder	Coating cylinder	
8.1	5.87	5.69	3.0
10.4	9.68	9.47	2.1
14	17.68	17.35	1.9
16	23.11	22.79	1.4
18.1	29.16	28.76	1.4

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## Appendix 2

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**CERTIFICATE OF CALIBRATION  
(NIST TRACEABLE)**

**Ω OMEGA®**

**Model Number:** HHF141      **CERTIFICATE PRESENTED TO:** \_\_\_\_\_

**Instrument S/N#:** 1015673      \_\_\_\_\_

**Program Version:** 3.20      \_\_\_\_\_

**Air Velocity (FPM):** 13.2-852      \_\_\_\_\_

Standard	As Sent
300	296
1000	995
3000	3017

**Temperature: °C or °F**

Standard	As Sent
0	/
50	/
100	/

**Rel. Humidity (%RH):** \_\_\_\_\_

Standard	As Sent
/	/
/	/
/	/

**CALIBRATION EQUIPMENT:**

**Pacer Inst. Digital Anemometer:**  
Model: DA400  
Serial Number: 1014068  
NIST Traceable Cert. #2008120214714  
Due: 03/23/2013

**Airflow Technical Products:**  
Open Jet Wind Tunnel  
Calibrated to Doc# 405-7-0154  
Due: 06/11/2013

**Fluke RTD Calibrator:**  
Model: Y12 SN: 1133144  
Cert. #620069-1196144-1339409057  
Due: 06/11/2013

**Edgetech Hygrometer:**  
Model: Dewprime II  
SN: 31122/1H1298MCR  
Cert. #2013.410012  
Due: 01/14/2014

**AS SENT ACCURACY:**  
Accuracy may vary based on units original design standards.

**Air Velocity:**  
AP275/AP1275:  
±/(1.0% of reading + 1 digit)  
AP100/AP1100:  
±/(0.25% FS + 0.75% reading + 1 digit)

**Temperature:**  
±/(0.3°C + 0.2% reading °C)

**Relative Humidity: ±/ - 2.0 %RH**

Standards are traceable to the National Institute of Standards and Technology (NIST), or to intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. Services rendered comply with ANSI/ISO 9000 Quality Manual, ISO 9001, the customer purchase order and with the requirements of ANSI/ISO 2140-1-1994 part 2. Calibration and verification are performed at an ambient temperature of 23±0.5°C and RH of <70%. Uncertainties of the measurements are based upon 95% confidence limits with the Test Uncertainty Ratio estimated at less than 4:1. Results from this calibration relate only to the unit calibrated. This report may not be reproduced in part or in whole without the prior written approval of Omega Engineering, Inc. The manufacturer's recommended calibration frequency is 1 year. Any number of fixtures may be used as instrument to drill out of tolerance before the next scheduled calibration. Reproduction cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. Services rendered are warranted for up to 100 (max 30 days), provided the unit has not been tampered with in any manner. Certificates are internally traced by model number and serial number.

**Calibrated by:** Tech: ③      **Date:** 2-26-13       **Omega Engineering, Inc.**  
**Due Date:** Feb 26, 2014      **PO Box 4647**  
One Omega Drive, Stamford, CT 06907 USA  
Email: [info@omega.com](mailto:info@omega.com)  
Phone: 203-359-1880

19274

Figure A2 Calibration certificates of anemometer


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# Appendix 3

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**JR3**  
Multi-Axis Load Cell Technologies

**FORCE-MOMENT SENSOR  
SPECIFICATION SHEET**

JR3, Inc.  
22 Harter Avenue  
Woodland, CA 95776  
  
(530) 661-3677  
Fax (530) 661-3701  
e-mail: jr3@jr3.com

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**75E20A4-1125-EF mFS 334N**  
Serial Number **3572**

Analog calibration.

	Electrical Load Settings	Sensor Load Ratings	Calibration Loads used
Fx	315 N	334 N	70.0 lbs
Fy	315 N	334 N	70.0 lbs
Fz	630 N	667 N	120.0 lbs
Mx	63 Nm	63.6 Nm	455.0 in-lbs
My	63 Nm	63.6 Nm	455.0 in-lbs
Mz	63 Nm	63.6 Nm	455.0 in-lbs

Calibration Matrix: Multiply the calibration matrix and the sensor  
Voltage vector to determine the loads. (N and Nm)

$\begin{bmatrix} 36.5929 & 0.2069 & -0.1376 & -1.9833 & -0.1037 & 0.0795 \\ 0.1724 & 36.6431 & -0.0938 & 0.0099 & -2.0348 & 0.6183 \\ 1.5202 & 1.1847 & 73.8182 & -0.5367 & -0.1993 & -4.8031 \\ 0.0690 & 0.0299 & 0.0111 & 7.4566 & 0.0073 & -0.1531 \\ 0.0093 & 0.1860 & -0.0269 & -0.0051 & 7.0215 & -0.0923 \\ 0.0073 & 0.0364 & 0.1006 & 0.0465 & 0.0152 & 7.1161 \end{bmatrix}$	$\begin{bmatrix} \text{Fx Volts} \\ \text{Fy Volts} \\ \text{Fz Volts} \\ \text{Mx Volts} \\ \text{My Volts} \\ \text{Mz Volts} \end{bmatrix}$
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Sensor Excitation +/-3.0V  
Shunt Voltages:

Fx	Fy	Fz	Mx	My	Mz
3.9569	3.8796	6.2123	5.7022	5.9657	5.2076

<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Pin</th> <th>Signal</th> <th>Connector</th> </tr> </thead> <tbody> <tr> <td>Pin 1</td> <td>Fx</td> <td>5 4 3 2 1</td> </tr> <tr> <td>Pin 2</td> <td>Fy</td> <td>9 8 7 6</td> </tr> <tr> <td>Pin 3</td> <td>Fz</td> <td>DE9S</td> </tr> <tr> <td>Pin 4</td> <td>Mx</td> <td></td> </tr> <tr> <td>Pin 5</td> <td>My</td> <td></td> </tr> <tr> <td>Pin 6</td> <td>Mz</td> <td></td> </tr> <tr> <td>Pin 7</td> <td>+12V (12 to 15)</td> <td></td> </tr> <tr> <td>Pin 8</td> <td>-12V (12 to 15)</td> <td></td> </tr> <tr> <td>Pin 9</td> <td>COMMON</td> <td></td> </tr> </tbody> </table>	Pin	Signal	Connector	Pin 1	Fx	5 4 3 2 1	Pin 2	Fy	9 8 7 6	Pin 3	Fz	DE9S	Pin 4	Mx		Pin 5	My		Pin 6	Mz		Pin 7	+12V (12 to 15)		Pin 8	-12V (12 to 15)		Pin 9	COMMON		<p>Final Inspection:</p> <table border="0"> <tr> <td>Calibration Date</td> <td>22 Oct 2013</td> </tr> <tr> <td>Calibration Matrix</td> <td>24 Oct 2013</td> </tr> <tr> <td>Axis Orientation</td> <td>✓</td> </tr> <tr> <td>Units (N and Nm)</td> <td>✓</td> </tr> <tr> <td>Hardware Correct</td> <td>✓</td> </tr> <tr> <td>Label Correct</td> <td>✓</td> </tr> <tr> <td>Functional Test</td> <td>✓</td> </tr> <tr> <td>Inspection Date</td> <td>2013-10-24</td> </tr> <tr> <td>Inspector Initial</td> <td>EBA</td> </tr> </table>	Calibration Date	22 Oct 2013	Calibration Matrix	24 Oct 2013	Axis Orientation	✓	Units (N and Nm)	✓	Hardware Correct	✓	Label Correct	✓	Functional Test	✓	Inspection Date	2013-10-24	Inspector Initial	EBA	
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Figure A3 Calibration certificates of force-moment sensor

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