

**OHIO DEPARTMENT OF TRANSPORTATION**  
**Office Of Materials Management**  
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 Chemical Section  
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Subject: Results of the Round Robin tests on bridge paint and comparison of data to show uniformity of results using specified methodology.

Introduction

The resulting data of the paint round robin testing program is analyzed and summarized around the arithmetic mean ( $\bar{u}$ ). The standard deviation ( $s$ ) is defined as the square root of the average square deviation of each data point from the mean. If  $N$  is the total number of data points, which becomes  $(N - 1)$  considering degrees of freedom,  $X_i$  represents a data point,  $\sum (X_i - \bar{u})^2$  is the sum of the square of the difference of the data points from the mean, the standard deviation would be;

$$s = \left\{ \sum (X_i - \bar{u})^2 \right\}^{1/2} / (N - 1)^{1/2}$$

The number of standard deviations a data point is away from the mean,  $(X_i - \bar{u})/s$ , is an indication, for the purposes of this program, of the uniformity of testing between the participants. ***A  $(X_i - \bar{u})/s$  value of 2 or greater infers a procedural problem.***

Data

Company	ODOT	Sherwin Williams	Ameron	Carboline	ICI	International
<b>Total solids</b>	58.64	58.66	58.69	58.80	58.40	58.33
<b>Pigment</b>	20.90	20.72	20.66	xxxx	20.80	20.80
<b>Weight (lbs./gal)</b>	8.90	8.83	8.90	8.85	8.83	8.70
<b>Viscosity (KU)</b>	78	85	77	77	80	80

**% Total Solids**

$u = 58.59$

$S(X_i - u)^2 = .166$

$(N - 1) = 5$

$s = \{ .166/5 \}^{1/2}$

$s = 0.18$

Company	$X_i$	$(X_i - u)$	$(X_i - u)^2$
ODOT	58.64	.05	.003
Sherwin-Williams	58.66	.07	.005
Ameron	58.69	.10	.010
Carboline	58.80	.21	.044
ICI	58.40	-.19	.036
International	58.33	-.26	.068

Company	$(X_i - u)$	$(X_i - u)/s$
ODOT	.05	.28
Sherwin-Williams	.07	.39
Ameron	.10	.56
Carboline	.21	1.17
ICI	-.19	-1.06
International	-.26	-1.44

The results for the Total Solid data show a range of 0.28 to -1.44 standard deviations from the mean value. There are no procedural problems apparent for ASTM D 2369 as all participants are below standard deviations.

**Pigment Content**

$u = 20.78$

$S(X_i - u)^2 = 5.97$

$(N - 1) = 6$

$s = \{5.97/6\}^{1/2}$

$s = 1.00$

Company	$X_i$	$(X_i - u)$	$(X_i - u)^2$
<b>ODOT</b>	20.90	.12	.014
<b>Sherwin-Williams</b>	20.72	-.06	.004
<b>Ameron</b>	20.66	-.12	.014
<b>Carboline</b>	xxxx	xxxx	xxxx
<b>ICI</b>	20.80	.02	0
<b>International</b>	20.80	.02	0

Company	$(X_i - u)$	$(X_i - u)/s$
<b>ODOT</b>	.12	1.33
<b>Sherwin-Williams</b>	-.06	-.67
<b>Ameron</b>	.12	-1.33
<b>Carboline</b>	xxxx	xxxx
<b>ICI</b>	.02	.22
<b>International</b>	.02	.22

The results for the percent pigment data ranges from 0.22 to 1.33 standard deviations from the mean value. There are no procedural problems for ASTM D 2698.

**Weight per Gallon**

$u = 8.84$

$S(X_i - u)^2 = .28$

$(N - 1) = 5$

$s = \{ .28/5 \}^{1/2}$

$s = 0.24$

Company	$X_i$	$(X_i - u)$	$(X_i - u)^2$
<b>ODOT</b>	8.90	.06	.004
<b>Sherwin-Williams</b>	8.83	-.01	0
<b>Ameron</b>	8.90	.06	.004
<b>Carboline</b>	8.85	.01	0
<b>ICI</b>	8.83	-.01	0
<b>International</b>	8.70	-.14	.020

Company	$(X_i - u)$	$(X_i - u)/s$
<b>ODOT</b>	.06	.25
<b>Sherwin-Williams</b>	-.01	0
<b>Ameron</b>	.06	.25
<b>Carboline</b>	.01	0
<b>ICI</b>	-.01	0
<b>International</b>	-.14	-.58

Results for weight per gallon range from 0 to 0.58 standard deviations from the mean value. There are no procedural problems for ASTM D 1475.

**Stormer Viscosity**

$u = 79.50$

$S(Xi - u)^2 = 45.50$

$(N - 1) = 5$

$s = \{45.50/5\}^{1/2}$

$s = 3.02$

<b>Company</b>	<b>Xi</b>	<b>(Xi - u)</b>	<b>(Xi - u) 2</b>
<b>ODOT</b>	78	-1.5	2.25
<b>Sherwin-Williams</b>	85	5.5	30.25
<b>Ameron</b>	77	-2.5	6.25
<b>Carboline</b>	77	-2.5	6.25
<b>ICI</b>	80	.5	.25
<b>International</b>	80	.5	.25

<b>Company</b>	<b>(Xi - u)</b>	<b>(Xi - u)/s</b>
<b>ODOT</b>	-1.5	-.50
<b>Sherwin-Williams</b>	5.5	1.82
<b>Ameron</b>	-2.5	-.83
<b>Carboline</b>	-2.5	-.83
<b>ICI</b>	.5	-.17
<b>International</b>	.5	-.17

The results of the Stormer Viscosity shows a range of 0.17 to 1.82 standard deviations from the mean value. There are no procedural problems evident for ASTM D 562.

### **Conclusion**

This program was established to ensure uniformity in testing paint according to specified methods.

**(Xi - u)/s**, represents the distance of the submitted data from the arithmetical mean of the data submitted by all participants. A data point which is 2 or more standard deviations from the mean should be considered suspect. Companies with values that were 2 or more standard deviations from the mean will be contacted and asked to explain their results. Uniformity in the performance of testing among participating producers and between these producers and the Ohio DOT is important. Uniformity of testing must exist in order to determine the validity of the results of testing problem paint samples when there is controversy as to whose test results reflect the actual condition of paint batches used on ODOT projects.

Thanks to all the participants for taking the time to participate in this program.

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