

OHIO DEPARTMENT OF TRANSPORTATION
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Subject: Results of the Round Robin tests on 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 (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, Xi represents a data point, S(Xi - U) 2 is the sum of the square of the difference of the data points from the mean, the standard deviation would be;

$$s = \{S(Xi - u) ^2 \} ^{1/2} / (N - 1) ^{1/2}$$

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

Data

Company	ODOT	Aexcel	Sherwin-Williams	Ennis @ Richmond, VA	Ennis @ Ennis, TX	Polycarb	Epolpex
Total solids	40.73	40.80	40.90	40.28	40.55	41.07	38.90
Pigment	26.93	24.95	27.34	27.28	27.33	27.49	28.12
Weight (lbs./gal)	10.53	10.54	10.46	10.58	10.55	10.58	10.52
Viscosity (KU)	102	103	101	103	101	101	-----

% Total Solids

$u = 40.46$

$S(Xi - u)^2 = 3.2$

$(N - 1) = 6$

$s = \{3.2/6\}^{1/2}$

$s = 0.73$

Company	Xi	(Xi - u)	(Xi - u) 2
ODOT	40.73	0.27	0.07
Aexcel	40.80	0.34	0.12
Sherwin-Williams (traffic)	40.90	0.44	0.19
Ennis Paint, VA	40.28	-0.18	0.03
Ennis Paint, TX	40.55	0.09	0.01
Polycarb	41.07	0.61	0.37
Epoplex	38.90	-1.56	2.43

Company	(Xi - u)	(Xi - u)/s
ODOT	0.27	0.37
Aexcel	0.34	0.47
Sherwin-Williams (traffic)	0.44	0.60
Ennis Paint, VA	-0.18	-0.25
Ennis Paint, TX	0.09	0.12
Polycarb	0.61	0.84
Epoplex	-1.56	-2.14

The results for the Total Solid data show a range of 0.12 to -2.14 standard deviations from the mean value. For the most part the total solid values are very close and no procedural problems are apparent. Epoplex had a Total Solid value over two (2) standard deviations from the mean. If the method for determining total solids was ASTM D-2369 for all participants, the total solid value for Epoplex shows a procedural problem.

Pigment Content

$$u = 27.06$$

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

$$(N - 1) = 6$$

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

$$s = 1.00$$

Company	X_i	$(X_i - u)$	$(X_i - u)^2$
ODOT	26.93	-0.13	0.02
Aexcel	24.95	-2.11	4.45
Sherwin-Williams (traffic)	27.34	0.28	0.08
Ennis Paint, VA	27.28	-0.22	0.05
Ennis Paint, TX	27.33	0.27	0.07
Polycarb	27.49	0.43	0.18
Epoplex	28.12	1.06	1.12

Company	$(X_i - u)$	$(X_i - u)/s$
ODOT	-0.13	-0.13
Aexcel	-2.11	-2.11
Sherwin-Williams (traffic)	0.28	0.28
Ennis Paint, VA	-0.22	-0.22
Ennis Paint, TX	0.27	0.27
Polycarb	0.43	0.43
Epoplex	1.06	1.06

The results for the percent pigment data ranges from -0.13 to -2.11 standard deviations from the mean value. Aexcel's percent pigment estimate is low relative to all other participants.

Weight per Gallon

$$u = 10.54$$

$$S(X_i - u)^2 = 0.01$$

$$(N - 1) = 6$$

$$s = \{0.01/6\}^{1/2}$$

$$s = 0.04$$

Company	X_i	$(X_i - u)$	$(X_i - u)^2$
ODOT	10.53	-0.01	0
Aexcel	10.54	0	0
Sherwin-Williams (traffic)	10.46	-0.08	0.01
Ennis Paint, VA	10.58	0.04	0.002
Ennis Paint, TX	10.55	0.01	0
Polycarb	10.58	0.04	0.002
Epoplex	10.52	-0.02	0

Company	$(X_i - u)$	$(X_i - u)/s$
ODOT	-0.01	-0.25
Aexcel	0	0
Sherwin-Williams (traffic)	-0.08	-2
Ennis Paint, VA	0.04	1
Ennis Paint, TX	0.01	0.25
Polycarb	0.04	1
Epoplex	-0.02	-0.5

Results for weight per gallon range from 0 to -2 standard deviations from the mean value. Although the weight per gallon figure submitted by Sherwin-Williams was not far off from the data submitted by all other participants, most of the data was extremely close to the mean.

Stormer Viscosity

$$u = 101.83$$

$$S(X_i - u)^2 = 4.84$$

$$(N - 1) = 5$$

$$s = \{4.84/5\}^{1/2}$$

$$s = 0.98$$

Company	X_i	$(X_i - u)$	$(X_i - u)^2$
ODOT	102	0.17	0.03
Aexcel	103	1.17	1.37
Sherwin-Williams (traffic)	101	-0.83	0.69
Ennis Paint, VA	103	1.17	1.37
Ennis Paint, TX	101	-0.83	0.69
Polycarb	101	-0.83	0.69
Epoplex	-----	-----	-----

Company	$(X_i - u)$	$(X_i - u)/s$
ODOT	0.17	0.17
Aexcel	1.17	1.19
Sherwin-Williams (traffic)	-0.83	-0.85
Ennis Paint, VA	1.17	1.19
Ennis Paint, TX	-0.83	-0.85
Polycarb	-0.83	-0.85
Epoplex	-----	-----

The results of the Stormer Viscosity shows a range of 0.17 to 1.19 standard deviations from the mean value. There are no procedural problems evident.

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. For several of the tests performed there were values that were 2 or more standard deviations from the mean. Companies will be contacted and asked to explain these 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.

I want to thank all the participants for taking the time to participate in this program. Your cooperation and your timely responses are appreciated. I look forward to the same partnership in our future working relationships.

I remain sincerely,

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