

**CEMENT AND CONCRETE REFERENCE LABORATORY**  
**PROFICIENCY SAMPLE PROGRAM**

**Final Report**  
**Portland Cement Proficiency Samples**  
**Number 211 and Number 212**



**CCRL**  
Cement and Concrete  
Reference Laboratory

March 2019

[www.ccril.us](http://www.ccril.us)

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Reference Laboratory

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March 27, 2019

**To: Participants in the CCRL Portland Cement Proficiency Sample Program**

**SUBJECT: Final Report on Portland Cement Proficiency Samples No. 211 and No. 212**

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in January 2019. Portland Cement Sample No. 211 was an ASTM C150 meeting the specifications of Type I and Type II, and contained limestone additions. Portland Cement Sample No. 212 was an ASTM C150 meeting the specifications of Type I, and Type II, and contained limestone additions and inorganic processing additions.

This report consists of a statistical Summary of Results, a set of general Scatter Diagrams, and associated detailed information. The Table of Results with individualized information for participating laboratories can be downloaded at our website located at: <http://www.ccrl.us/>. Additional information is provided in the following pages.

The CCRL Proficiency Sample Programs are intended for internal use by the laboratory as a tool to identify potential problems in laboratory procedures or test equipment and to initiate remedial actions. These programs are designed to complement the CCRL Laboratory Inspection Program as part of a total quality system. Care should be taken when using this program for any other purpose.

**Additional samples of these two cements and other CCRL samples are available for purchase.** These samples may be useful for equipment verification, technician training, and research. Contact CCRL for availability and price.

It is presently anticipated that the next Portland Cement Proficiency Samples will be distributed in June 2019.

Sincerely,

Kent Niedzielski  
Program Manager, Proficiency Sample Programs  
Cement and Concrete Reference Laboratory

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Sponsored by Committees C-1 and C-9 of ASTM International

**TO: Participants in the CCRL Portland Cement Proficiency Sample Program**

**FROM: Kent Niedzielski, Program Manager PSP**

**SUBJECT: Explanation of Final Report on Results of Tests for Portland Cement Proficiency Samples No. 211 and No. 212**

This letter, and the material included with it, constitutes the final report, and summary of results for the current pair of Portland Cement Proficiency Samples, which were distributed in January 2019. This material includes a Table of Results for individual laboratory data, a statistical Summary of Results, and a set of general Scatter Diagrams. Your unique laboratory number is displayed at the top of the individual Table of Results.

An explanation of the program is contained in the paper: "Statistical Evaluation of Interlaboratory Cement Tests" by J. R. Crandall and R. L. Blaine [View Document](#), and "Statistical Aspects of the Cement Testing Program" by W.J. Youden [View Document](#), which can be found in Volume 59, Proceedings of the 62<sup>nd</sup> Annual Meeting of the Society, June 25, 1959, American Society for Testing and Materials.

Each laboratory receives an individualized Table of Results. The Table of Results shows the, test title, and the reporting unit in the first two columns. After that it lists in order, the laboratory's results for the odd and even numbered samples, overall averages for the odd and even numbered samples, and the laboratory's ratings for the odd and even samples.

Laboratory ratings, shown in the Table of Results for the individual laboratory, were determined in the manner described by Crandall and Blaine using a rating scale of 1 to 5 instead of 0 to 4. The ratings have no valid standing beyond showing the difference between the individual laboratory result and the average for a particular test.

The following table details the relationship between the ratings and the averages.

<b>Ratings</b>	<b>Range (Number of Standard Deviations)</b>	<b>Number (Per 100) of Laboratories achieving the rating <sup>1</sup></b>
5	Less than 1	69
4	1 to 1.5	18
3	1.5 to 2	9
2	2 to 2.5	3
1	Greater than 2.5	1

The sign of the rating merely shows whether the result reported was greater or less than the average obtained.

Participants subscribing to the primary chemical analysis portion of this report should note that the statistics were calculated using data obtained by wet methods, and rapid methods of chemical analysis. Participants in the secondary chemical analysis should note that laboratory ratings are assigned using primary chemical statistics.

Please note that individual laboratory ratings were not given for the flow of air content mortar (test no. 190) and compressive strength mortar (test no. 230). Air content flows in the range of  $87.5 \pm 7.5$  are satisfactory; labs with flow values outside this range will be flagged as a "Labs Eliminated" or "Labs Off Diagram" on the scatter diagram. Averages, standard deviations, and a scatter diagram are provided for your information. This information may be a helpful indicator of a problem with flow table apparatus or

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<sup>1</sup>Youden, W.J., "Statistical Aspects of the Cement Testing Program", Volume 59, *Proceedings of the 62<sup>nd</sup> Annual Meeting of the Society, June 25, 1959, American Society for Testing and Materials.*

mortar mixing procedures. Flow values of 151 were assigned to laboratories reporting a mortar flow off the flow table top.

In cases where some laboratories' results are eliminated, averages, standard deviations, coefficients of variation, and the ratings of the other laboratories' results, are recalculated using the data remaining after the elimination. Since the laboratory ratings given are the results from this one series of tests, you need not attach too much significance to a single low rating, or pair of ratings, from this one series. A continuing tendency to get low ratings on several pairs of samples should lead a laboratory to consider the types of error, systematic and random, contribute to ratings that are low. Systematic error, which is indicated by low ratings with the same signs on each pair of samples, means a consistent error is occurring in equipment and/or test procedures. One indication of random error is low ratings on both samples with different signs. Since systematic error occurs with more regularity, its cause is generally easier to find than the cause of random error.

### **Summary of Results**

Usually, averages, standard deviations, and coefficients of variation are given with all results reported, and then with one or more outlying results omitted. Sometimes, two or more recalculations with laboratories omitted, have been done for the same test. In these cases, all of the laboratories omitted in previous recalculations are also omitted in subsequent ones. Results omitted are values that are more than three standard deviations from the mean of one or both samples. Often, elimination of these outlying results has little effect on the average, but may have a more pronounced effect on the standard deviation and coefficient of variation.

### **Scatter Diagrams**

General scatter diagrams are supplied with this report. Crandall and Blaine describe the manner of preparing scatter diagrams, and their interpretation, in the paper published in the 1959 ASTM Proceedings. Each laboratory will receive a complete set of diagrams according to their subscription to the given program.

Using the results received from each laboratory, a scatter diagram is generated for each test method by plotting the value for the odd numbered samples on the X, or horizontal axis, against the value for the even numbered samples on the Y, or vertical axis. To find your point, just plot as you would when plotting any scatter diagram. Vertical and horizontal dashed lines, which divide the diagrams into four sections or quadrants, place the average values for the odd and even numbered samples, respectively. The first line of print under the diagram includes the test number, as given on the data sheet, the test title, and the number of data points on the diagrams. The number of plotted points may not agree with the total number of data pairs included in the analysis because a few points may be off the diagram, and some points may represent several data pairs, which are identical. Laboratories whose points are off the diagram will have a rating of  $\pm 1$  for that particular test. As described in Crandall and Blaine, a tight circular pattern of points around the intersection of the median lines is the ideal situation. Stretching out of the pattern into the first (upper right) and third (lower left) quadrants, suggests some kind of bias, or tendency for laboratories to get high or low results on both samples. Examination of the scatter diagrams indicates strong evidence of bias on many tests.

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

Sample No. 211

Sample No. 212

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Silicon Dioxide (percent)</b>							
	223	20.55	0.27	1.31	18.84	0.34	1.83
	*218	20.55	0.18	0.87	18.80	0.24	1.27
* Labs Eliminated - 15, 206, 1079, 1644, 2477							
<b>Aluminum Oxide (percent)</b>							
	222	4.32	0.13	3.0	4.49	0.12	2.7
	*216	4.32	0.11	2.4	4.50	0.09	2.0
* Labs Eliminated - 42, 95, 547, 2477, 4099, 4325							
<b>Ferric Oxide (percent)</b>							
	223	3.48	0.13	3.8	3.38	0.15	4.4
	*220	3.48	0.05	1.5	3.37	0.06	1.7
* Labs Eliminated - 547, 1435, 4316							
<b>Calcium Oxide (percent)</b>							
	223	62.76	0.46	0.73	61.72	0.48	0.78
	*221	62.76	0.39	0.63	61.72	0.47	0.77
* Labs Eliminated - 2477, 3368							
<b>Magnesium Oxide (percent)</b>							
	224	3.12	0.21	6.6	4.60	0.26	5.7
	*218	3.11	0.09	2.8	4.63	0.13	2.7
* Labs Eliminated - 137, 162, 1079, 1644, 2477, 4316							
<b>Sulfur Trioxide (percent)</b>							
	228	2.52	0.12	4.8	3.21	0.11	3.3
	*222	2.51	0.06	2.4	3.21	0.07	2.3
* Labs Eliminated - 497, 768, 1079, 2477, 4099, 4325							
<b>Loss on Ignition (percent)</b>							
	230	2.07	0.26	12.4	2.63	0.32	12.2
	*216	2.06	0.08	3.7	2.65	0.07	2.8
* Labs Eliminated - 17, 34, 48, 116, 148, 206, 493, 1251, 2465, 2466, 2477, 2683, 3279, 4099							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

Sample No. 211

Sample No. 212

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Sodium Oxide (percent)</b>							
	219	0.141	0.035	25	0.197	0.034	17
	*211	0.139	0.027	19	0.197	0.025	13
* Labs Eliminated - 1, 11, 99, 175, 354, 3279, 4099, 4316							
<b>Potassium Oxide (percent)</b>							
	221	0.582	0.048	8.2	0.866	0.038	4.4
	*215	0.578	0.021	3.6	0.870	0.025	2.9
* Labs Eliminated - 95, 289, 497, 1079, 1644, 2477							
<b>Strontium Oxide (percent)</b>							
	113	0.076	0.013	17	0.020	0.009	48
	*102	0.077	0.004	5	0.018	0.003	16
* Labs Eliminated - 43, 94, 95, 137, 415, 547, 768, 1079, 1466, 1657, 4325							
<b>Titanium Dioxide (percent)</b>							
	183	0.26	0.011	4.3	0.25	0.009	3.6
	*175	0.26	0.007	2.7	0.25	0.006	2.6
* Labs Eliminated - 162, 175, 698, 2293, 3238, 3606, 4099, 4325							
<b>Phosphorus Pentoxide (percent)</b>							
	180	0.058	0.022	37.6	0.106	0.024	22.7
	*168	0.056	0.006	10.4	0.104	0.006	5.4
* Labs Eliminated - 48, 90, 95, 99, 494, 504, 1079, 2463, 3279, 4099, 4316, 4325							
<b>Zinc Oxide (percent)</b>							
	105	0.103	0.015	14.6	0.007	0.012	183.9
	*97	0.106	0.005	5.1	0.005	0.002	31.0
* Labs Eliminated - 94, 413, 547, 768, 1079, 1916, 2360, 2484							
<b>Manganic Oxide (percent)</b>							
	146	0.251	0.028	11.1	0.128	0.012	9.7
	*136	0.253	0.010	4.0	0.126	0.005	3.9
* Labs Eliminated - 47, 94, 101, 354, 491, 1079, 1594, 3297, 4297, 4325							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

Sample No. 211

Sample No. 212

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Chloride (percent)</b>							
	134	0.012	0.008	66	0.006	0.008	126
	*126	0.011	0.004	34	0.005	0.003	60
* Labs Eliminated - 90, 94, 105, 457, 491, 1644, 2293, 4325							
<b>Insoluble Residue (percent)</b>							
	207	0.44	0.15	33	0.34	0.18	53
	*200	0.43	0.10	22	0.32	0.09	28
* Labs Eliminated - 17, 23, 24, 1435, 2293, 3249, 3368							
<b>Free Lime (percent)</b>							
	173	0.54	0.17	31	0.65	0.19	29
	*171	0.53	0.16	31	0.65	0.18	27
* Labs Eliminated - 94, 3368							
<b>Carbon Dioxide (percent)</b>							
	200	1.45	0.28	19.5	1.58	0.23	14.6
	*187	1.45	0.12	8.1	1.60	0.12	7.5
* Labs Eliminated - 15, 43, 74, 129, 203, 206, 440, 698, 1916, 2465, 3415, 4051, 4404							
<b>Limestone Content (percent)</b>							
	195	3.4	0.5	13.3	3.7	0.6	15.1
	*181	3.4	0.3	7.6	3.8	0.3	7.4
* Labs Eliminated - 5, 15, 43, 74, 129, 203, 206, 440, 768, 1916, 2465, 4051, 4150, 4404							
<b>Chromium Oxide (percent)</b>							
	104	0.029	0.007	23	0.013	0.005	42
	*96	0.028	0.004	13	0.012	0.002	17
* Labs Eliminated - 94, 116, 415, 438, 886, 1079, 3238, 4099							
<b>Tricalcium Silicate (percent)</b>							
	195	53.0	2.8	5.2	59.3	3.1	5.2
	*192	53.0	2.7	5.1	59.4	2.8	4.7
* Labs Eliminated - 206, 1079, 2477							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

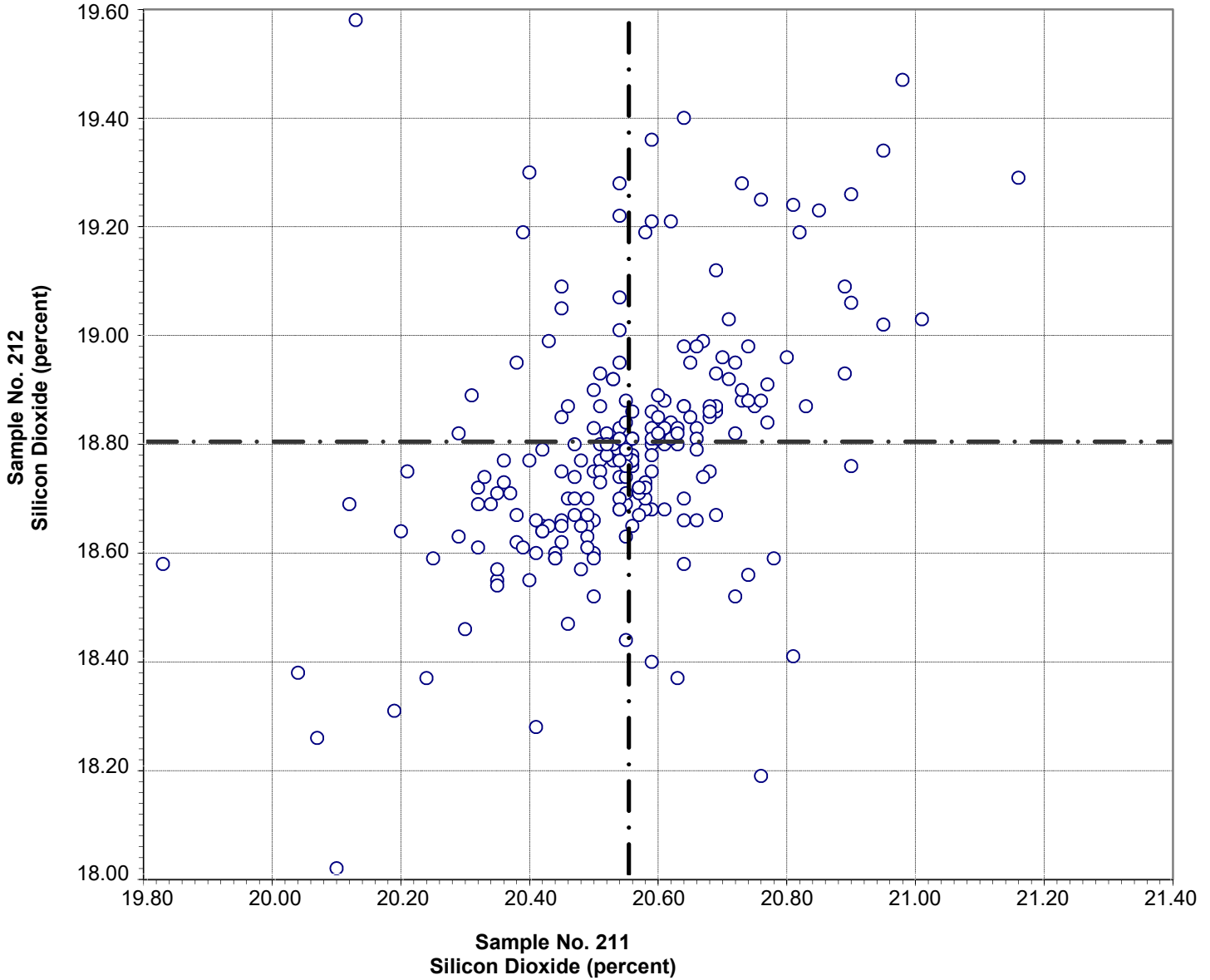
Sample No. 211

Sample No. 212

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Dicalcium Silicate (percent)</b>							
	195	18.6	2.5	13.2	8.7	2.9	33.4
	*187	18.6	2.0	10.9	8.5	2.2	25.8
* Labs Eliminated - 15, 18, 126, 206, 1079, 1644, 2477, 4138							
<b>Tricalcium Aluminate (percent)</b>							
	195	5.5	0.5	9.7	6.1	0.5	8.2
	*191	5.5	0.3	5.6	6.1	0.3	4.8
* Labs Eliminated - 547, 1435, 3238, 4316							
<b>Tetracalcium Aluminoferrite (percent)</b>							
	195	10.6	0.4	4.2	10.2	0.5	4.8
	*187	10.5	0.1	1.4	10.1	0.2	1.8
* Labs Eliminated - 95, 206, 547, 694, 1435, 2477, 3238, 4316							



**CCRL Proficiency Sample Program  
Silicon Dioxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



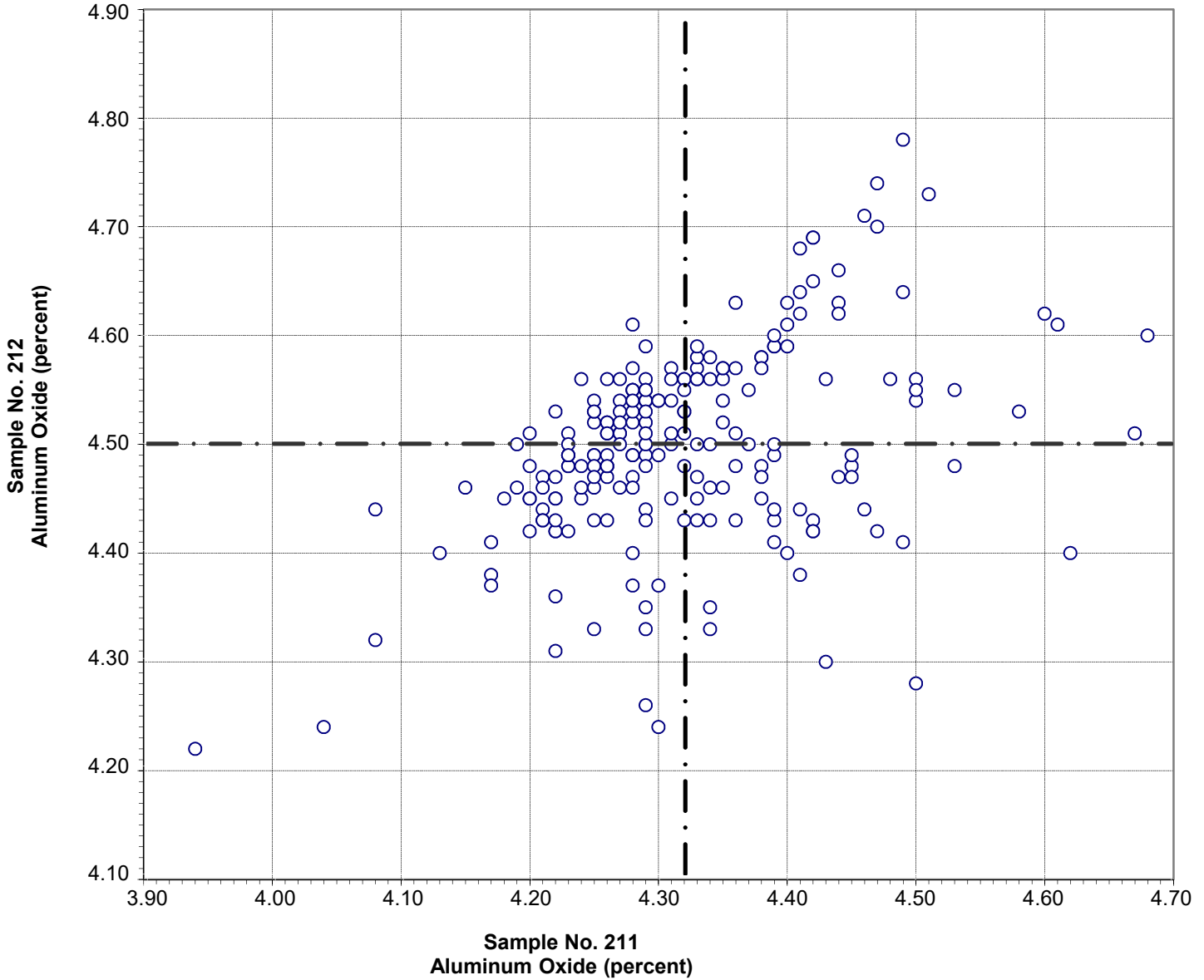
Test No. 10 Silicon Dioxide 216 Points

Sample No. 211	Ave 20.55	S.D. 0.18	C.V. 0.87
Sample No. 212	Ave 18.80	S.D. 0.24	C.V. 1.27

Labs Eliminated: 15, 206, 1079, 1644, 2477

Labs off Diagram: 694, 3297

**CCRL Proficiency Sample Program  
Aluminum Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**

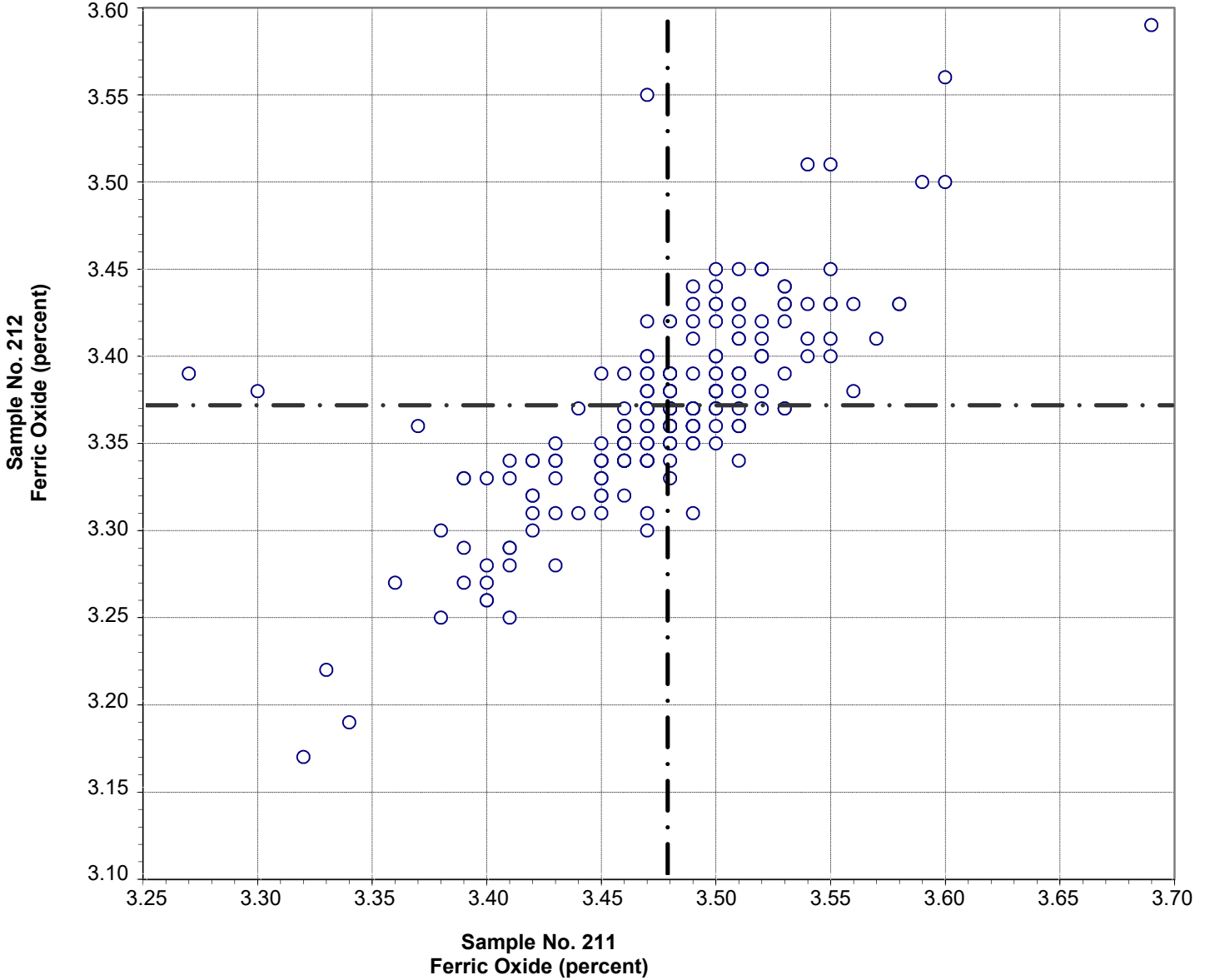


Test No. 21 Aluminum Oxide 216 Points

Sample No. 211	Ave 4.32	S.D. 0.11	C.V. 2.4
Sample No. 212	Ave 4.50	S.D. 0.09	C.V. 2.0

Labs Eliminated: 42, 95, 547, 2477, 4099, 4325

**CCRL Proficiency Sample Program  
 Ferric Oxide  
 PORTLAND CEMENT Samples No. 211 and No. 212**



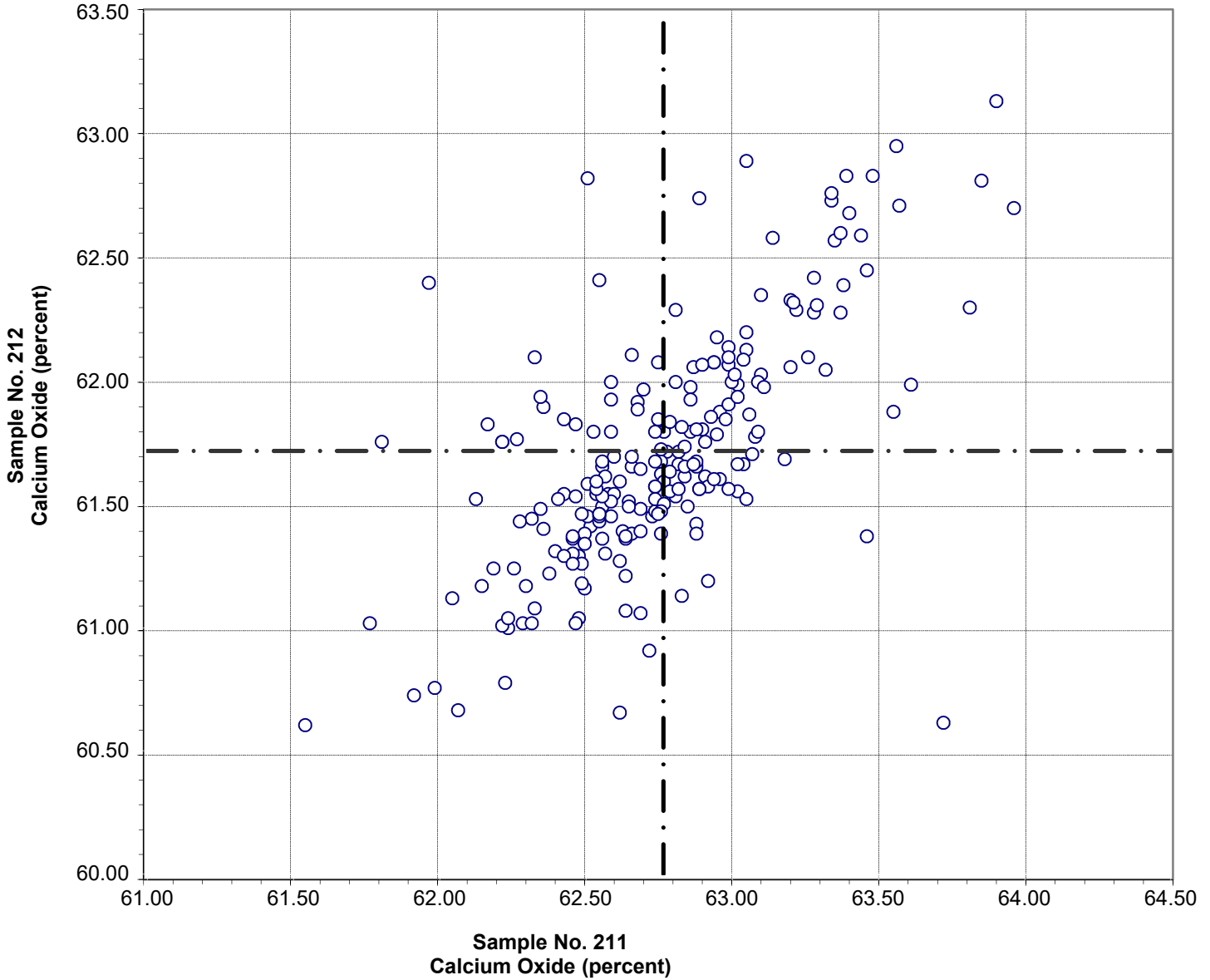
Test No. 30 Ferric Oxide 219 Points

Sample No. 211	Ave 3.48	S.D. 0.05	C.V. 1.5
Sample No. 212	Ave 3.37	S.D. 0.06	C.V. 1.7

Labs Eliminated: 547, 1435, 4316

Labs off Diagram: 95

**CCRL Proficiency Sample Program  
Calcium Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**

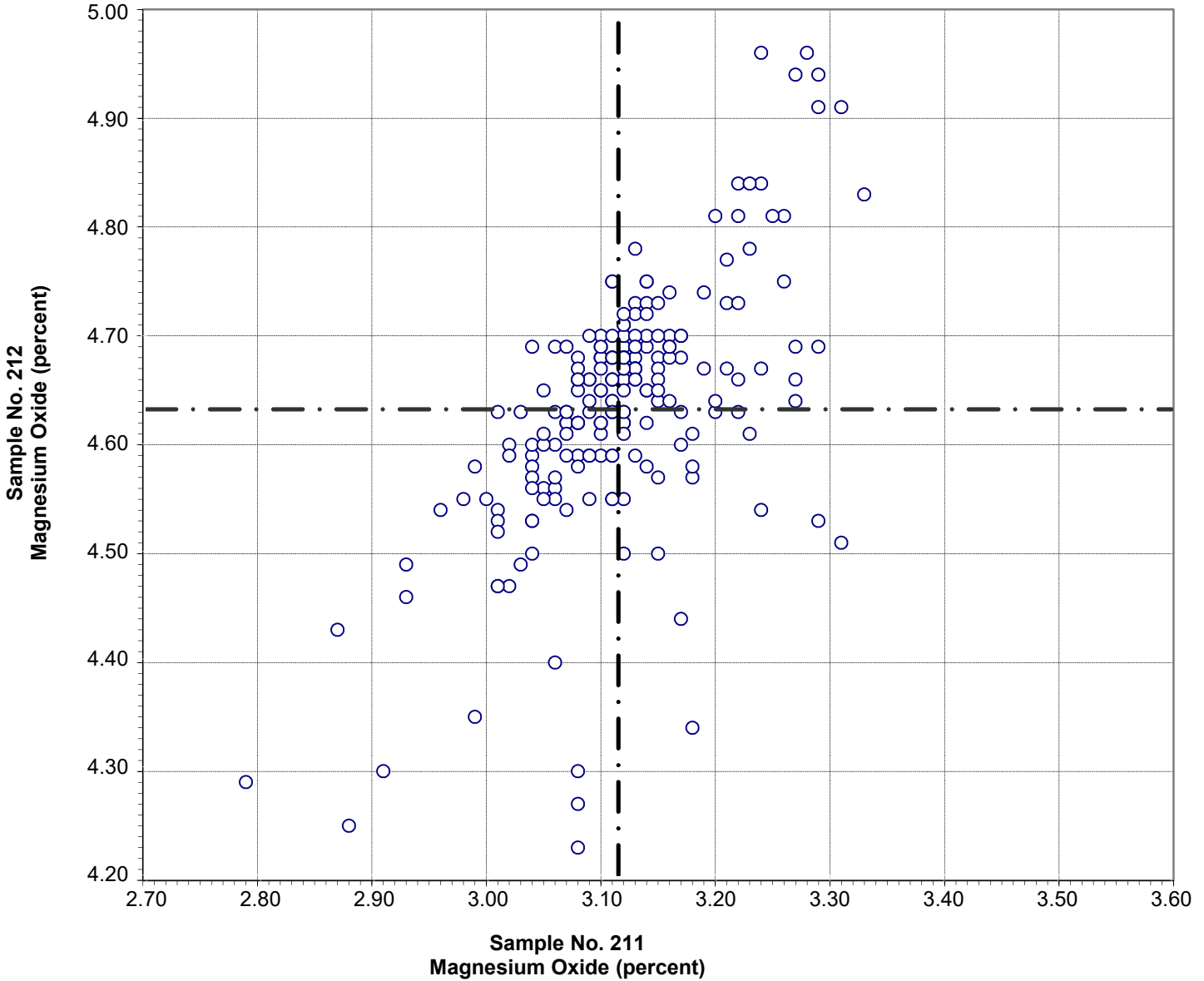


Test No. 40 Calcium Oxide 221 Points

Sample No. 211	Ave 62.76	S.D. 0.39	C.V. 0.63
Sample No. 212	Ave 61.72	S.D. 0.47	C.V. 0.77

Labs Eliminated: 2477, 3368

**CCRL Proficiency Sample Program  
Magnesium Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



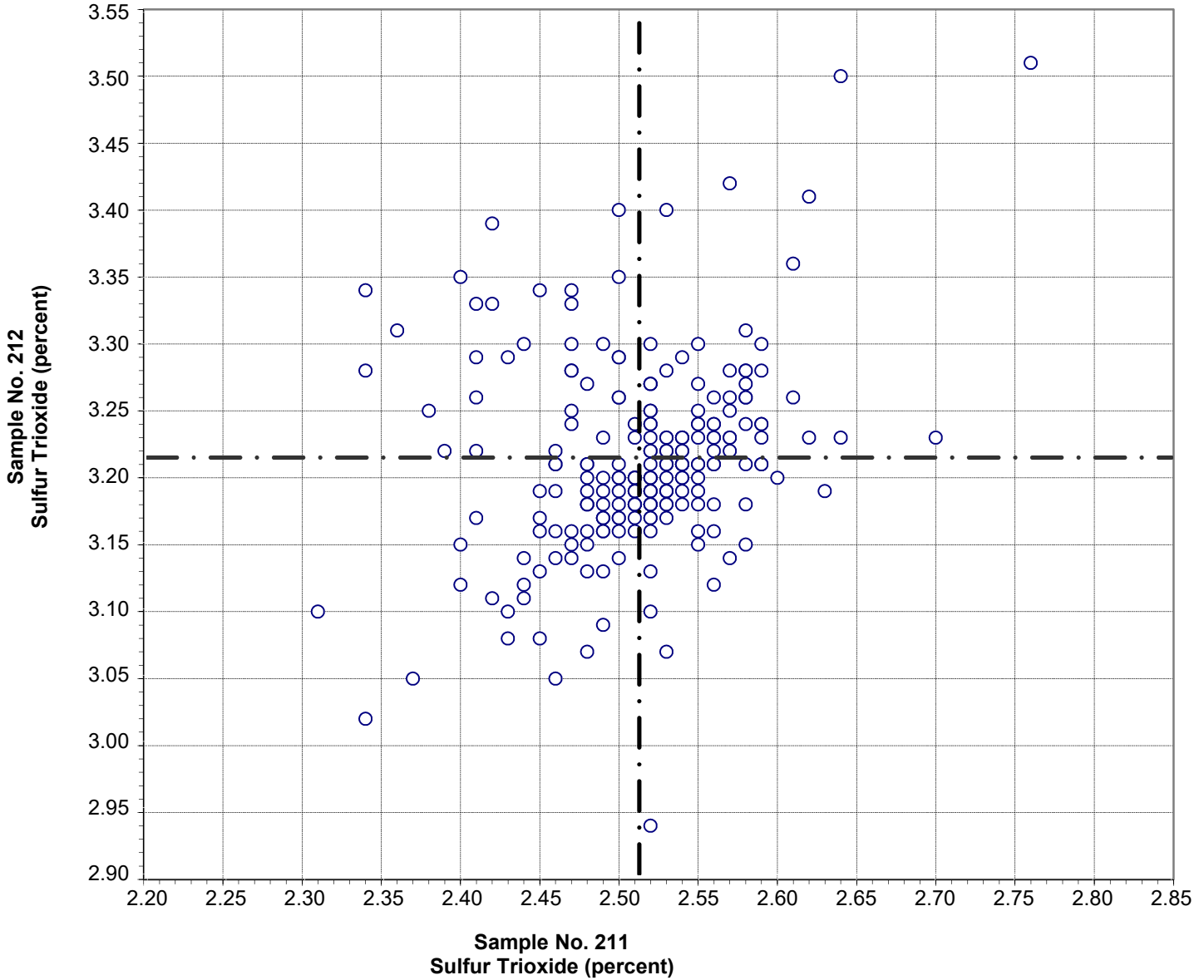
Test No. 50 Magnesium Oxide 216 Points

Sample No. 211 Ave 3.11 S.D. 0.09 C.V. 2.8  
 Sample No. 212 Ave 4.63 S.D. 0.13 C.V. 2.7

Labs Eliminated: 137, 162, 1079, 1644, 2477, 4316

Labs off Diagram: 95, 1940

**CCRL Proficiency Sample Program**  
**Sulfur Trioxide**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

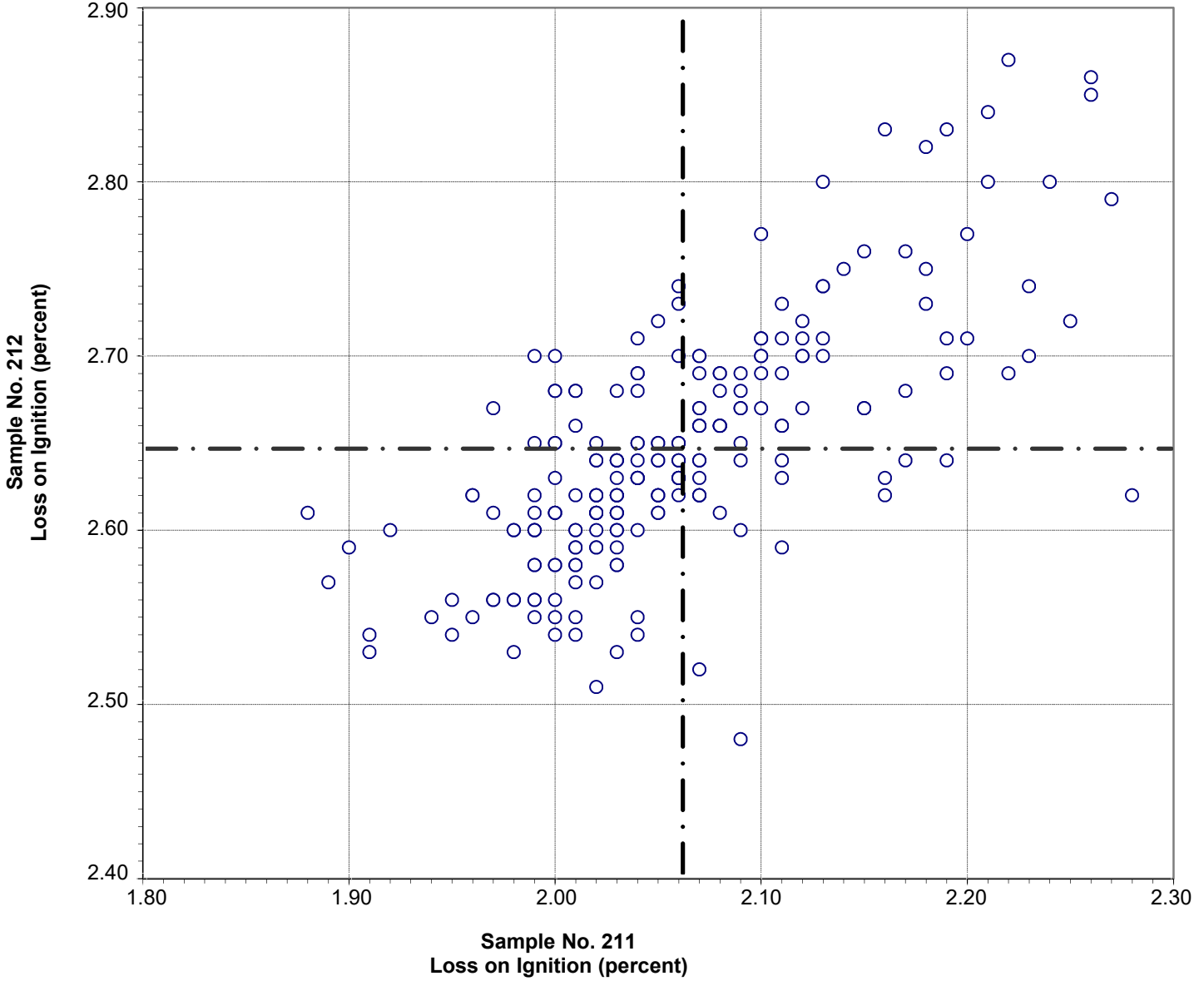


Test No. 60 Sulfur Trioxide 222 Points

Sample No. 211	Ave 2.51	S.D. 0.06	C.V. 2.4
Sample No. 212	Ave 3.21	S.D. 0.07	C.V. 2.3

Labs Eliminated: 497, 768, 1079, 2477, 4099, 4325

**CCRL Proficiency Sample Program  
Loss on Ignition  
PORTLAND CEMENT Samples No. 211 and No. 212**



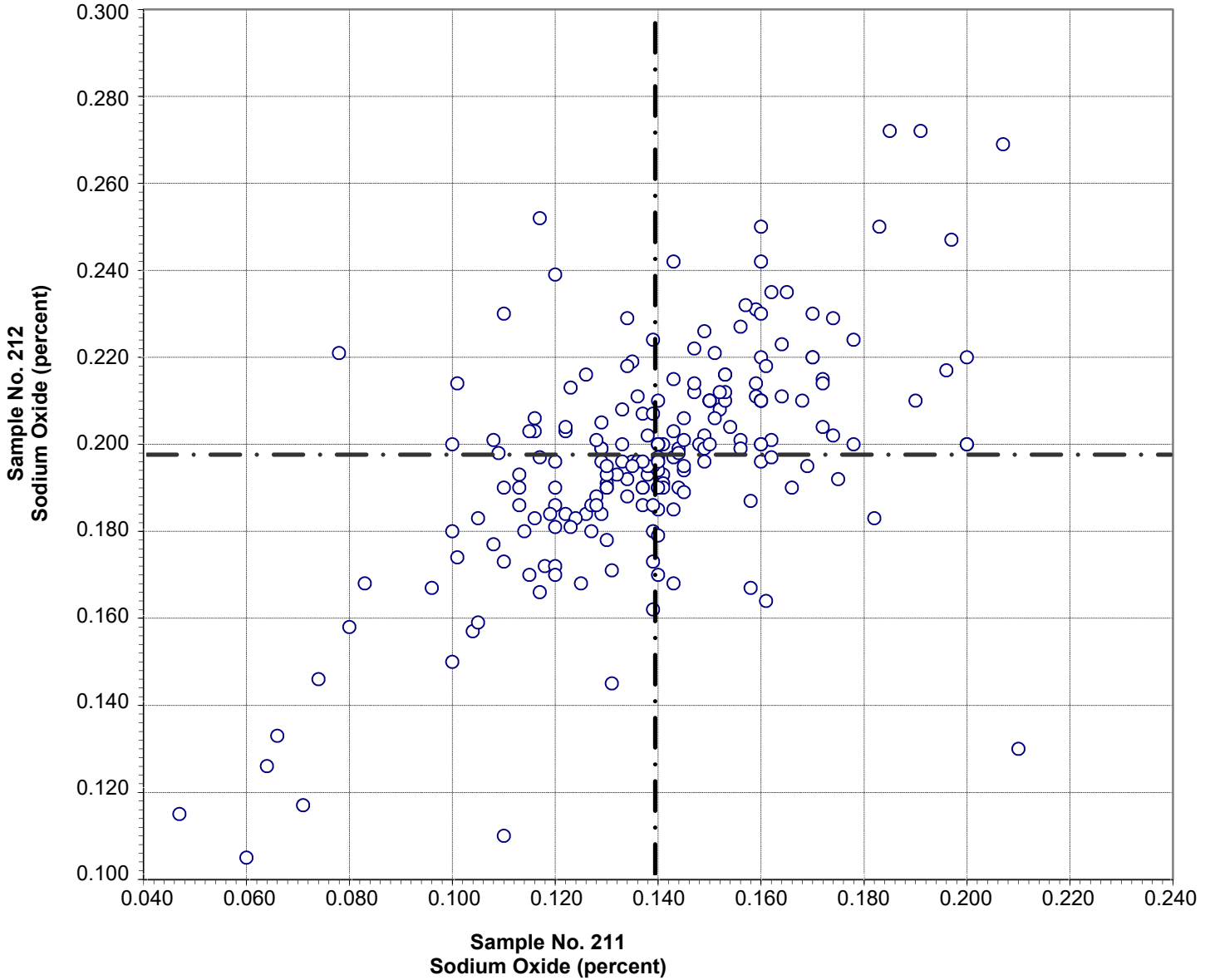
**Test No. 70 Loss on Ignition 214 Points**

Sample No. 211 Ave 2.06 S.D. 0.08 C.V. 3.7  
Sample No. 212 Ave 2.65 S.D. 0.07 C.V. 2.8

Labs Eliminated: 17, 34, 48, 116, 148, 206, 493, 1251, 2465, 2466, 2477, 2683, 3279, 4099

Labs off Diagram: 1715, 2352

**CCRL Proficiency Sample Program  
Sodium Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



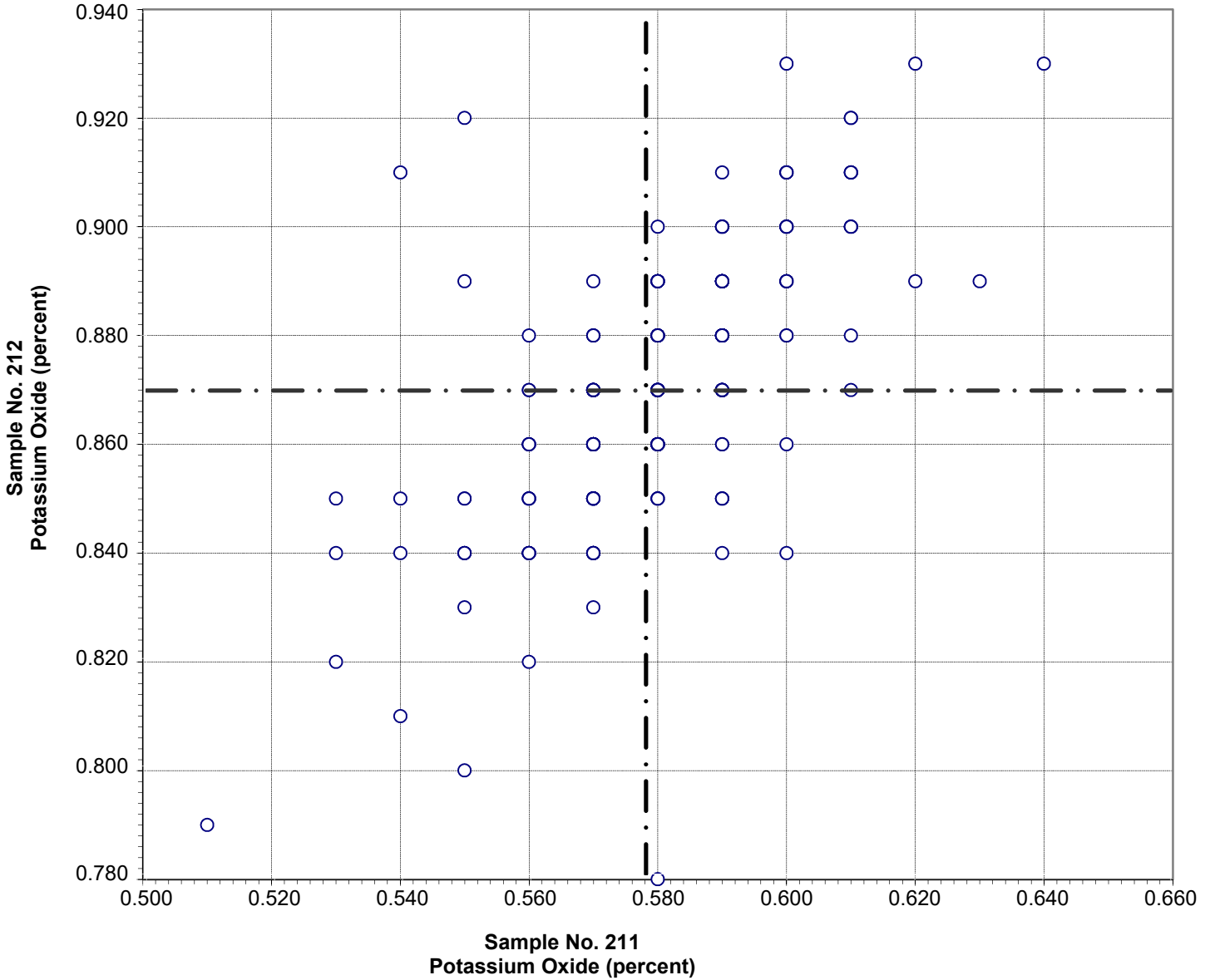
Test No. 90 Sodium Oxide 211 Points

Sample No. 211	Ave 0.139	S.D. 0.027	C.V. 19
Sample No. 212	Ave 0.197	S.D. 0.025	C.V. 13

Labs Eliminated: 1, 11, 99, 175, 354, 3279, 4099, 4316



**CCRL Proficiency Sample Program  
Potassium Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



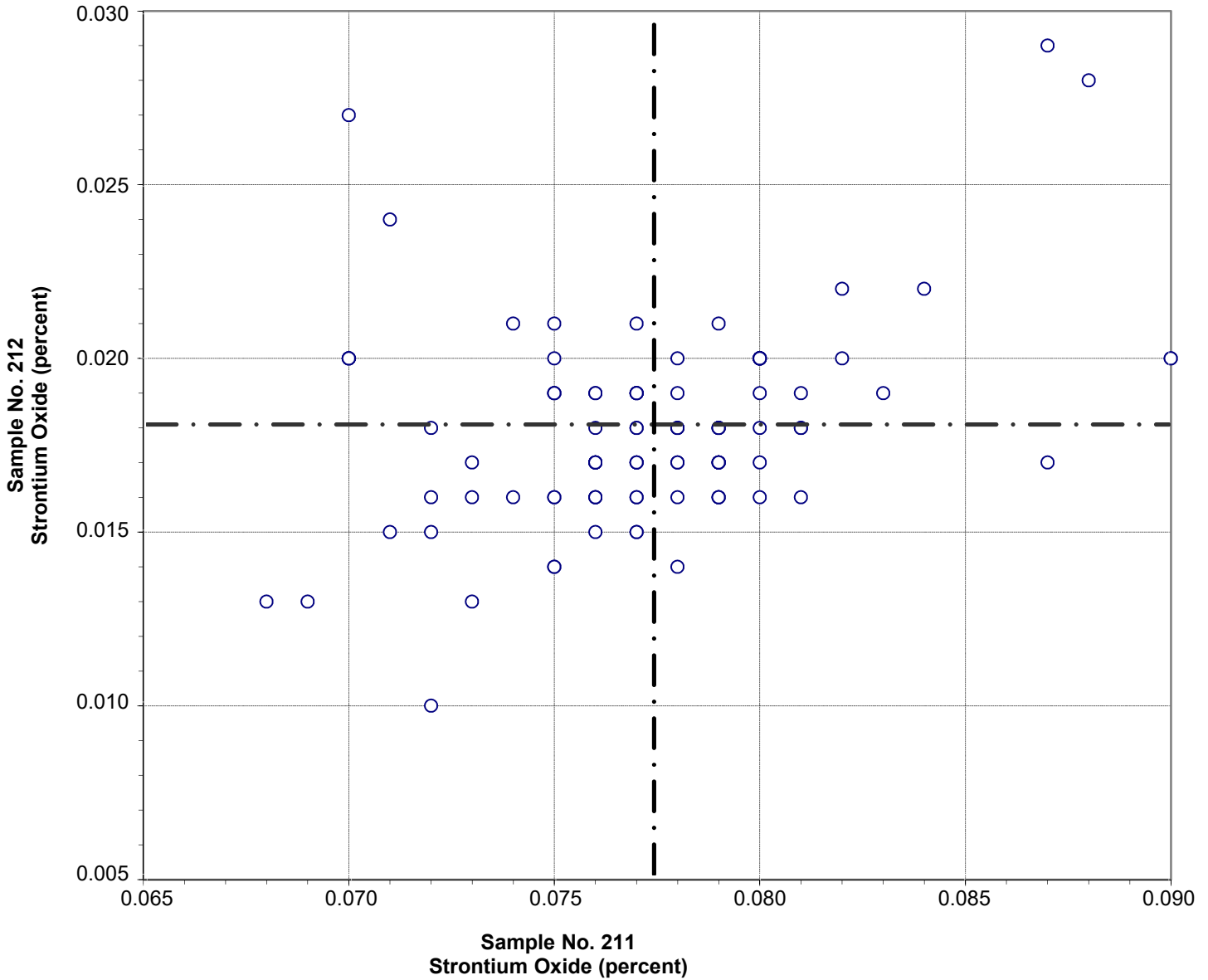
Test No. 100 Potassium Oxide 212 Points

Sample No. 211 Ave 0.578 S.D. 0.021 C.V. 3.6  
 Sample No. 212 Ave 0.870 S.D. 0.025 C.V. 2.9

Labs Eliminated: 95, 289, 497, 1079, 1644, 2477

Labs off Diagram: 36, 2463, 2466

**CCRL Proficiency Sample Program  
Strontium Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**

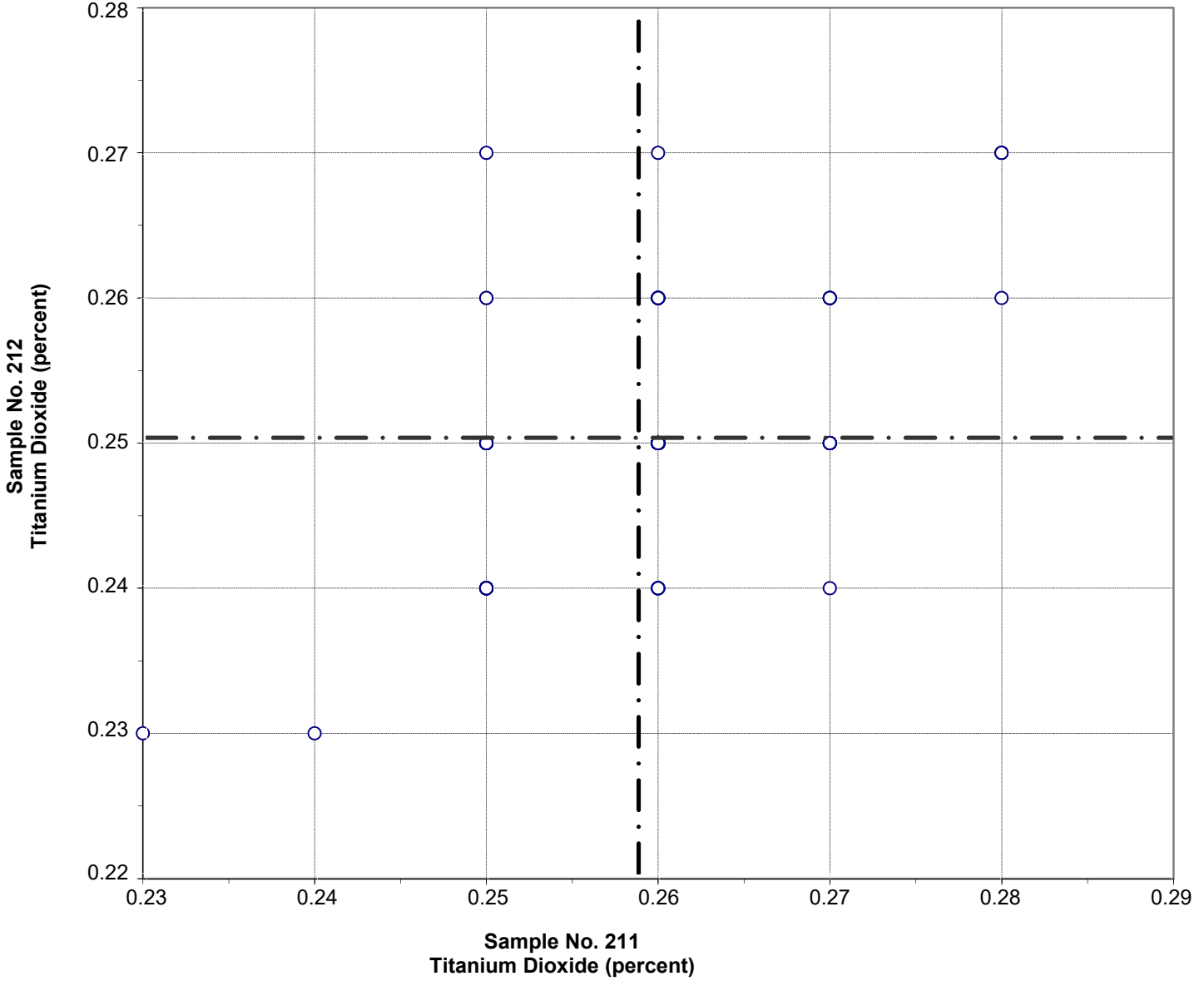


Test No. 92    Strontium Oxide    102 Points

Sample No. 211	Ave 0.077	S.D. 0.004	C.V. 5
Sample No. 212	Ave 0.018	S.D. 0.003	C.V. 16

Labs Eliminated: 43, 94, 95, 137, 415, 547, 768, 1079, 1466, 1657, 4325

**CCRL Proficiency Sample Program  
Titanium Dioxide  
PORTLAND CEMENT Samples No. 211 and No. 212**

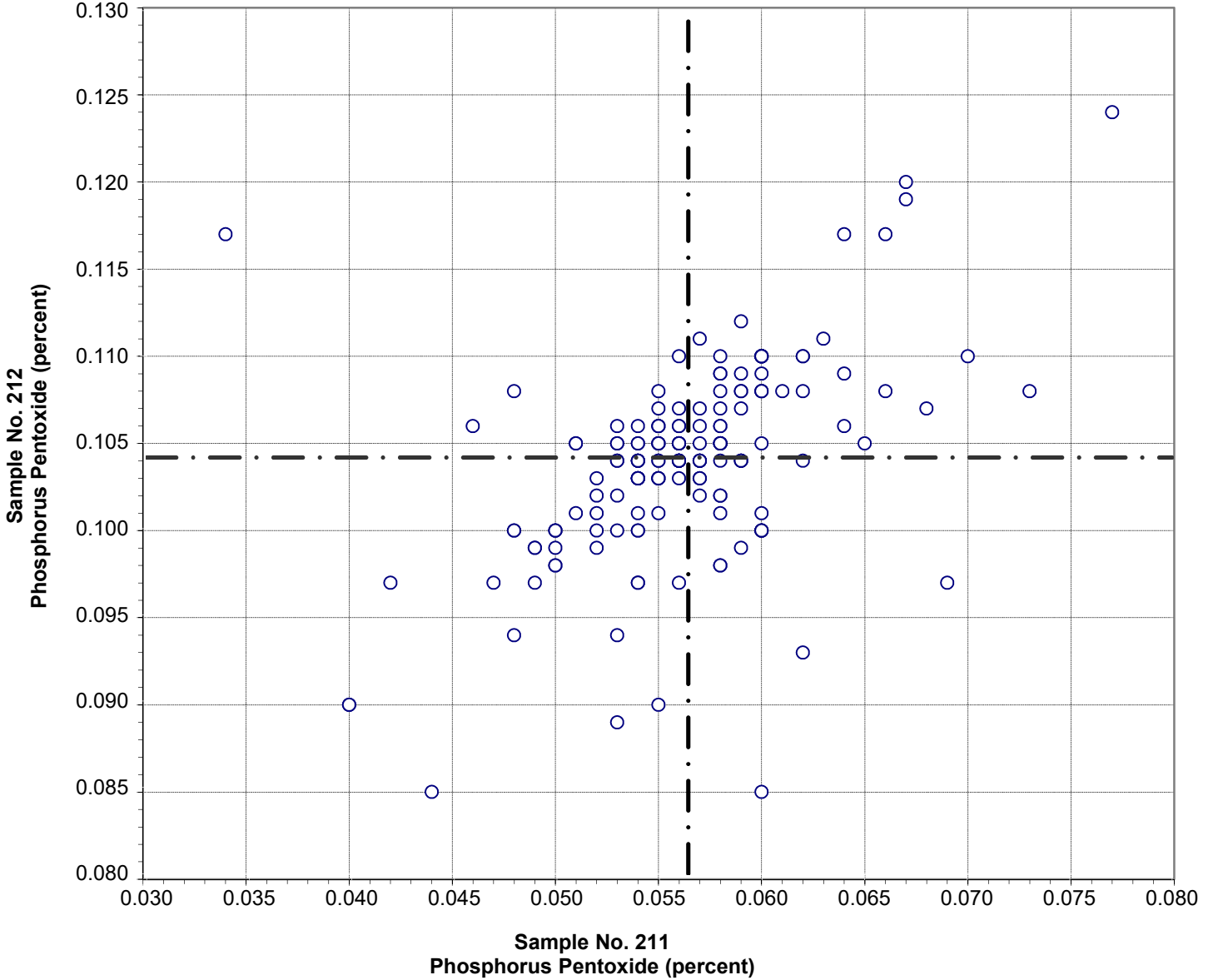


**Test No. 103 Titanium Dioxide 175 Points**

Sample No. 211	Ave 0.26	S.D. 0.007	C.V. 2.7
Sample No. 212	Ave 0.25	S.D. 0.006	C.V. 2.6

Labs Eliminated: 162, 175, 698, 2293, 3238, 3606, 4099, 4325

**CCRL Proficiency Sample Program  
Phosphorus Pentoxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



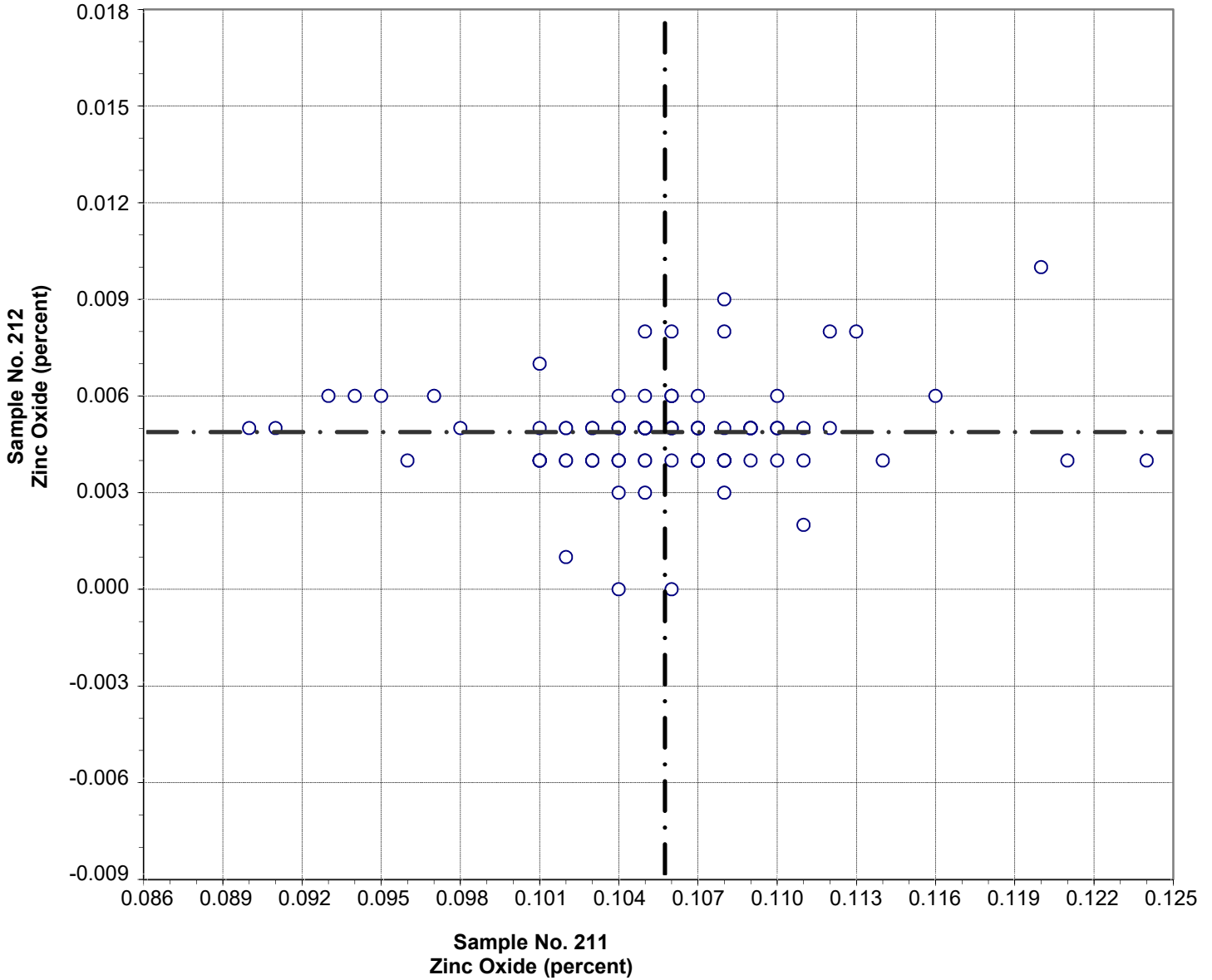
Test No. 102 Phosphorus Pentoxide 167 Points

Sample No. 211	Ave 0.056	S.D. 0.006	C.V. 10.4
Sample No. 212	Ave 0.104	S.D. 0.006	C.V. 5.4

Labs Eliminated: 48, 90, 95, 99, 494, 504, 1079, 2463, 3279, 4099, 4316, 4325

Labs off Diagram: 247

**CCRL Proficiency Sample Program  
Zinc Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**

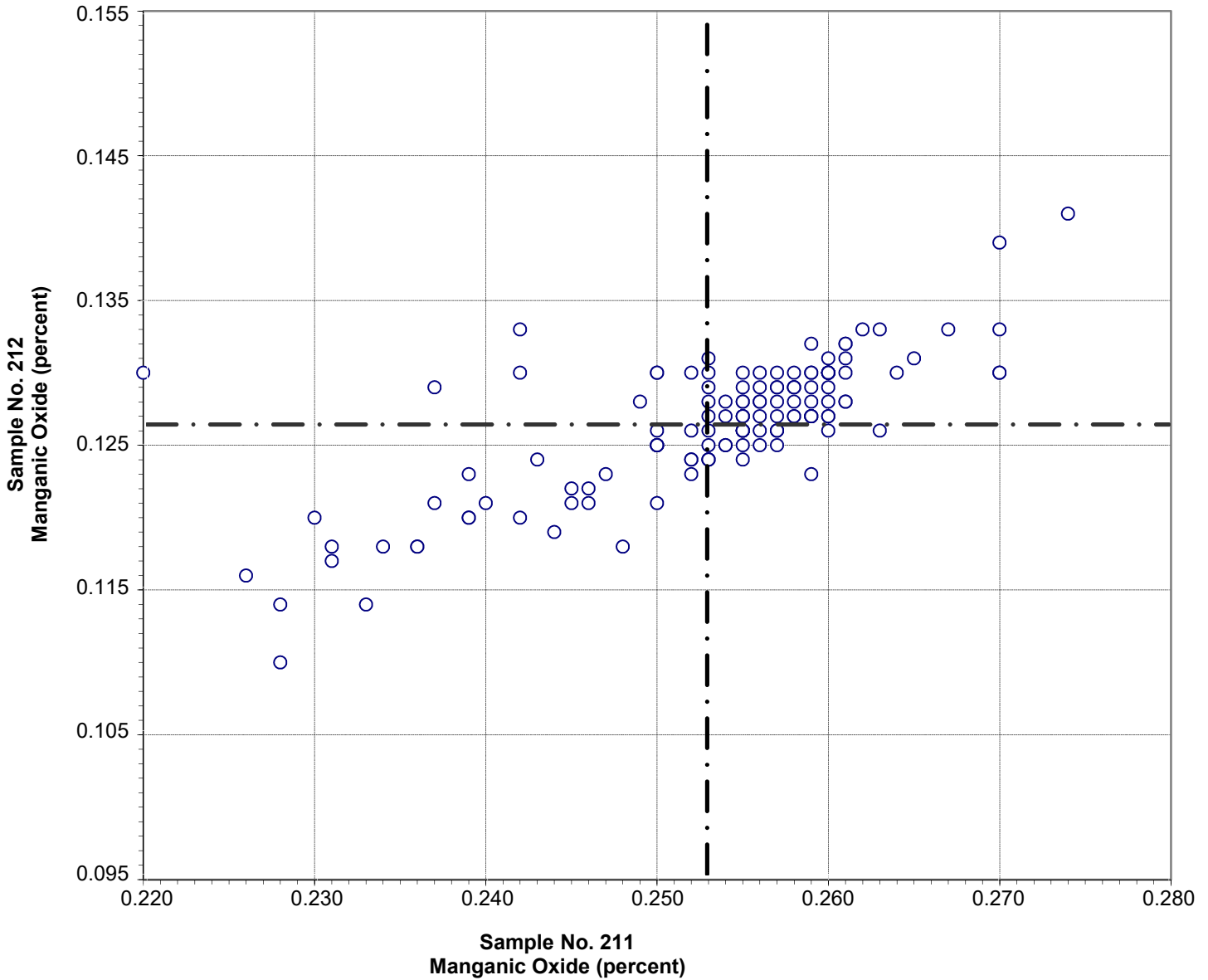


Test No. 99    Zinc Oxide    97 Points

Sample No. 211	Ave 0.106	S.D. 0.005	C.V. 5.1
Sample No. 212	Ave 0.005	S.D. 0.002	C.V. 31.0

Labs Eliminated: 94, 413, 547, 768, 1079, 1916, 2360, 2484

**CCRL Proficiency Sample Program  
Manganic Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



Test No. 101 Manganic Oxide 135 Points

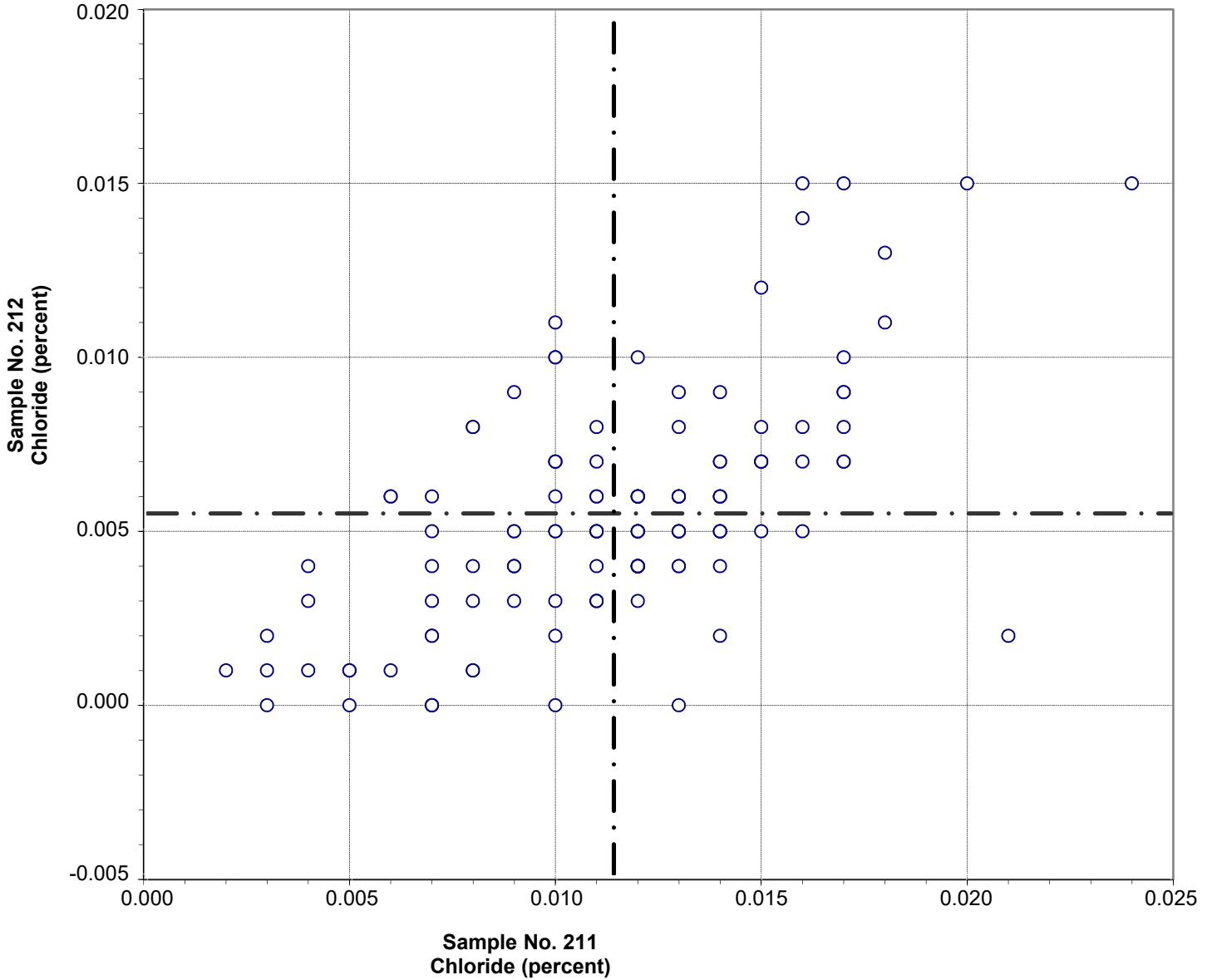
Sample No. 211 Ave 0.253 S.D. 0.010 C.V. 4.0

Sample No. 212 Ave 0.126 S.D. 0.005 C.V. 3.9

Labs Eliminated: 47, 94, 101, 354, 491, 1079, 1594, 3297, 4297, 4325

Labs off Diagram: 768

**CCRL Proficiency Sample Program  
Chloride  
PORTLAND CEMENT Samples No. 211 and No. 212**

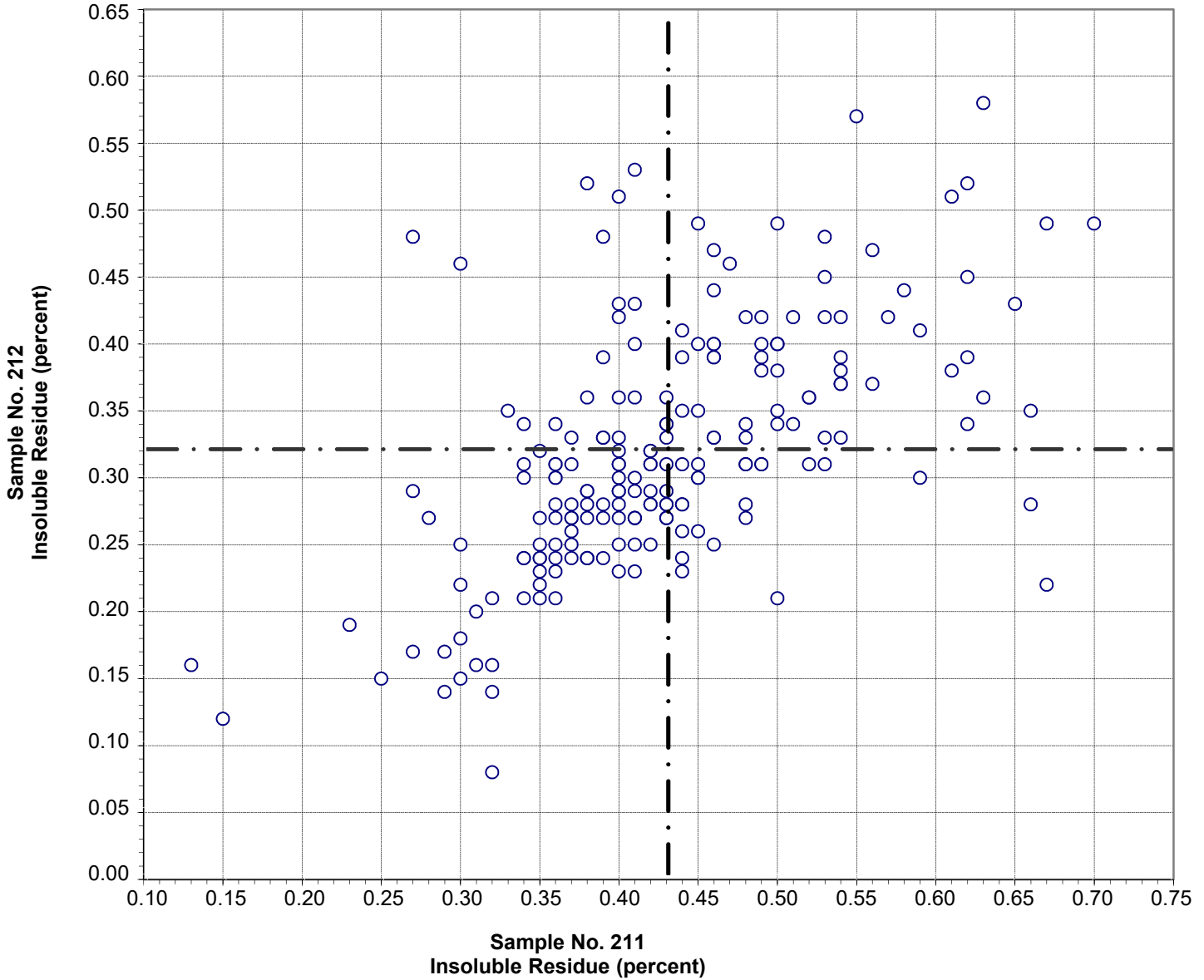


Test No. 104 Chloride 126 Points

Sample No. 211	Ave 0.011	S.D. 0.004	C.V. 34
Sample No. 212	Ave 0.005	S.D. 0.003	C.V. 60

Labs Eliminated: 90, 94, 105, 457, 491, 1644, 2293, 4325

**CCRL Proficiency Sample Program  
Insoluble Residue  
PORTLAND CEMENT Samples No. 211 and No. 212**



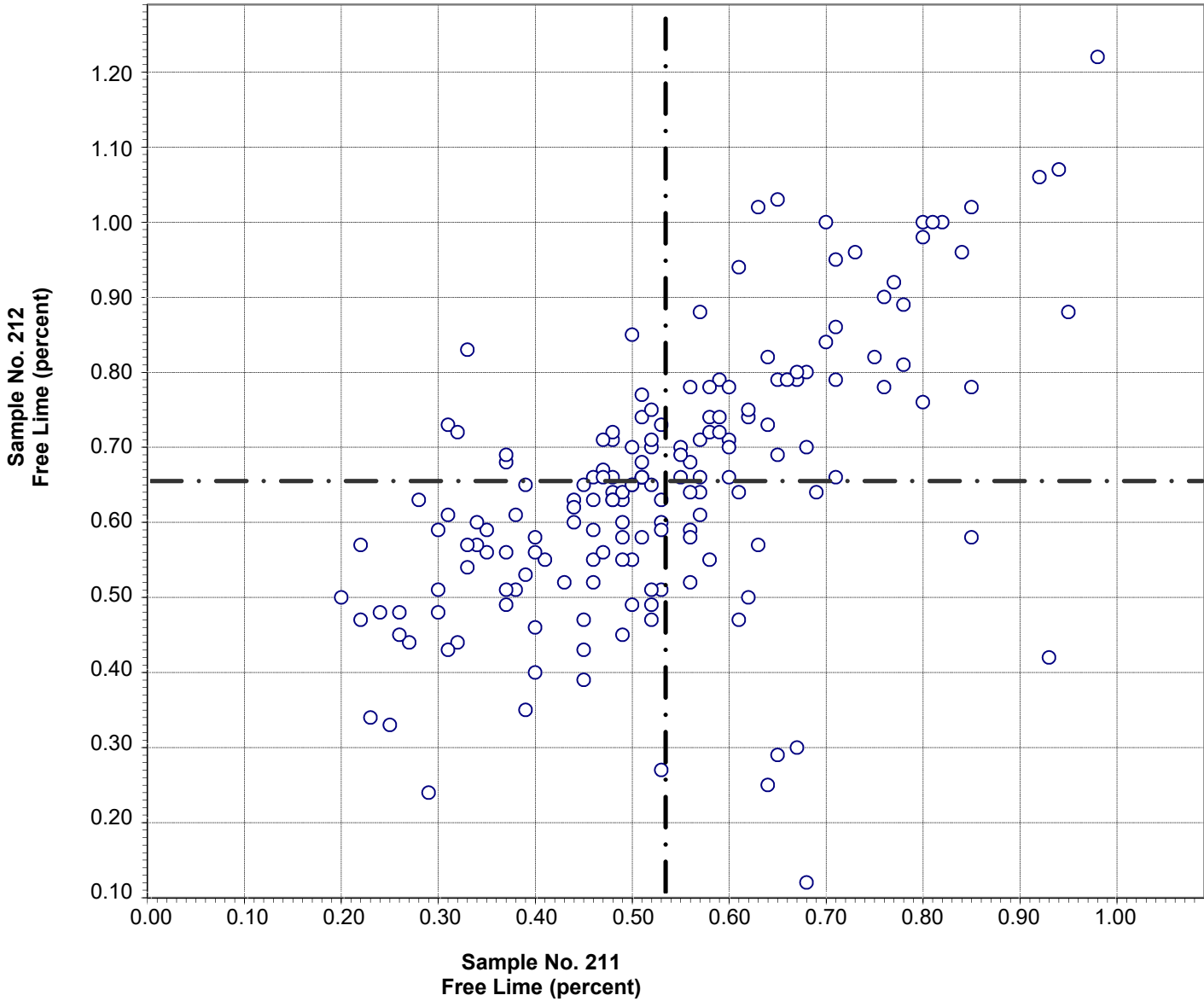
Test No. 80 Insoluble Residue 200 Points

Sample No. 211	Ave 0.43	S.D. 0.10	C.V. 22
Sample No. 212	Ave 0.32	S.D. 0.09	C.V. 28

Labs Eliminated: 17, 23, 24, 1435, 2293, 3249, 3368



**CCRL Proficiency Sample Program**  
**Free Lime**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

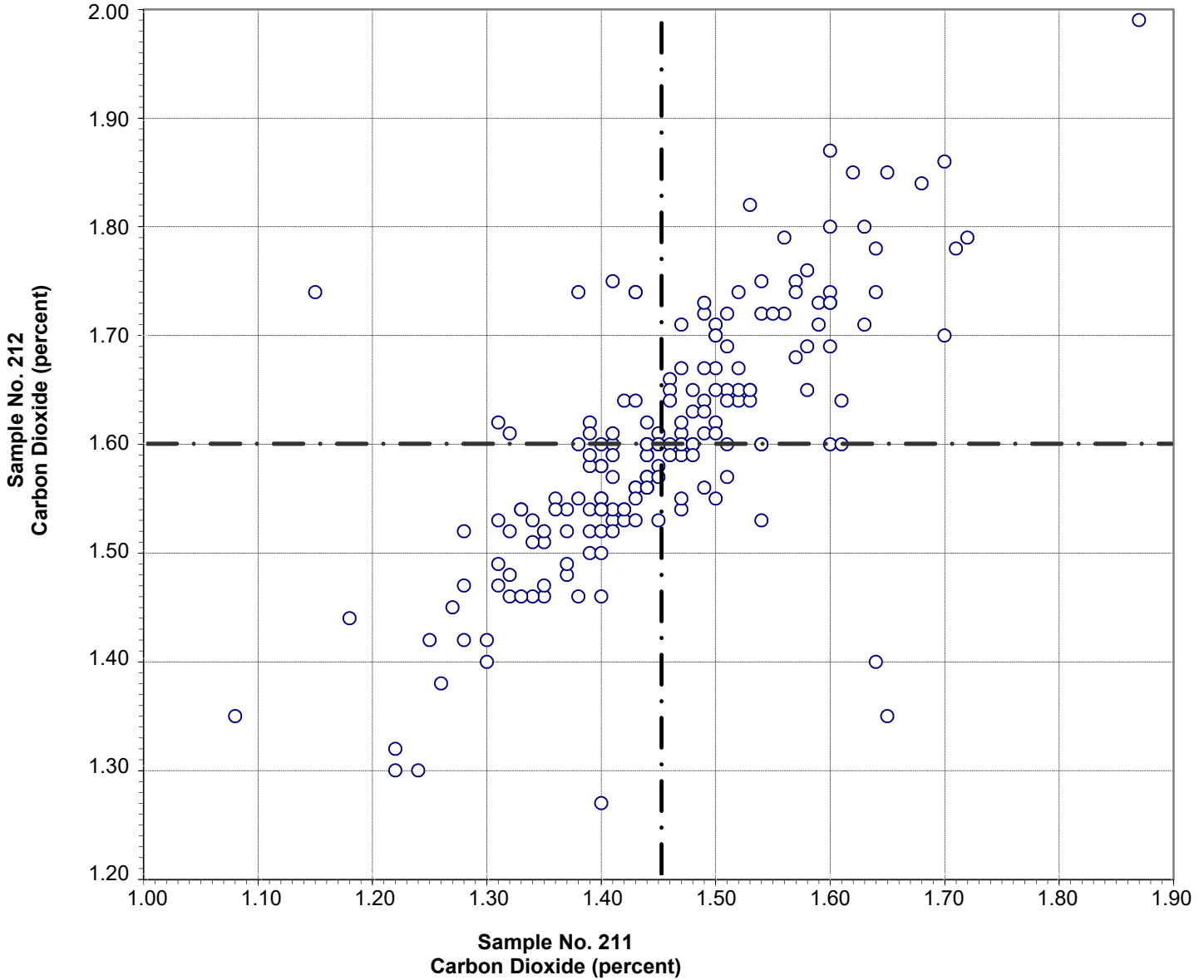


Test No. 41 Free Lime 171 Points

Sample No. 211	Ave 0.53	S.D. 0.16	C.V. 31
Sample No. 212	Ave 0.65	S.D. 0.18	C.V. 27

Labs Eliminated: 94, 3368

**CCRL Proficiency Sample Program  
Carbon Dioxide  
PORTLAND CEMENT Samples No. 211 and No. 212**



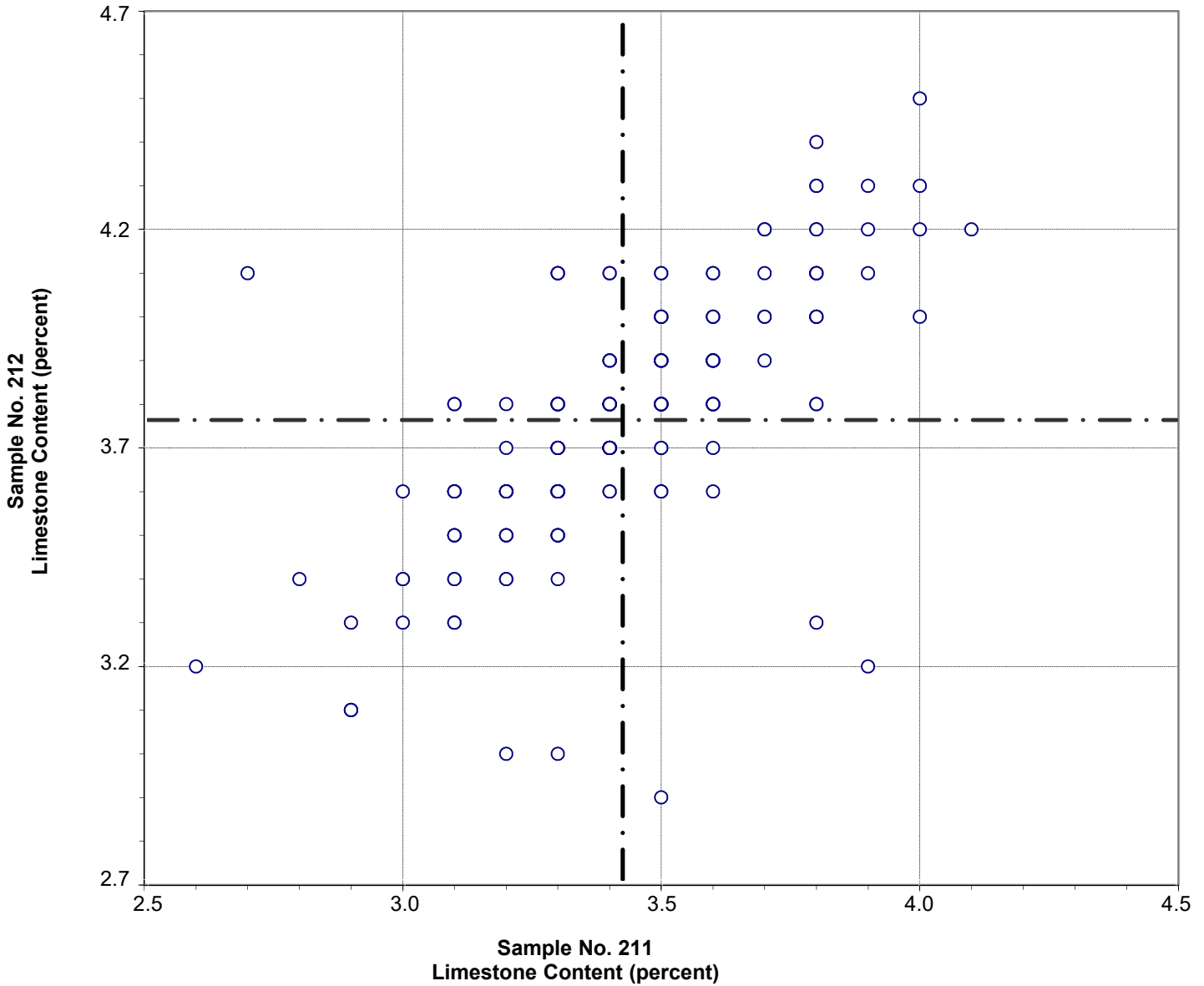
Test No. 97   Carbon Dioxide   186 Points

Sample No. 211   Ave 1.45   S.D. 0.12   C.V. 8.1  
Sample No. 212   Ave 1.60   S.D. 0.12   C.V. 7.5

Labs Eliminated: 15, 43, 74, 129, 203, 206, 440, 698, 1916, 2465, 3415, 4051, 4404

Labs off Diagram: 4150

**CCRL Proficiency Sample Program  
Limestone Content  
PORTLAND CEMENT Samples No. 211 and No. 212**

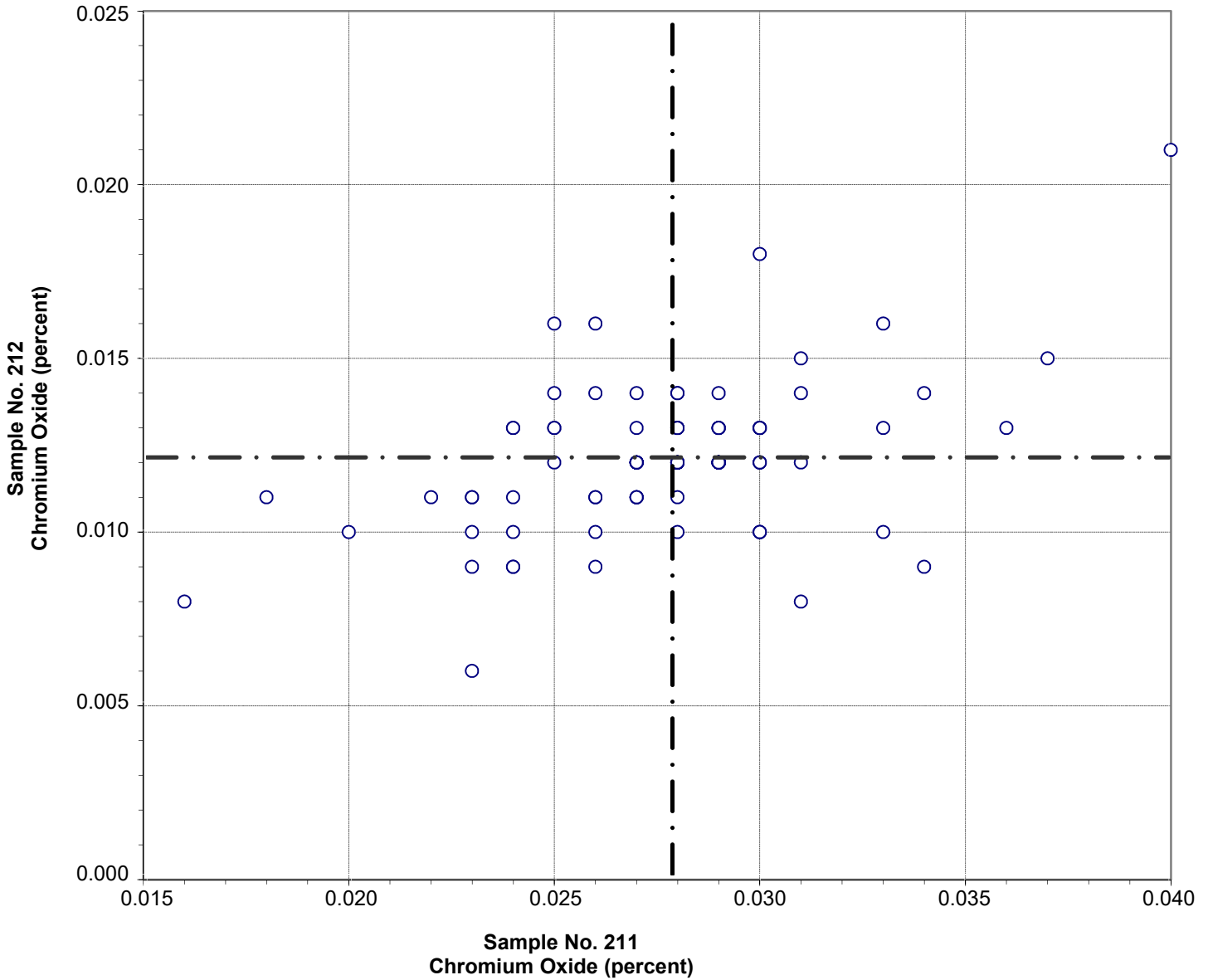


Test No. 98 Limestone Content 181 Points

Sample No. 211 Ave 3.4 S.D. 0.3 C.V. 7.6  
 Sample No. 212 Ave 3.8 S.D. 0.3 C.V. 7.4

Labs Eliminated: 5, 15, 43, 74, 129, 203, 206, 440, 768, 1916, 2465, 4051, 4150, 4404

**CCRL Proficiency Sample Program  
Chromium Oxide  
PORTLAND CEMENT Samples No. 211 and No. 212**

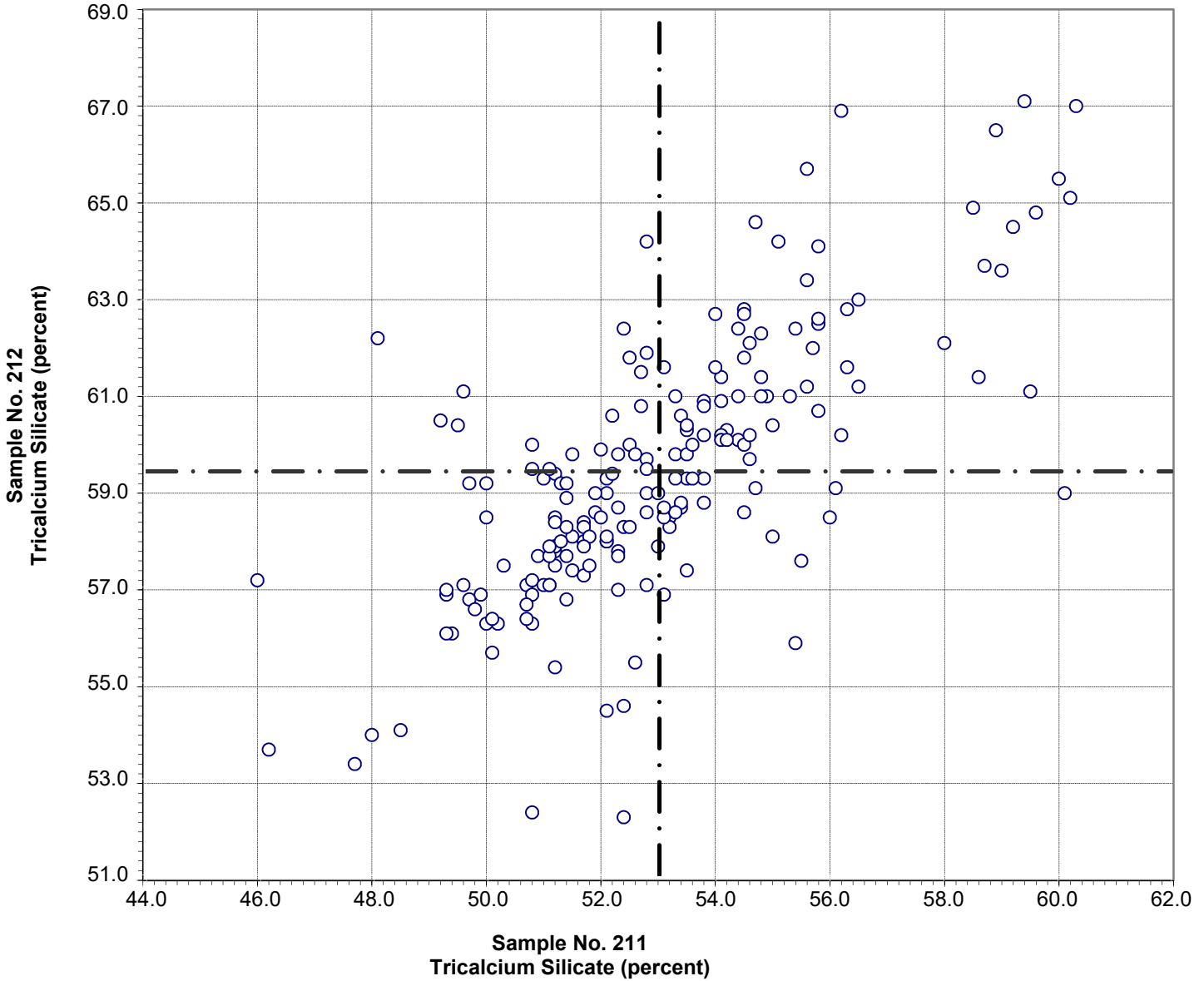


Test No. 105 Chromium Oxide 96 Points

Sample No. 211	Ave 0.028	S.D. 0.004	C.V. 13
Sample No. 212	Ave 0.012	S.D. 0.002	C.V. 17

Labs Eliminated: 94, 116, 415, 438, 886, 1079, 3238, 4099

**CCRL Proficiency Sample Program  
Tricalcium Silicate  
PORTLAND CEMENT Samples No. 211 and No. 212**



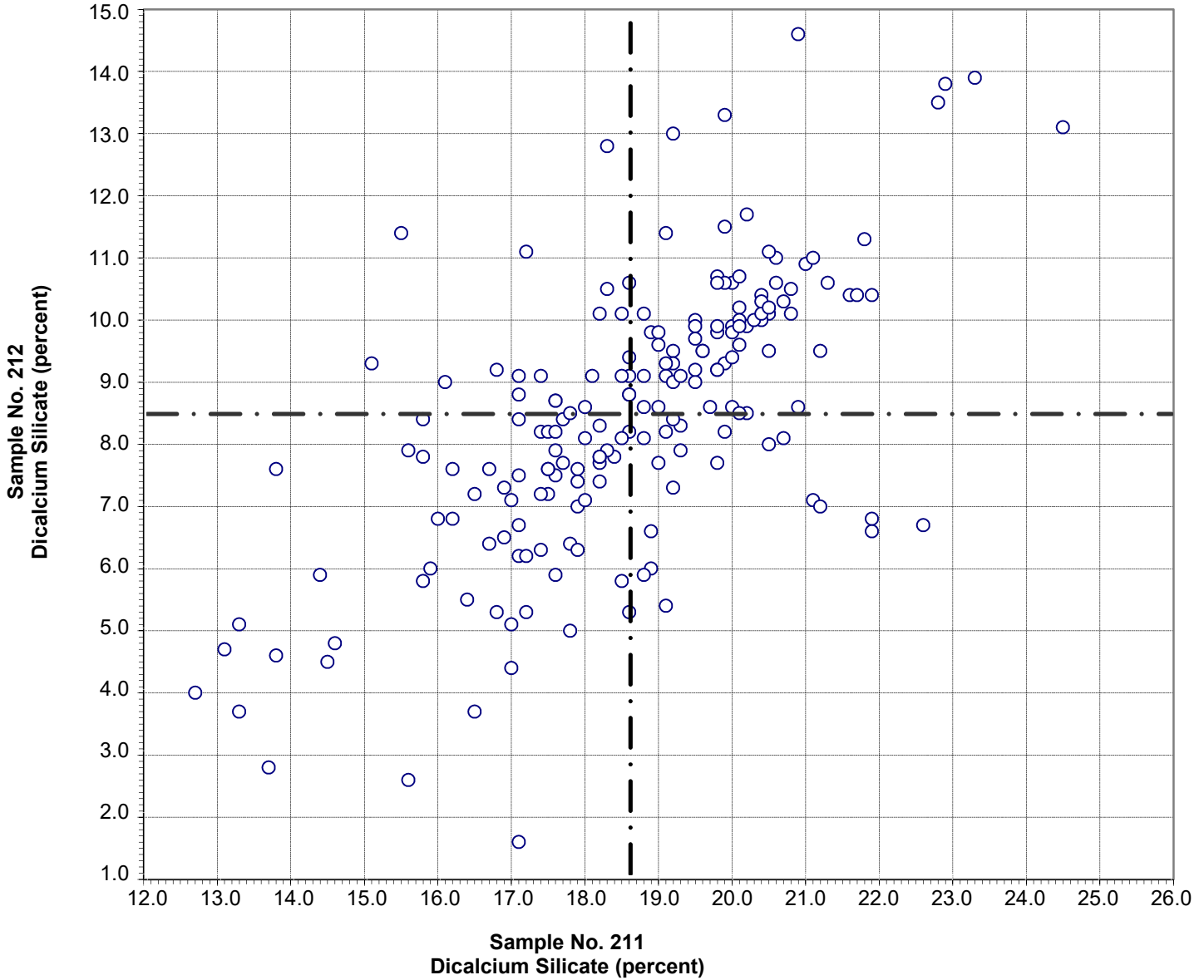
Test No. 106 Tricalcium Silicate 191 Points

Sample No. 211	Ave 53.0	S.D. 2.7	C.V. 5.1
Sample No. 212	Ave 59.4	S.D. 2.8	C.V. 4.7

Labs Eliminated: 206, 1079, 2477

Labs off Diagram: 15

**CCRL Proficiency Sample Program  
Dicalcium Silicate  
PORTLAND CEMENT Samples No. 211 and No. 212**



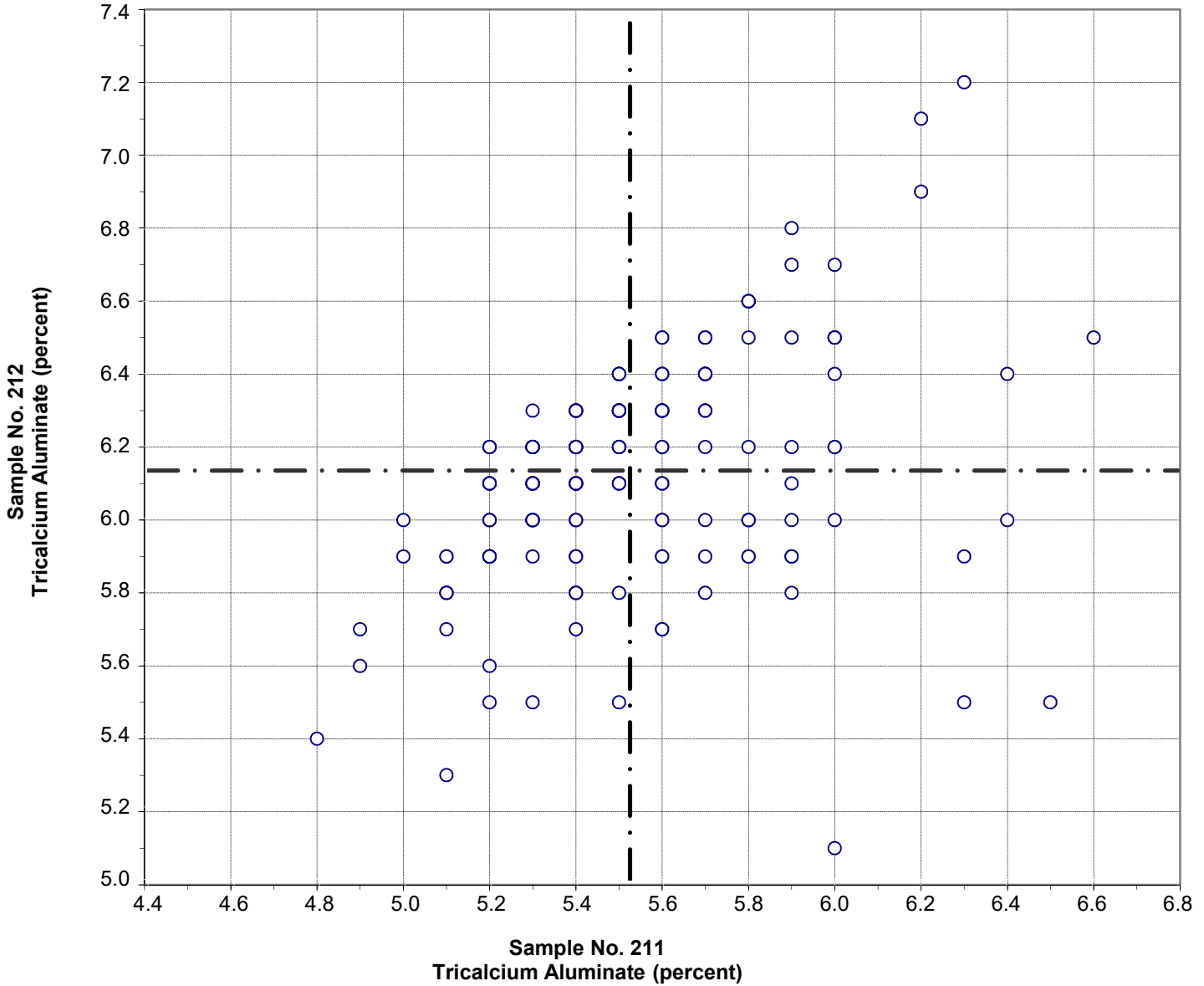
Test No. 107 Dicalcium Silicate 187 Points

Sample No. 211 Ave 18.6 S.D. 2.0 C.V. 10.9

Sample No. 212 Ave 8.5 S.D. 2.2 C.V. 25.8

Labs Eliminated: 15, 18, 126, 206, 1079, 1644, 2477, 4138

**CCRL Proficiency Sample Program  
Tricalcium Aluminate  
PORTLAND CEMENT Samples No. 211 and No. 212**

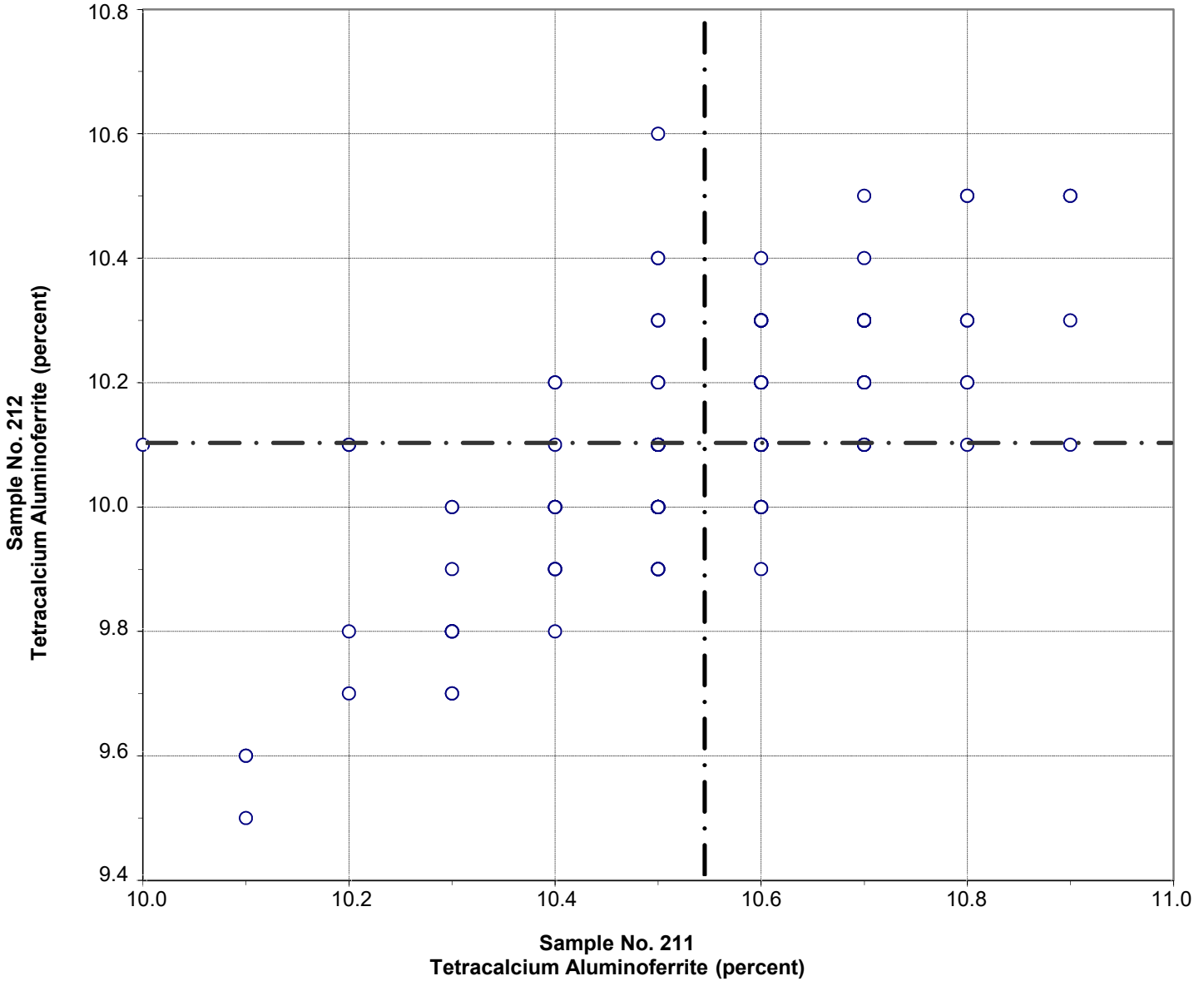


Test No. 108 Tricalcium Aluminate 191 Points

Sample No. 211	Ave 5.5	S.D. 0.3	C.V. 5.6
Sample No. 212	Ave 6.1	S.D. 0.3	C.V. 4.8

Labs Eliminated: 547, 1435, 3238, 4316

**CCRL Proficiency Sample Program  
Tetracalcium Aluminoferrite  
PORTLAND CEMENT Samples No. 211 and No. 212**



Test No. 109 Tetracalcium Aluminoferrite 187 Points

Sample No. 211 Ave 10.5 S.D. 0.1 C.V. 1.4  
 Sample No. 212 Ave 10.1 S.D. 0.2 C.V. 1.8

Labs Eliminated: 95, 206, 547, 694, 1435, 2477, 3238, 4316



**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

Sample No. 211

Sample No. 212

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Normal Consistency - % Water (percent)</b>							
	244	25.0	1.75	7.00	26.1	1.71	6.60
	*242	24.9	0.40	1.60	26.1	0.45	1.70
* Labs Eliminated - 1079, 1435							
<b>Vicat Time of Set - Initial (minutes)</b>							
	241	153	14	9	129	16	12
	*235	153	13	8	128	13	10
* Labs Eliminated - 41, 46, 116, 515, 823, 2477							
<b>Vicat Time of Set - Final (minutes)</b>							
	230	260	29	11	241	32	13
	*225	259	26	10	239	27	11
* Labs Eliminated - 14, 75, 116, 169, 309							
<b>Gillmore Time of Set - Initial (minutes)</b>							
	127	185	22	12	169	25	15
	*125	184	20	11	168	24	14
* Labs Eliminated - 515, 4351							
<b>Gillmore Time of Set - Final (minutes)</b>							
	127	293	39	13	278	41	15
	*125	291	35	12	276	37	13
* Labs Eliminated - 515, 4351							
<b>False Set - Paste Method (percent)</b>							
	186	75	9.1	12.0	72	8.3	11.6
	*183	76	8.7	11.6	72	7.8	10.9
* Labs Eliminated - 116, 143, 493							
<b>Autoclave Expansion (percent)</b>							
	230	0.03	0.022	79	0.11	0.051	48
	*217	0.03	0.015	53	0.11	0.044	40
* Labs Eliminated - 4, 95, 134, 169, 450, 1466, 2360, 2465, 2466, 2522, 3605, 4297, 4404							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

Test (unit)	Sample No. 211				Sample No. 212		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Air Content % (percent)</b>							
	231	9.0	1.3	14	7.8	1.2	15
	*229	9.1	1.2	13	7.8	1.1	14
* Labs Eliminated - 1644, 2490							
<b>Air Content - % Water (percent)</b>							
	223	68.9	2.5	3.7	69.3	2.5	3.6
	*220	68.8	2.2	3.2	69.2	2.2	3.2
* Labs Eliminated - 565, 1644, 3662							
<b>Air Content - Flow (percent)</b>							
	223	87	3.4	3.9	88	3.5	4.0
	*222	87	3.4	3.9	88	3.4	3.9
* Labs Eliminated - 203							
<b>Compressive Strength - 3 day (psi)</b>							
	250	3162	245	7.8	4176	295	7.1
	*245	3159	220	7.0	4190	272	6.5
* Labs Eliminated - 32, 46, 3834, 4080, 4216							
<b>Compressive Strength - 7 day (psi)</b>							
	252	4231	290	6.8	4977	322	6.5
	*251	4232	290	6.8	4982	315	6.3
* Labs Eliminated - 30							
<b>Compressive Strength - 28 day (psi)</b>							
	237	6358	439	6.9	6022	378	6.3
	*234	6369	428	6.7	6038	350	5.8
* Labs Eliminated - 15, 33, 203							
<b>Compressive Strength - Flow (percent)</b>							
	237	114	10	8.8	117	10	8.6
	*232	115	9	7.9	117	9	7.8
* Labs Eliminated - 47, 98, 1019, 1644, 2481							

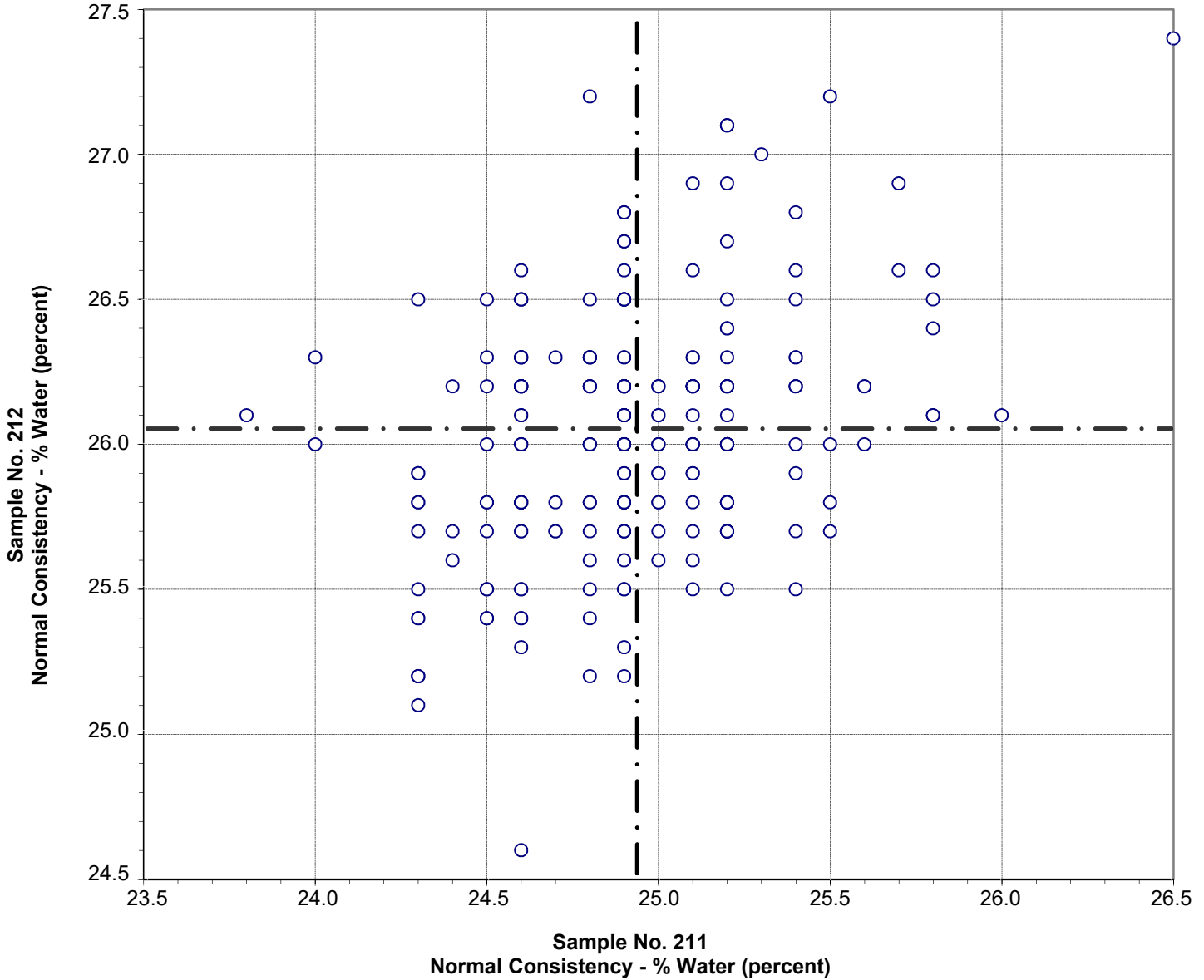
**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

Final Report – March 27, 2019

SUMMARY OF RESULTS

Test (unit)	Sample No. 211				Sample No. 212		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Fineness - Air Permeability (m<sup>2</sup>/kg)</b>							
	242	368	16	4.4	393	15	3.9
	*235	367	11	3.0	392	12	3.1
* Labs Eliminated - 4, 44, 474, 515, 823, 3834, 4097							
<b>Fineness - 45µm Sieve (percent)</b>							
	227	95.24	0.99	1.04	96.56	0.75	0.77
	*222	95.31	0.80	0.83	96.63	0.58	0.60
* Labs Eliminated - 26, 98, 116, 416, 3834							
<b>C1038 Mortar Bar Expansion (percent)</b>							
	162	0.006	0.006	102	0.007	0.011	154
	*150	0.005	0.003	52	0.006	0.003	50
* Labs Eliminated - 64, 132, 146, 205, 413, 457, 491, 886, 1054, 2352, 3607, 4351							

**CCRL Proficiency Sample Program**  
**Normal Consistency - % Water**  
**PORTLAND CEMENT Samples No. 211 and No. 212**



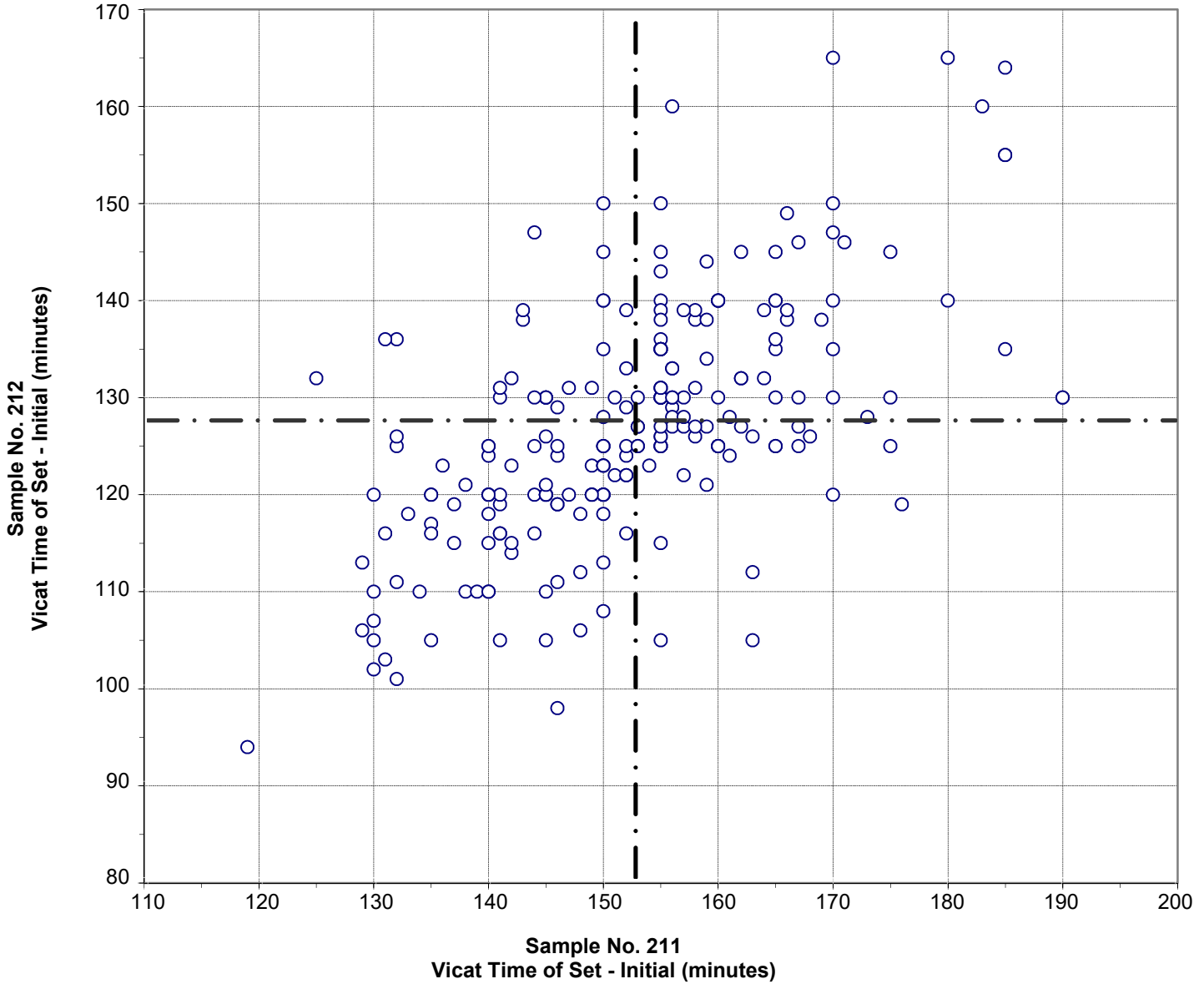
Test No. 110    Normal Consistency - % Water    239 Points

Sample No. 211	Ave 24.9	S.D. 0.40	C.V. 1.60
Sample No. 212	Ave 26.1	S.D. 0.45	C.V. 1.70

Labs Eliminated: 1079, 1435

Labs off Diagram: 41, 162, 2477

**CCRL Proficiency Sample Program**  
**Vicat Time of Set - Initial**  
**PORTLAND CEMENT Samples No. 211 and No. 212**



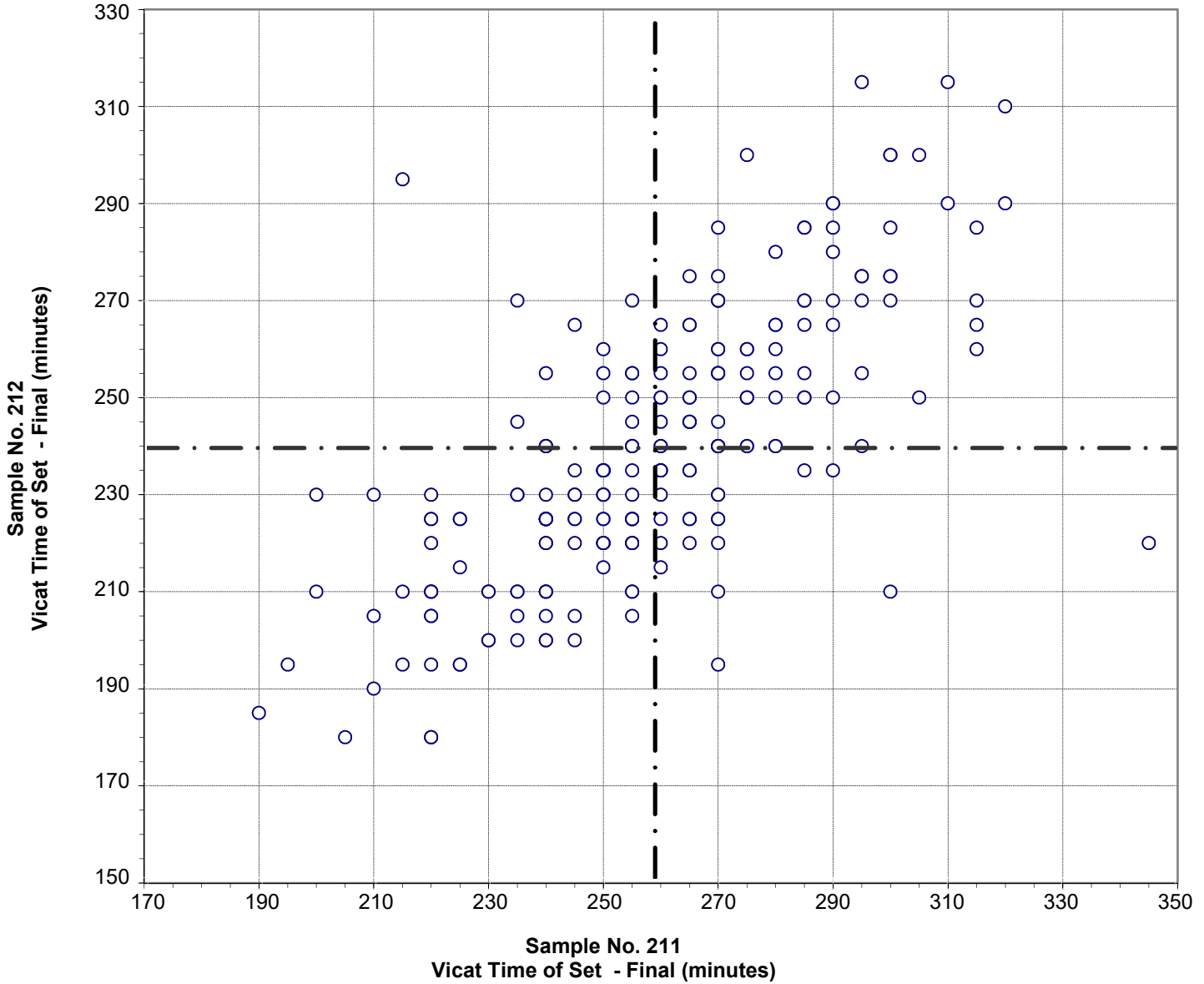
Test No. 120 Vicat Time of Set - Initial 233 Points

Sample No. 211 Ave 153 S.D. 13 C.V. 8  
 Sample No. 212 Ave 128 S.D. 13 C.V. 10

Labs Eliminated: 41, 46, 116, 515, 823, 2477

Labs off Diagram: 203, 1644

**CCRL Proficiency Sample Program**  
**Vicat Time of Set - Final**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

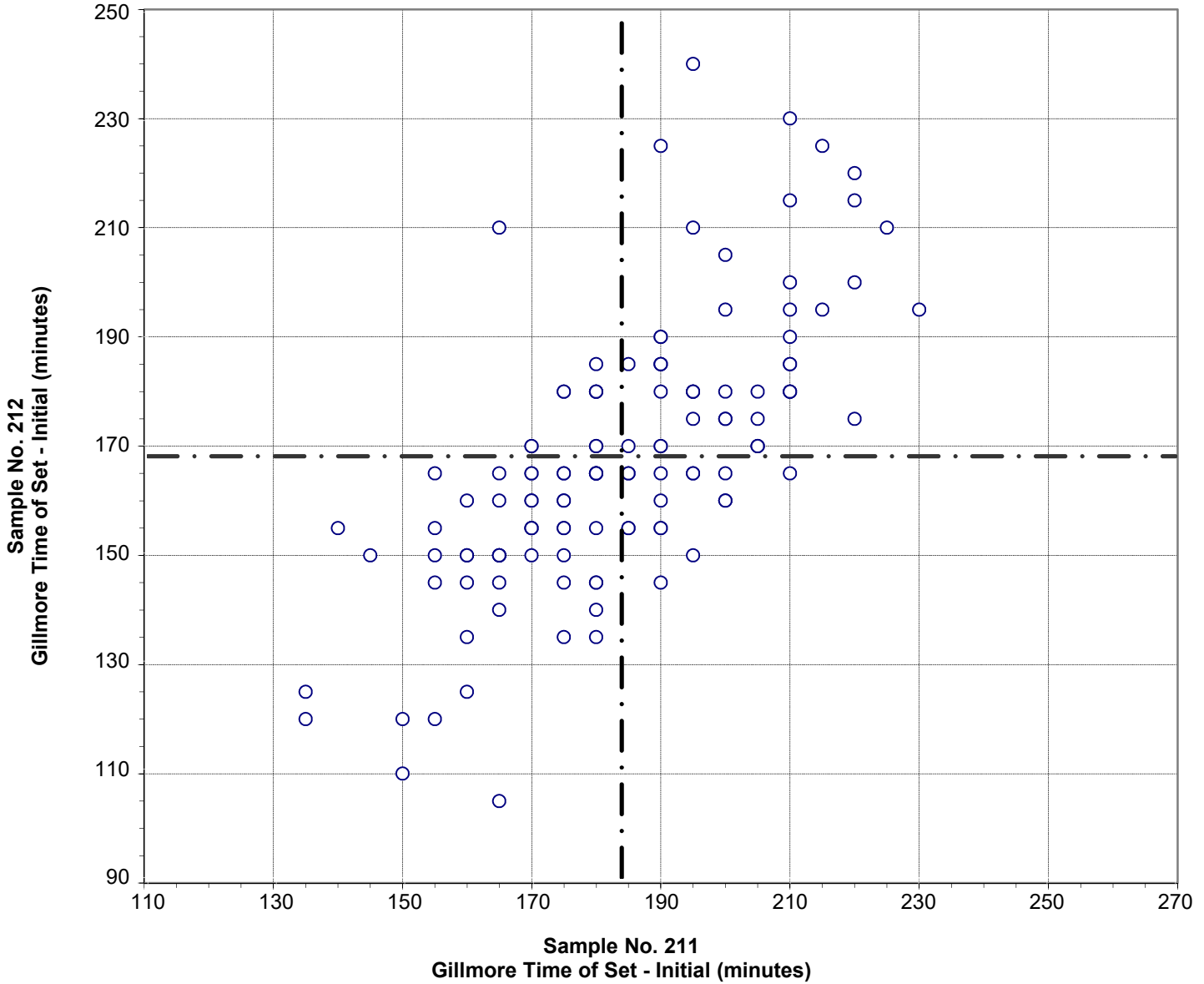


Test No. 121 Vicat Time of Set - Final 225 Points

Sample No. 211	Ave 259	S.D. 26	C.V. 10
Sample No. 212	Ave 239	S.D. 27	C.V. 11

Labs Eliminated: 14, 75, 116, 169, 309

**CCRL Proficiency Sample Program  
Gillmore Time of Set - Initial  
PORTLAND CEMENT Samples No. 211 and No. 212**

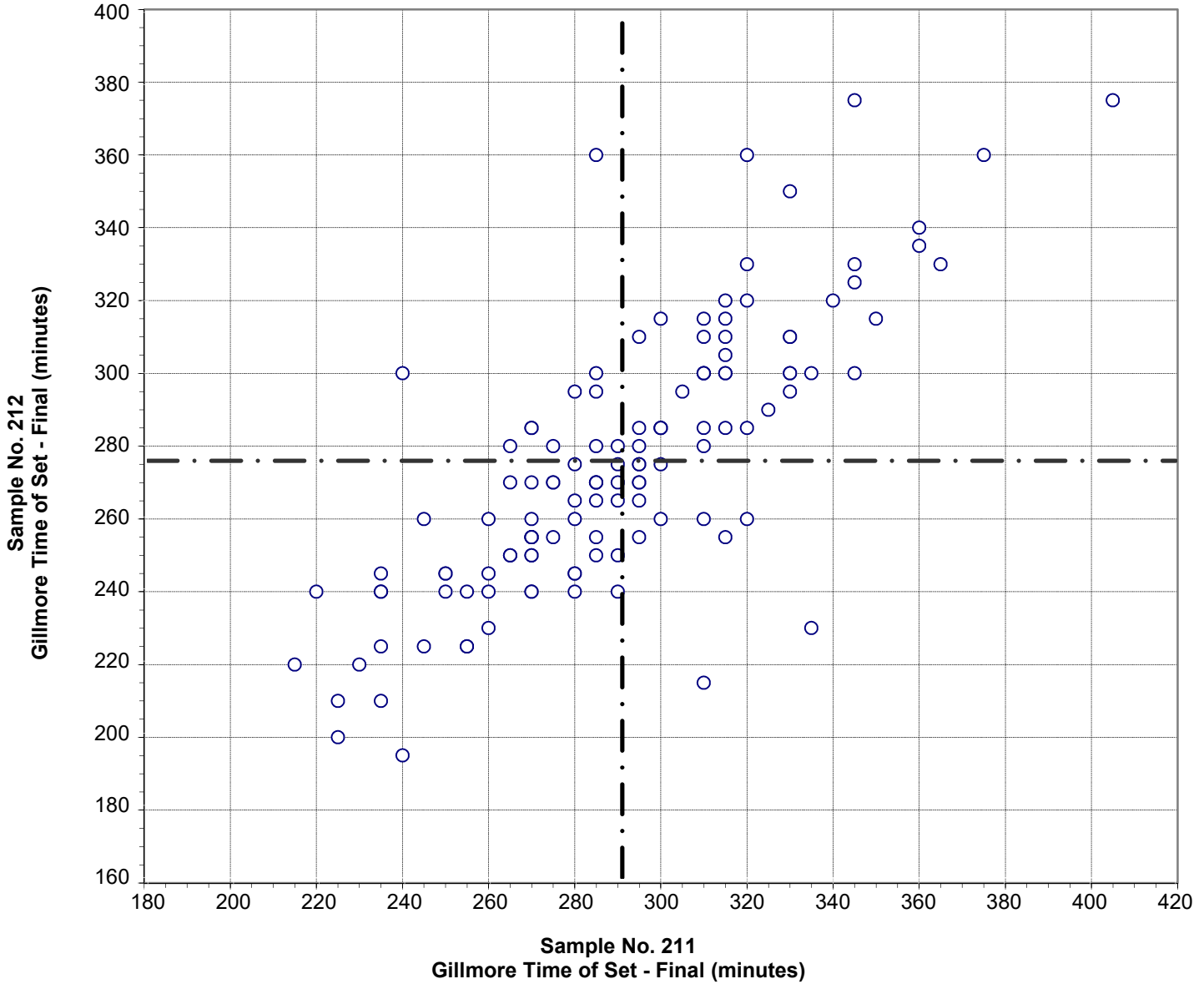


**Test No. 130 Gillmore Time of Set - Initial 125 Points**

Sample No. 211	Ave 184	S.D. 20	C.V. 11
Sample No. 212	Ave 168	S.D. 24	C.V. 14

Labs Eliminated: 515, 4351

**CCRL Proficiency Sample Program  
Gillmore Time of Set - Final  
PORTLAND CEMENT Samples No. 211 and No. 212**



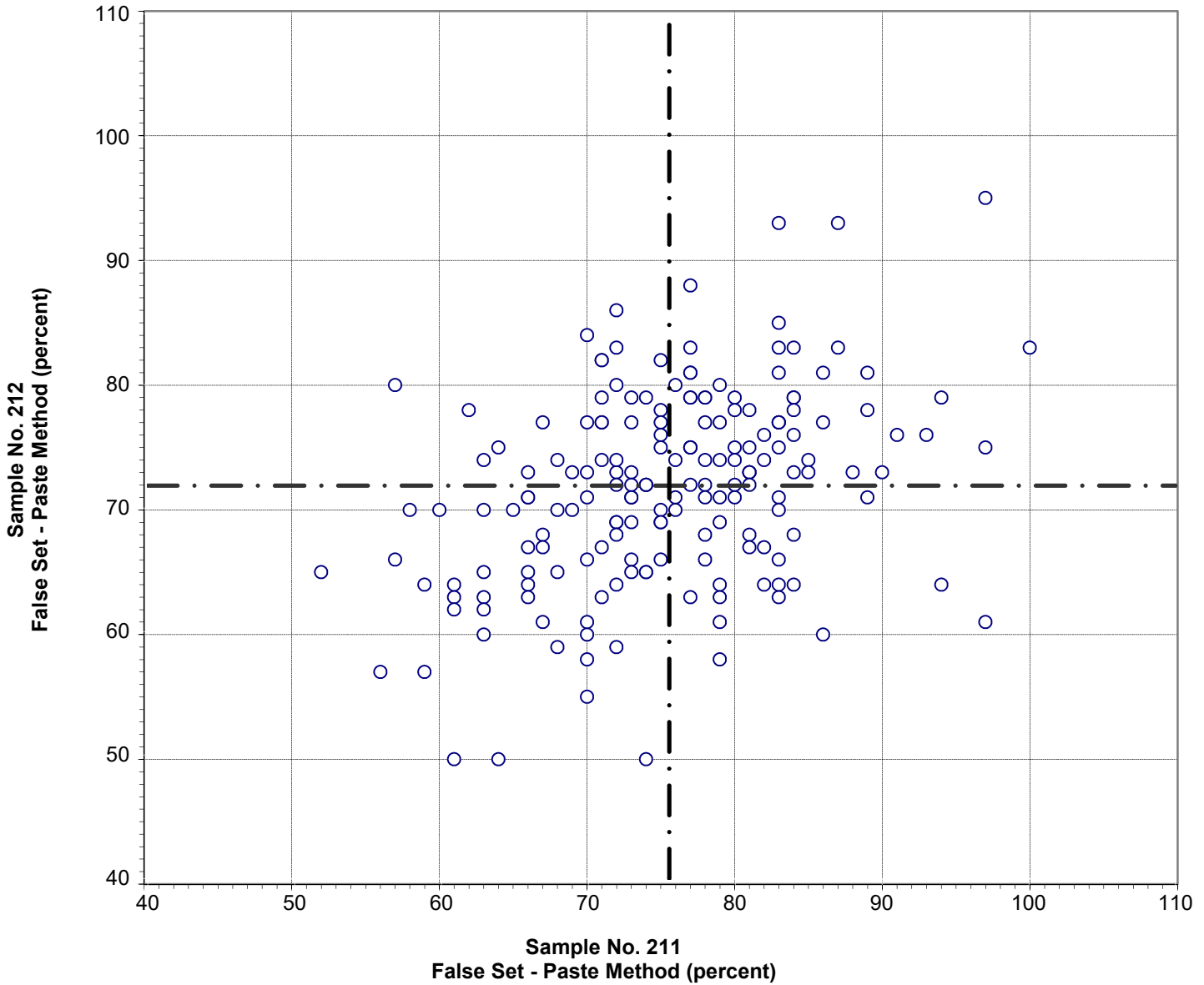
Test No. 140 Gillmore Time of Set - Final 125 Points

Sample No. 211	Ave 291	S.D. 35	C.V. 12
Sample No. 212	Ave 276	S.D. 37	C.V. 13

Labs Eliminated: 515, 4351



**CCRL Proficiency Sample Program  
False Set - Paste Method  
PORTLAND CEMENT Samples No. 211 and No. 212**

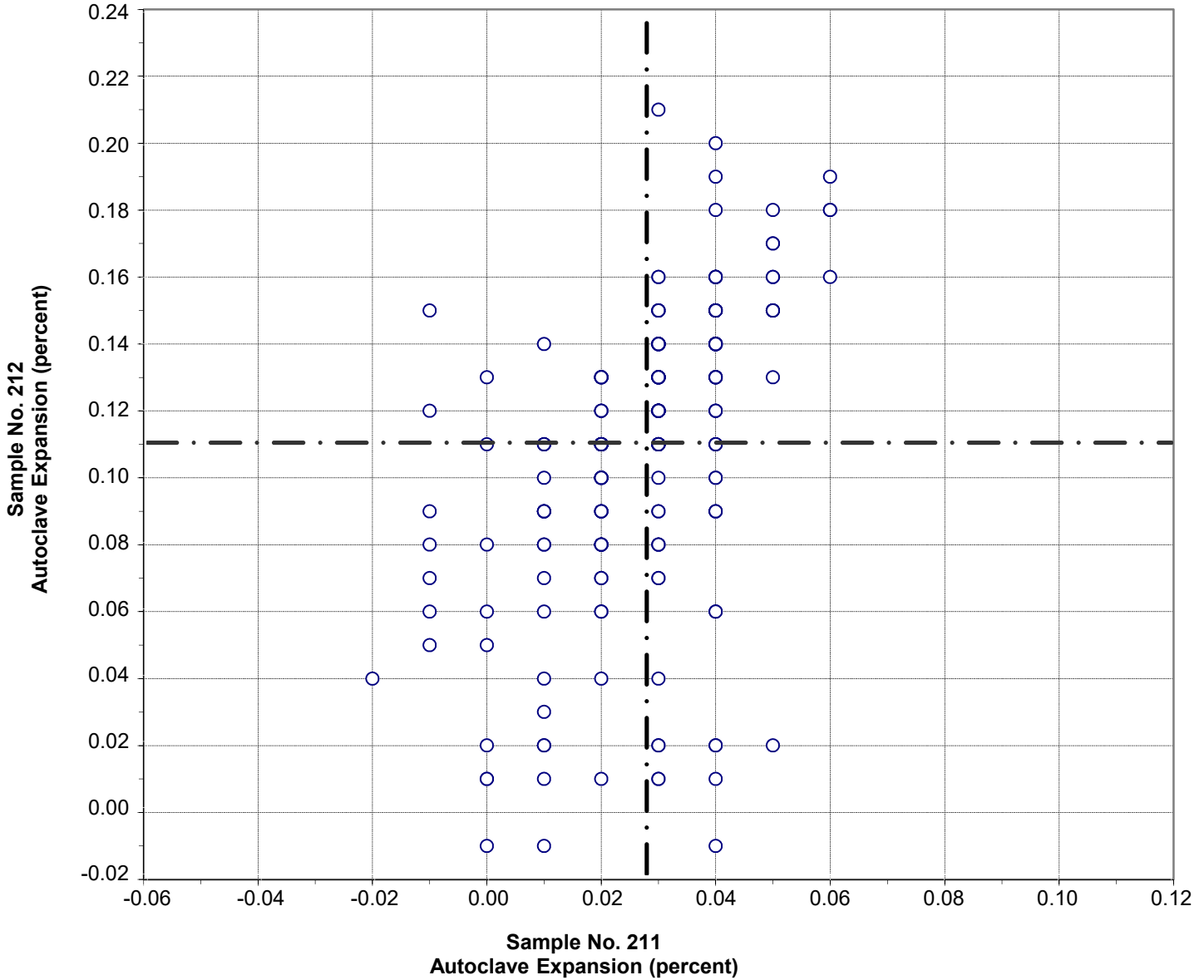


Test No. 150    False Set - Paste Method    183 Points

Sample No. 211	Ave 76	S.D. 8.7	C.V. 11.6
Sample No. 212	Ave 72	S.D. 7.8	C.V. 10.9

Labs Eliminated: 116, 143, 493

**CCRL Proficiency Sample Program  
Autoclave Expansion  
PORTLAND CEMENT Samples No. 211 and No. 212**

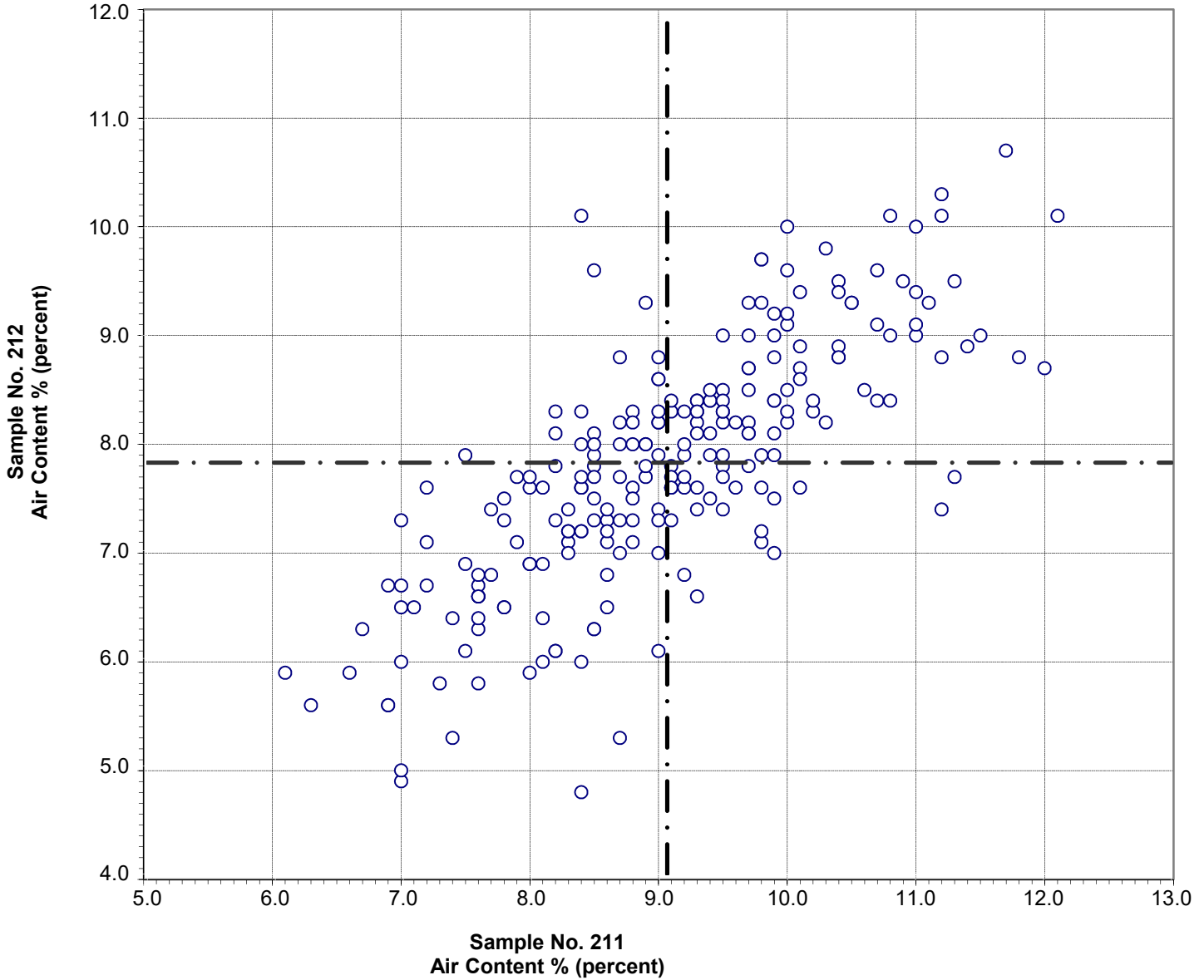


Test No. 160 Autoclave Expansion 217 Points

Sample No. 211	Ave 0.03	S.D. 0.015	C.V. 53
Sample No. 212	Ave 0.11	S.D. 0.044	C.V. 40

Labs Eliminated: 4, 95, 134, 169, 450, 1466, 2360, 2465, 2466, 2522, 3605, 4297, 4404

**CCRL Proficiency Sample Program**  
**Air Content %**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

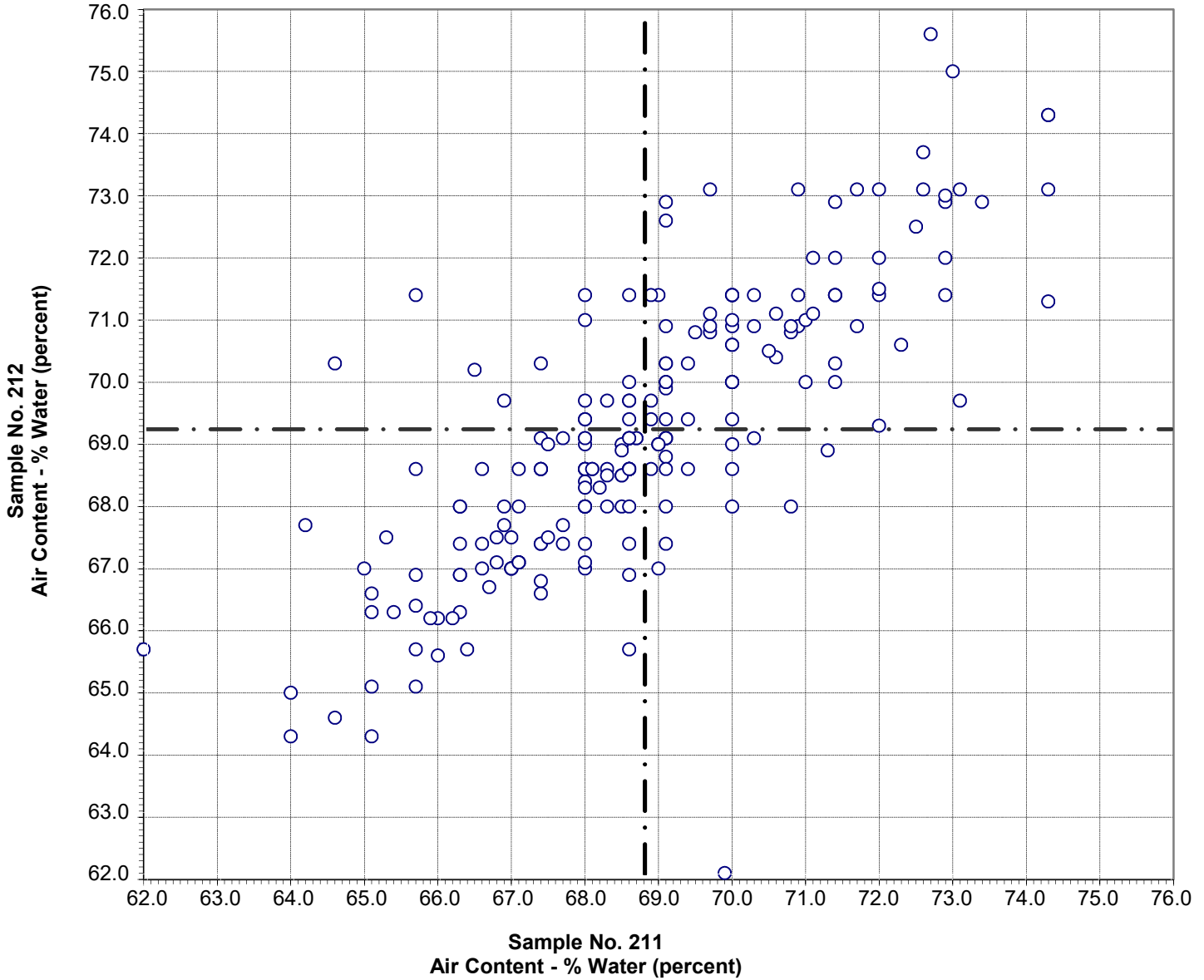


Test No. 170   Air Content %   229 Points

Sample No. 211	Ave 9.1	S.D. 1.2	C.V. 13
Sample No. 212	Ave 7.8	S.D. 1.1	C.V. 14

Labs Eliminated: 1644, 2490

**CCRL Proficiency Sample Program**  
**Air Content - % Water**  
**PORTLAND CEMENT Samples No. 211 and No. 212**



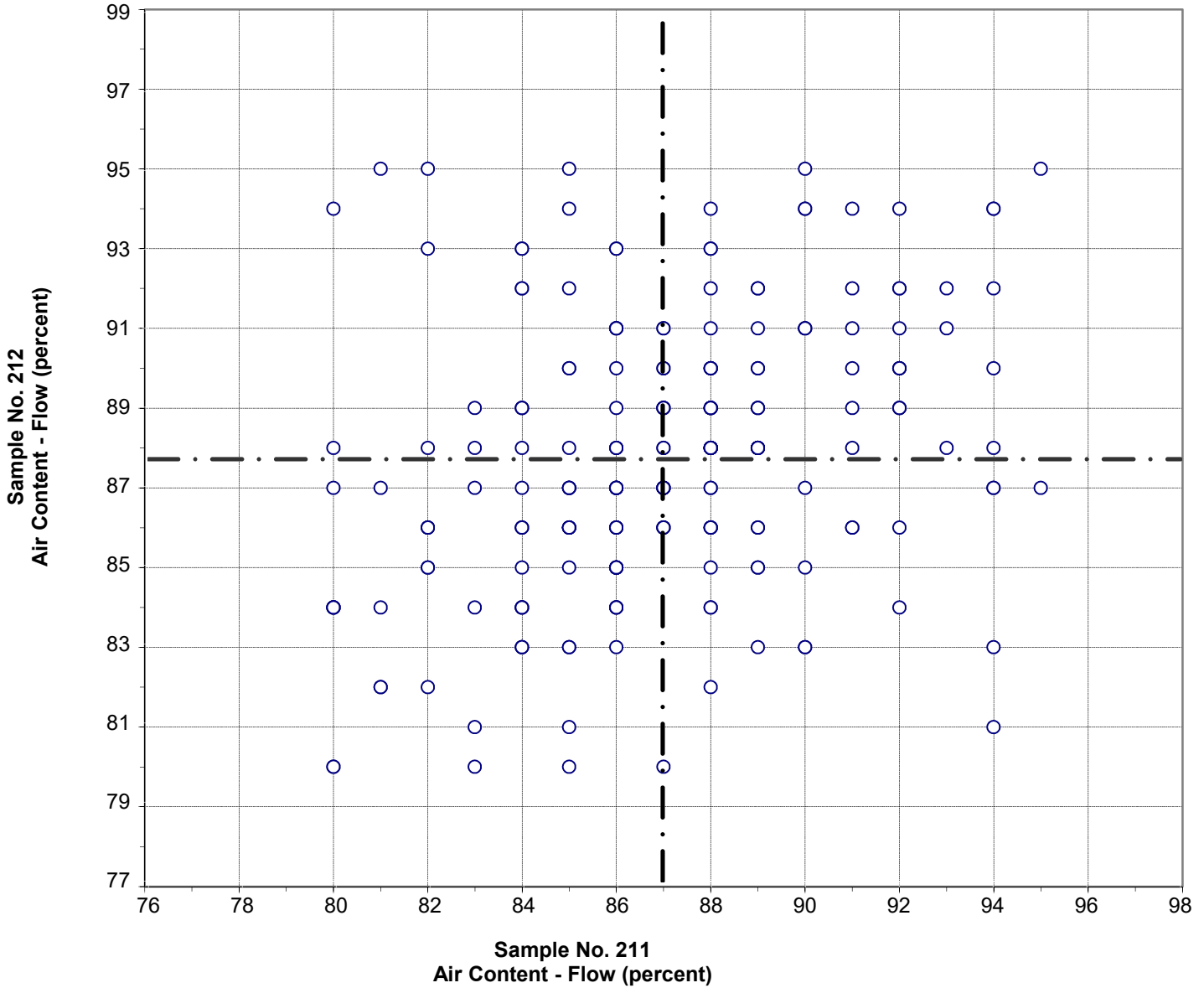
Test No. 180    Air Content - % Water    219 Points

Sample No. 211	Ave 68.8	S.D. 2.2	C.V. 3.2
Sample No. 212	Ave 69.2	S.D. 2.2	C.V. 3.2

Labs Eliminated: 565, 1644, 3662

Labs off Diagram: 4097

**CCRL Proficiency Sample Program**  
**Air Content - Flow**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

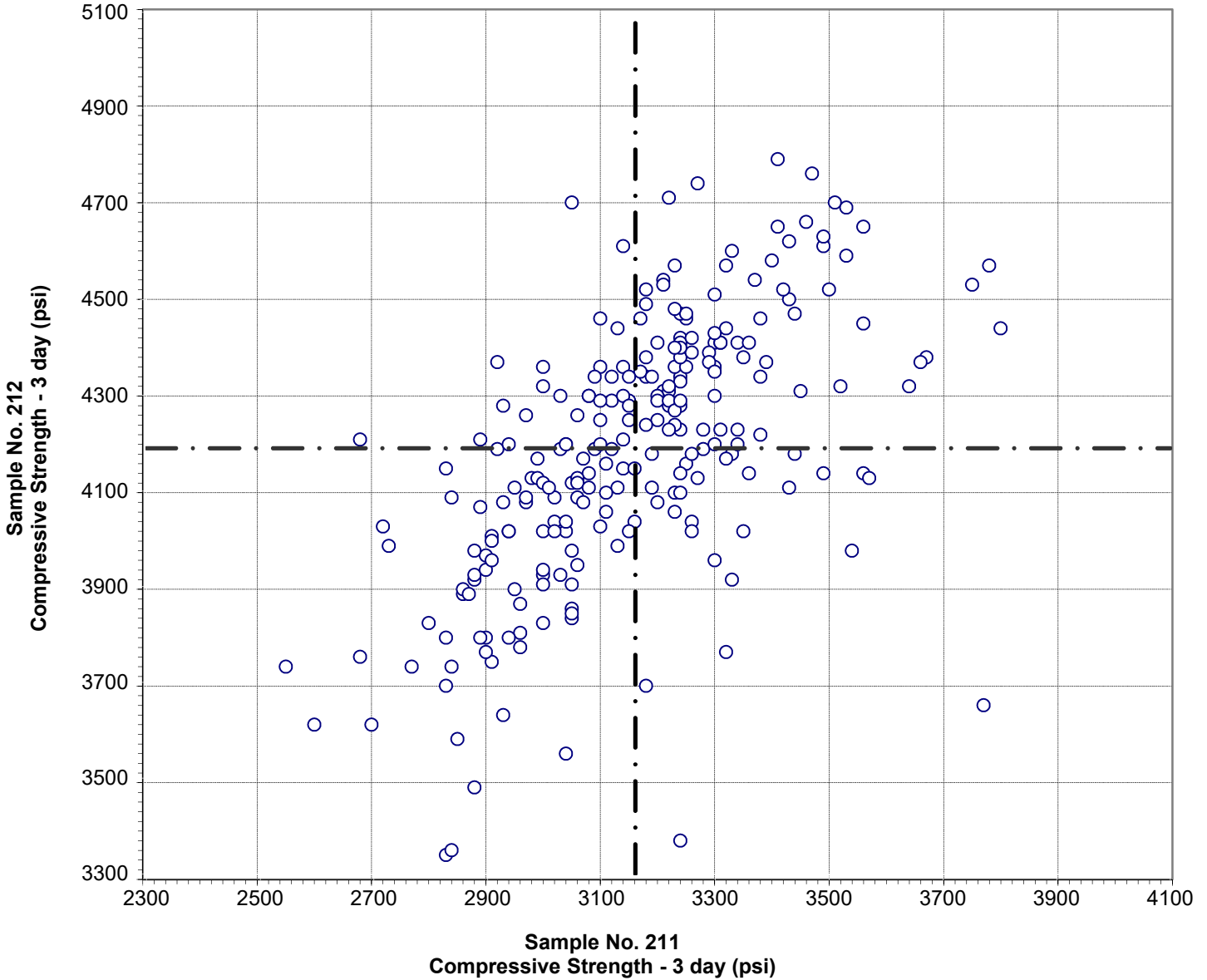


Test No. 190    Air Content - Flow    222 Points

Sample No. 211	Ave 87	S.D. 3.4	C.V. 3.9
Sample No. 212	Ave 88	S.D. 3.4	C.V. 3.9

Labs Eliminated: 203

**CCRL Proficiency Sample Program  
Compressive Strength - 3 day  
PORTLAND CEMENT Samples No. 211 and No. 212**

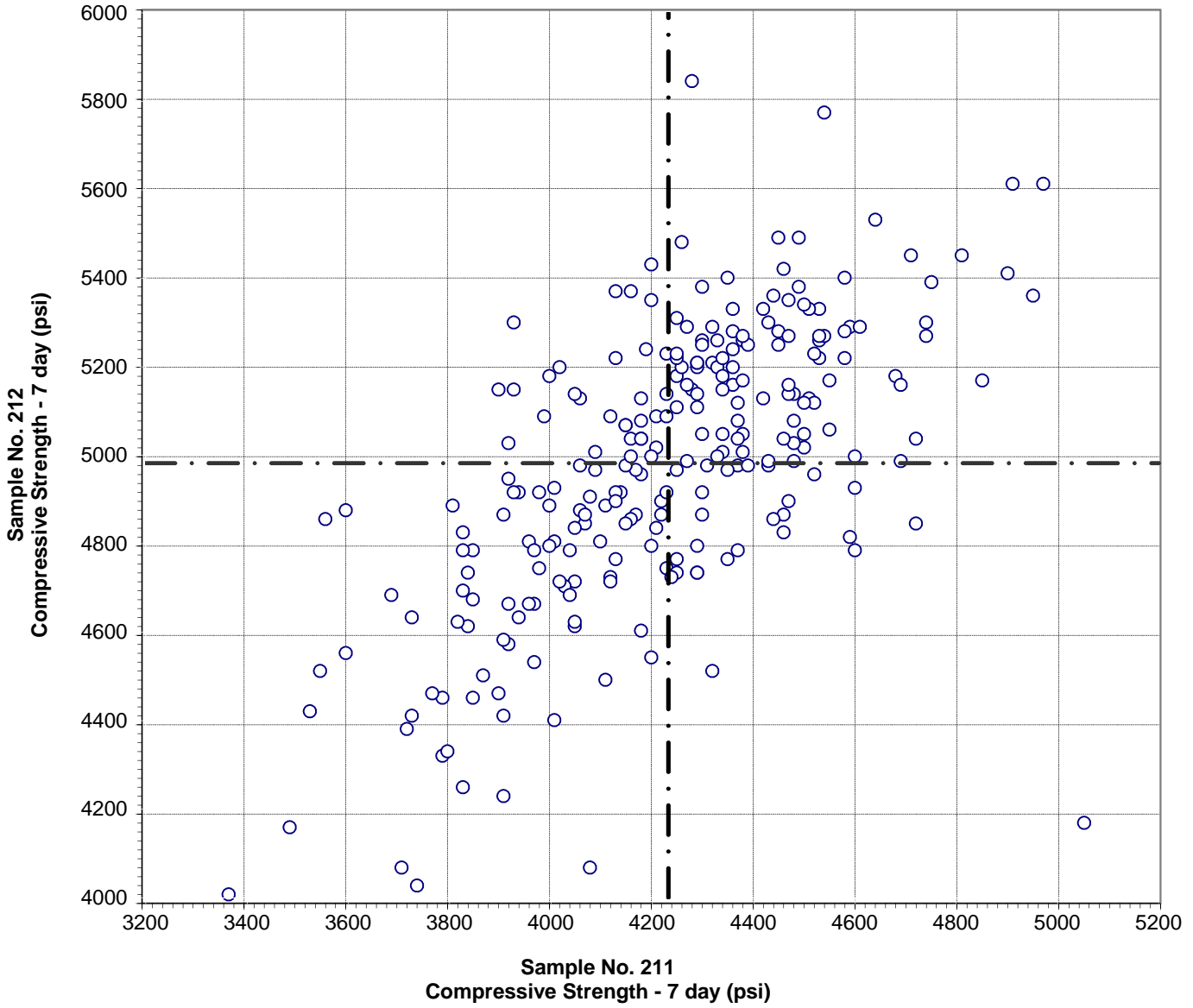


Test No. 200    Compressive Strength - 3 day    245 Points

Sample No. 211	Ave 3159	S.D. 220	C.V. 7.0
Sample No. 212	Ave 4190	S.D. 272	C.V. 6.5

Labs Eliminated: 32, 46, 3834, 4080, 4216

**CCRL Proficiency Sample Program  
Compressive Strength - 7 day  
PORTLAND CEMENT Samples No. 211 and No. 212**

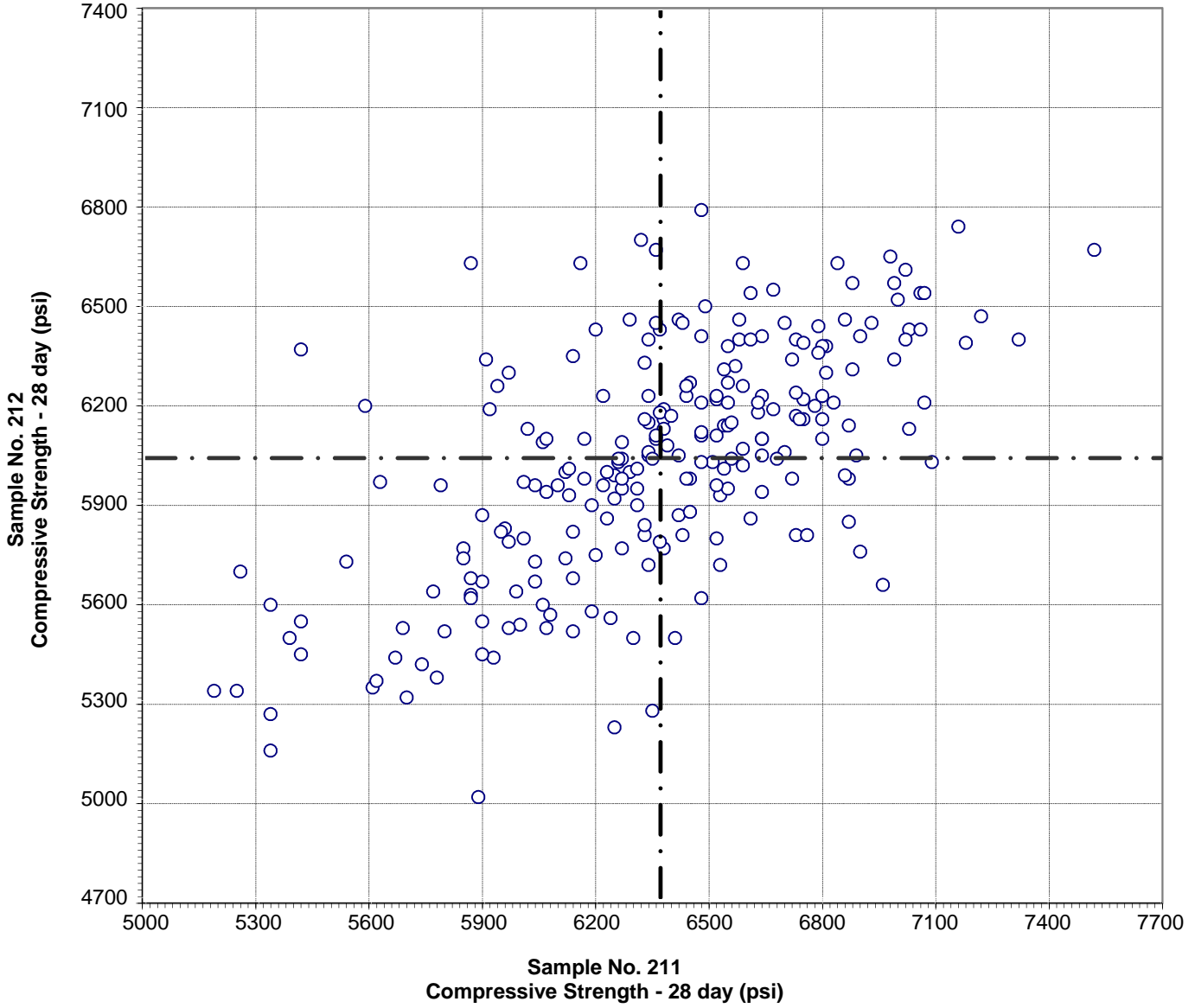


Test No. 210    Compressive Strength - 7 day    251 Points

Sample No. 211	Ave 4232	S.D. 290	C.V. 6.8
Sample No. 212	Ave 4982	S.D. 315	C.V. 6.3

Labs Eliminated: 30

**CCRL Proficiency Sample Program  
Compressive Strength - 28 day  
PORTLAND CEMENT Samples No. 211 and No. 212**



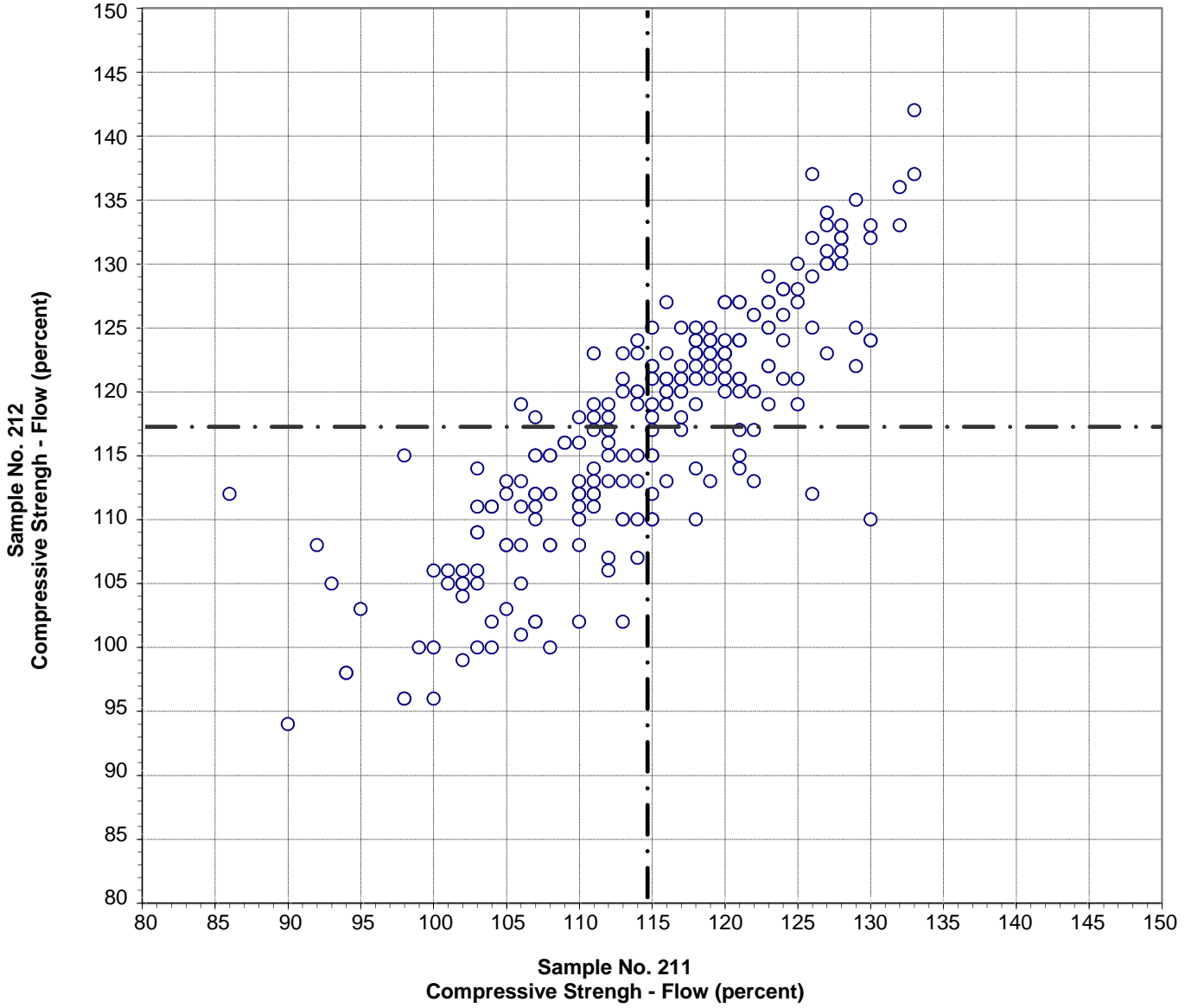
Test No. 211    Compressive Strength - 28 day    234 Points

Sample No. 211	Ave 6369	S.D. 428	C.V. 6.7
Sample No. 212	Ave 6038	S.D. 350	C.V. 5.8

Labs Eliminated: 15, 33, 203



**CCRL Proficiency Sample Program  
Compressive Strength - Flow  
PORTLAND CEMENT Samples No. 211 and No. 212**

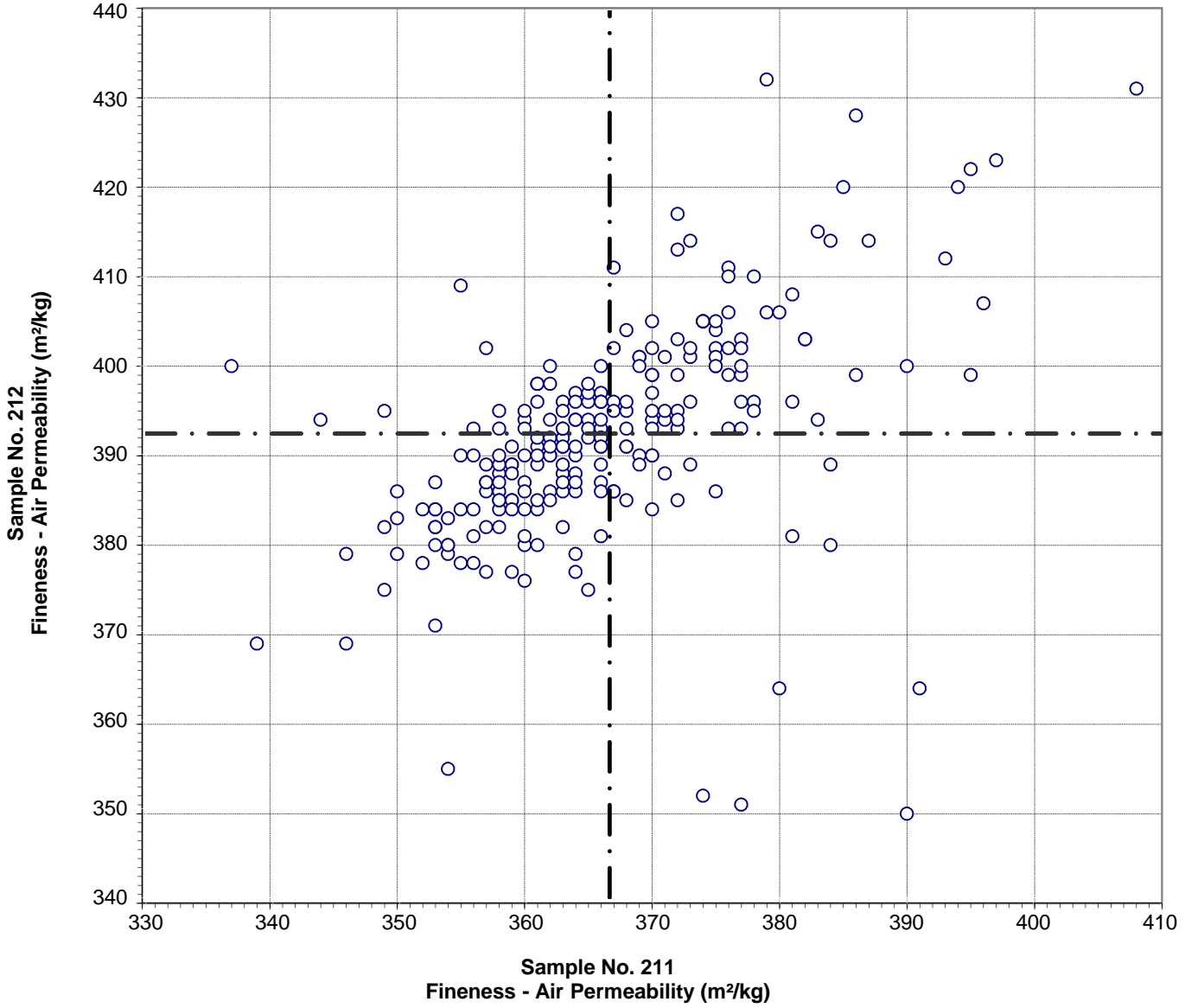


Test No. 230    Compressive Strength - Flow    232 Points

Sample No. 211	Ave 115	S.D. 9	C.V. 7.9
Sample No. 212	Ave 117	S.D. 9	C.V. 7.8

Labs Eliminated: 47, 98, 1019, 1644, 2481

**CCRL Proficiency Sample Program  
Fineness - Air Permeability  
PORTLAND CEMENT Samples No. 211 and No. 212**

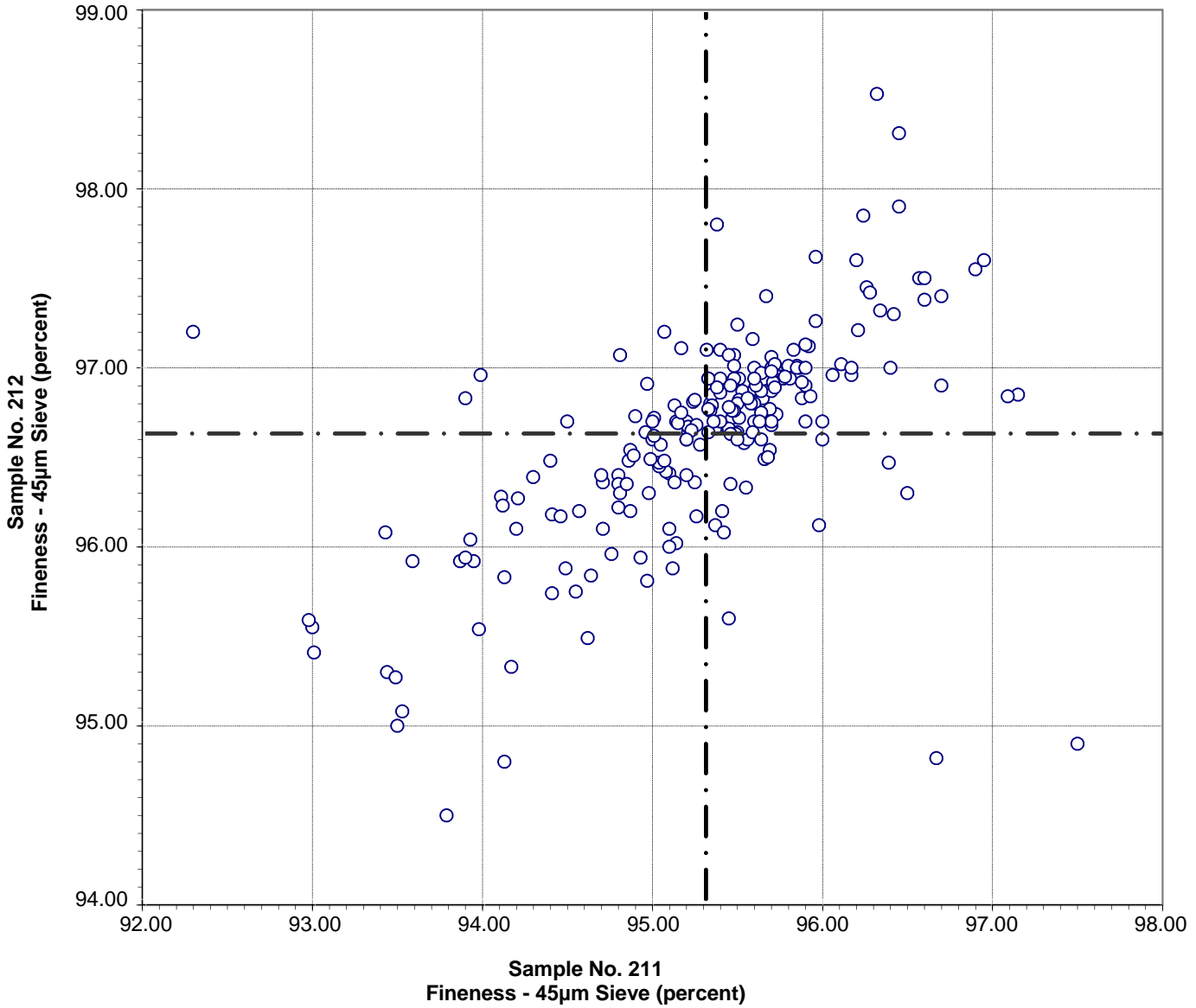


Test No. 270    Fineness - Air Permeability    235 Points

Sample No. 211	Ave 367	S.D. 11	C.V. 3.0
Sample No. 212	Ave 392	S.D. 12	C.V. 3.1

Labs Eliminated: 4, 44, 474, 515, 823, 3834, 4097

**CCRL Proficiency Sample Program**  
**Fineness - 45µm Sieve**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

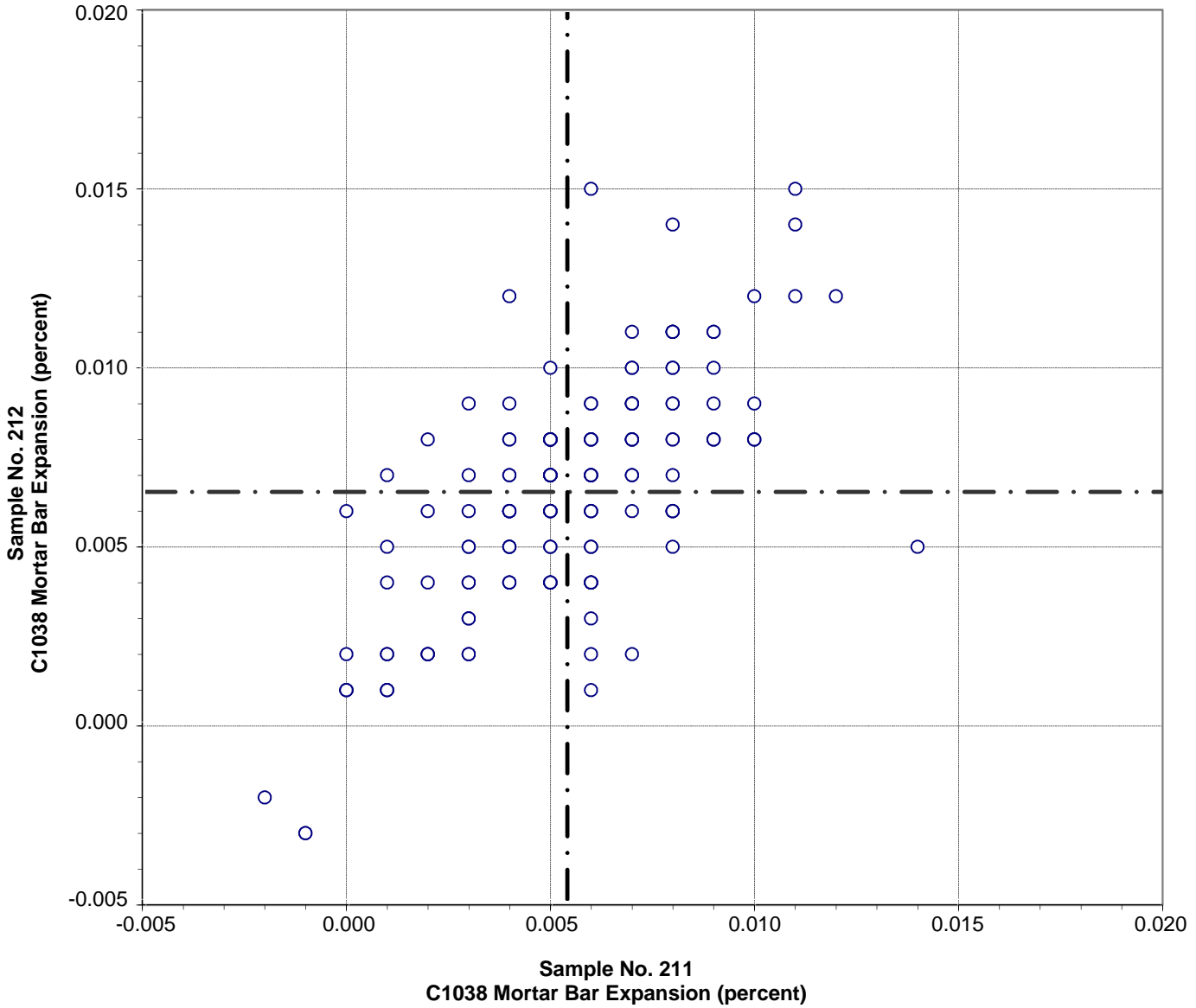


Test No. 281    Fineness - 45µm Sieve    222 Points

Sample No. 211	Ave 95.31	S.D. 0.80	C.V. 0.83
Sample No. 212	Ave 96.63	S.D. 0.58	C.V. 0.60

Labs Eliminated: 26, 98, 116, 416, 3834

**CCRL Proficiency Sample Program  
C1038 Mortar Bar Expansion  
PORTLAND CEMENT Samples No. 211 and No. 212**



Test No. 400 C1038 Mortar Bar Expansion 150 Points

Sample No. 211	Ave 0.005	S.D. 0.003	C.V. 52
Sample No. 212	Ave 0.006	S.D. 0.003	C.V. 50

Labs Eliminated: 64, 132, 146, 205, 413, 457, 491, 886, 1054, 2352, 3607, 4351

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 211 and No. 212

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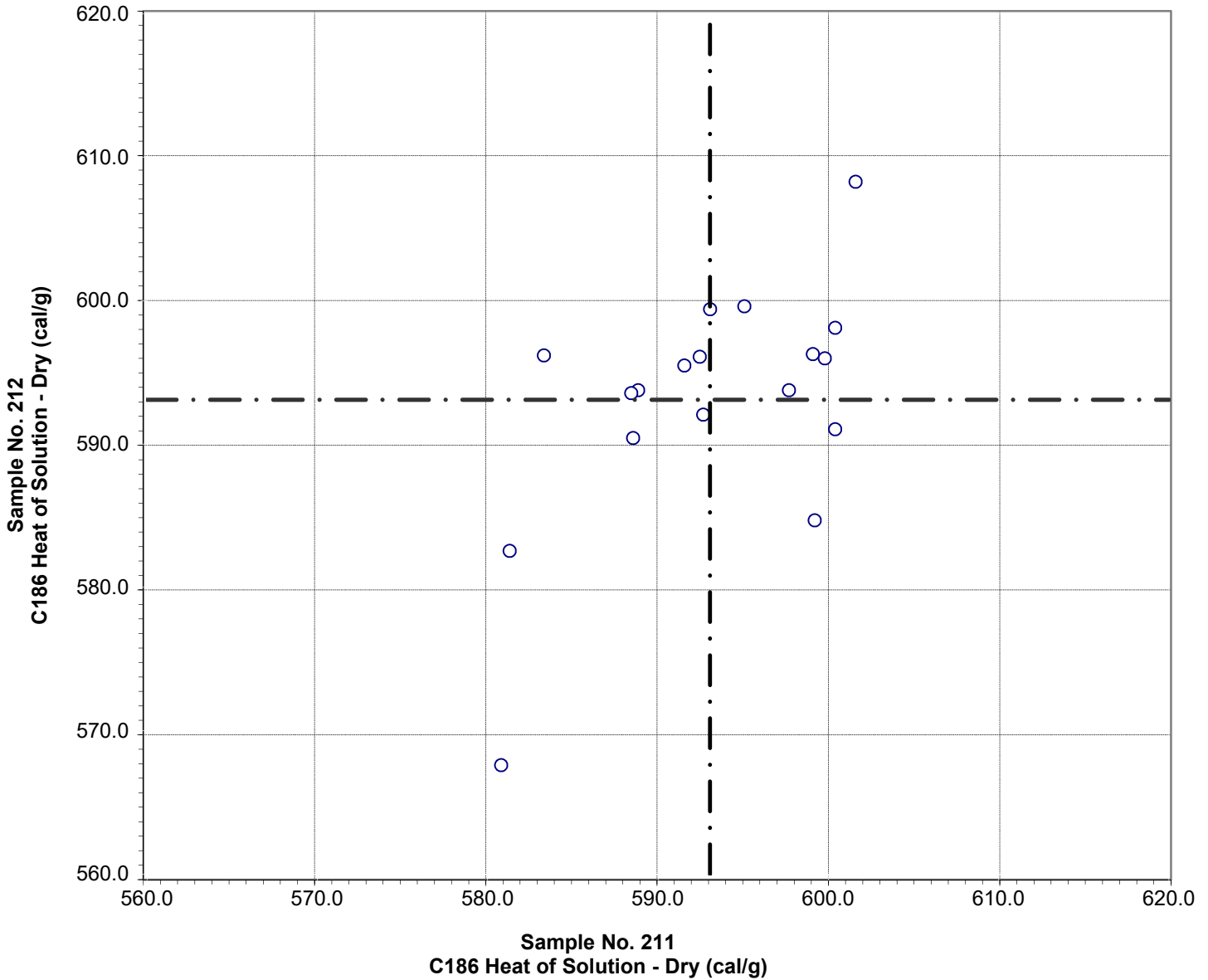
SUMMARY OF RESULTS

Sample No. 211

Sample No. 212

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>C186 Heat of Solution - Dry (cal/g)</b>							
	19	592.6	6.8	1.1	595.3	12.8	2.1
	*18	593.0	6.7	1.1	593.1	8.4	1.4
* Labs Eliminated - 4051							
<b>C186 Heat of Solution - 7 day (cal/g)</b>							
	19	518.4	5.2	1.0	510.9	7.7	1.5
No Labs Eliminated for This Test							
<b>C186 Heat of Solution 28 day (cal/g)</b>							
	17	506.2	5.1	1.0	499.6	12.5	2.5
No Labs Eliminated for This Test							
<b>C186 Heat of Hydration - 7 day (cal/g)</b>							
	21	74.1	4.7	6.4	84.4	13.4	15.9
	*20	74.3	4.8	6.5	81.9	6.8	8.3
* Labs Eliminated - 4051							
<b>C186 Heat of Hydration - 28 day (cal/g)</b>							
	18	87.8	9.0	10.3	94.7	15.4	16.3
No Labs Eliminated for This Test							
<b>C1702 Heat of Hydration - 3 day (J/g)</b>							
	20	260	41	15.7	332	57	17.1
	*18	256	12	4.7	329	25	7.6
* Labs Eliminated - 116, 4051							
<b>C1702 Heat of Hydration - 7 day (J/g)</b>							
	20	315	48	15.3	374	63	16.8
	*18	311	15	4.8	370	27	7.3
* Labs Eliminated - 116, 4051							

**CCRL Proficiency Sample Program  
C186 Heat of Solution - Dry  
PORTLAND CEMENT Samples No. 211 and No. 212**

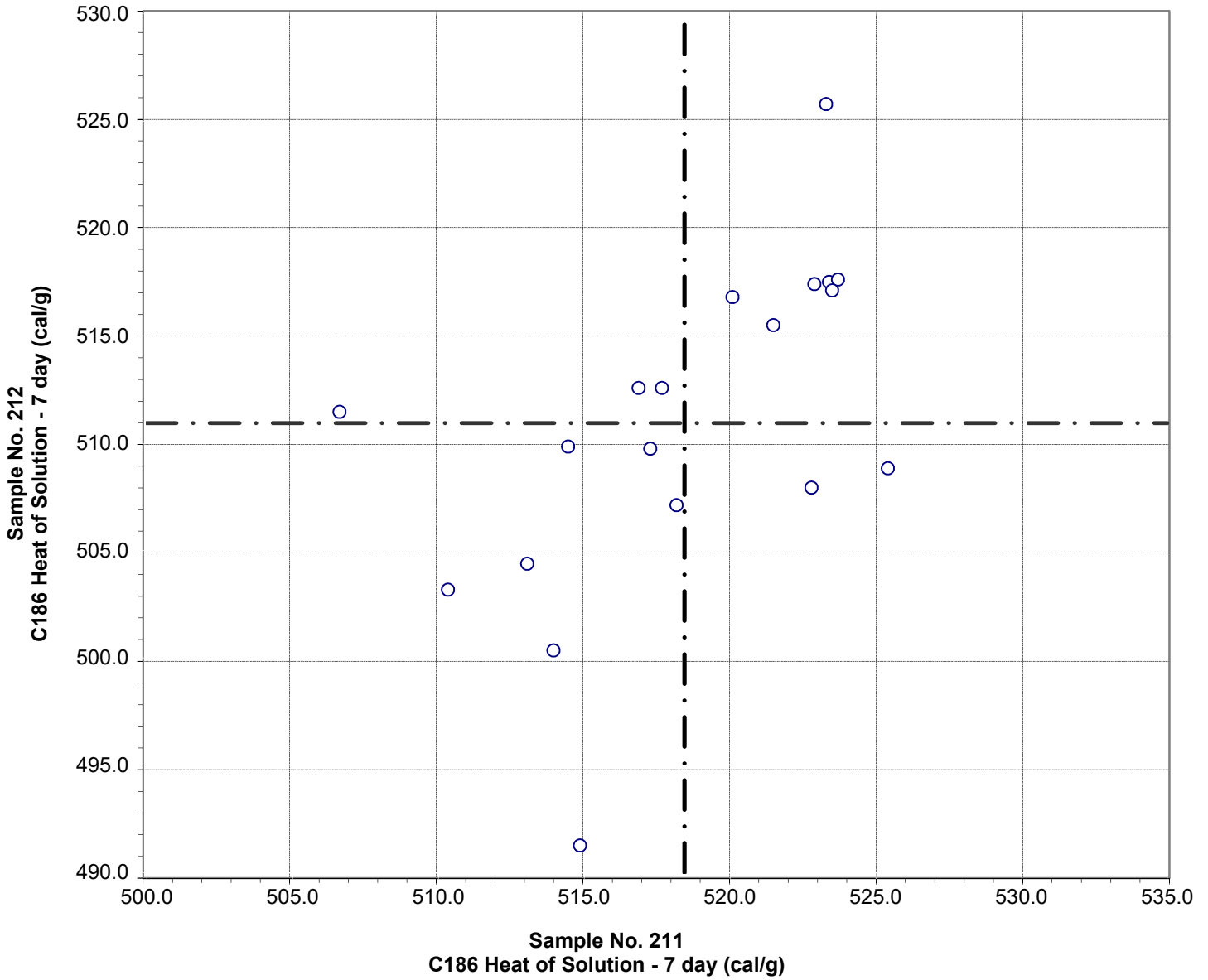


Test No. 291 C186 Heat of Solution - Dry 18 Points

Sample No. 211	Ave 593.0	S.D. 6.7	C.V. 1.1
Sample No. 212	Ave 593.1	S.D. 8.4	C.V. 1.4

Labs Eliminated: 4051

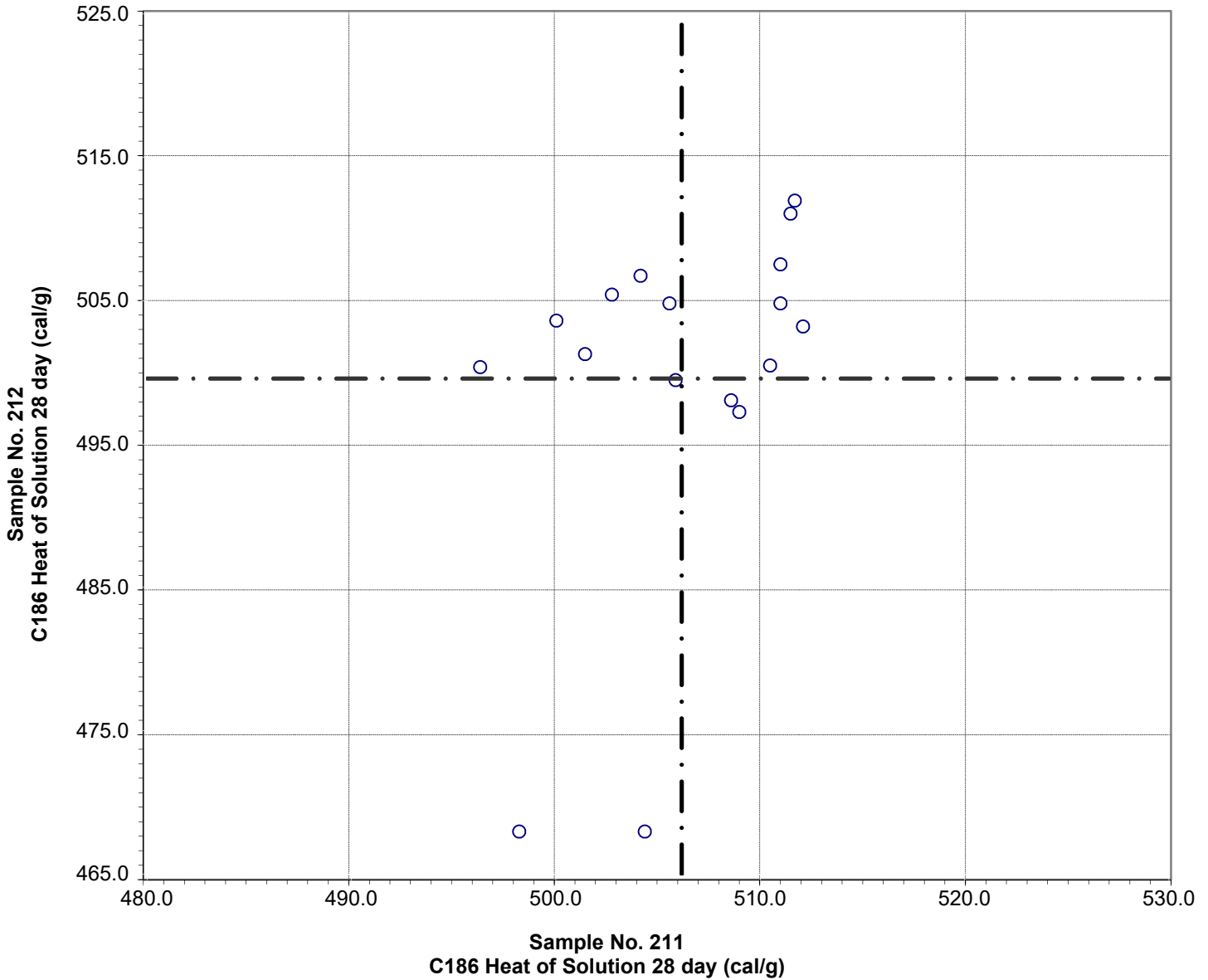
**CCRL Proficiency Sample Program**  
**C186 Heat of Solution - 7 day**  
**PORTLAND CEMENT Samples No. 211 and No. 212**



Test No. 292 C186 Heat of Solution - 7 day 19 Points

Sample No. 211	Ave 518.4	S.D. 5.2	C.V. 1.0
Sample No. 212	Ave 510.9	S.D. 7.7	C.V. 1.5

**CCRL Proficiency Sample Program  
C186 Heat of Solution 28 day  
PORTLAND CEMENT Samples No. 211 and No. 212**

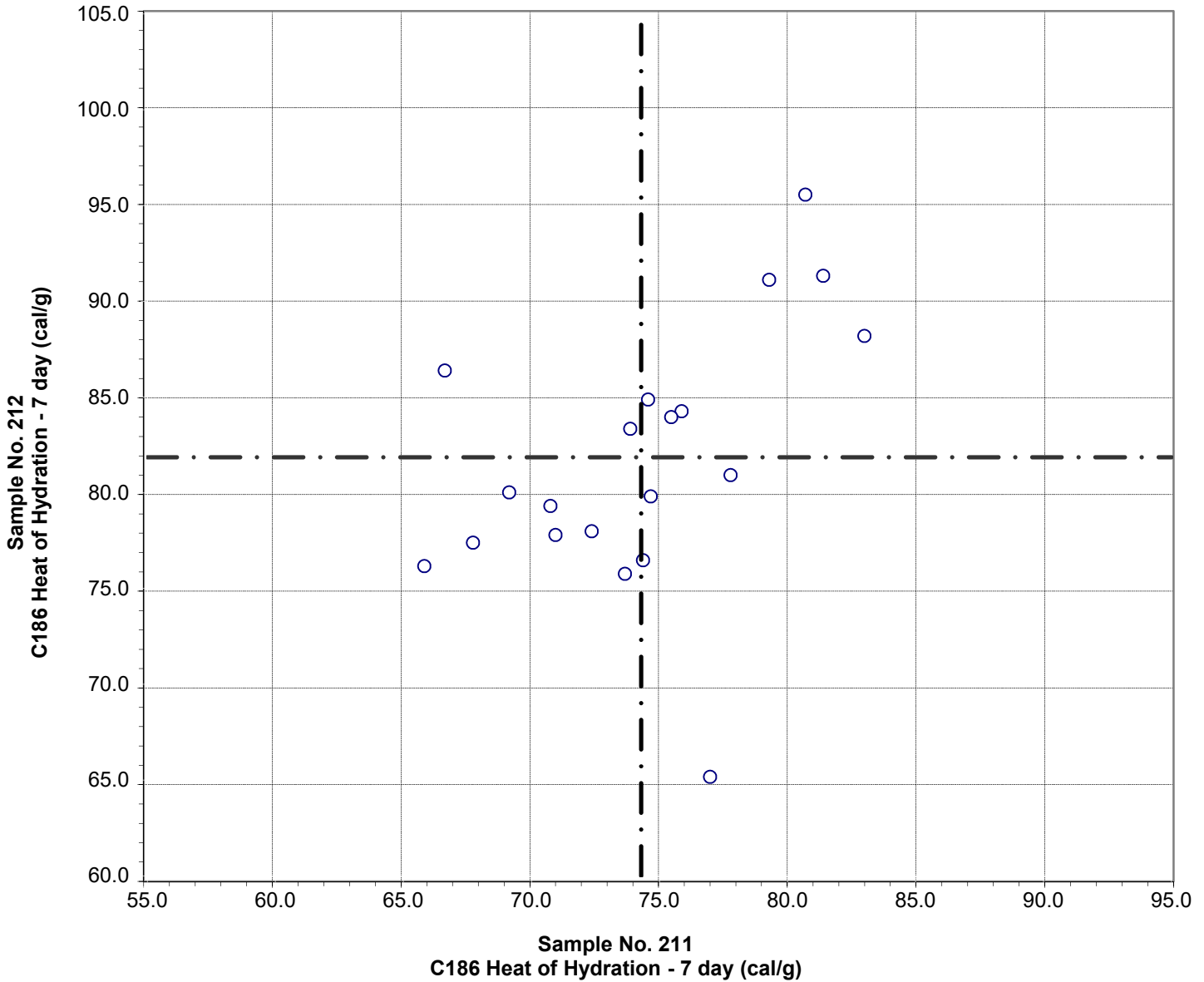


Test No. 301 C186 Heat of Solution 28 day 17 Points

Sample No. 211	Ave 506.2	S.D. 5.1	C.V. 1.0
Sample No. 212	Ave 499.6	S.D. 12.5	C.V. 2.5



**CCRL Proficiency Sample Program**  
**C186 Heat of Hydration - 7 day**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

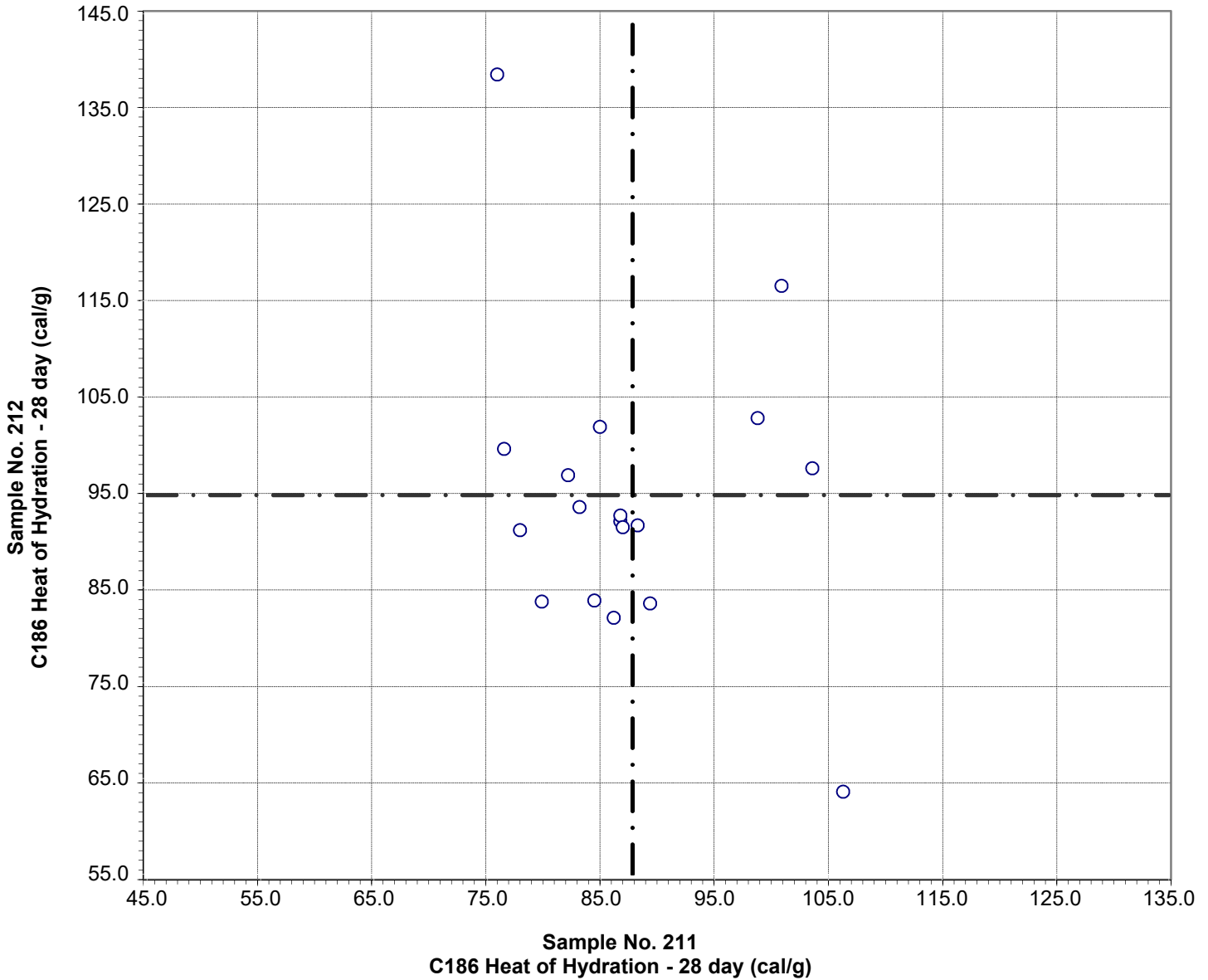


Test No. 290 C186 Heat of Hydration - 7 day 20 Points

Sample No. 211	Ave 74.3	S.D. 4.8	C.V. 6.5
Sample No. 212	Ave 81.9	S.D. 6.8	C.V. 8.3

Labs Eliminated: 4051

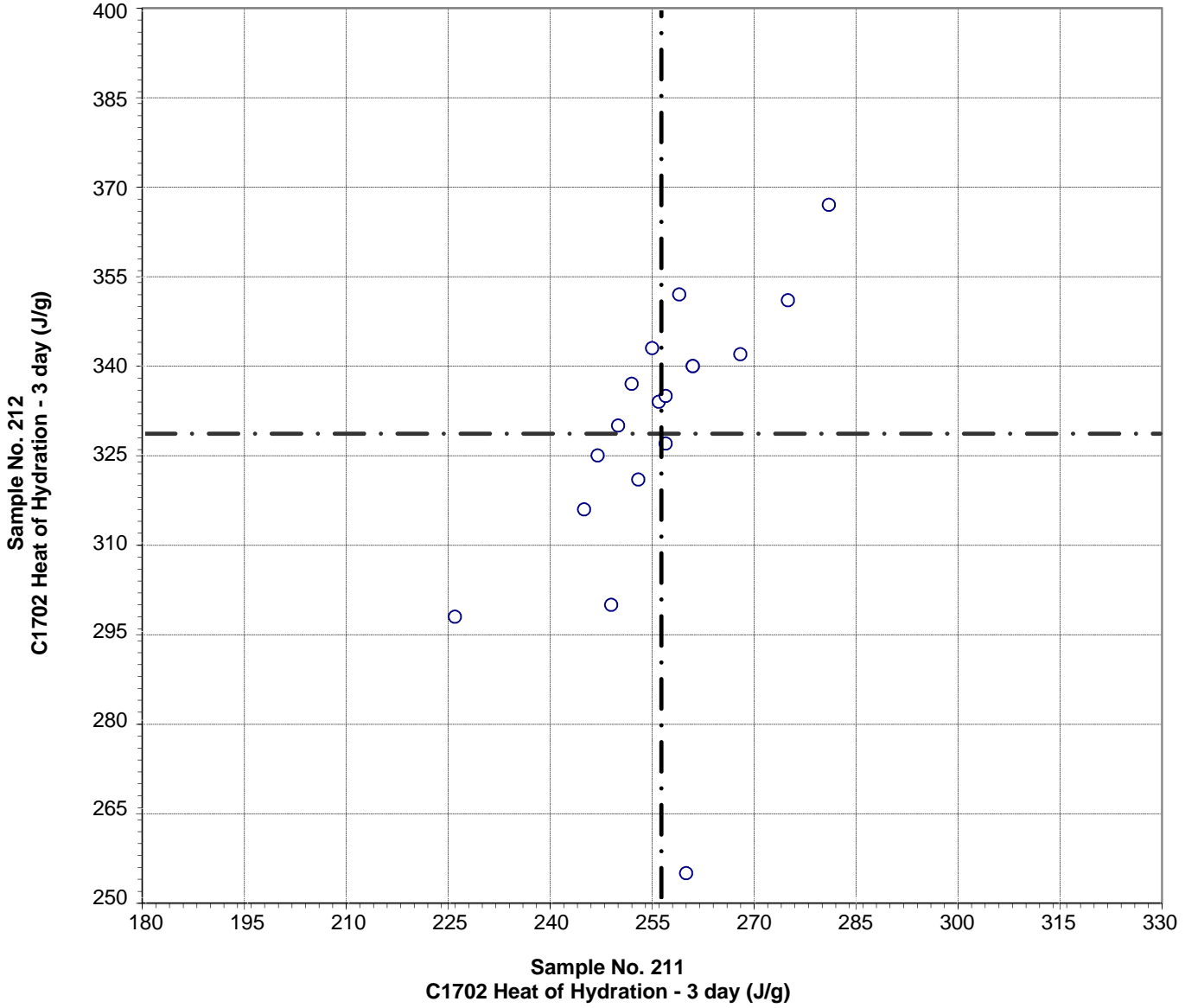
**CCRL Proficiency Sample Program  
C186 Heat of Hydration - 28 day  
PORTLAND CEMENT Samples No. 211 and No. 212**



Test No. 300 C186 Heat of Hydration - 28 day 18 Points

Sample No. 211	Ave 87.8	S.D. 9.0	C.V. 10.3
Sample No. 212	Ave 94.7	S.D. 15.4	C.V. 16.3

**CCRL Proficiency Sample Program**  
**C1702 Heat of Hydration - 3 day**  
**PORTLAND CEMENT Samples No. 211 and No. 212**

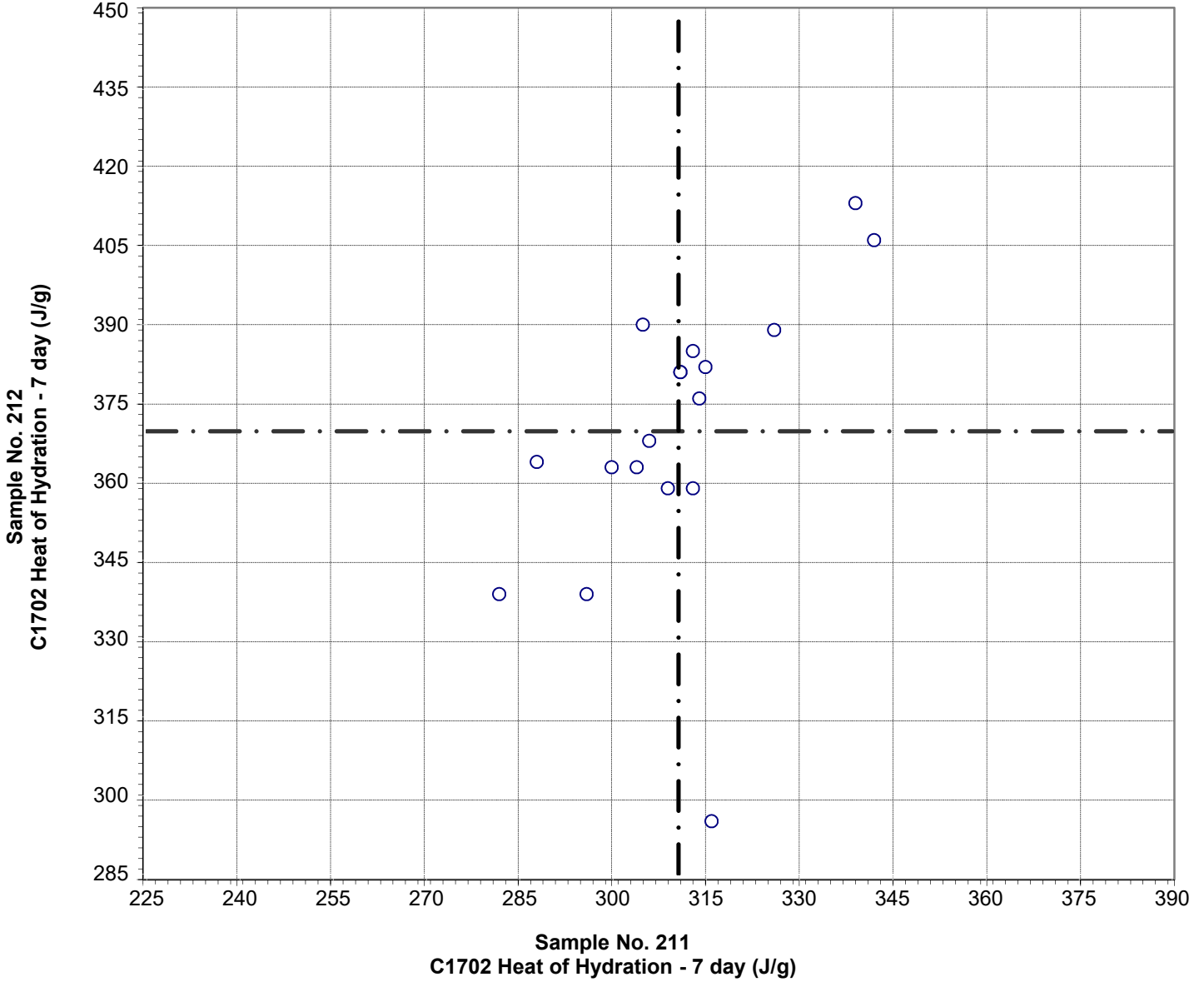


Test No. 500 C1702 Heat of Hydration - 3 day 18 Points

Sample No. 211	Ave 256	S.D. 12	C.V. 4.7
Sample No. 212	Ave 329	S.D. 25	C.V. 7.6

Labs Eliminated: 116, 4051

**CCRL Proficiency Sample Program  
C1702 Heat of Hydration - 7 day  
PORTLAND CEMENT Samples No. 211 and No. 212**



Test No. 510 C1702 Heat of Hydration - 7 day 18 Points

Sample No. 211	Ave 311	S.D. 15	C.V. 4.8
Sample No. 212	Ave 370	S.D. 27	C.V. 7.3

Labs Eliminated: 116, 4051