

CEMENT AND CONCRETE REFERENCE LABORATORY PROFICIENCY SAMPLE PROGRAM

Final Report Portland Cement Proficiency Samples Number 213 and Number 214

September 2019



CCRL
Cement and Concrete
Reference Laboratory

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Cement and Concrete
Reference Laboratory

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September 20, 2019

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 213 and No. 214

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in July 2019. Portland Cement Sample No. 213 and Portland Cement Sample No. 214 were ASTM C150 cements meeting the specifications of Type V, and contained limestone 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 January 2019.

Sincerely,

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



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Reference Laboratory

www.ccrl.us

September 20, 2019

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 213 and No. 214

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in July 2019. Portland Cement Sample No. 213 and Portland Cement Sample No. 214 were ASTM C150 cements meeting the specifications of Type I and Type II, and contained limestone 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.

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

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. 213 and No. 214

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 July 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 62nd 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.

Ratings	Range (Number of Standard Deviations)	Number (Per 100) of Laboratories achieving the rating ¹
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 ± 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

¹Youden, W.J., "Statistical Aspects of the Cement Testing Program", Volume 59, *Proceedings of the 62nd 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 ± 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. 213 and No. 214

Final Report – September 20, 2019

SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Silicon Dioxide (percent)							
	206	20.41	0.30	1.49	20.23	0.27	1.32
	*200	20.38	0.20	0.99	20.21	0.18	0.88
* Labs Eliminated - 8, 203, 206, 3287, 4099, 4297							
Aluminum Oxide (percent)							
	204	3.84	0.21	5.6	3.98	0.21	5.2
	*193	3.86	0.10	2.6	4.01	0.09	2.1
* Labs Eliminated - 4, 42, 95, 547, 975, 2363, 4099, 4115, 4297, 4351, 4447							
Ferric Oxide (percent)							
	205	3.04	0.09	2.9	3.50	0.10	2.9
	*200	3.04	0.05	1.5	3.51	0.05	1.4
* Labs Eliminated - 25, 42, 206, 246, 547							
Calcium Oxide (percent)							
	206	64.28	0.56	0.87	63.35	0.50	0.79
	*203	64.31	0.50	0.78	63.38	0.43	0.68
* Labs Eliminated - 1, 42, 4099							
Magnesium Oxide (percent)							
	207	3.49	0.13	3.6	2.59	0.14	5.2
	*203	3.49	0.09	2.5	2.60	0.08	2.9
* Labs Eliminated - 246, 2463, 4297, 4404							
Sulfur Trioxide (percent)							
	210	1.81	0.22	11.9	2.94	0.14	4.7
	*205	1.79	0.07	4.2	2.94	0.08	2.8
* Labs Eliminated - 50, 175, 246, 4099, 4404							
Loss on Ignition (percent)							
	215	2.61	0.18	6.8	2.50	0.17	6.6
	*205	2.63	0.09	3.3	2.51	0.09	3.6
* Labs Eliminated - 35, 413, 494, 975, 1435, 1942, 2683, 4099, 4270, 4297							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

Final Report – September 20, 2019

SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Sodium Oxide (percent)							
	198	0.103	0.032	31	0.229	0.044	19
	*190	0.102	0.024	23	0.233	0.032	14
* Labs Eliminated - 66, 99, 246, 354, 1054, 1644, 4099, 4404							
Potassium Oxide (percent)							
	203	0.246	0.048	19.4	0.529	0.038	7.3
	*190	0.240	0.014	5.7	0.533	0.017	3.1
* Labs Eliminated - 95, 139, 175, 246, 416, 438, 1644, 2437, 2463, 2466, 4138, 4297, 4404							
Strontium Oxide (percent)							
	105	0.150	0.014	9	0.058	0.048	83
	*96	0.151	0.007	5	0.051	0.004	8
* Labs Eliminated - 8, 78, 494, 692, 881, 2463, 3605, 3607, 4042							
Titanium Dioxide (percent)							
	167	0.21	0.014	6.7	0.18	0.014	7.7
	*162	0.21	0.010	4.8	0.18	0.010	5.3
* Labs Eliminated - 95, 2437, 3238, 4042, 4404							
Phosphorus Pentoxide (percent)							
	163	0.050	0.017	34.3	0.080	0.022	27.4
	*150	0.047	0.006	13.4	0.077	0.007	8.8
* Labs Eliminated - 48, 99, 116, 146, 246, 494, 502, 1079, 2463, 3250, 4099, 4115, 4404							
Zinc Oxide (percent)							
	102	0.053	0.030	56.0	0.041	0.005	11.1
	*96	0.050	0.003	5.1	0.042	0.002	5.4
* Labs Eliminated - 78, 94, 116, 206, 502, 1916							
Manganic Oxide (percent)							
	138	0.107	0.011	10.5	0.060	0.013	21.1
	*128	0.107	0.005	4.2	0.059	0.004	6.4
* Labs Eliminated - 25, 94, 219, 413, 491, 2477, 3238, 3297, 4042, 4404							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

Final Report – September 20, 2019

SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Chloride (percent)							
	123	0.005	0.008	175	0.007	0.007	101
	*114	0.003	0.003	94	0.005	0.003	61
* Labs Eliminated - 4, 25, 94, 142, 692, 982, 1916, 3415, 3607							
Insoluble Residue (percent)							
	187	0.65	0.25	39	0.62	0.29	47
	*179	0.62	0.12	20	0.59	0.11	19
* Labs Eliminated - 4, 431, 881, 2938, 3415, 4297, 4351, 4447							
Free Lime (percent)							
	150	1.30	0.30	23	1.09	0.28	26
	*142	1.34	0.23	17	1.10	0.21	19
* Labs Eliminated - 43, 78, 152, 494, 1942, 2352, 2360, 4138							
Carbon Dioxide (percent)							
	179	1.86	0.19	10.1	1.69	0.20	11.7
	*173	1.86	0.14	7.6	1.69	0.14	8.0
* Labs Eliminated - 42, 246, 247, 3607, 4270, 4404							
Limestone Content (percent)							
	176	4.7	0.6	11.8	4.4	0.5	11.2
	*171	4.7	0.4	8.4	4.5	0.4	8.4
* Labs Eliminated - 42, 247, 440, 1657, 4404							
Chromium Oxide (percent)							
	92	0.013	0.018	139	0.009	0.008	90
	*85	0.009	0.003	31	0.007	0.003	39
* Labs Eliminated - 66, 116, 206, 415, 493, 684, 3607							
Tricalcium Silicate (percent)							
	177	66.1	3.1	4.6	59.7	2.4	4.1
	*173	66.2	2.7	4.0	59.6	2.3	3.8
* Labs Eliminated - 95, 175, 246, 4297							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

Final Report – September 20, 2019

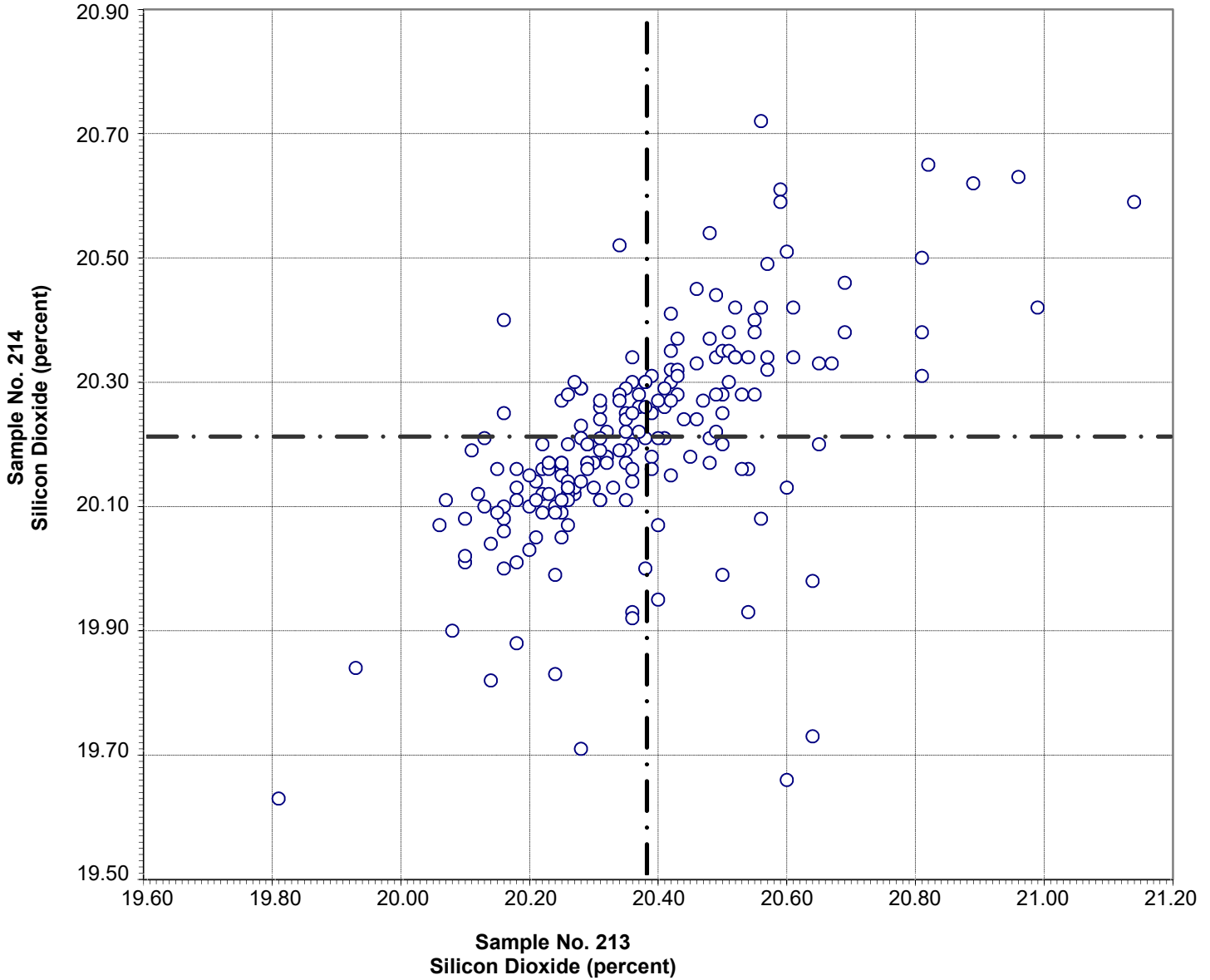
SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Dicalcium Silicate (percent)							
	177	7.6	2.7	35.0	11.9	2.1	17.3
	*172	7.5	2.2	28.7	12.0	1.8	15.3
* Labs Eliminated - 95, 175, 246, 547, 4297							
Tricalcium Aluminate (percent)							
	179	4.9	0.5	10.8	4.6	0.4	9.3
	*173	4.9	0.3	6.2	4.6	0.2	5.1
* Labs Eliminated - 42, 95, 975, 3238, 4115, 4297							
Tetracalcium Aluminoferrite (percent)							
	178	9.1	0.6	7.0	10.5	0.3	3.1
	*170	9.1	0.2	1.7	10.6	0.2	1.5
* Labs Eliminated - 25, 169, 206, 246, 497, 547, 3185, 3238							

**CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 213 and No. 214**



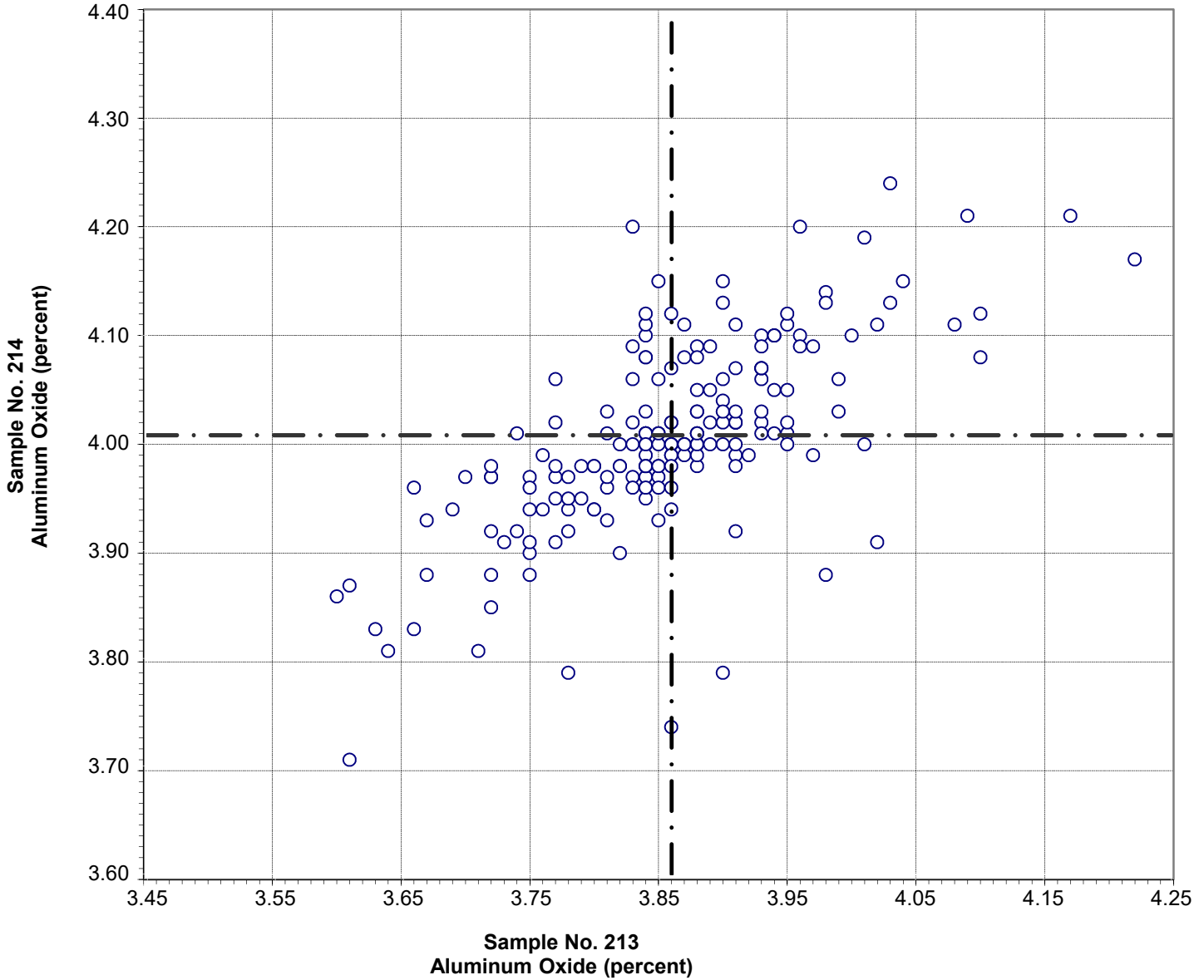
Test No. 10 Silicon Dioxide 198 Points

Sample No. 213	Ave 20.38	S.D. 0.20	C.V. 0.99
Sample No. 214	Ave 20.21	S.D. 0.18	C.V. 0.88

Labs Eliminated: 8, 203, 206, 3287, 4099, 4297

Labs off Diagram: 881, 2437

**CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

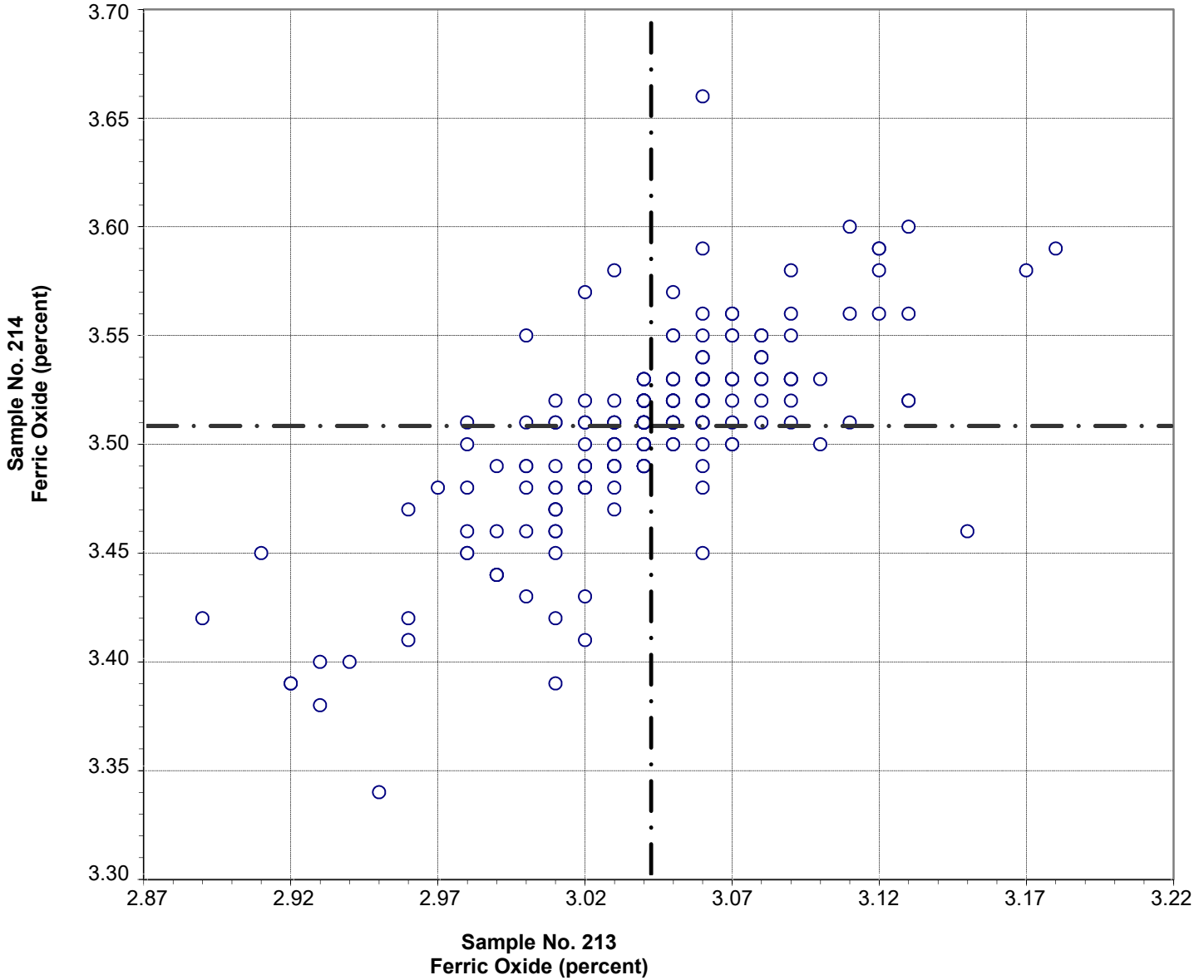


Test No. 21 Aluminum Oxide 193 Points

Sample No. 213	Ave 3.86	S.D. 0.10	C.V. 2.6
Sample No. 214	Ave 4.01	S.D. 0.09	C.V. 2.1

Labs Eliminated: 4, 42, 95, 547, 975, 2363, 4099, 4115, 4297, 4351, 4447

**CCRL Proficiency Sample Program
 Ferric Oxide
 PORTLAND CEMENT Samples No. 213 and No. 214**



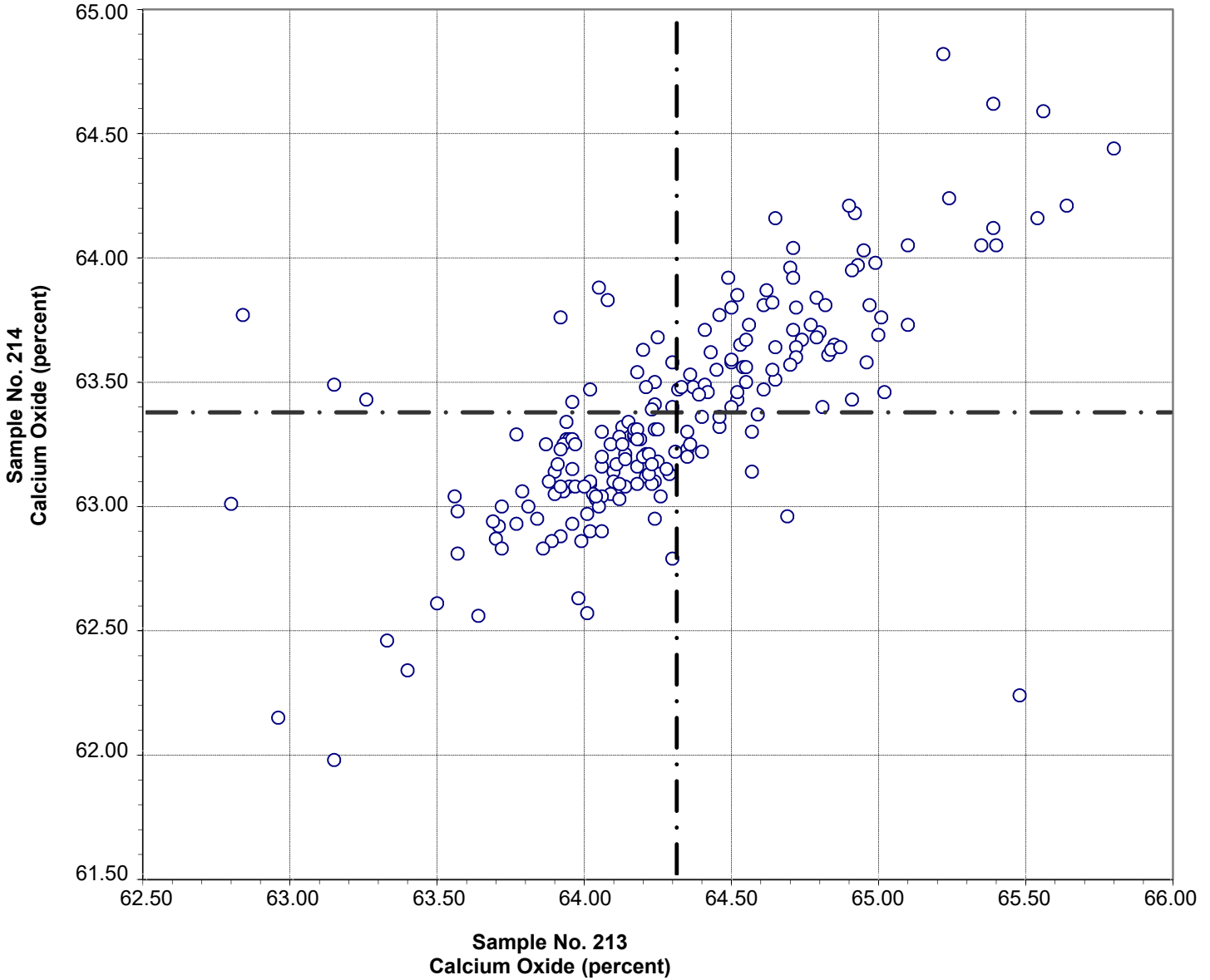
Test No. 30 Ferric Oxide 199 Points

Sample No. 213	Ave 3.04	S.D. 0.05	C.V. 1.5
Sample No. 214	Ave 3.51	S.D. 0.05	C.V. 1.4

Labs Eliminated: 25, 42, 206, 246, 547

Labs off Diagram: 3185

**CCRL Proficiency Sample Program
Calcium Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

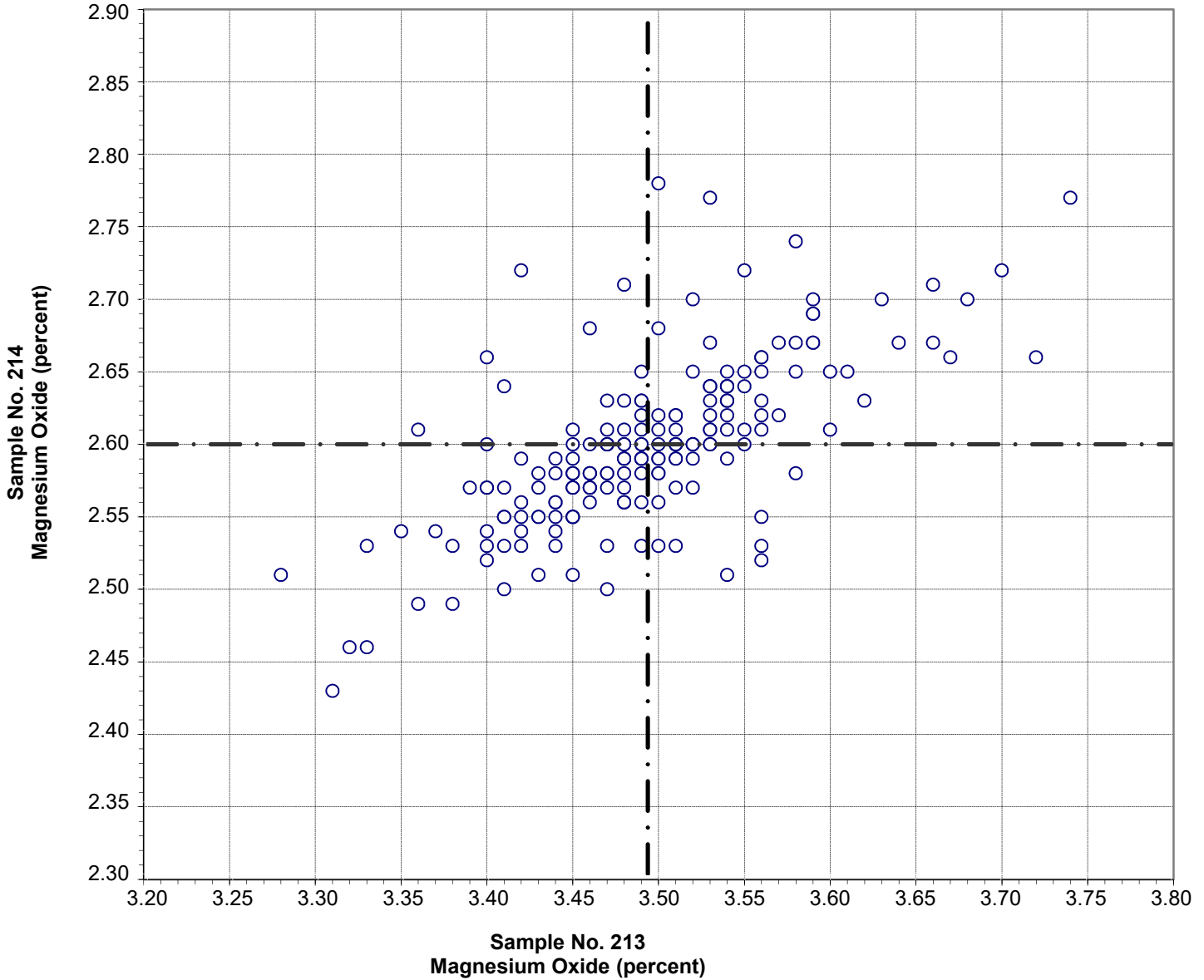


Test No. 40 Calcium Oxide 203 Points

Sample No. 213	Ave 64.31	S.D. 0.50	C.V. 0.78
Sample No. 214	Ave 63.38	S.D. 0.43	C.V. 0.68

Labs Eliminated: 1, 42, 4099

**CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

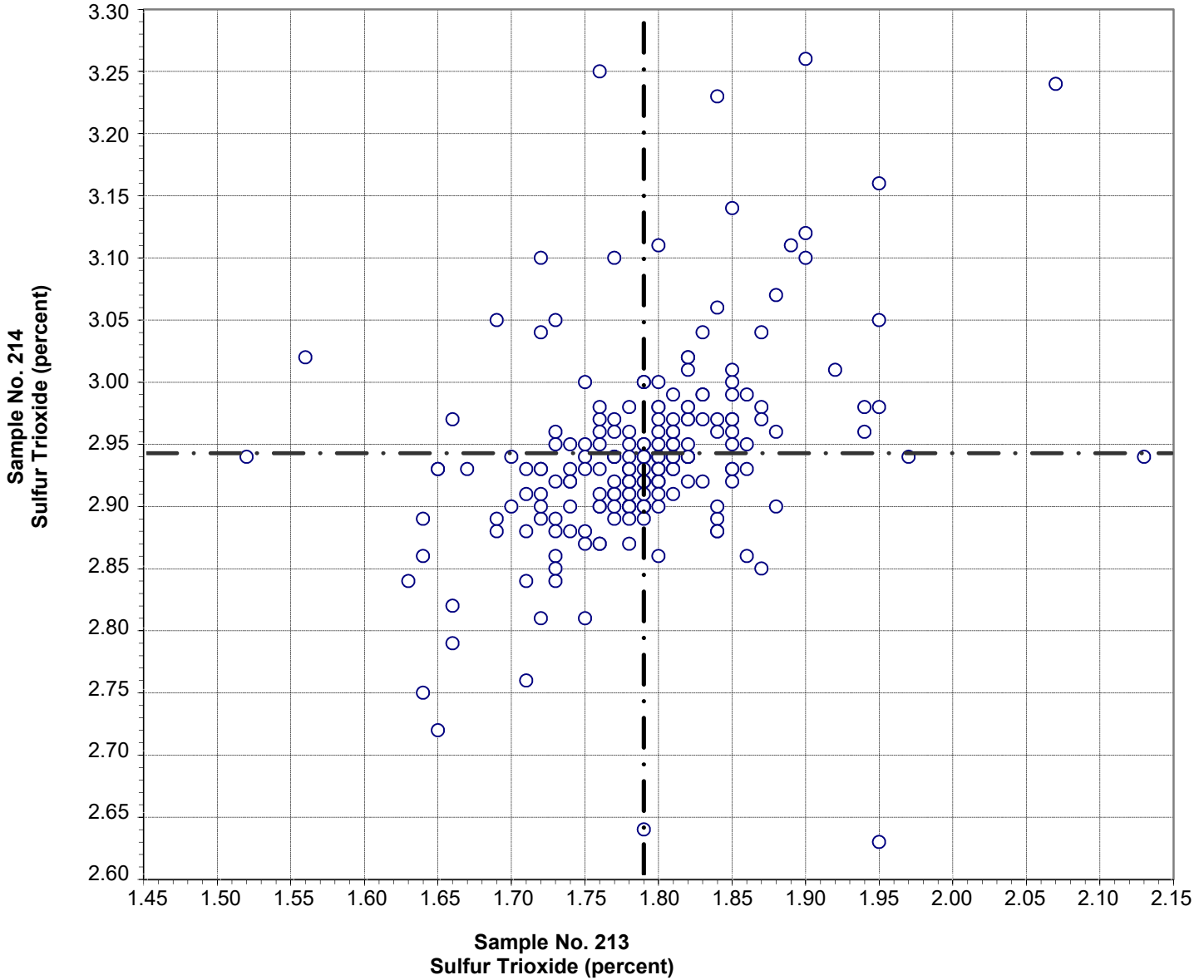


Test No. 50 Magnesium Oxide 194 Points

Sample No. 213	Ave 3.49	S.D. 0.07	C.V. 2.1
Sample No. 214	Ave 2.60	S.D. 0.06	C.V. 2.2

Labs Eliminated: 42, 95, 175, 206, 246, 407, 494, 1644, 1676, 2463, 4099, 4297, 4404

**CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 213 and No. 214**

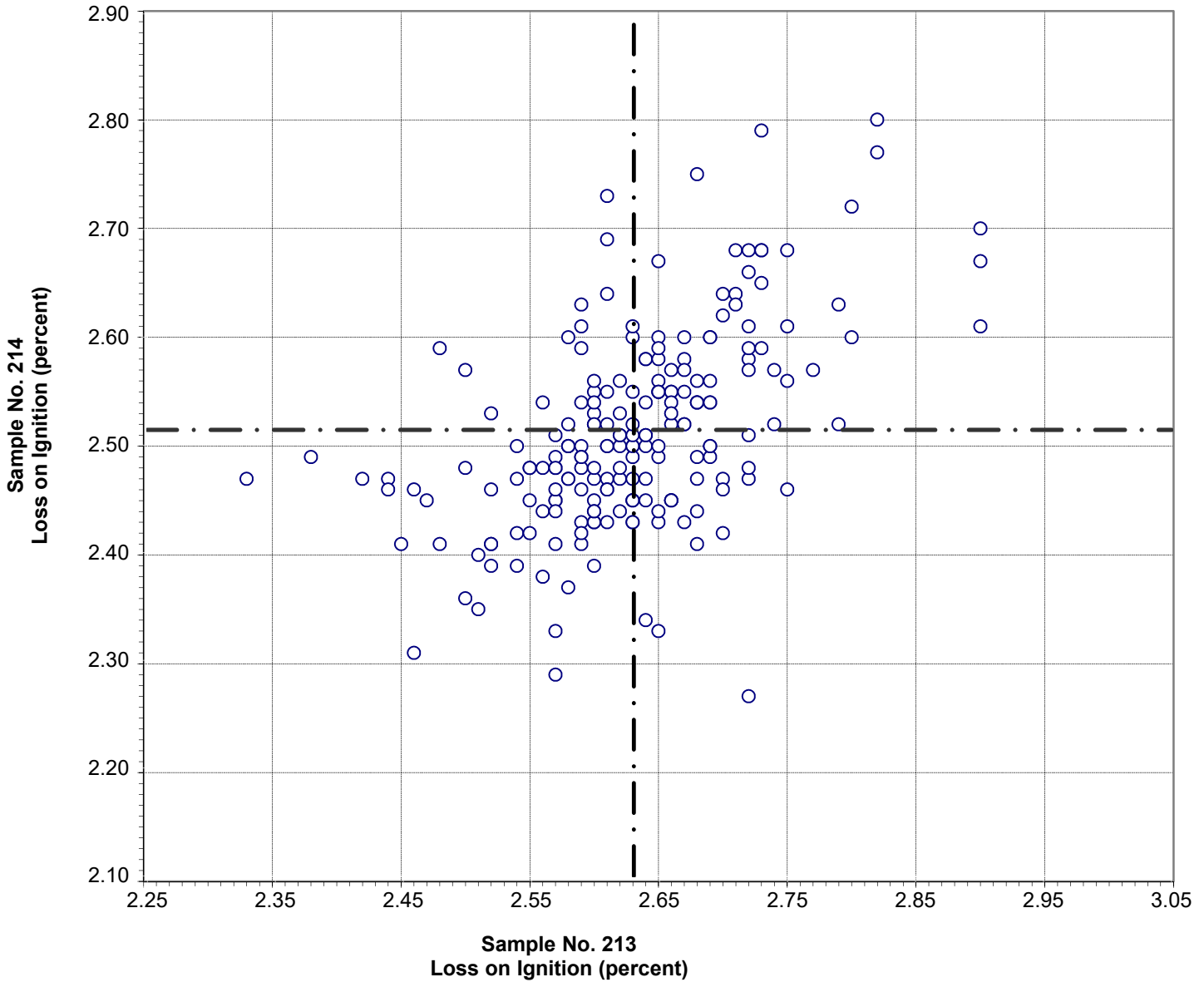


Test No. 60 Sulfur Trioxide 205 Points

Sample No. 213	Ave 1.79	S.D. 0.07	C.V. 4.2
Sample No. 214	Ave 2.94	S.D. 0.08	C.V. 2.8

Labs Eliminated: 50, 175, 246, 4099, 4404

**CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 213 and No. 214**

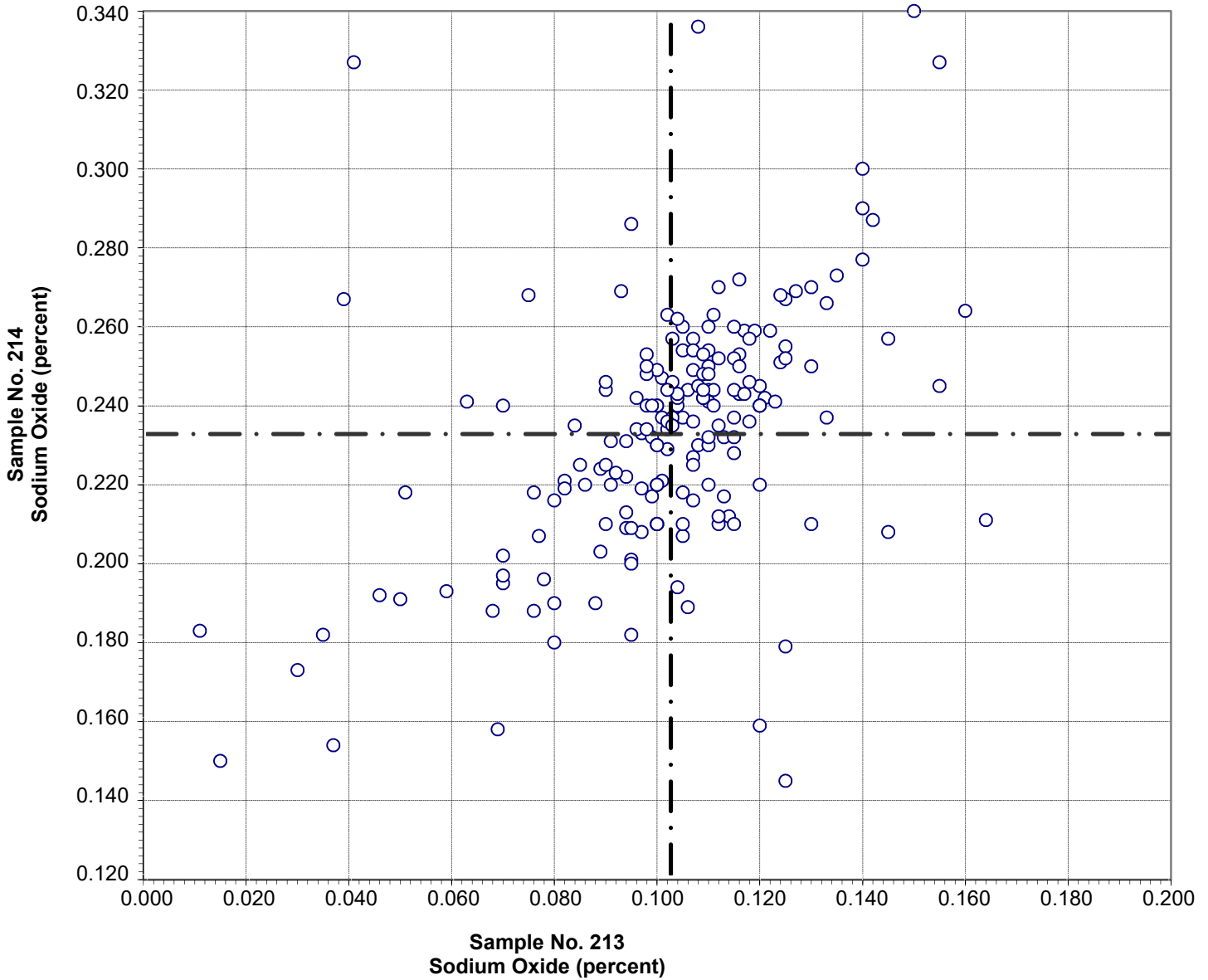


Test No. 70 Loss on Ignition 205 Points

Sample No. 213	Ave 2.63	S.D. 0.09	C.V. 3.3
Sample No. 214	Ave 2.51	S.D. 0.09	C.V. 3.6

Labs Eliminated: 35, 413, 494, 975, 1435, 1942, 2683, 4099, 4270, 4297

**CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**



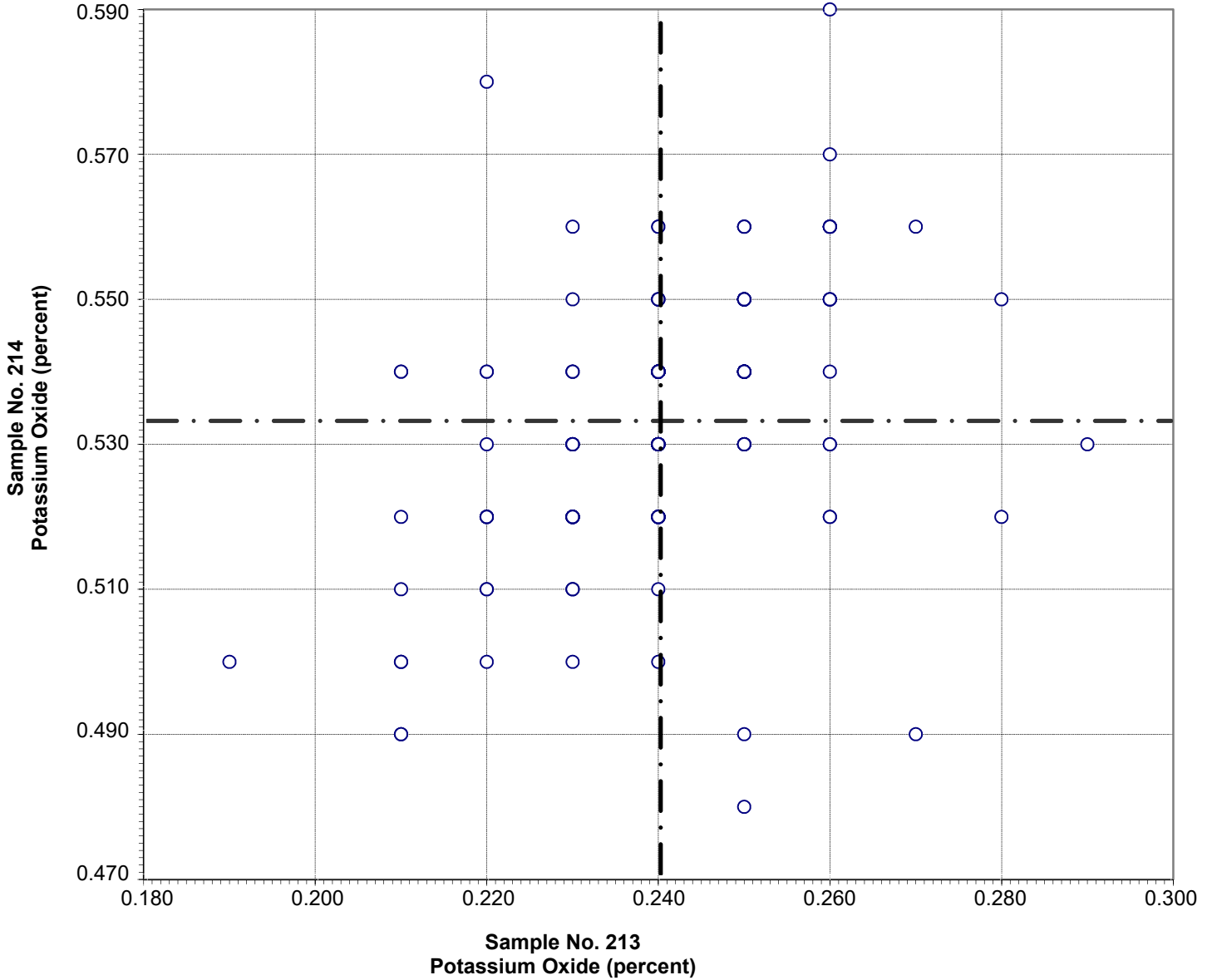
Test No. 90 Sodium Oxide 189 Points

Sample No. 213	Ave 0.102	S.D. 0.024	C.V. 23
Sample No. 214	Ave 0.233	S.D. 0.032	C.V. 14

Labs Eliminated: 66, 99, 246, 354, 1054, 1644, 4099, 4404

Labs off Diagram: 2463

**CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

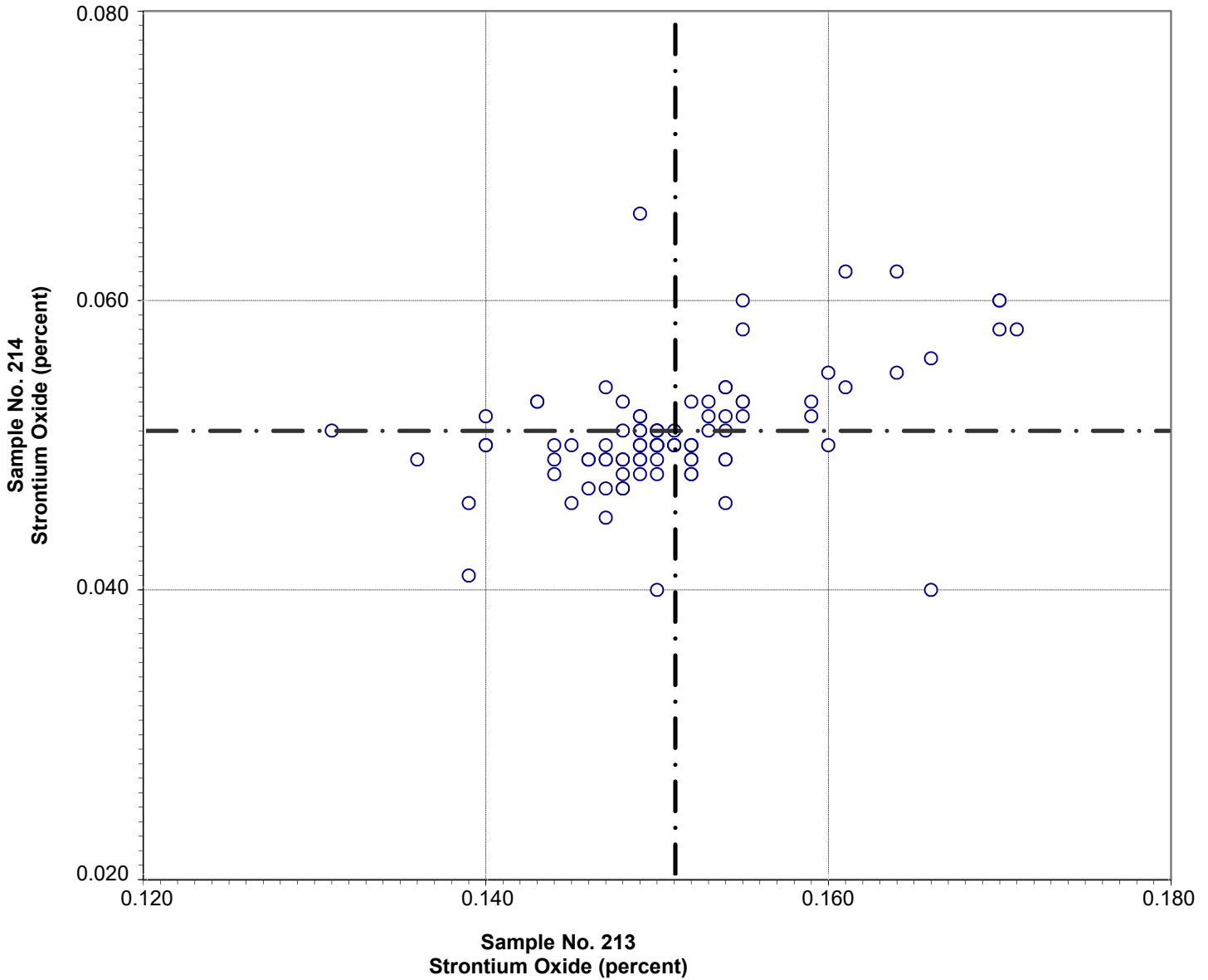


Test No. 100 Potassium Oxide 190 Points

Sample No. 213	Ave 0.240	S.D. 0.014	C.V. 5.7
Sample No. 214	Ave 0.533	S.D. 0.017	C.V. 3.1

Labs Eliminated: 95, 139, 175, 246, 416, 438, 1644, 2437, 2463, 2466, 4138, 4297, 4404

**CCRL Proficiency Sample Program
Strontium Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

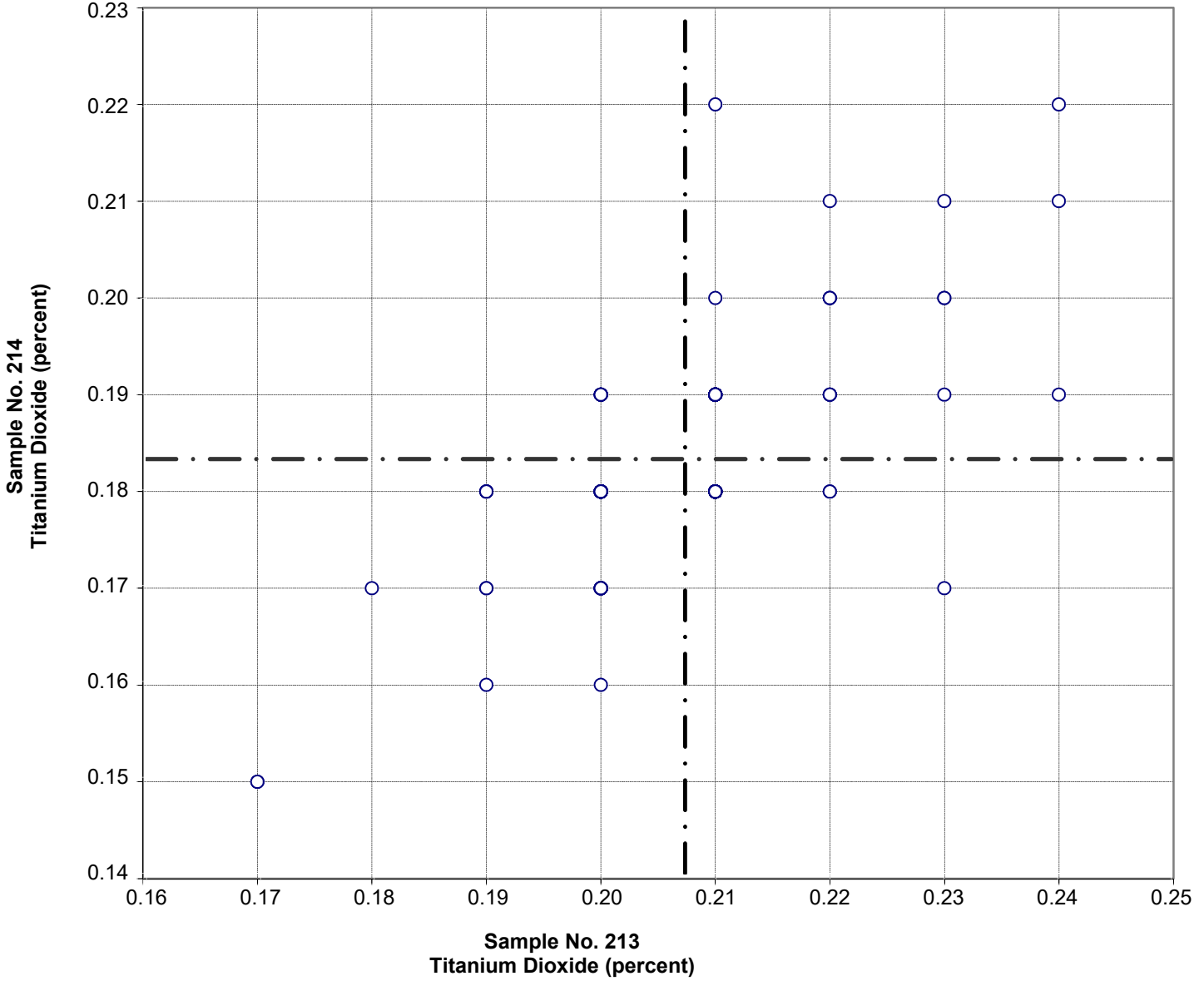


Test No. 92 Strontium Oxide 96 Points

Sample No. 213	Ave 0.151	S.D. 0.007	C.V. 5
Sample No. 214	Ave 0.051	S.D. 0.004	C.V. 8

Labs Eliminated: 8, 78, 494, 692, 881, 2463, 3605, 3607, 4042

**CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 213 and No. 214**

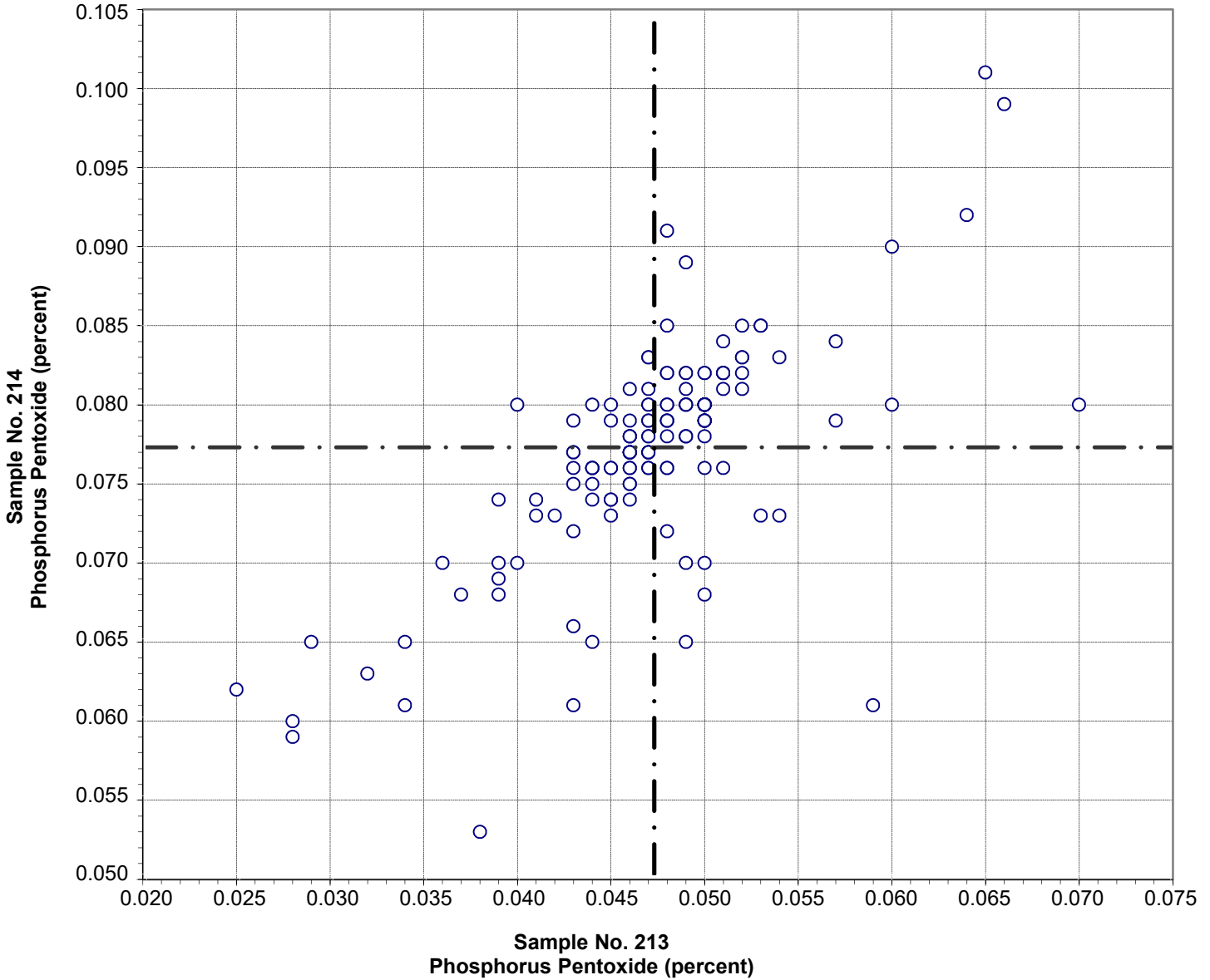


Test No. 103 Titanium Dioxide 162 Points

Sample No. 213	Ave 0.21	S.D. 0.010	C.V. 4.8
Sample No. 214	Ave 0.18	S.D. 0.010	C.V. 5.3

Labs Eliminated: 95, 2437, 3238, 4042, 4404

**CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 213 and No. 214**

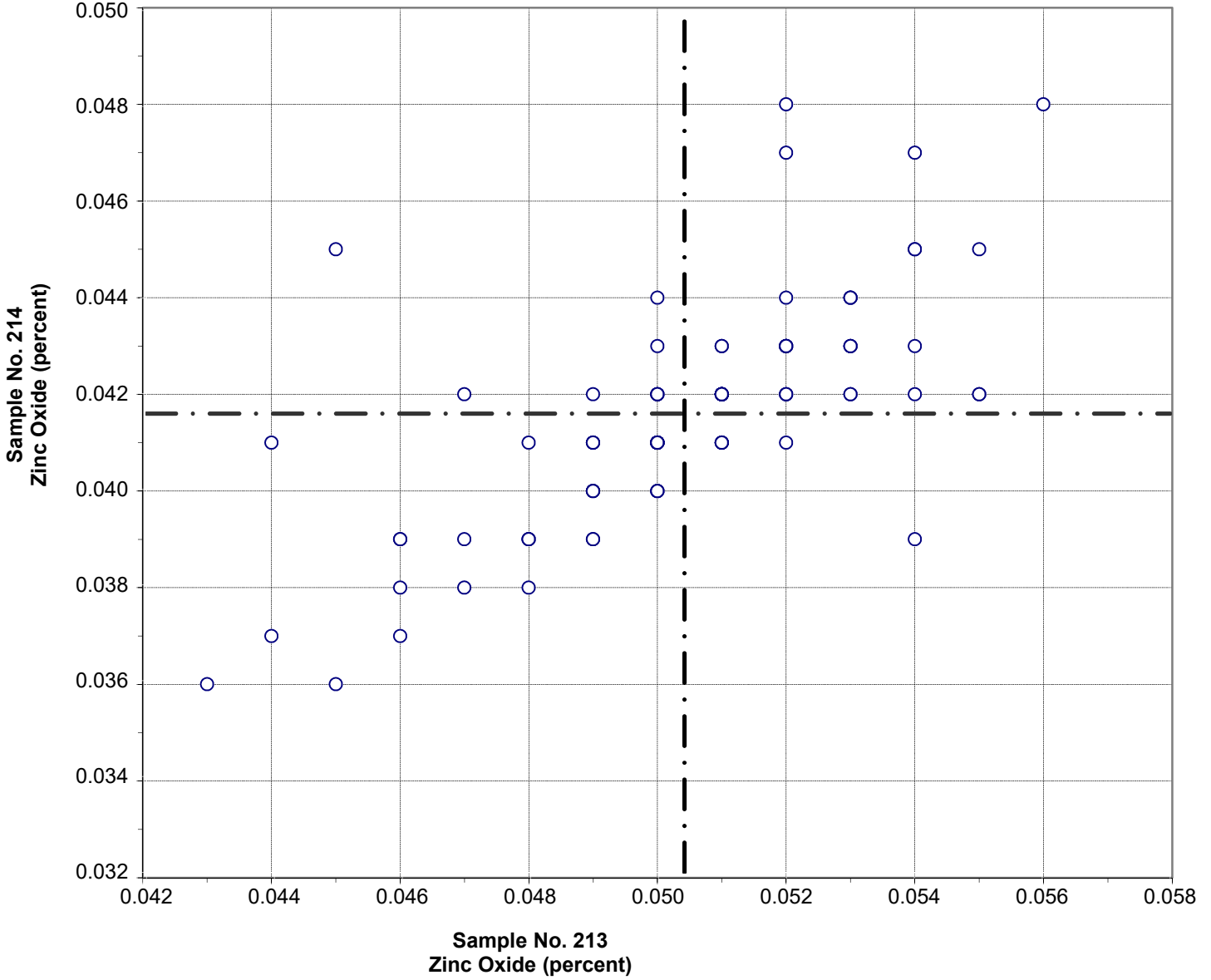


Test No. 102 Phosphorus Pentoxide 150 Points

Sample No. 213	Ave 0.047	S.D. 0.006	C.V. 13.4
Sample No. 214	Ave 0.077	S.D. 0.007	C.V. 8.8

Labs Eliminated: 48, 99, 116, 146, 246, 494, 502, 1079, 2463, 3250, 4099, 4115, 4404

**CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

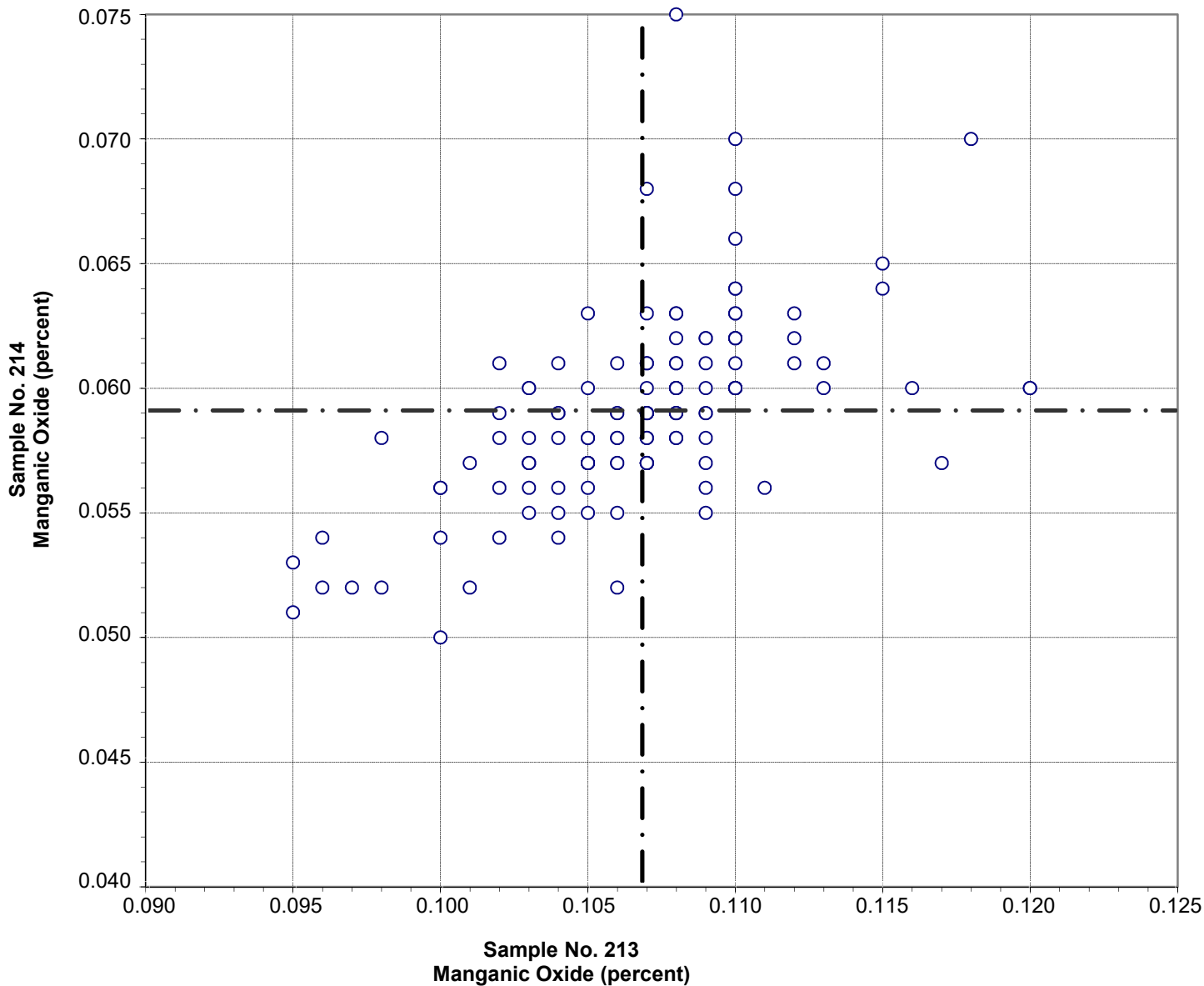


Test No. 99 Zinc Oxide 96 Points

Sample No. 213	Ave 0.050	S.D. 0.003	C.V. 5.1
Sample No. 214	Ave 0.042	S.D. 0.002	C.V. 5.4

Labs Eliminated: 78, 94, 116, 206, 502, 1916

**CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

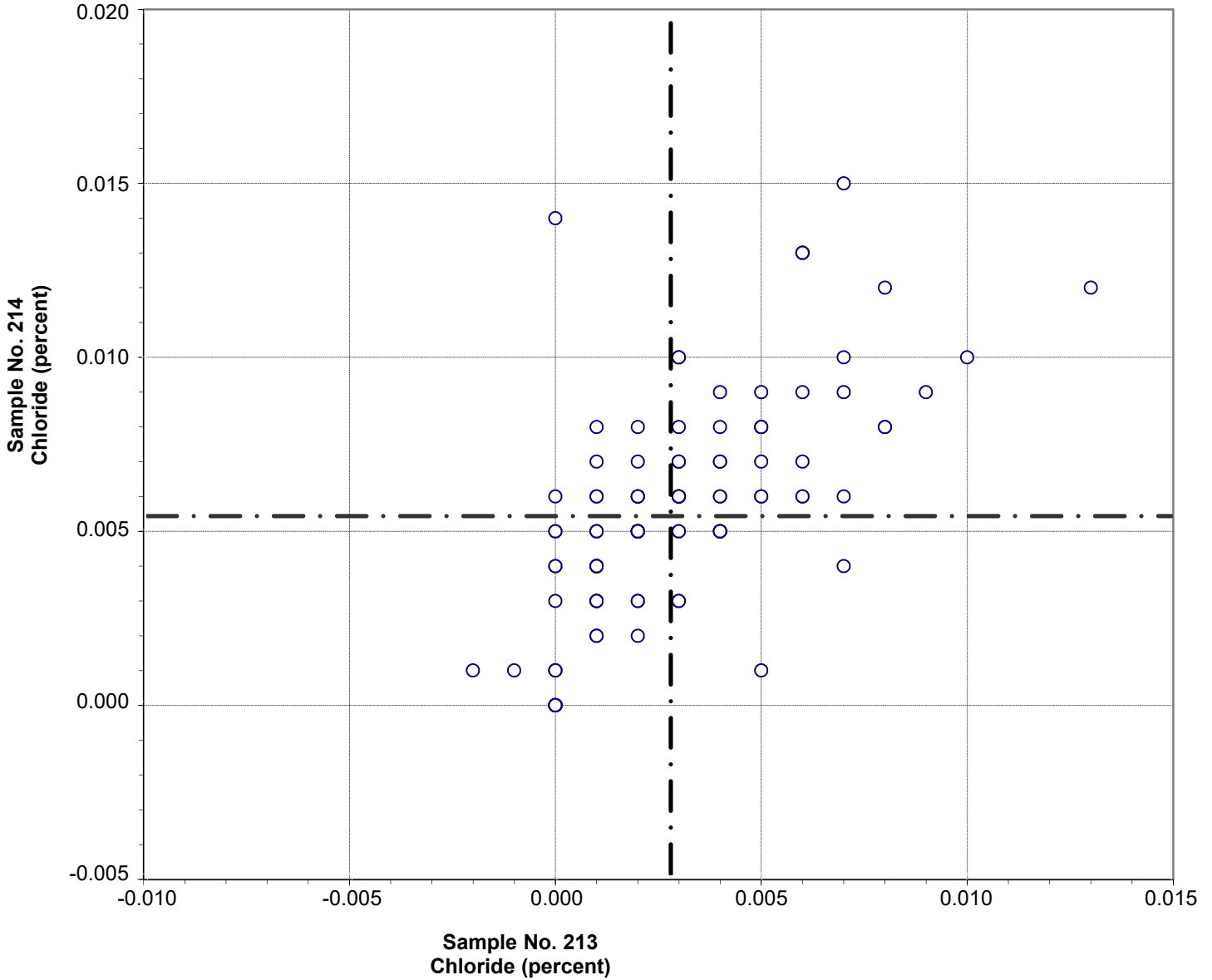


Test No. 101 Manganic Oxide 128 Points

Sample No. 213	Ave 0.107	S.D. 0.005	C.V. 4.2
Sample No. 214	Ave 0.059	S.D. 0.004	C.V. 6.4

Labs Eliminated: 25, 94, 219, 413, 491, 2477, 3238, 3297, 4042, 4404

**CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 213 and No. 214**

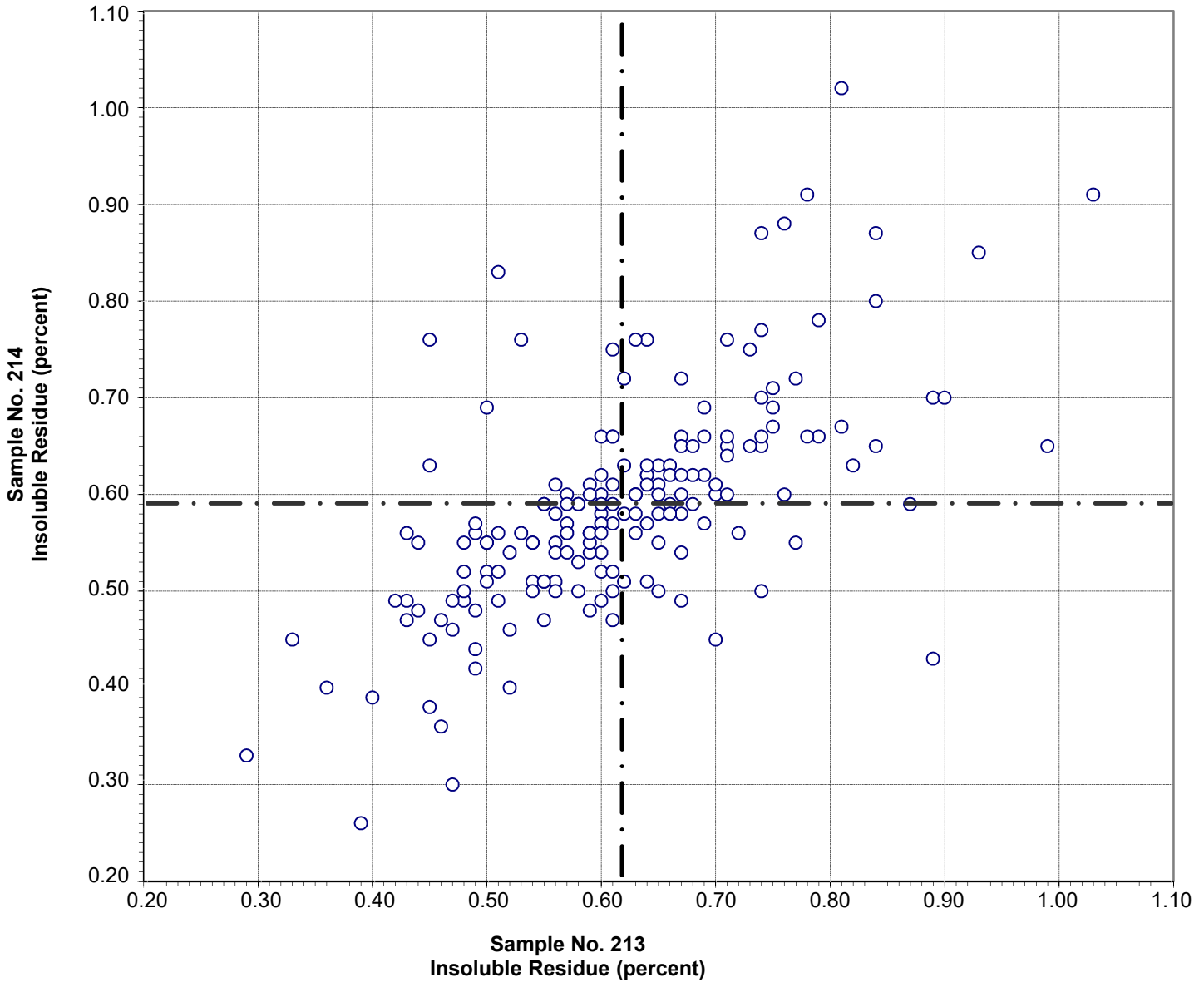


Test No. 104 Chloride 114 Points

Sample No. 213	Ave 0.003	S.D. 0.003	C.V. 94
Sample No. 214	Ave 0.005	S.D. 0.003	C.V. 61

Labs Eliminated: 4, 25, 94, 142, 692, 982, 1916, 3415, 3607

**CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 213 and No. 214**

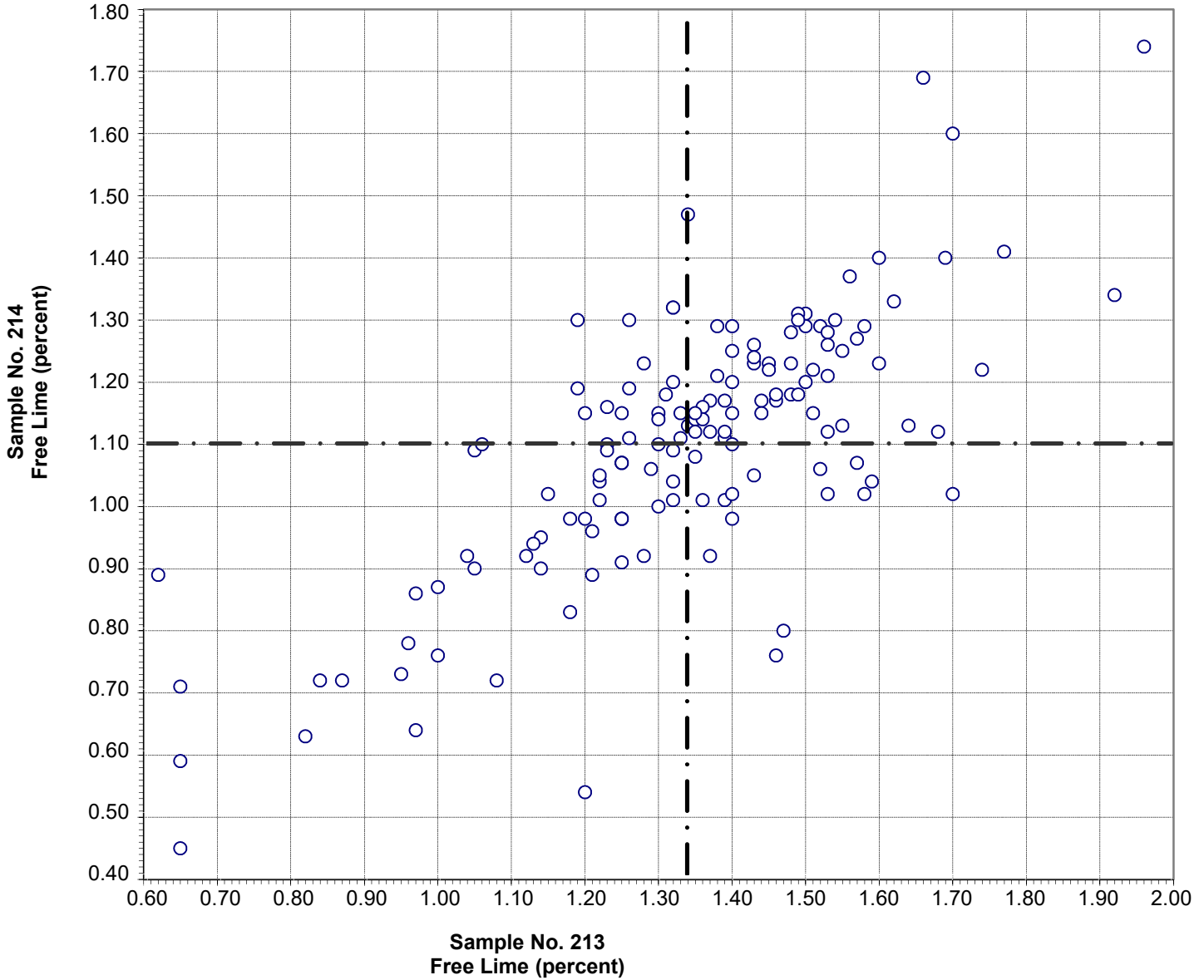


Test No. 80 Insoluble Residue 179 Points

Sample No. 213	Ave 0.62	S.D. 0.12	C.V. 20
Sample No. 214	Ave 0.59	S.D. 0.11	C.V. 19

Labs Eliminated: 4, 431, 881, 2938, 3415, 4297, 4351, 4447

CCRL Proficiency Sample Program
Free Lime
PORTLAND CEMENT Samples No. 213 and No. 214

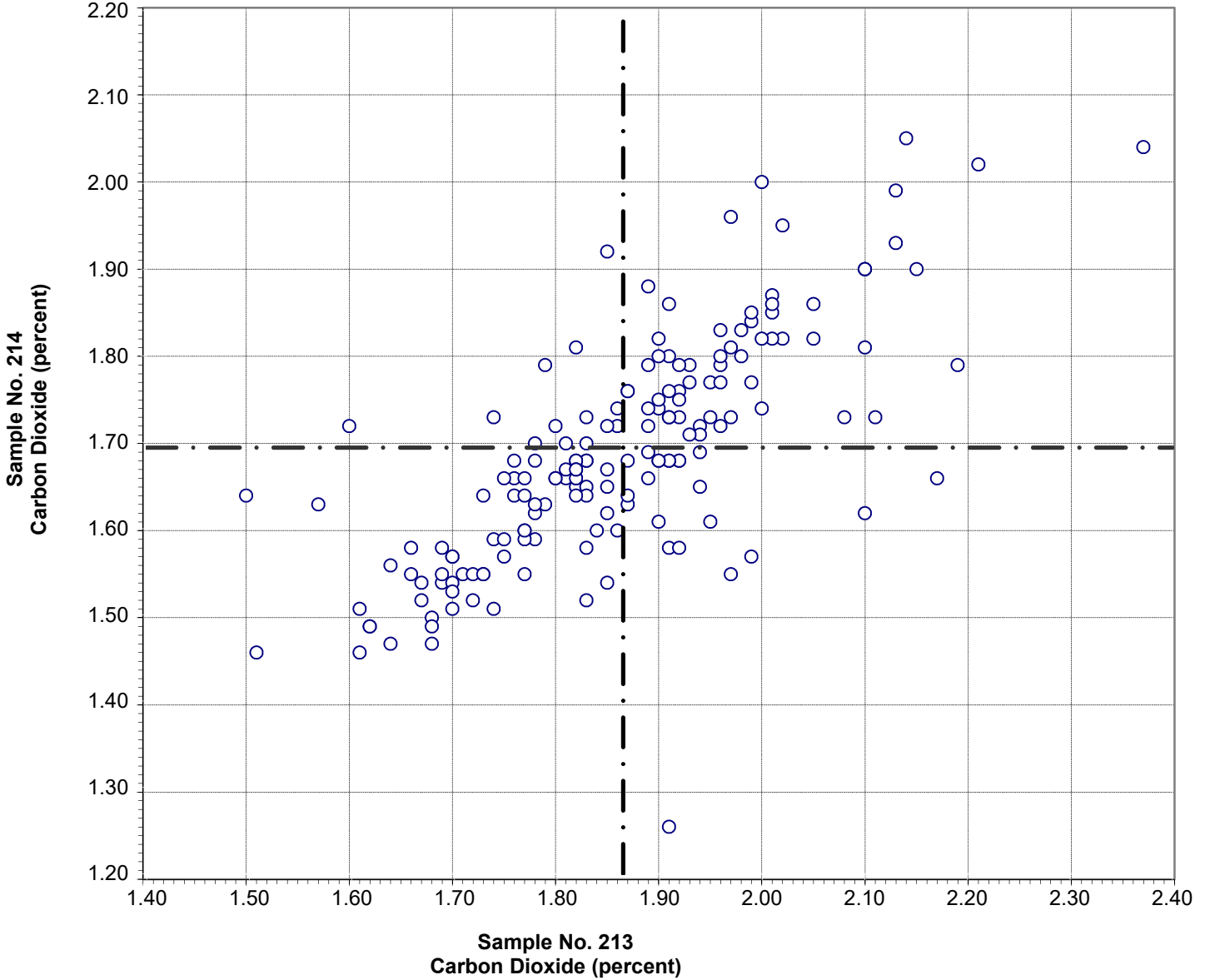


Test No. 41 Free Lime 142 Points

Sample No. 213	Ave 1.34	S.D. 0.23	C.V. 17
Sample No. 214	Ave 1.10	S.D. 0.21	C.V. 19

Labs Eliminated: 43, 78, 152, 494, 1942, 2352, 2360, 4138

**CCRL Proficiency Sample Program
Carbon Dioxide
PORTLAND CEMENT Samples No. 213 and No. 214**



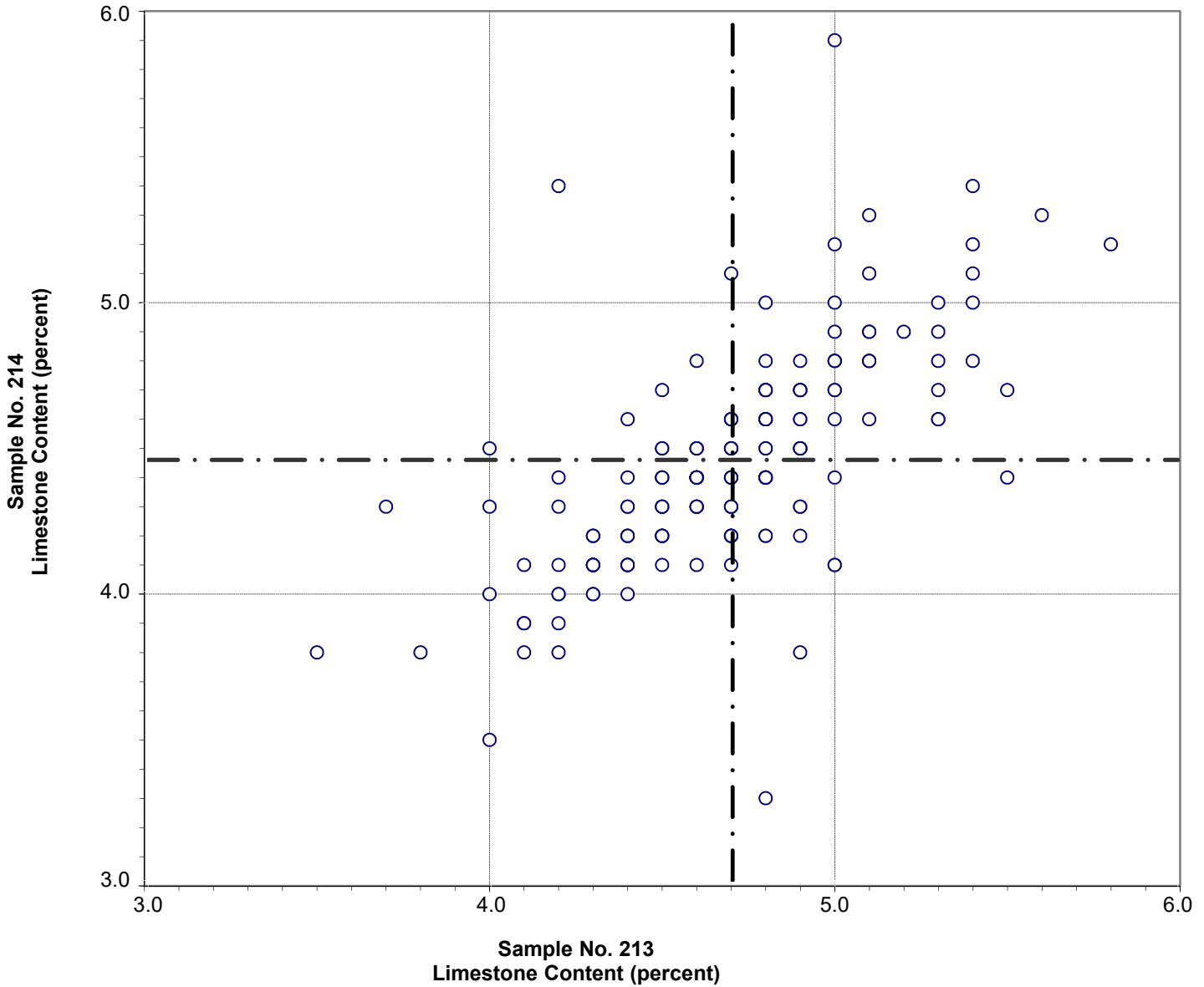
Test No. 97 Carbon Dioxide 172 Points

Sample No. 213	Ave 1.86	S.D. 0.14	C.V. 7.6
Sample No. 214	Ave 1.69	S.D. 0.14	C.V. 8.0

Labs Eliminated: 42, 246, 247, 3607, 4270, 4404

Labs off Diagram: 502

**CCRL Proficiency Sample Program
Limestone Content
PORTLAND CEMENT Samples No. 213 and No. 214**



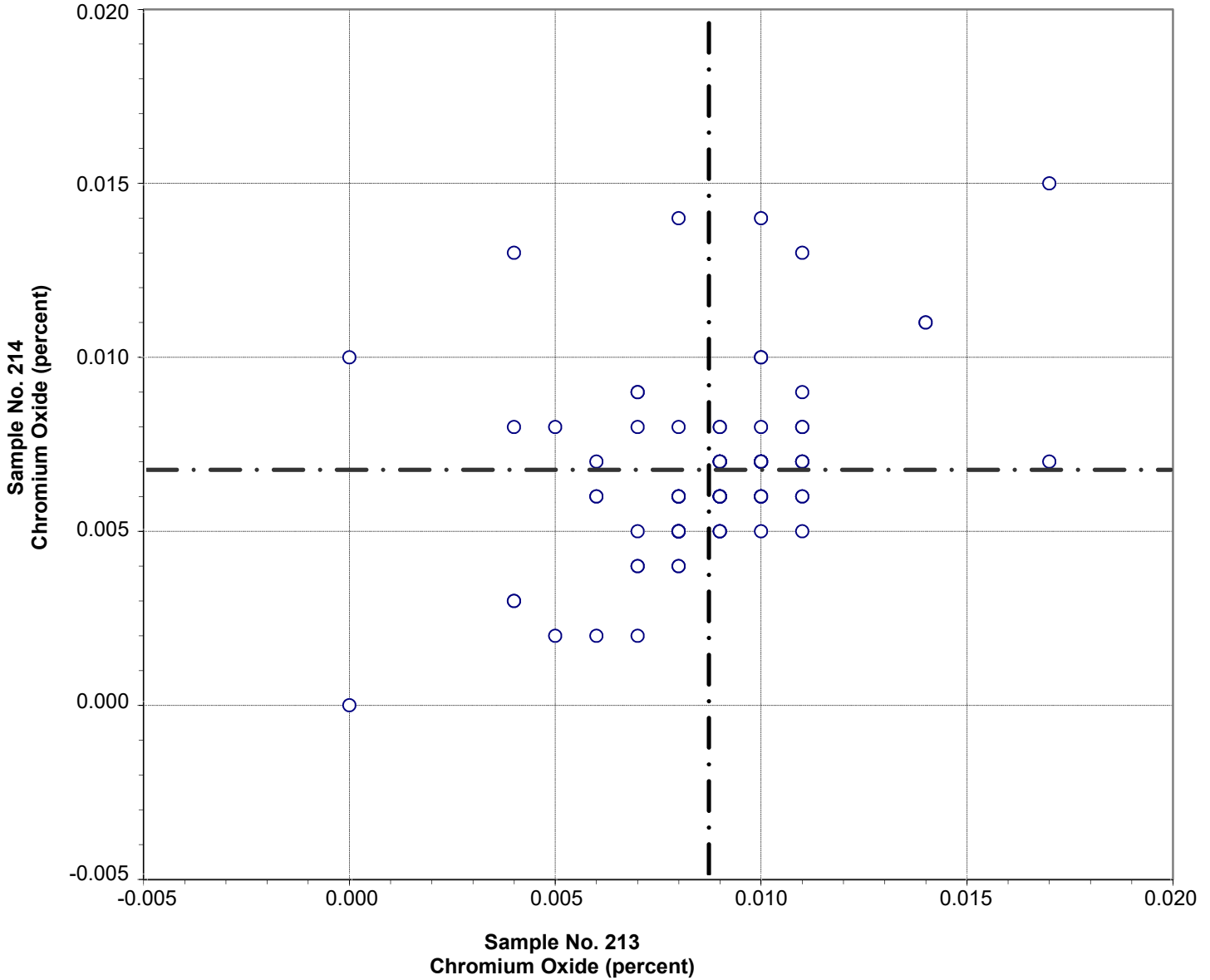
Test No. 98 Limestone Content 170 Points

Sample No. 213	Ave 4.7	S.D. 0.4	C.V. 8.4
Sample No. 214	Ave 4.5	S.D. 0.4	C.V. 8.4

Labs Eliminated: 42, 247, 440, 1657, 4404

Labs off Diagram: 3607

**CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 213 and No. 214**

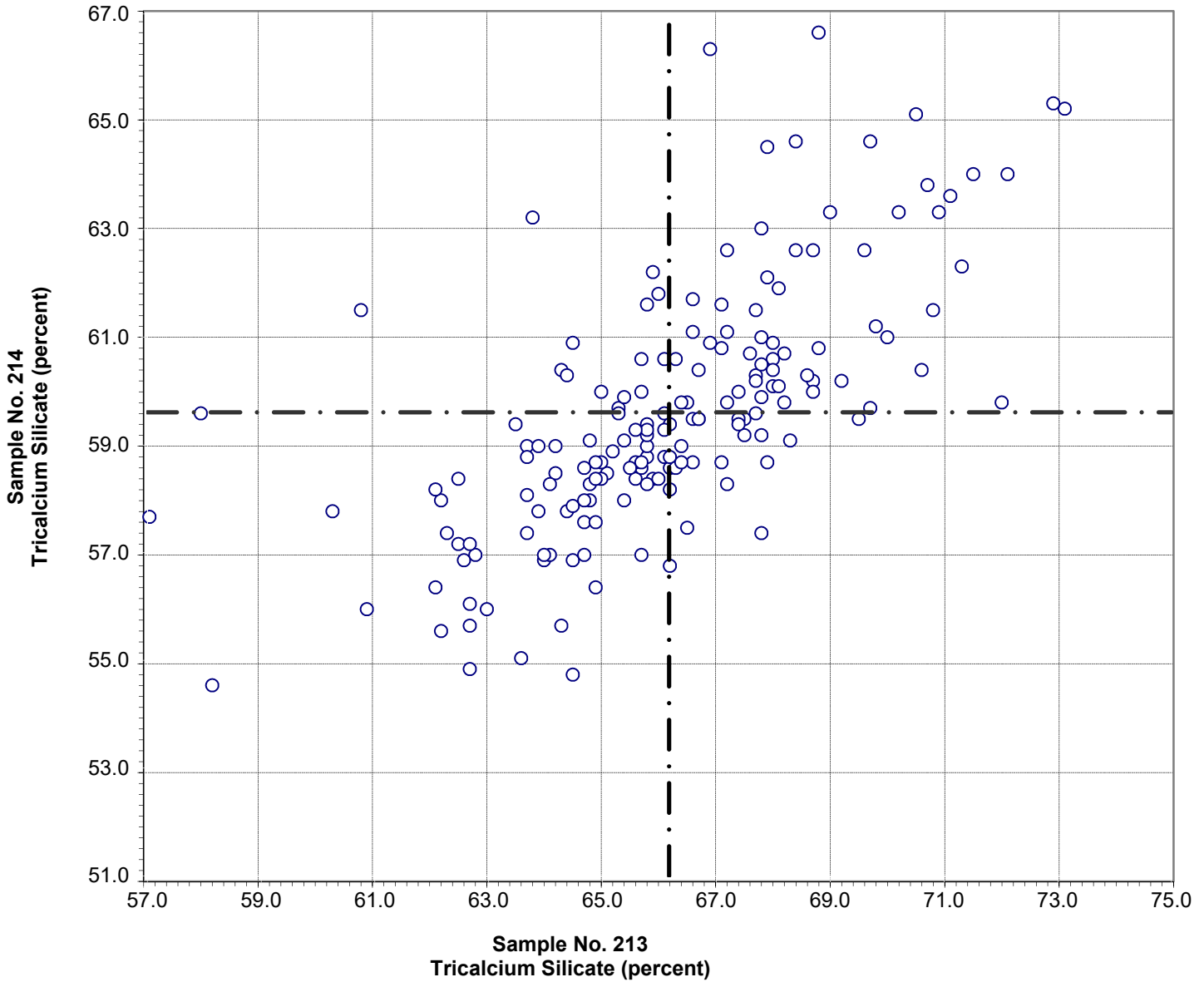


Test No. 105 Chromium Oxide 85 Points

Sample No. 213	Ave 0.009	S.D. 0.003	C.V. 31
Sample No. 214	Ave 0.007	S.D. 0.003	C.V. 39

Labs Eliminated: 66, 116, 206, 415, 493, 684, 3607

**CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 213 and No. 214**

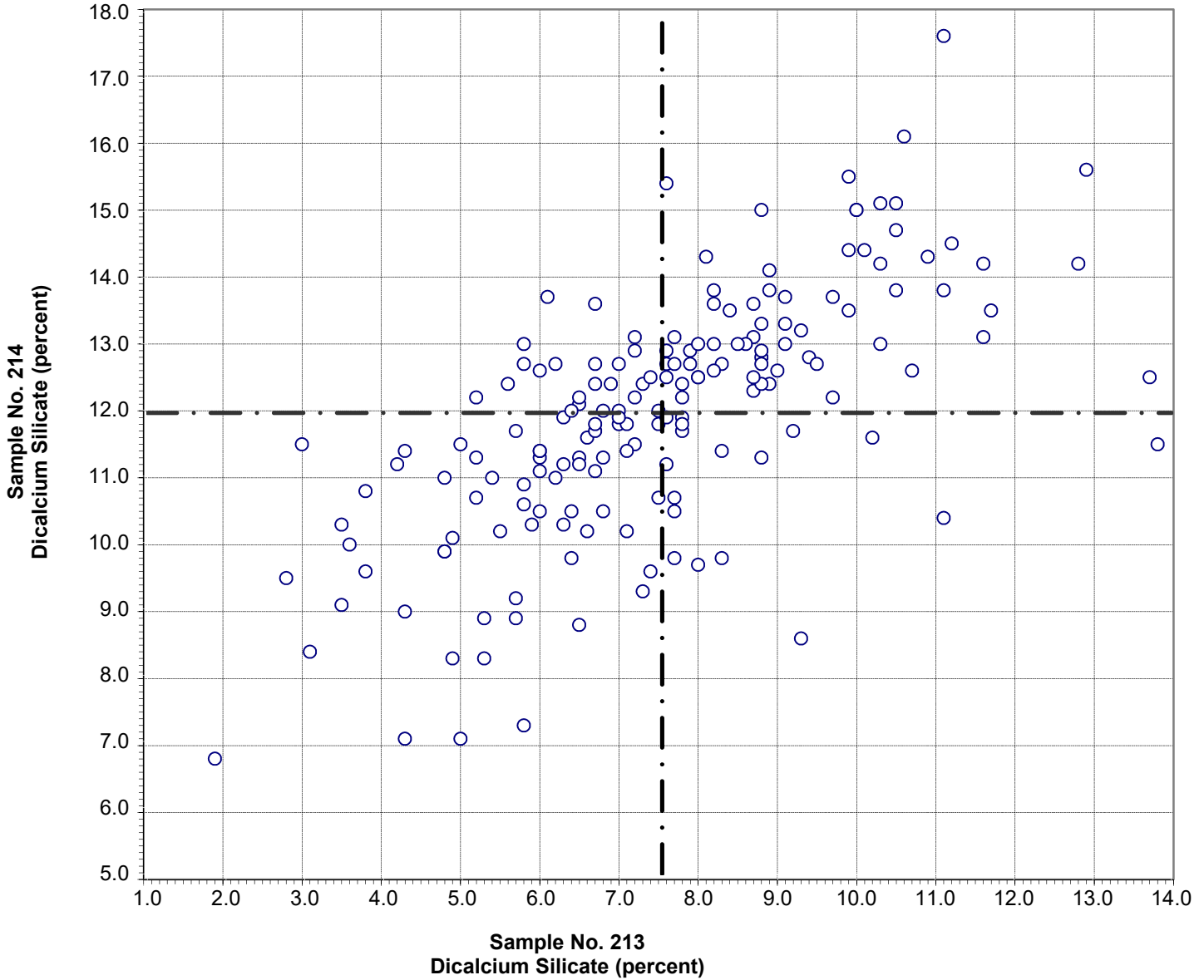


Test No. 106 Tricalcium Silicate 173 Points

Sample No. 213	Ave 66.2	S.D. 2.7	C.V. 4.0
Sample No. 214	Ave 59.6	S.D. 2.3	C.V. 3.8

Labs Eliminated: 95, 175, 246, 4297

**CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 213 and No. 214**

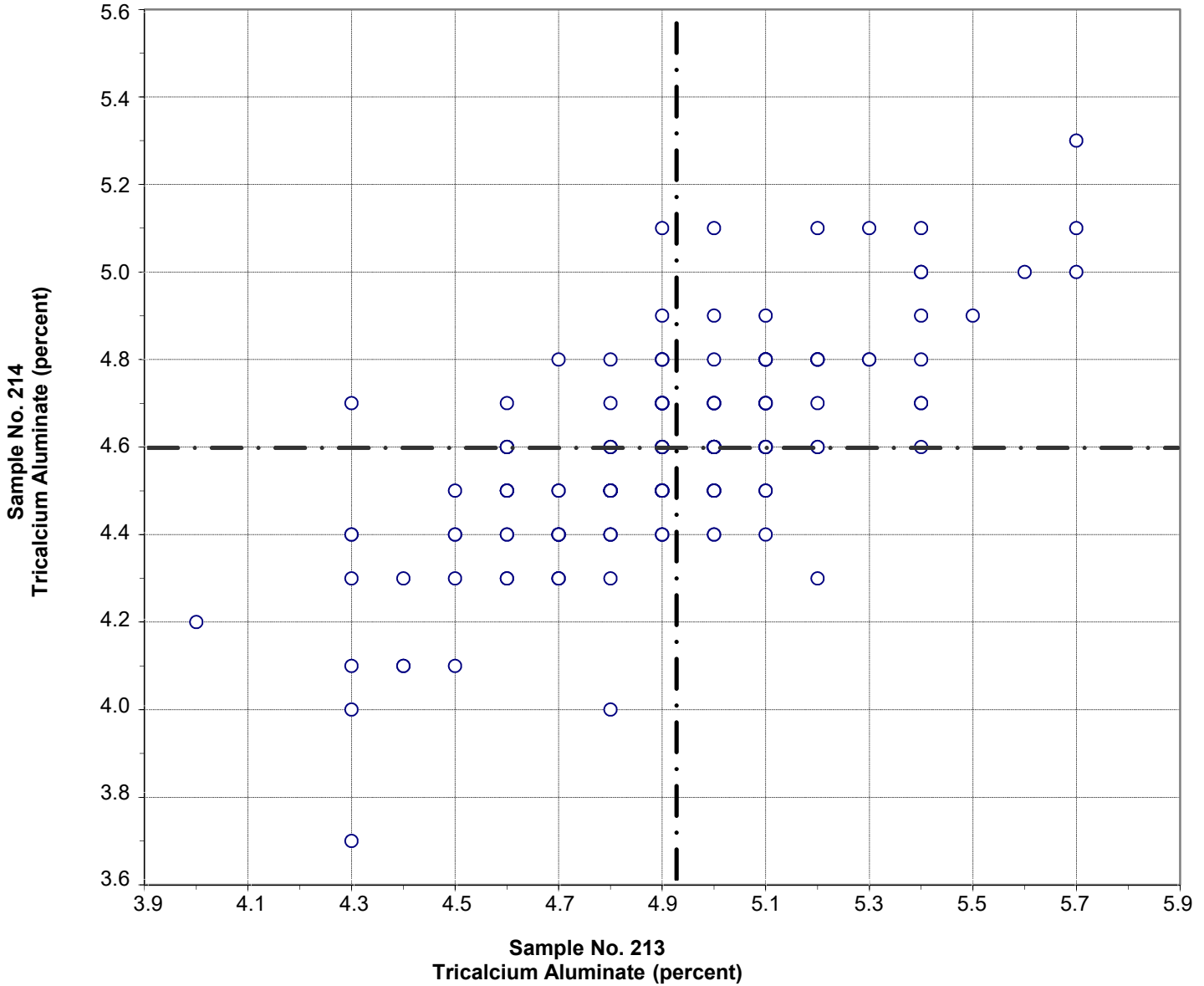


Test No. 107 Dicalcium Silicate 172 Points

Sample No. 213 Ave 7.5 S.D. 2.2 C.V. 28.7
Sample No. 214 Ave 12.0 S.D. 1.8 C.V. 15.3

Labs Eliminated: 95, 175, 246, 547, 4297

**CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 213 and No. 214**



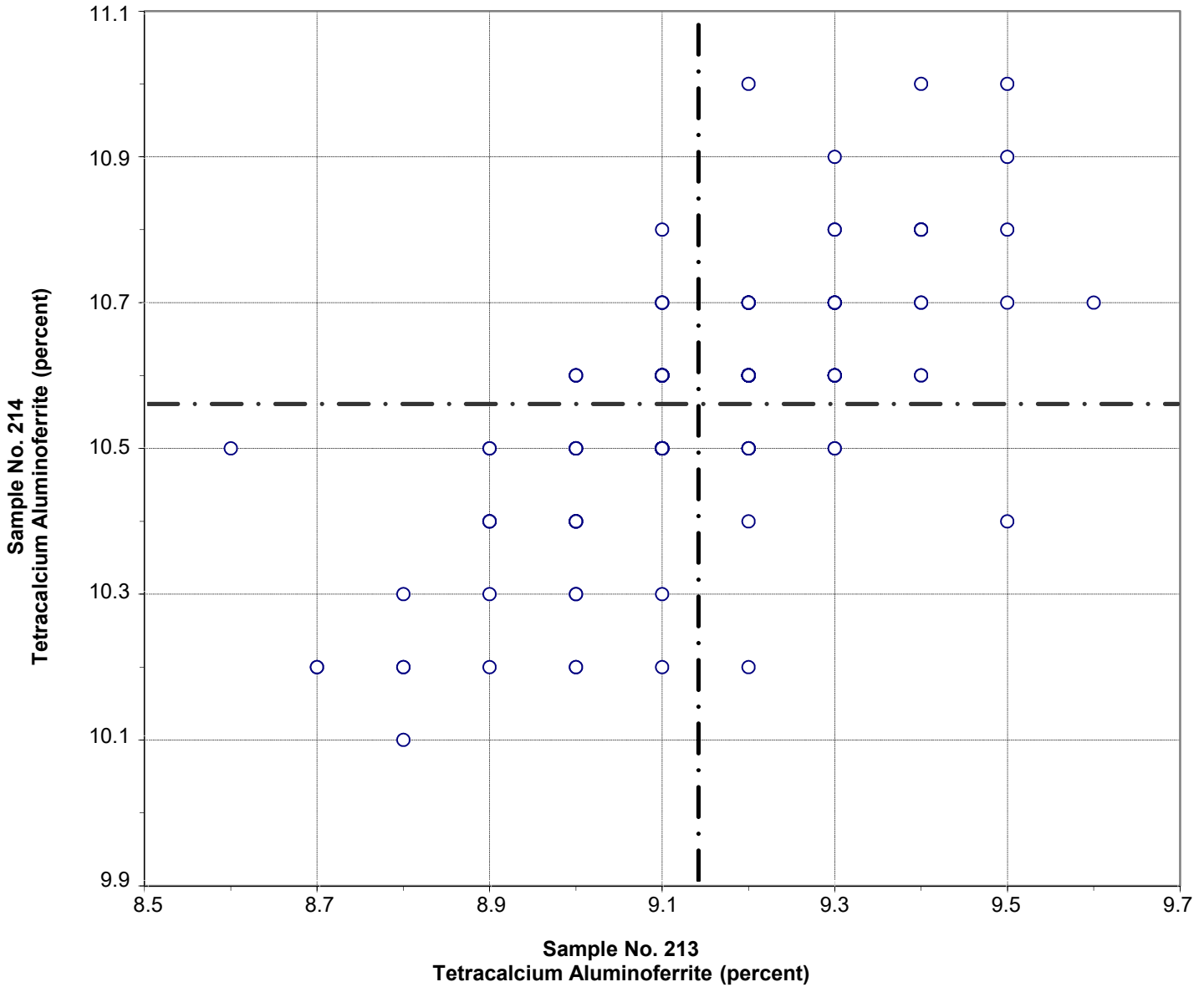
Test No. 108 Tricalcium Aluminate 172 Points

Sample No. 213	Ave 4.9	S.D. 0.3	C.V. 6.2
Sample No. 214	Ave 4.6	S.D. 0.2	C.V. 5.1

Labs Eliminated: 42, 95, 975, 3238, 4115, 4297

Labs off Diagram: 4

**CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 213 and No. 214**



Test No. 109 Tetracalcium Aluminoferrite 170 Points

Sample No. 213 Ave 9.1 S.D. 0.2 C.V. 1.7
 Sample No. 214 Ave 10.6 S.D. 0.2 C.V. 1.5

Labs Eliminated: 25, 169, 206, 246, 497, 547, 3185, 3238

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

Final Report – September 20, 2019

SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Normal Consistency - % Water (percent)							
	227	27.1	1.87	6.90	25.3	1.75	6.90
	*226	27.3	0.55	2.00	25.4	0.52	2.10
* Labs Eliminated - 1079							
Vicat Time of Set - Initial (minutes)							
	223	124	12	10	120	14	12
	*218	124	11	9	119	12	10
* Labs Eliminated - 51, 52, 203, 360, 4433							
Vicat Time of Set - Final (minutes)							
	212	231	33	14	225	31	14
	*207	231	28	12	224	28	13
* Labs Eliminated - 14, 132, 309, 1940, 3368							
Gillmore Time of Set - Initial (minutes)							
	115	160	25	16	160	27	17
	*113	158	22	14	159	23	14
* Labs Eliminated - 51, 1054							
Gillmore Time of Set - Final (minutes)							
	115	268	39	15	263	38	15
	*113	266	37	14	260	34	13
* Labs Eliminated - 51, 515							
False Set - Paste Method (percent)							
	171	83	10.2	12.3	82	8.9	10.8
	*167	84	8.0	9.5	83	7.7	9.3
* Labs Eliminated - 116, 222, 493, 497							
Autoclave Expansion (percent)							
	213	0.05	0.082	154	0.03	0.060	220
	*204	0.04	0.017	38	0.02	0.014	71
* Labs Eliminated - 38, 93, 116, 222, 246, 547, 1054, 1594, 4270							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

Final Report – September 20, 2019

SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Air Content % (percent)							
	211	8.4	1.1	13	8.3	1.1	14
	*209	8.4	1.0	12	8.3	1.1	13
* Labs Eliminated - 565, 1644							
Air Content - % Water (percent)							
	201	68.9	4.0	5.9	69.1	4.2	6.0
	*196	69.1	1.9	2.8	69.4	2.0	2.9
* Labs Eliminated - 49, 565, 1644, 1715, 4042							
Air Content - Flow (percent)							
	203	88	3.7	4.2	87	3.6	4.1
	*202	88	3.2	3.7	87	3.3	3.8
* Labs Eliminated - 78							
Compressive Strength - 3 day (psi)							
	234	3685	293	7.9	3768	314	8.3
	*230	3681	257	7.0	3775	286	7.6
* Labs Eliminated - 103, 180, 4042, 4433							
Compressive Strength - 7 day (psi)							
	235	5050	389	7.7	4626	333	7.2
	*229	5051	334	6.6	4645	303	6.5
* Labs Eliminated - 22, 36, 42, 1222, 4042, 4433							
Compressive Strength - 28 day (psi)							
	221	6865	566	8.2	5683	448	7.9
	*216	6902	513	7.4	5688	423	7.4
* Labs Eliminated - 9, 49, 1019, 1222, 4433							
Compressive Strength - Flow (percent)							
	215	113	10	8.8	108	9	8.2
	*212	113	9	8.0	109	9	7.8
* Labs Eliminated - 38, 49, 51							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

Final Report – September 20, 2019

SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
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Fineness - Air Permeability (m²/kg)

224	429	26	6.0	382	17	4.5
*212	429	16	3.6	381	12	3.2

* Labs Eliminated - 22, 95, 143, 146, 222, 246, 474, 515, 1773, 3245, 3368, 3752

Fineness - 45µm Sieve (percent)

214	98.52	7.02	7.13	95.60	6.82	7.13
*199	99.37	0.31	0.31	96.27	0.62	0.65

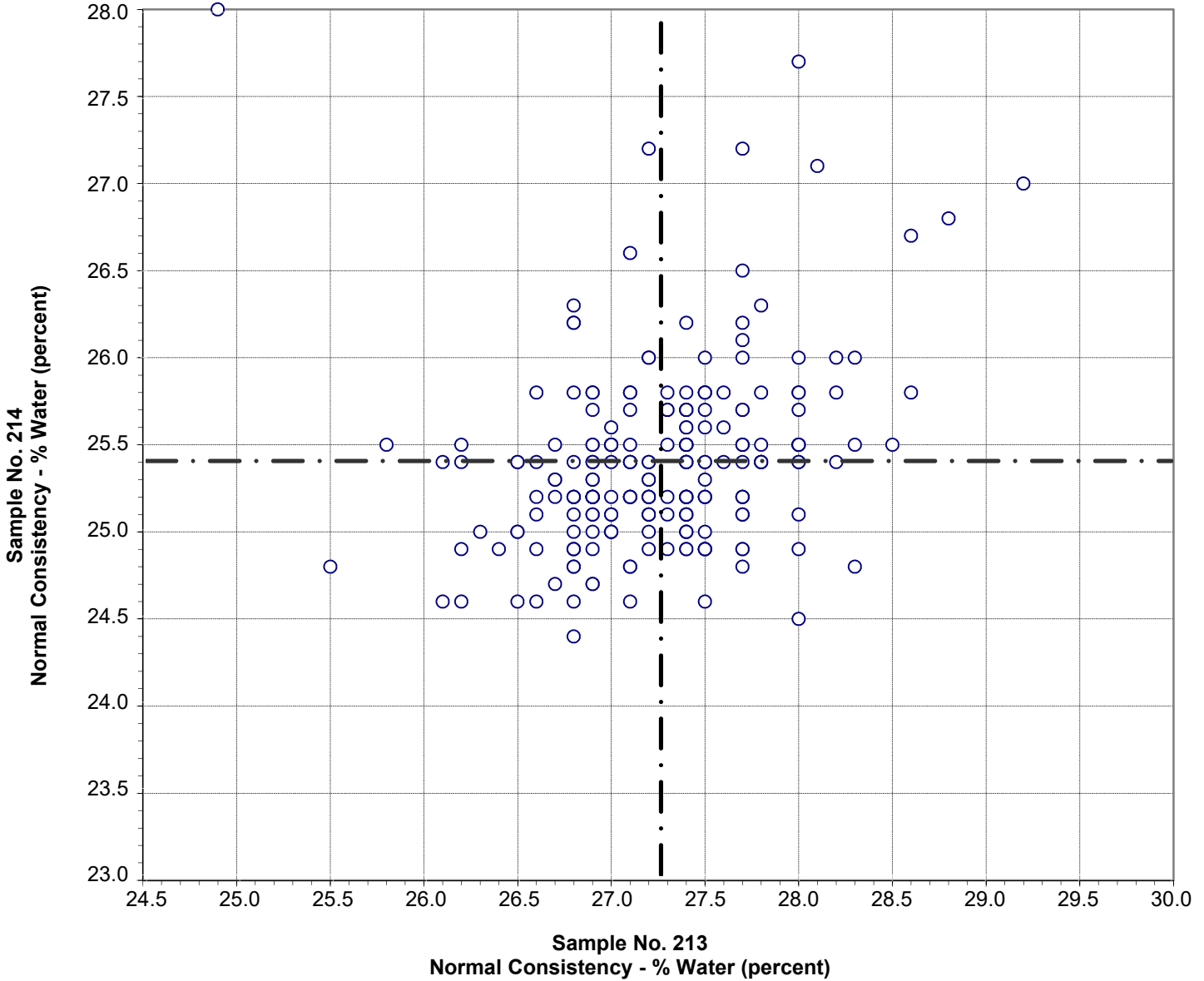
* Labs Eliminated - 26, 116, 132, 159, 246, 493, 698, 1940, 3245, 3606, 3607, 4042, 4270, 4404, 4433

C1038 Mortar Bar Expansion (percent)

146	0.005	0.004	76	0.006	0.006	108
*141	0.006	0.003	53	0.005	0.003	59

* Labs Eliminated - 15, 1251, 2483, 2490, 4351

**CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 213 and No. 214**

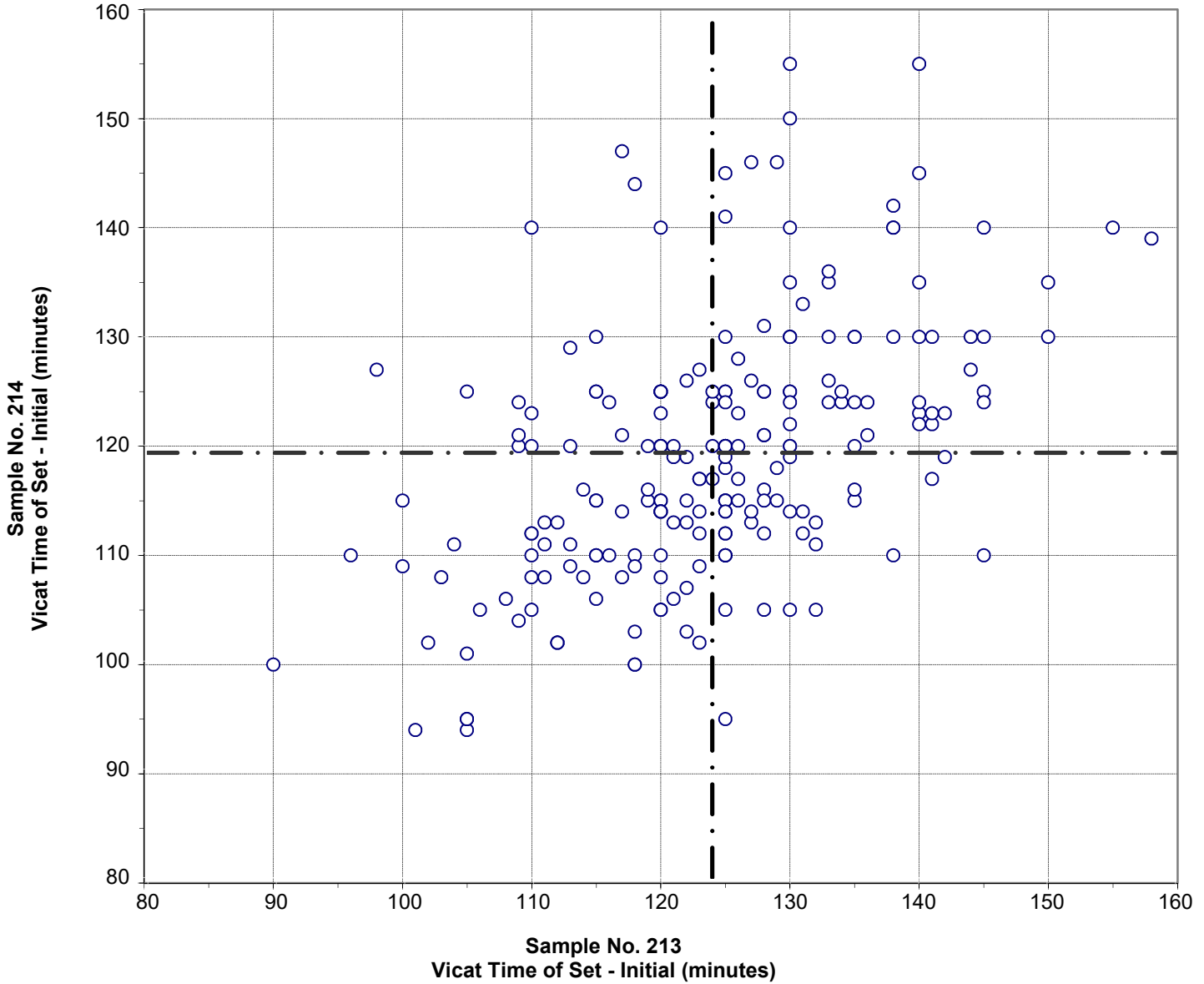


Test No. 110 Normal Consistency - % Water 226 Points

Sample No. 213	Ave 27.3	S.D. 0.55	C.V. 2.00
Sample No. 214	Ave 25.4	S.D. 0.52	C.V. 2.10

Labs Eliminated: 1079

CCRL Proficiency Sample Program
Vicat Time of Set - Initial
PORTLAND CEMENT Samples No. 213 and No. 214

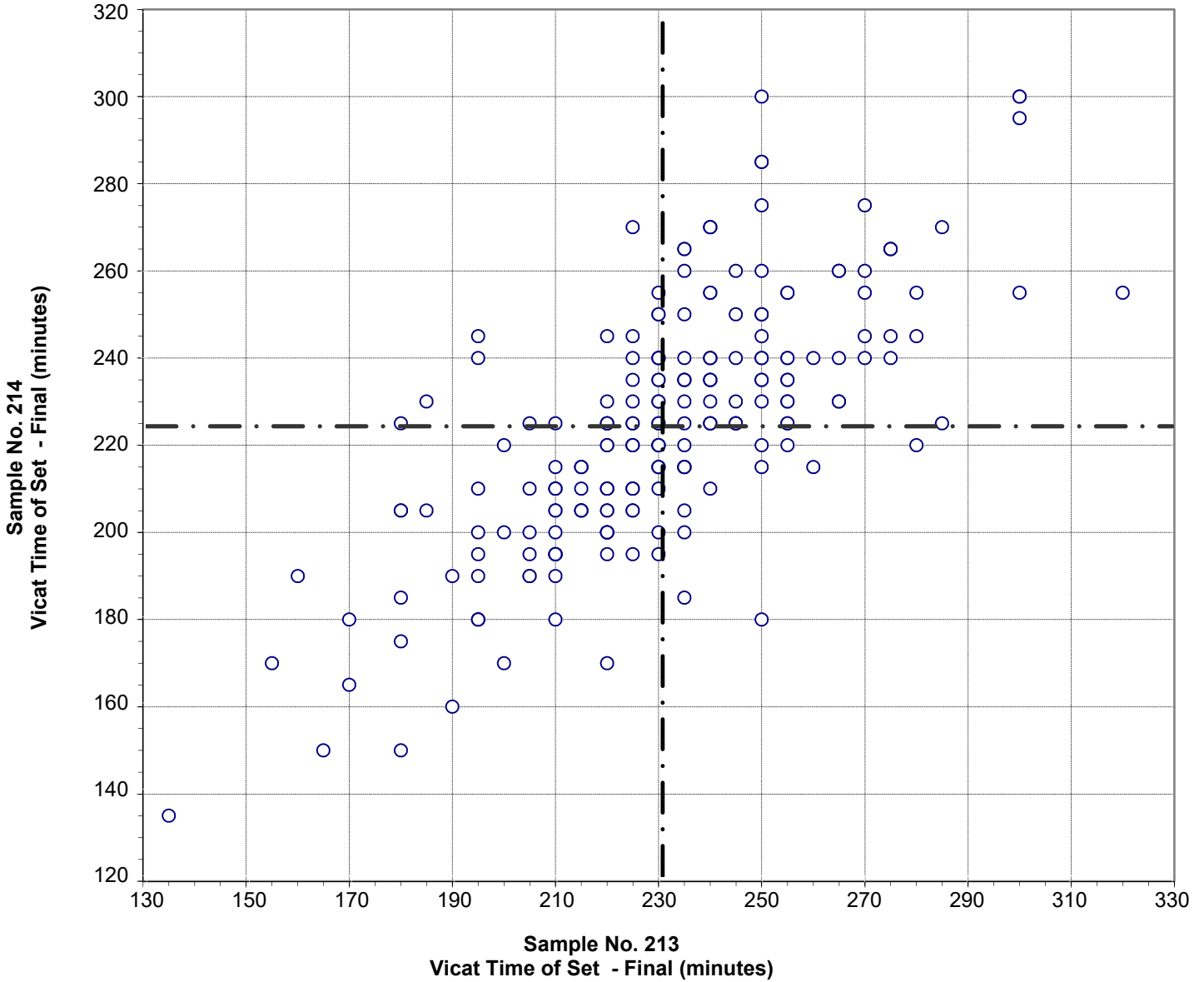


Test No. 120 Vicat Time of Set - Initial 218 Points

Sample No. 213	Ave 124	S.D. 11	C.V. 9
Sample No. 214	Ave 119	S.D. 12	C.V. 10

Labs Eliminated: 51, 52, 203, 360, 4433

**CCRL Proficiency Sample Program
 Vicat Time of Set - Final
 PORTLAND CEMENT Samples No. 213 and No. 214**

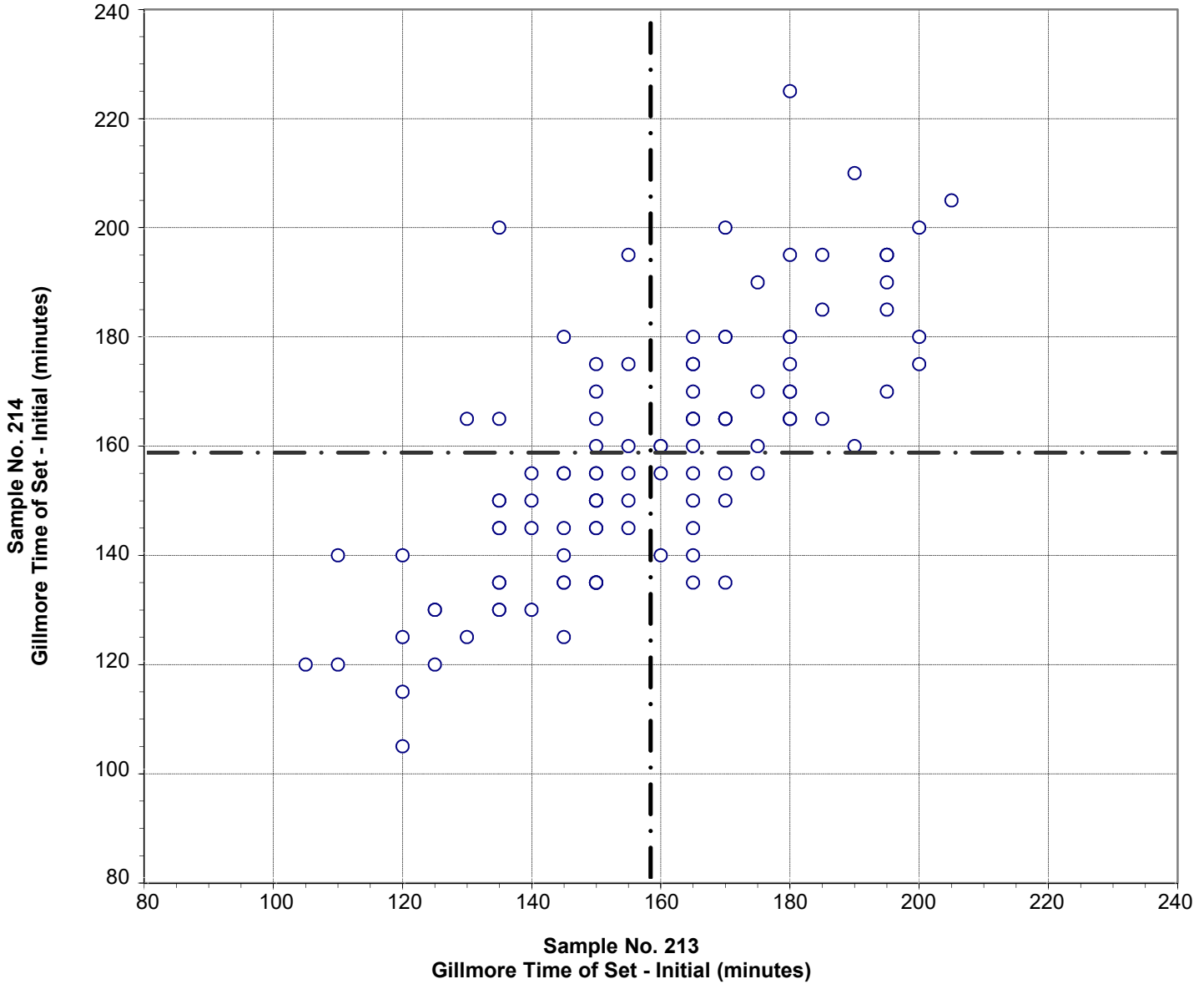


Test No. 121 Vicat Time of Set - Final 207 Points

Sample No. 213	Ave 231	S.D. 28	C.V. 12
Sample No. 214	Ave 224	S.D. 28	C.V. 13

Labs Eliminated: 14, 132, 309, 1940, 3368

**CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 213 and No. 214**

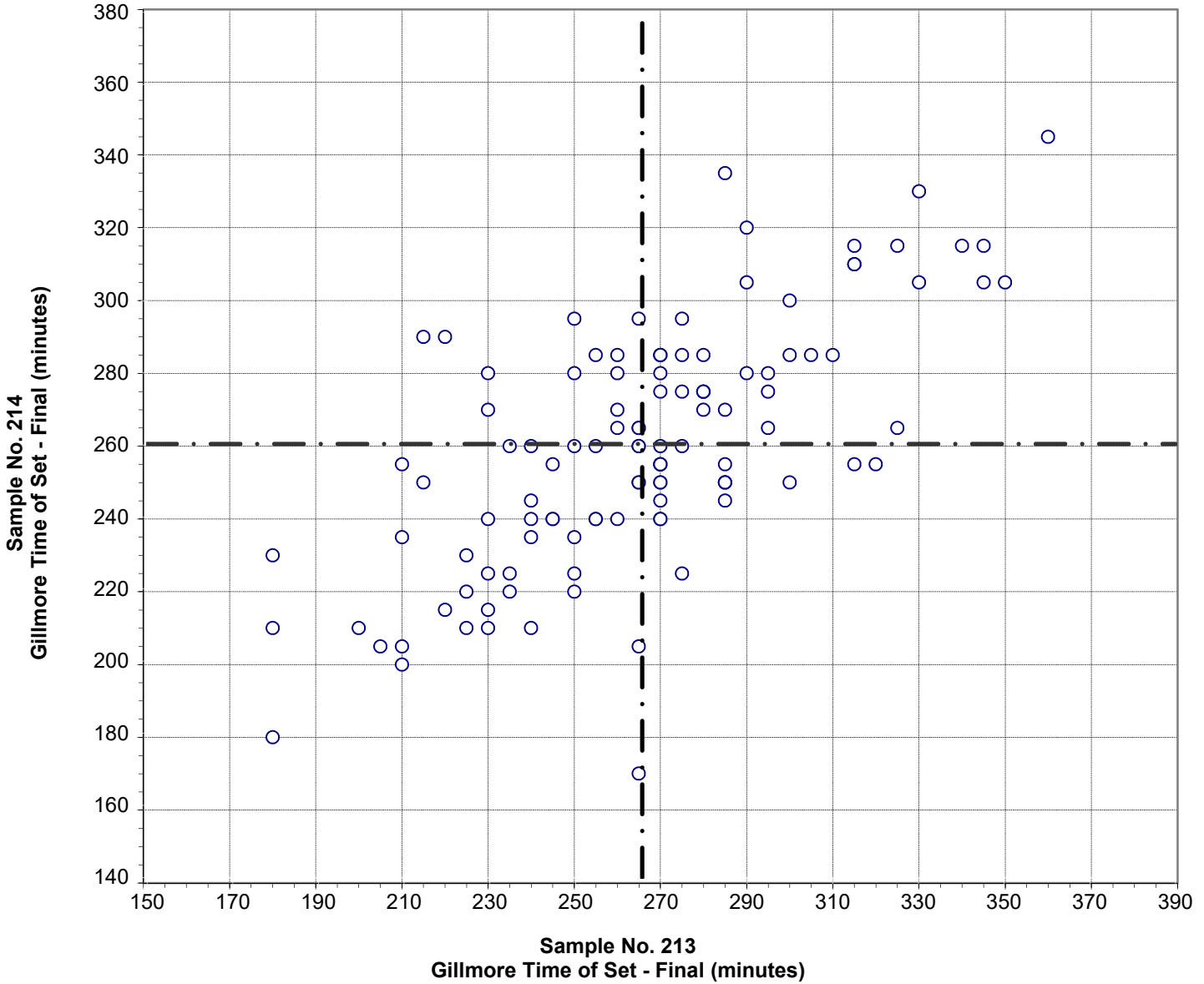


Test No. 130 Gillmore Time of Set - Initial 113 Points

Sample No. 213	Ave 158	S.D. 22	C.V. 14
Sample No. 214	Ave 159	S.D. 23	C.V. 14

Labs Eliminated: 51, 1054

**CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 213 and No. 214**

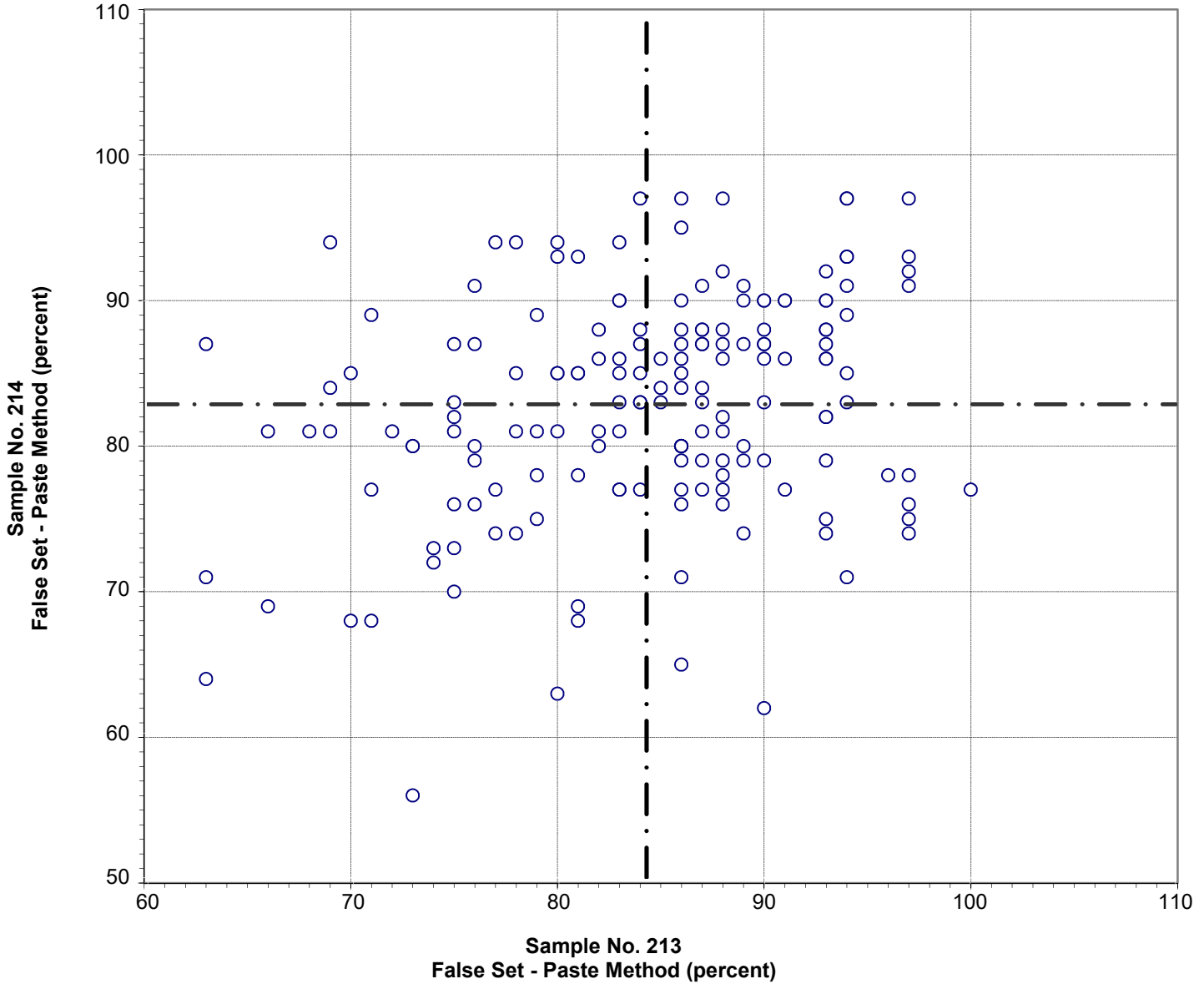


Test No. 140 Gillmore Time of Set - Final 113 Points

Sample No. 213	Ave 266	S.D. 37	C.V. 14
Sample No. 214	Ave 260	S.D. 34	C.V. 13

Labs Eliminated: 51, 515

**CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 213 and No. 214**

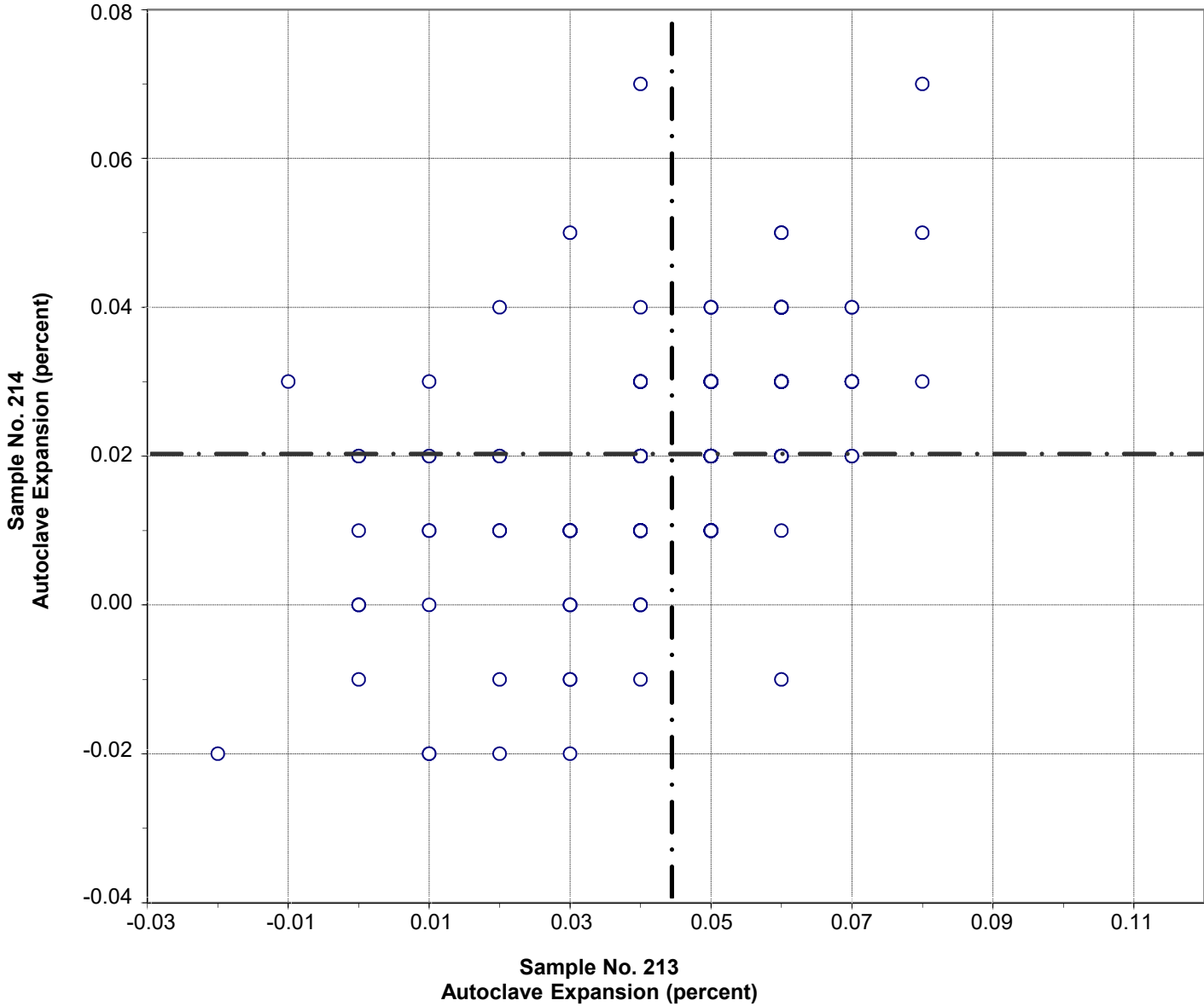


Test No. 150 False Set - Paste Method 167 Points

Sample No. 213	Ave 84	S.D. 8.0	C.V. 9.5
Sample No. 214	Ave 83	S.D. 7.7	C.V. 9.3

Labs Eliminated: 116, 222, 493, 497

**CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 213 and No. 214**

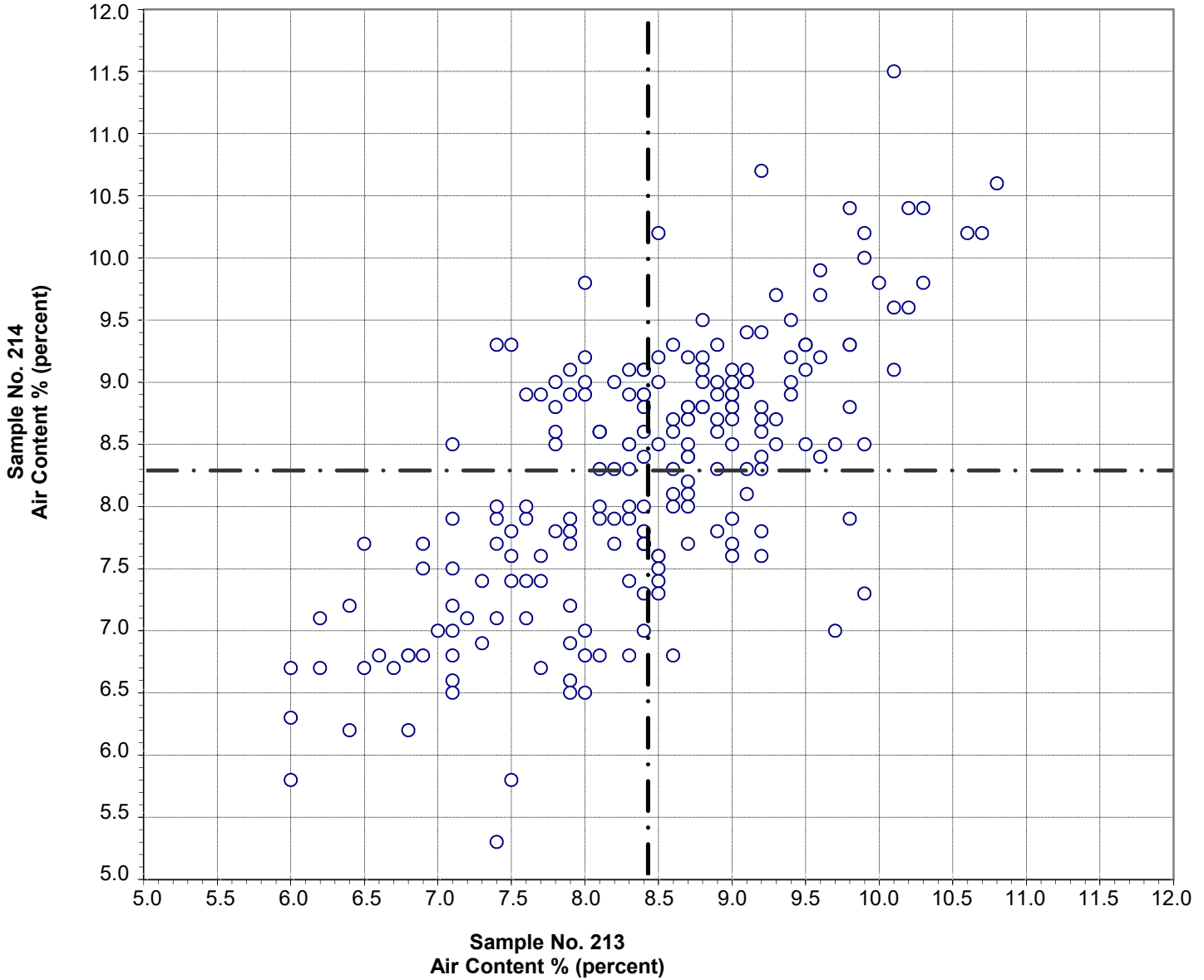


Test No. 160 Autoclave Expansion 204 Points

Sample No. 213	Ave 0.04	S.D. 0.017	C.V. 38
Sample No. 214	Ave 0.02	S.D. 0.014	C.V. 71

Labs Eliminated: 38, 93, 116, 222, 246, 547, 1054, 1594, 4270

CCRL Proficiency Sample Program
Air Content %
PORTLAND CEMENT Samples No. 213 and No. 214

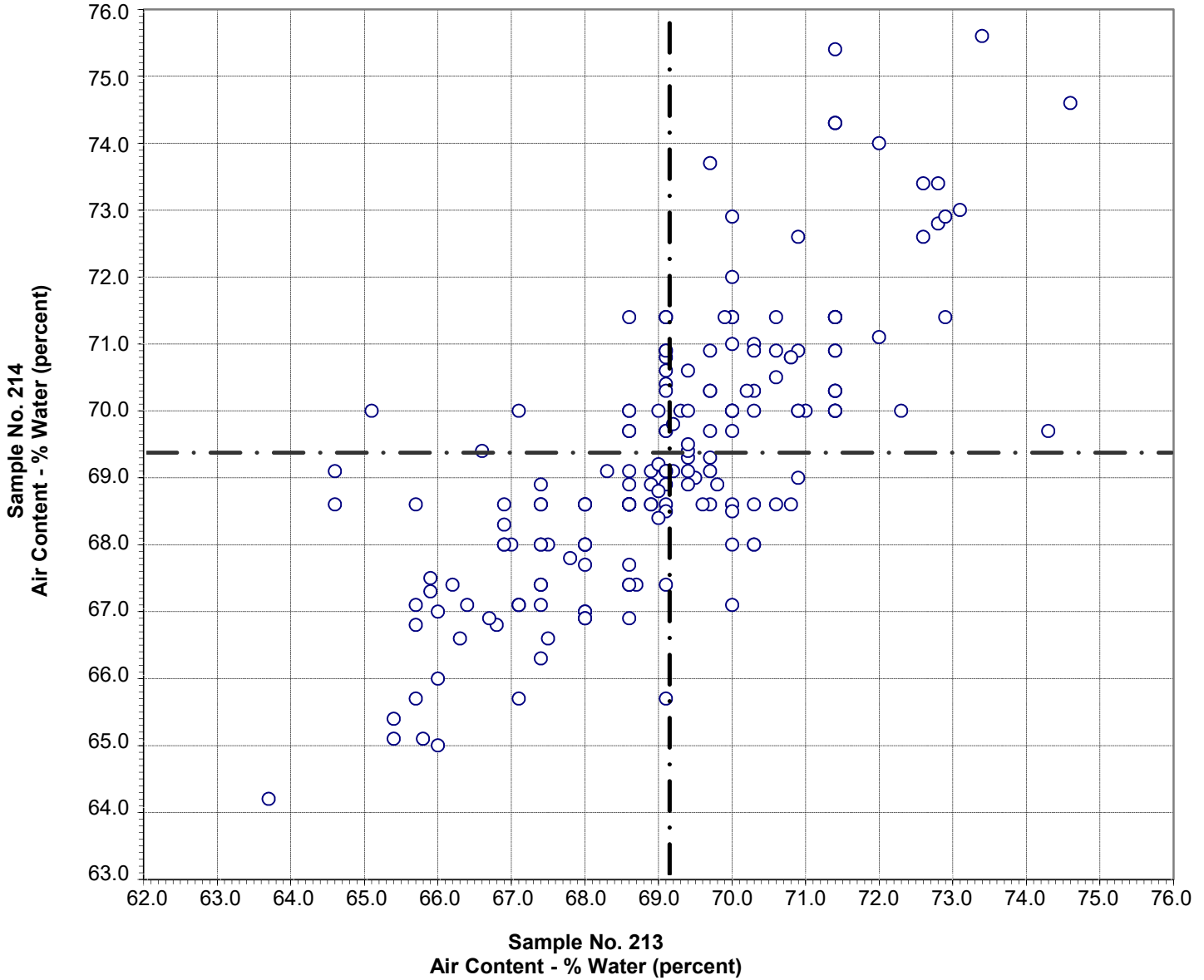


Test No. 170 Air Content % 209 Points

Sample No. 213	Ave 8.4	S.D. 1.0	C.V. 12
Sample No. 214	Ave 8.3	S.D. 1.1	C.V. 13

Labs Eliminated: 565, 1644

CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 213 and No. 214

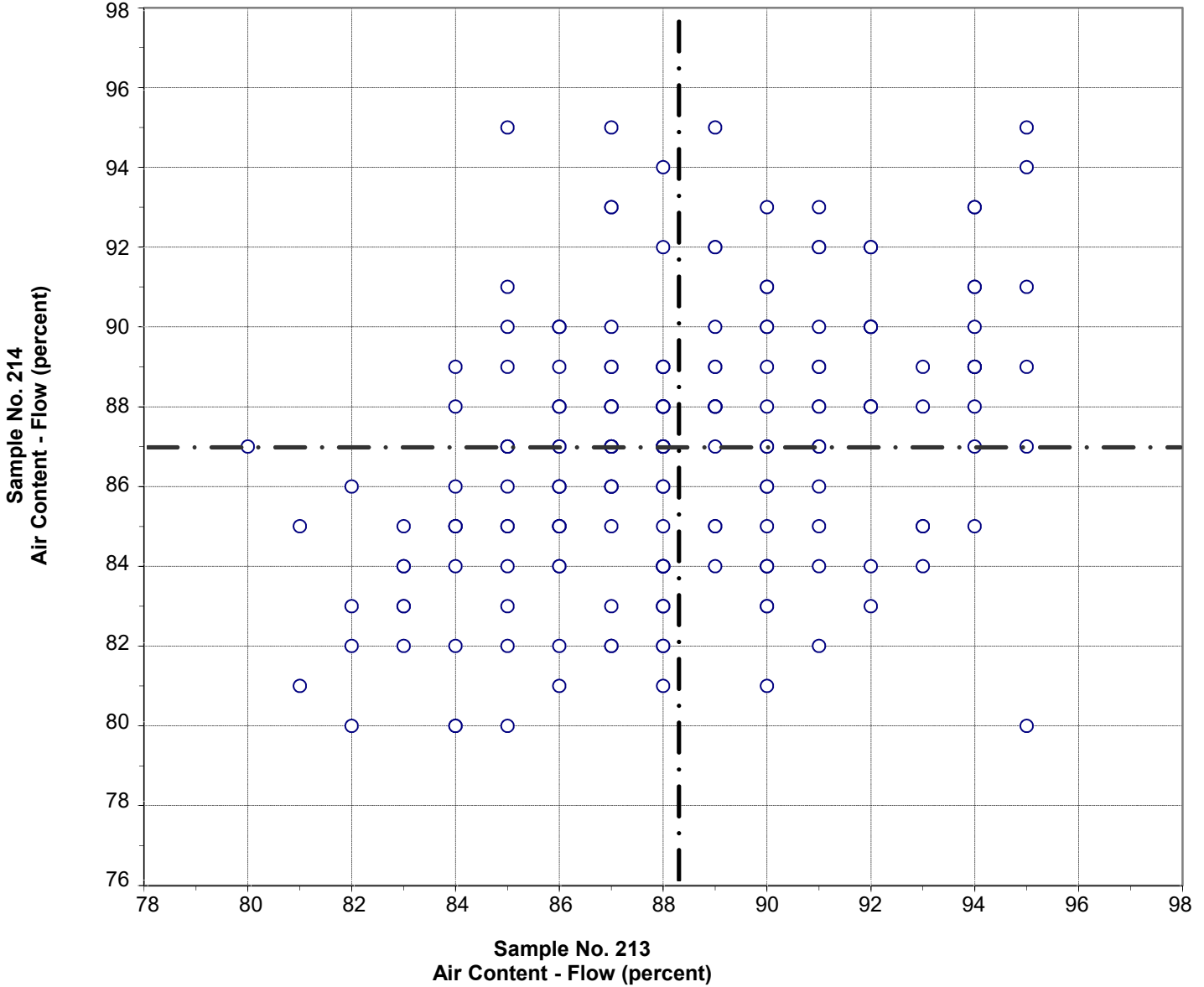


Test No. 180 Air Content - % Water 196 Points

Sample No. 213	Ave 69.1	S.D. 1.9	C.V. 2.8
Sample No. 214	Ave 69.4	S.D. 2.0	C.V. 2.9

Labs Eliminated: 49, 565, 1644, 1715, 4042

**CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 213 and No. 214**

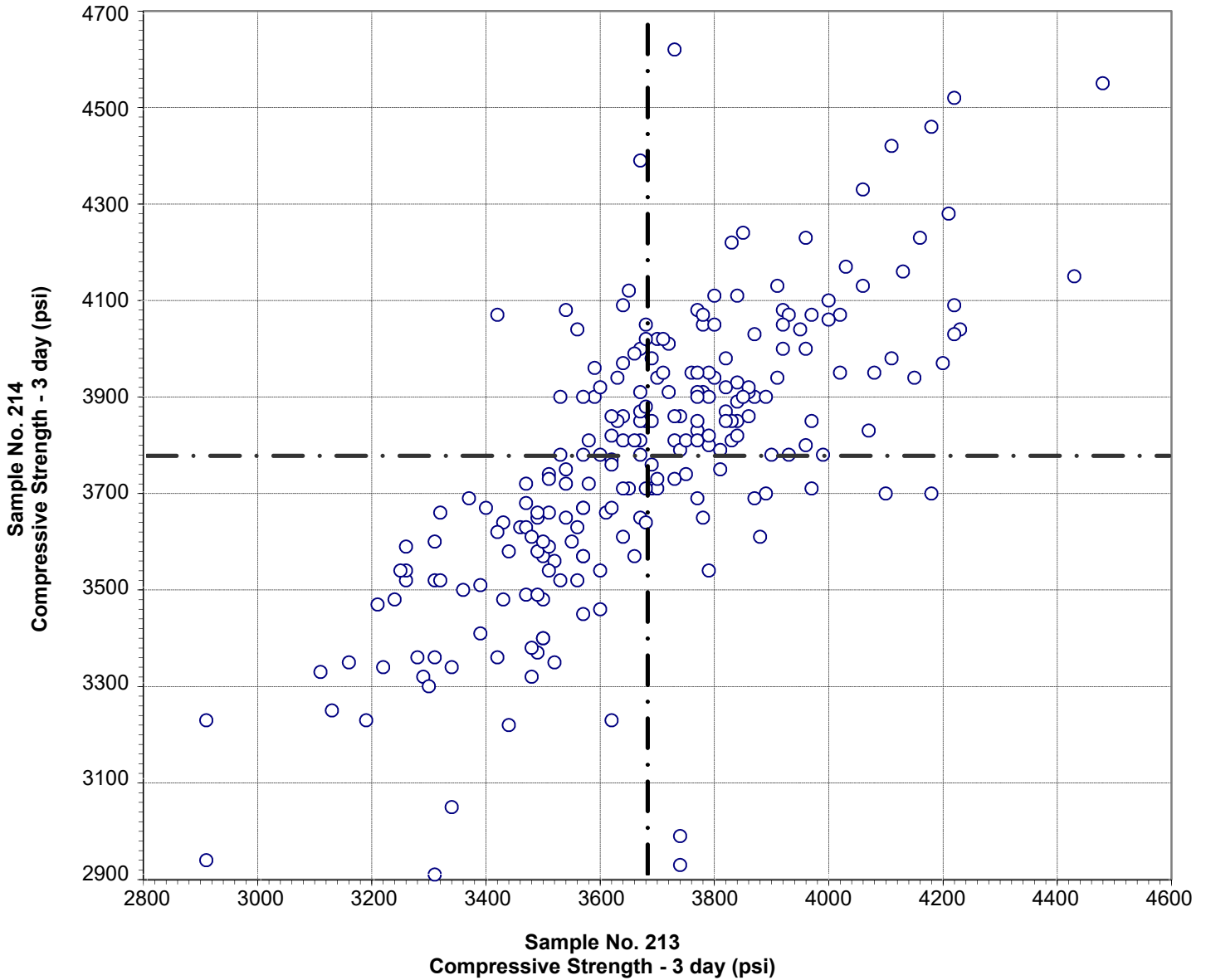


Test No. 190 Air Content - Flow 202 Points

Sample No. 213	Ave 88	S.D. 3.2	C.V. 3.7
Sample No. 214	Ave 87	S.D. 3.3	C.V. 3.8

Labs Eliminated: 78

**CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 213 and No. 214**

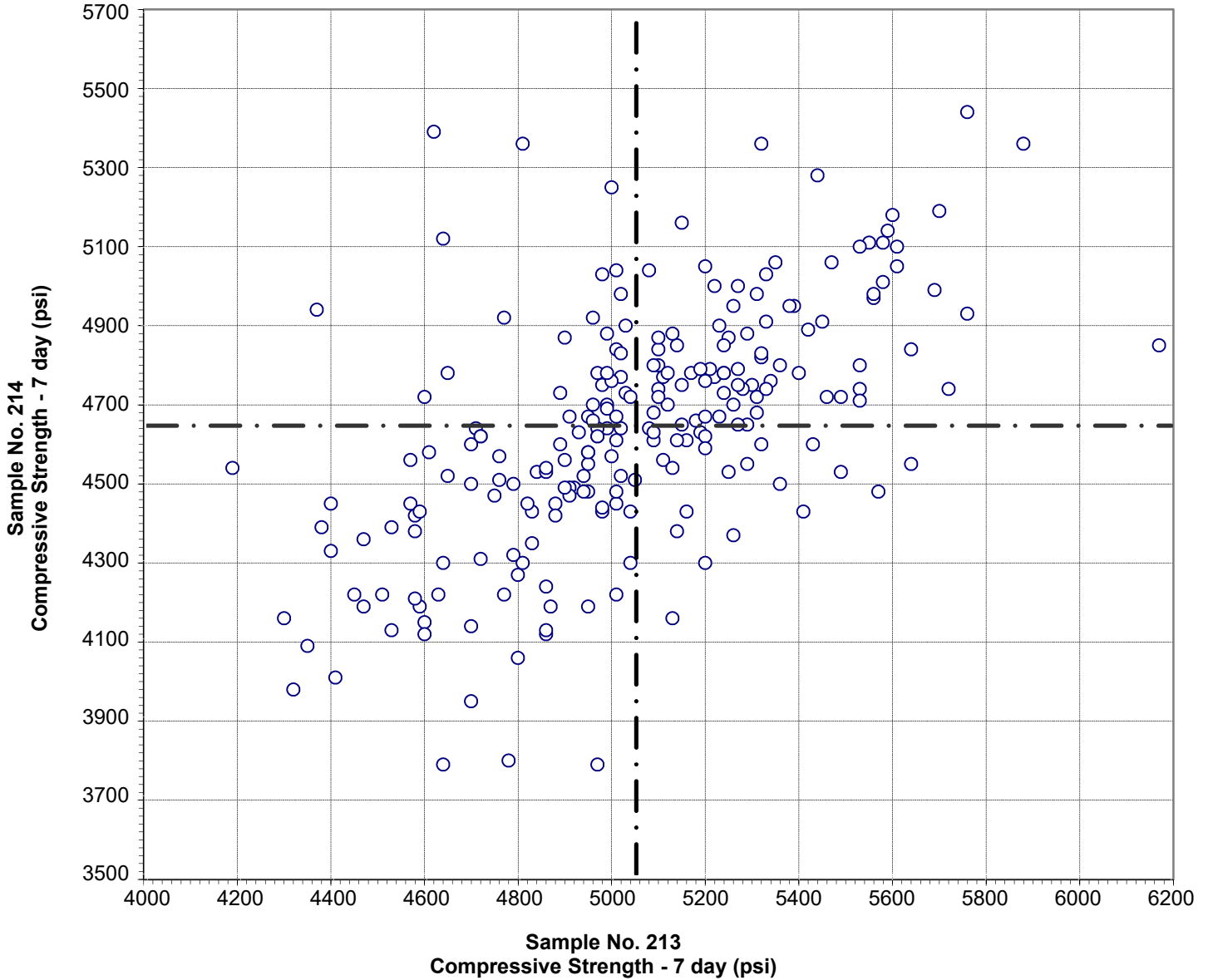


Test No. 200 Compressive Strength - 3 day 230 Points

Sample No. 213	Ave 3681	S.D. 257	C.V. 7.0
Sample No. 214	Ave 3775	S.D. 286	C.V. 7.6

Labs Eliminated: 103, 180, 4042, 4433

**CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 213 and No. 214**

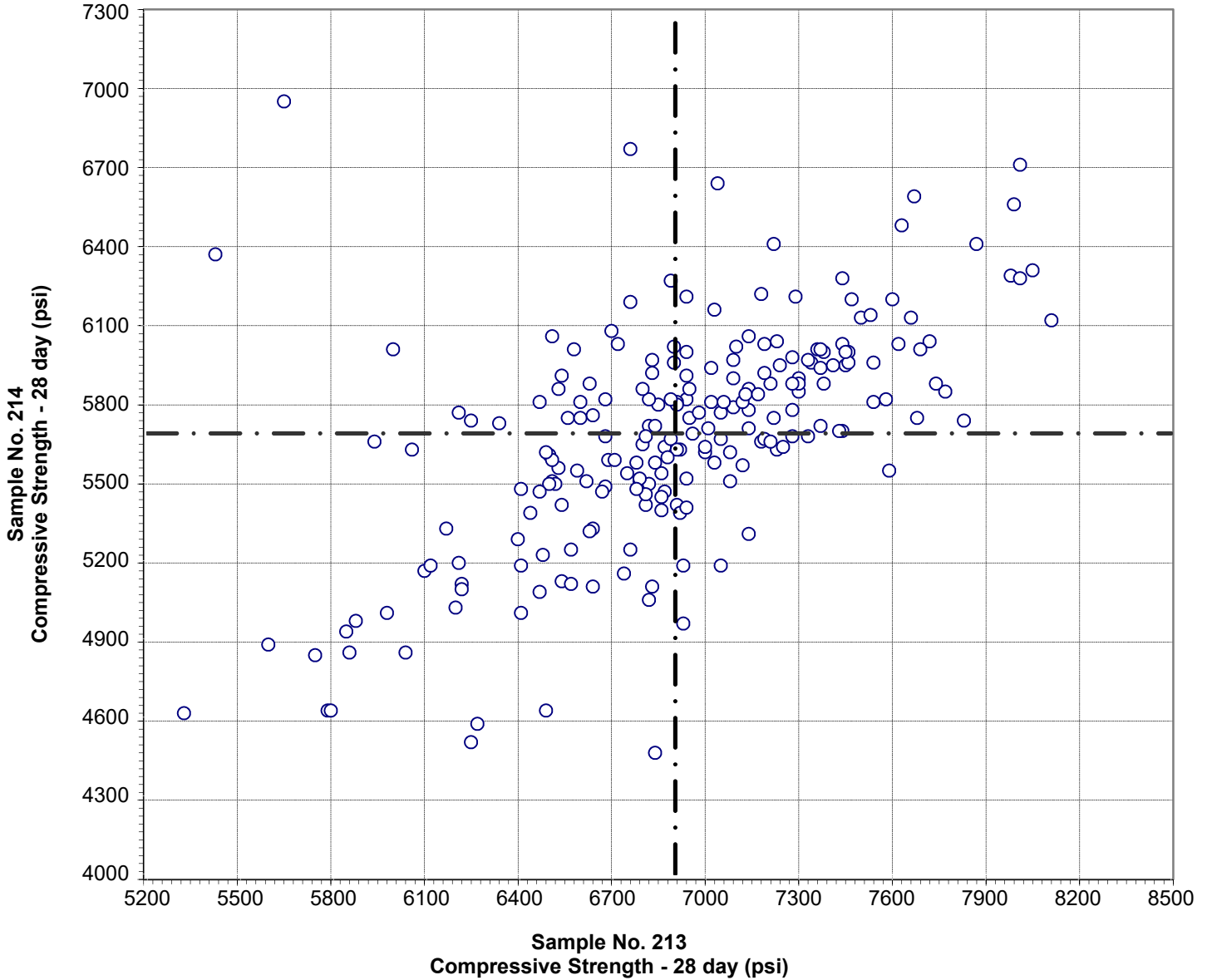


Test No. 210 Compressive Strength - 7 day 229 Points

Sample No. 213	Ave 5051	S.D. 334	C.V. 6.6
Sample No. 214	Ave 4645	S.D. 303	C.V. 6.5

Labs Eliminated: 22, 36, 42, 1222, 4042, 4433

**CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 213 and No. 214**

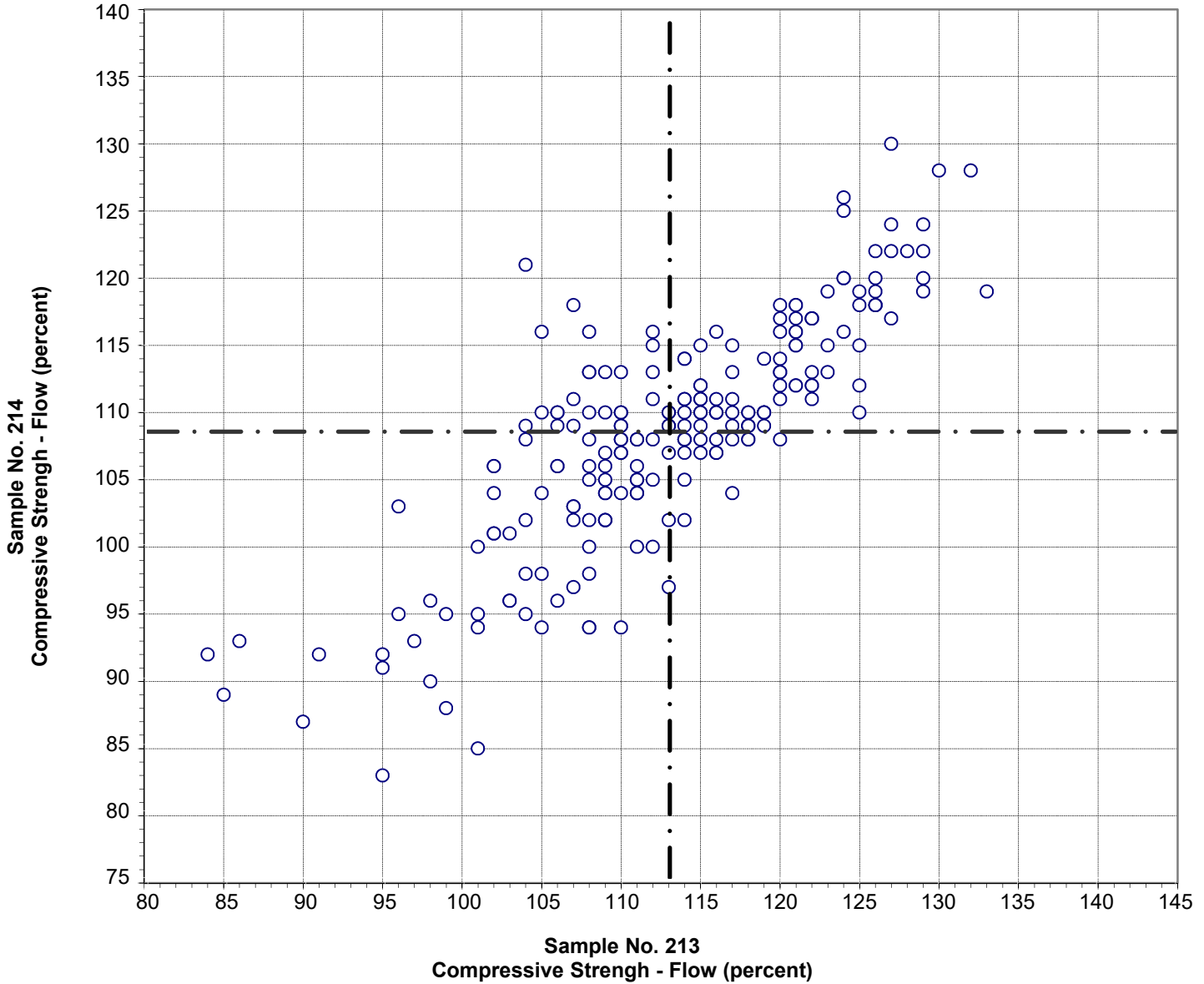


Test No. 211 Compressive Strength - 28 day 216 Points

Sample No. 213	Ave 6902	S.D. 513	C.V. 7.4
Sample No. 214	Ave 5688	S.D. 423	C.V. 7.4

Labs Eliminated: 9, 49, 1019, 1222, 4433

**CCRL Proficiency Sample Program
Compressive Strength - Flow
PORTLAND CEMENT Samples No. 213 and No. 214**

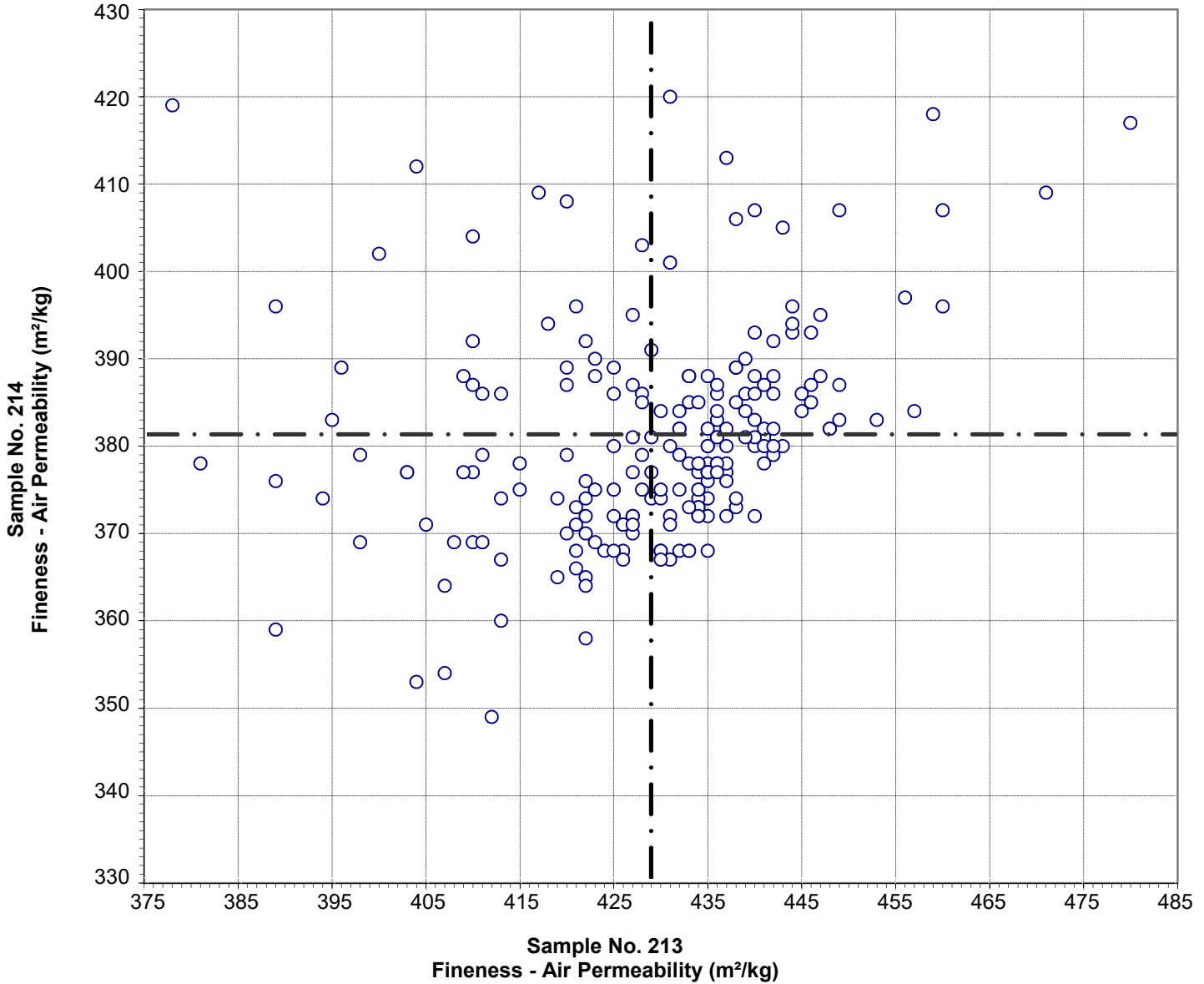


Test No. 230 Compressive Strength - Flow 212 Points

Sample No. 213	Ave 113	S.D. 9	C.V. 8.0
Sample No. 214	Ave 109	S.D. 9	C.V. 7.8

Labs Eliminated: 38, 49, 51

**CCRL Proficiency Sample Program
Fineness - Air Permeability
PORTLAND CEMENT Samples No. 213 and No. 214**



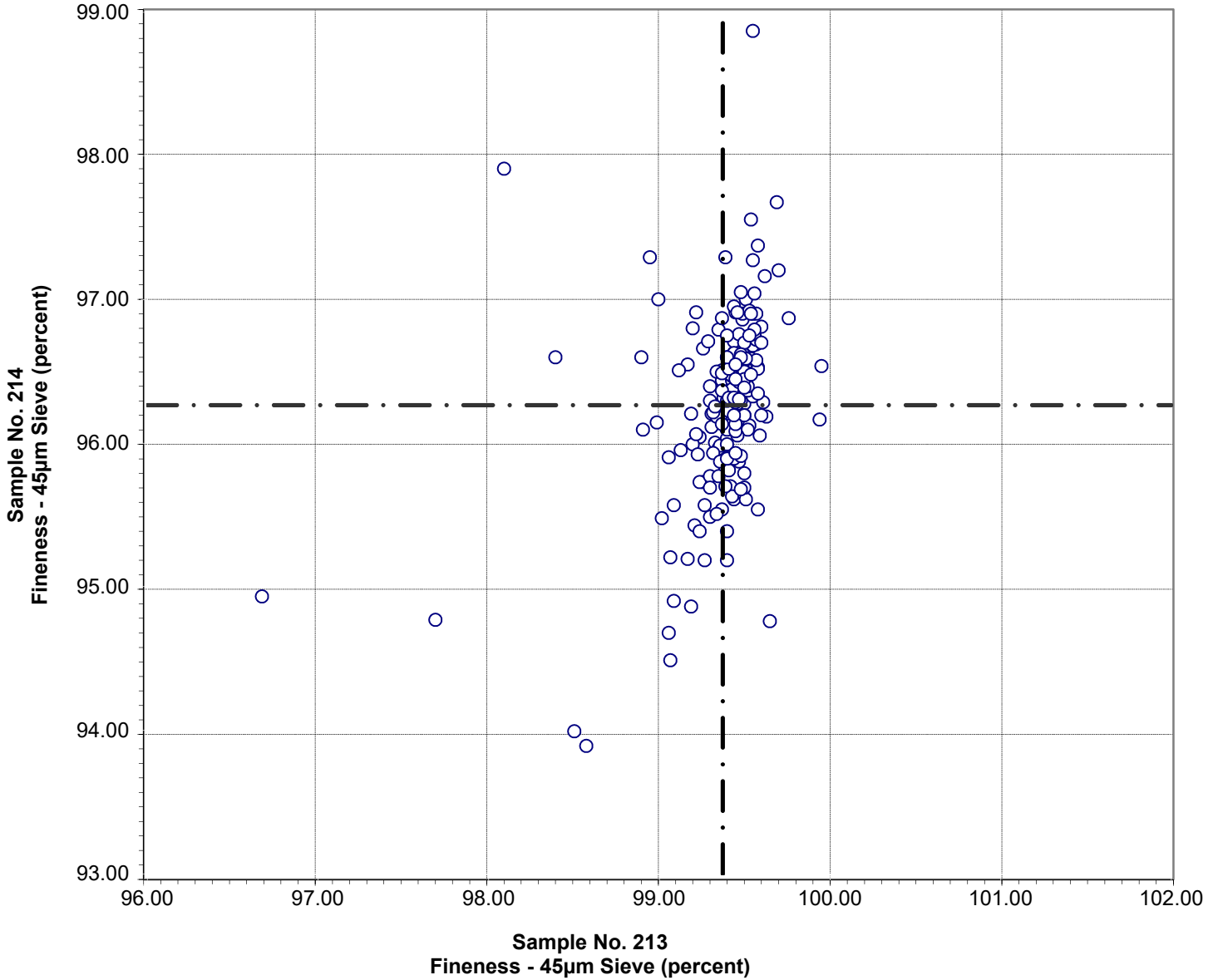
Test No. 270 Fineness - Air Permeability 211 Points

Sample No. 213	Ave 429	S.D. 16	C.V. 3.6
Sample No. 214	Ave 381	S.D. 12	C.V. 3.2

Labs Eliminated: 22, 95, 143, 146, 222, 246, 474, 515, 1773, 3245, 3368, 3752

Labs off Diagram: 4080

**CCRL Proficiency Sample Program
Fineness - 45µm Sieve
PORTLAND CEMENT Samples No. 213 and No. 214**

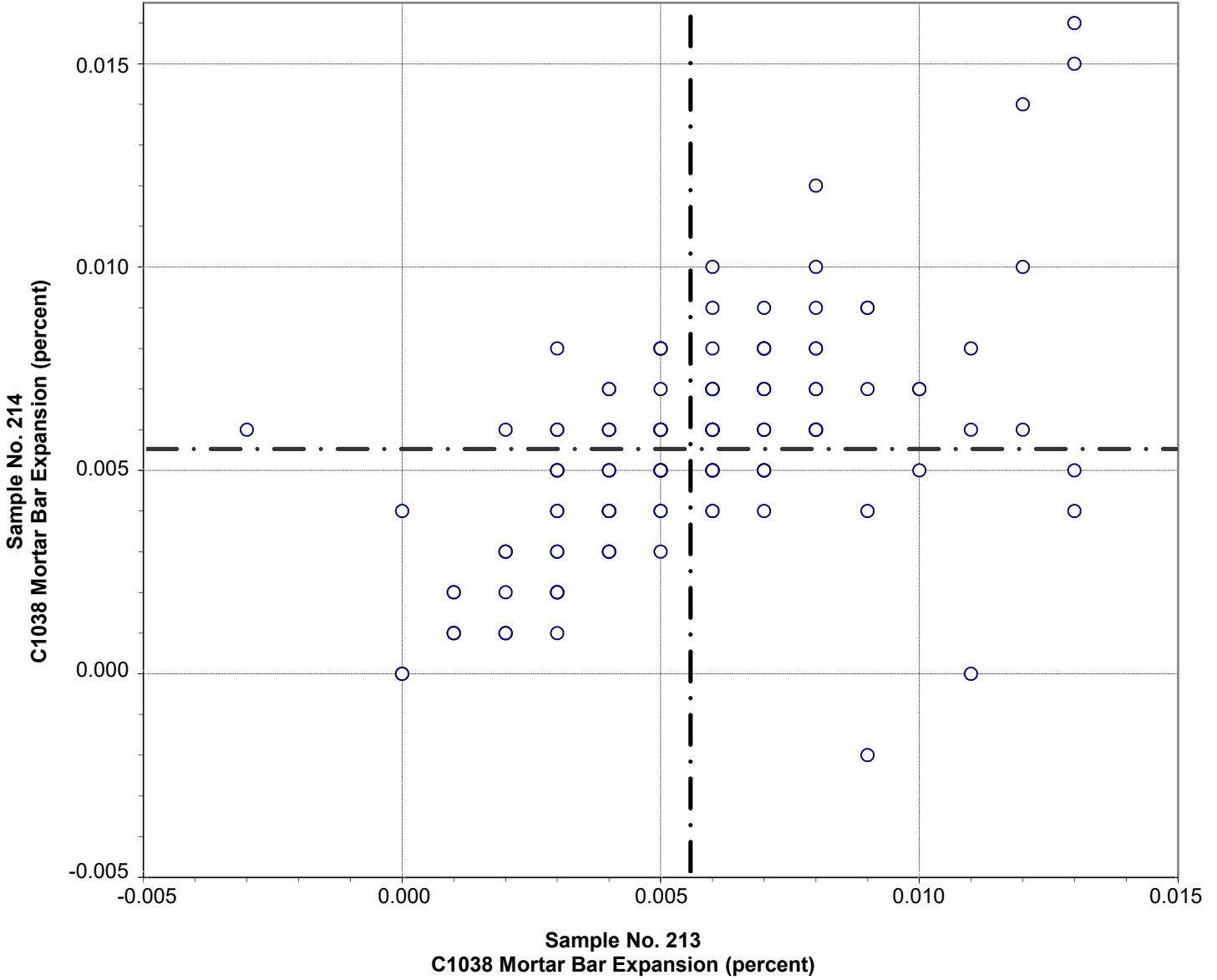


Test No. 281 Fineness - 45µm Sieve 199 Points

Sample No. 213	Ave 99.37	S.D. 0.31	C.V. 0.31
Sample No. 214	Ave 96.27	S.D. 0.62	C.V. 0.65

Labs Eliminated: 26, 116, 132, 159, 246, 493, 698, 1940, 3245, 3606, 3607, 4042, 4270, 4404, 4433

**CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 213 and No. 214**



Test No. 400 C1038 Mortar Bar Expansion 139 Points

Sample No. 213	Ave 0.006	S.D. 0.003	C.V. 53
Sample No. 214	Ave 0.005	S.D. 0.003	C.V. 59

Labs Eliminated: 15, 1251, 2483, 2490, 4351

Labs off Diagram: 93, 457

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 213 and No. 214

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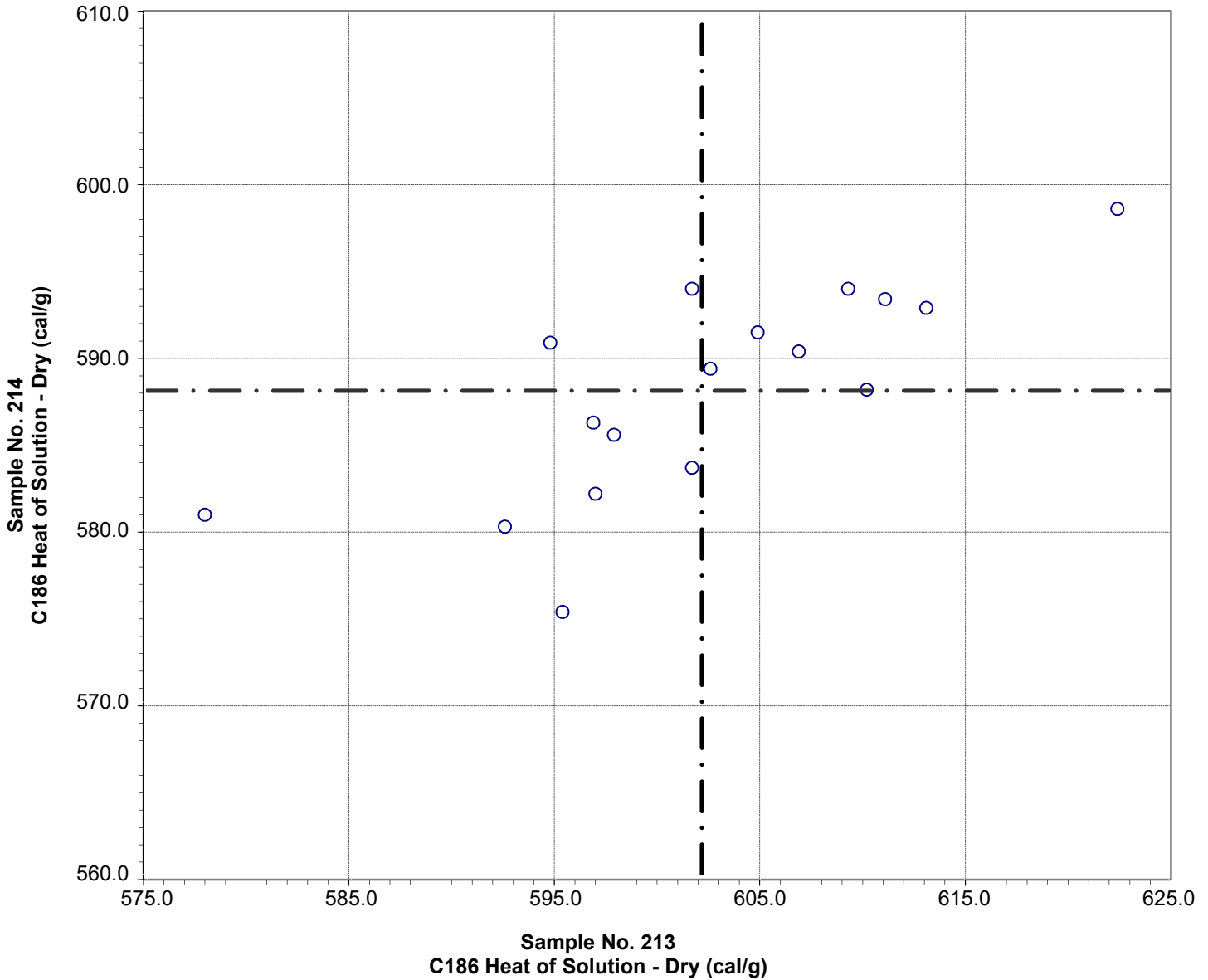
SUMMARY OF RESULTS

Sample No. 213

Sample No. 214

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
C186 Heat of Solution - Dry (cal/g)							
	18	609.3	31.9	5.2	595.4	31.3	5.3
	*17	602.1	10.0	1.7	588.1	6.1	1.0
* Labs Eliminated - 1644							
C186 Heat of Solution - 7 day (cal/g)							
	18	525.1	22.5	4.3	516.7	23.8	4.6
	*16	519.4	10.4	2.0	508.8	6.2	1.2
* Labs Eliminated - 1644, 4138							
C186 Heat of Solution 28 day (cal/g)							
	16	513.2	23.7	4.6	493.0	23.8	4.8
No Labs Eliminated for This Test							
C186 Heat of Hydration - 7 day (cal/g)							
	22	84.2	12.4	14.7	81.7	12.5	15.3
	*21	82.2	8.6	10.4	79.3	5.2	6.6
* Labs Eliminated - 1644							
C186 Heat of Hydration - 28 day (cal/g)							
	17	98.5	14.6	14.8	94.2	20.7	22.0
	*16	95.5	7.8	8.2	89.8	10.5	11.7
* Labs Eliminated - 1644							
C1702 Heat of Hydration - 3 day (J/g)							
	15	273.6	29.9	10.9	286.7	32.1	11.2
	*14	280.6	13.3	4.8	294.4	11.6	3.9
* Labs Eliminated - 116							
C1702 Heat of Hydration - 7 day (J/g)							
	16	338.6	34.5	10.2	331.6	31.8	9.6
	*15	346.5	14.4	4.1	339.1	10.7	3.2
* Labs Eliminated - 116							

**CCRL Proficiency Sample Program
C186 Heat of Solution - Dry
PORTLAND CEMENT Samples No. 213 and No. 214**

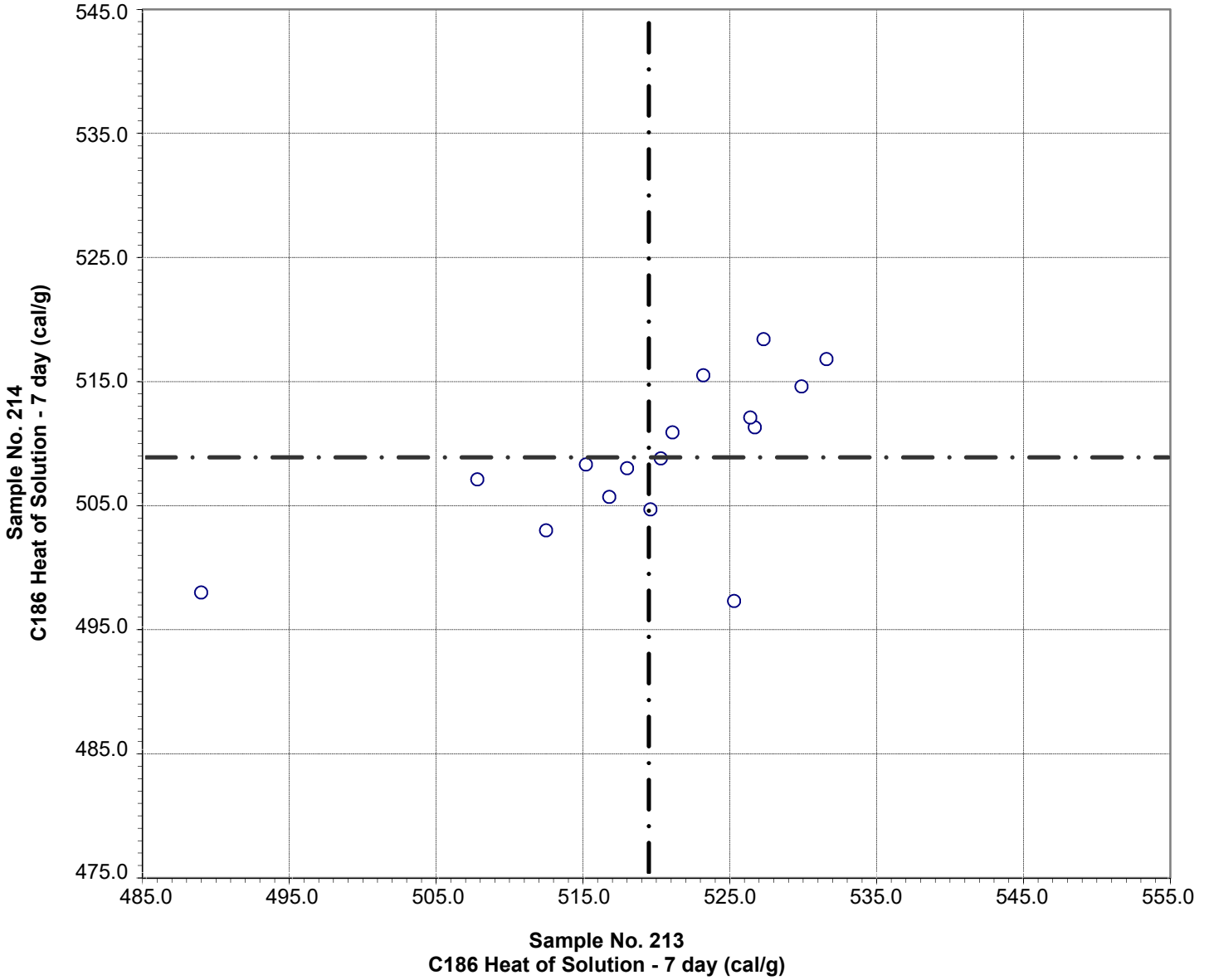


Test No. 291 C186 Heat of Solution - Dry 17 Points

Sample No. 213	Ave 602.1	S.D. 10.0	C.V. 1.7
Sample No. 214	Ave 588.1	S.D. 6.1	C.V. 1.0

Labs Eliminated: 1644

**CCRL Proficiency Sample Program
C186 Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 213 and No. 214**

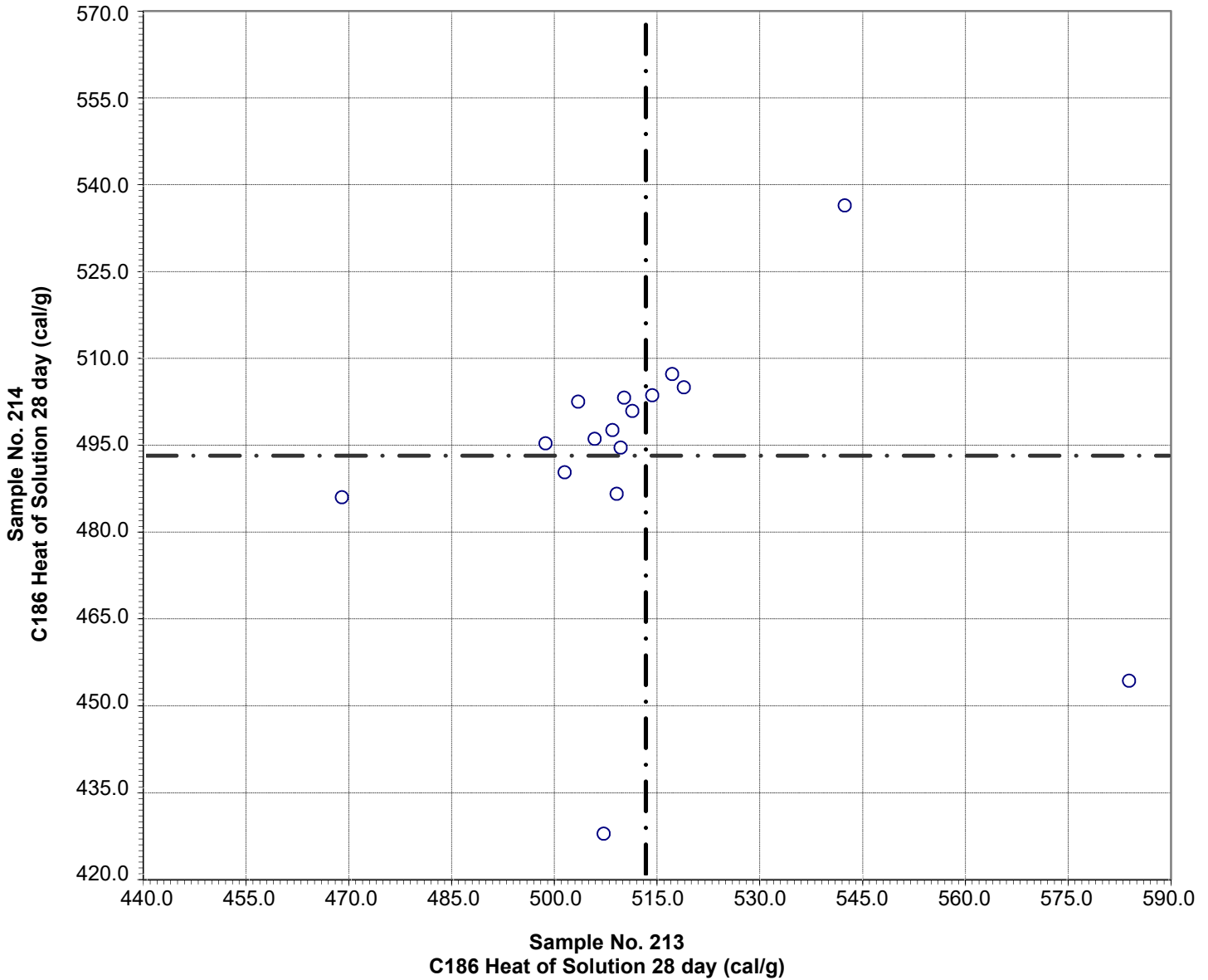


Test No. 292 C186 Heat of Solution - 7 day 16 Points

Sample No. 213	Ave 519.4	S.D. 10.4	C.V. 2.0
Sample No. 214	Ave 508.8	S.D. 6.2	C.V. 1.2

Labs Eliminated: 1644, 4138

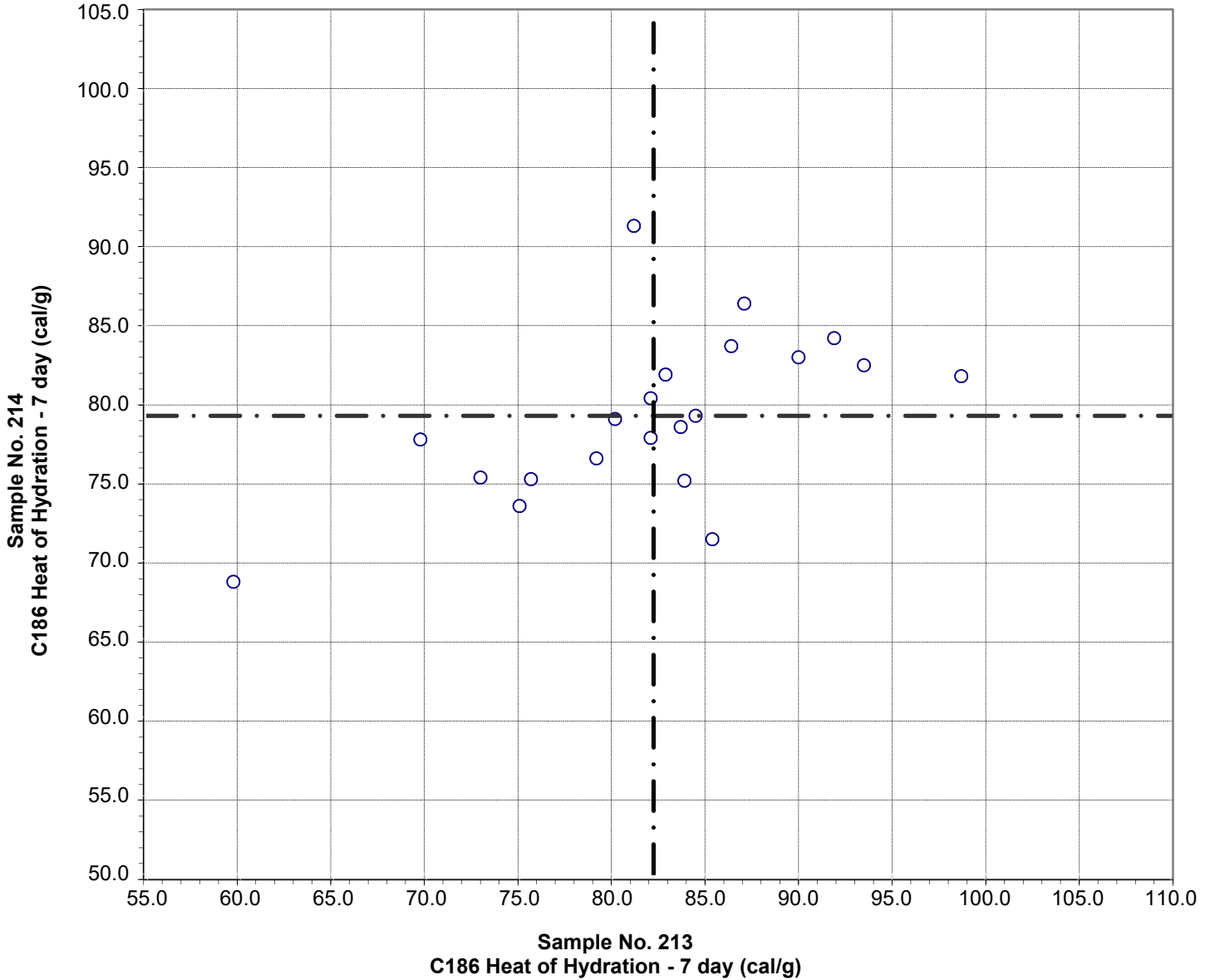
CCRL Proficiency Sample Program
C186 Heat of Solution 28 day
PORTLAND CEMENT Samples No. 213 and No. 214



Test No. 301 C186 Heat of Solution 28 day 16 Points

Sample No. 213	Ave 513.2	S.D. 23.7	C.V. 4.6
Sample No. 214	Ave 493.0	S.D. 23.8	C.V. 4.8

**CCRL Proficiency Sample Program
C186 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 213 and No. 214**

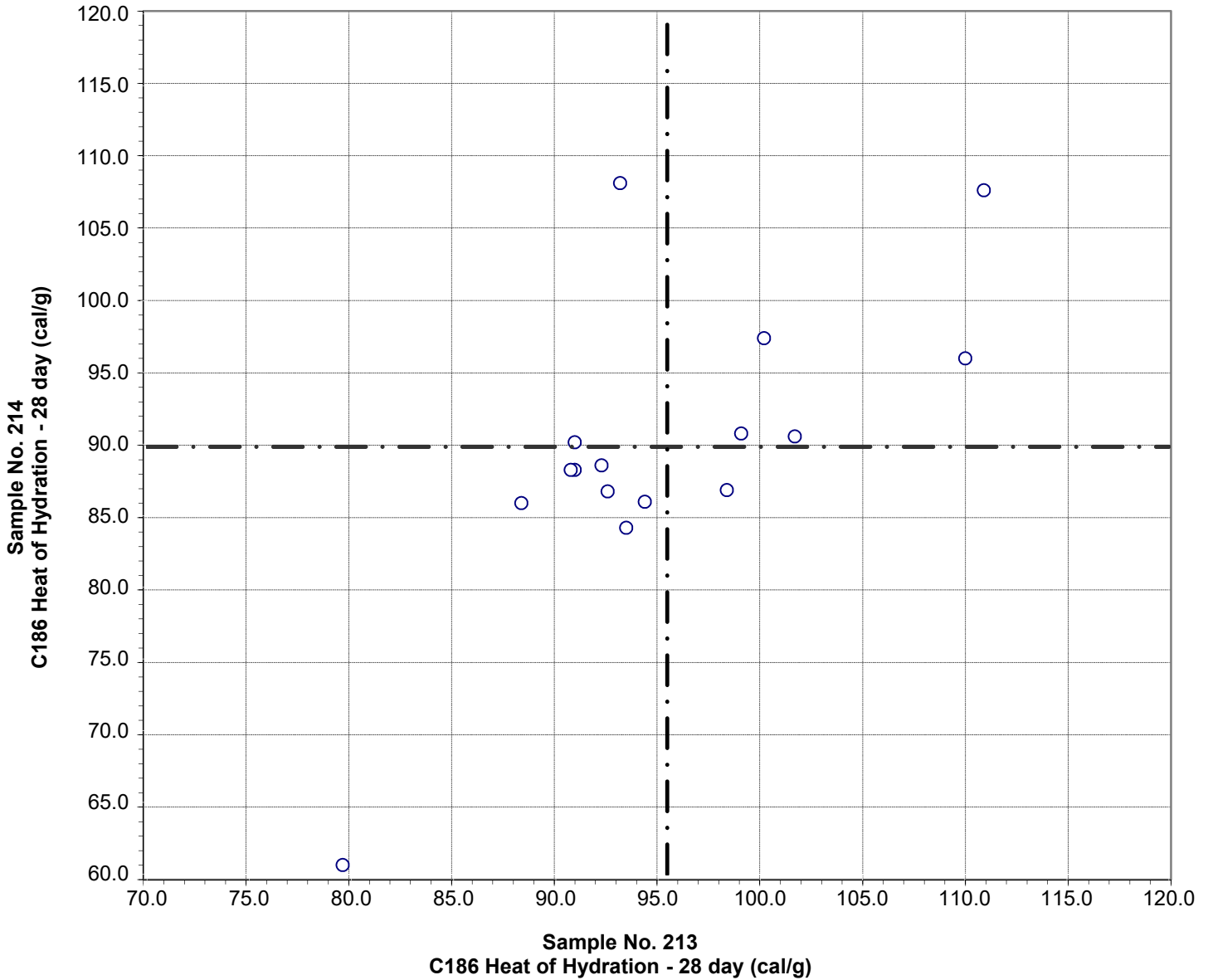


Test No. 290 C186 Heat of Hydration - 7 day 21 Points

Sample No. 213	Ave 82.2	S.D. 8.6	C.V. 10.4
Sample No. 214	Ave 79.3	S.D. 5.2	C.V. 6.6

Labs Eliminated: 1644

**CCRL Proficiency Sample Program
C186 Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 213 and No. 214**

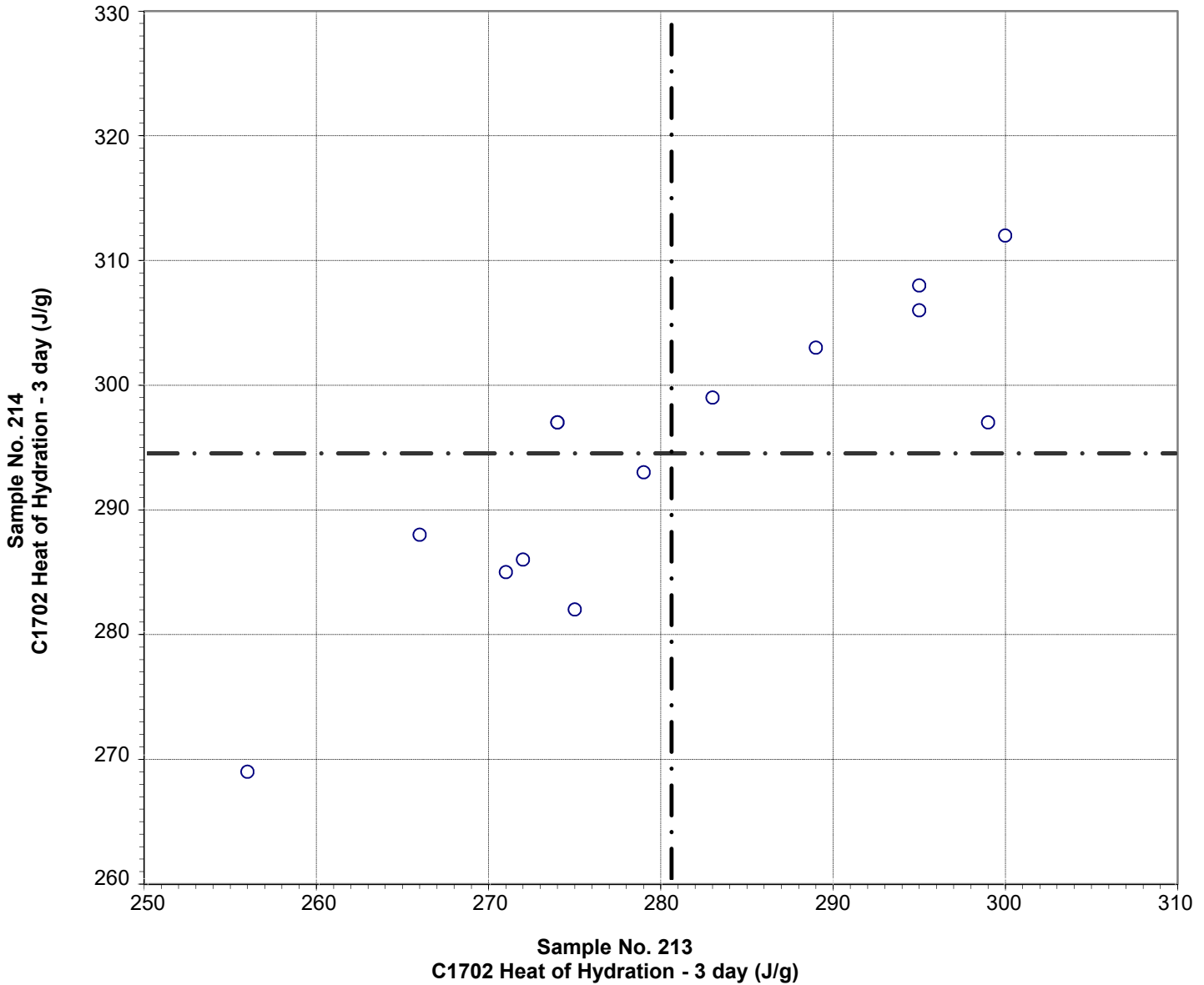


Test No. 300 C186 Heat of Hydration - 28 day 16 Points

Sample No. 213	Ave 95.5	S.D. 7.8	C.V. 8.2
Sample No. 214	Ave 89.8	S.D. 10.5	C.V. 11.7

Labs Eliminated: 1644

**CCRL Proficiency Sample Program
C1702 Heat of Hydration - 3 day
PORTLAND CEMENT Samples No. 213 and No. 214**

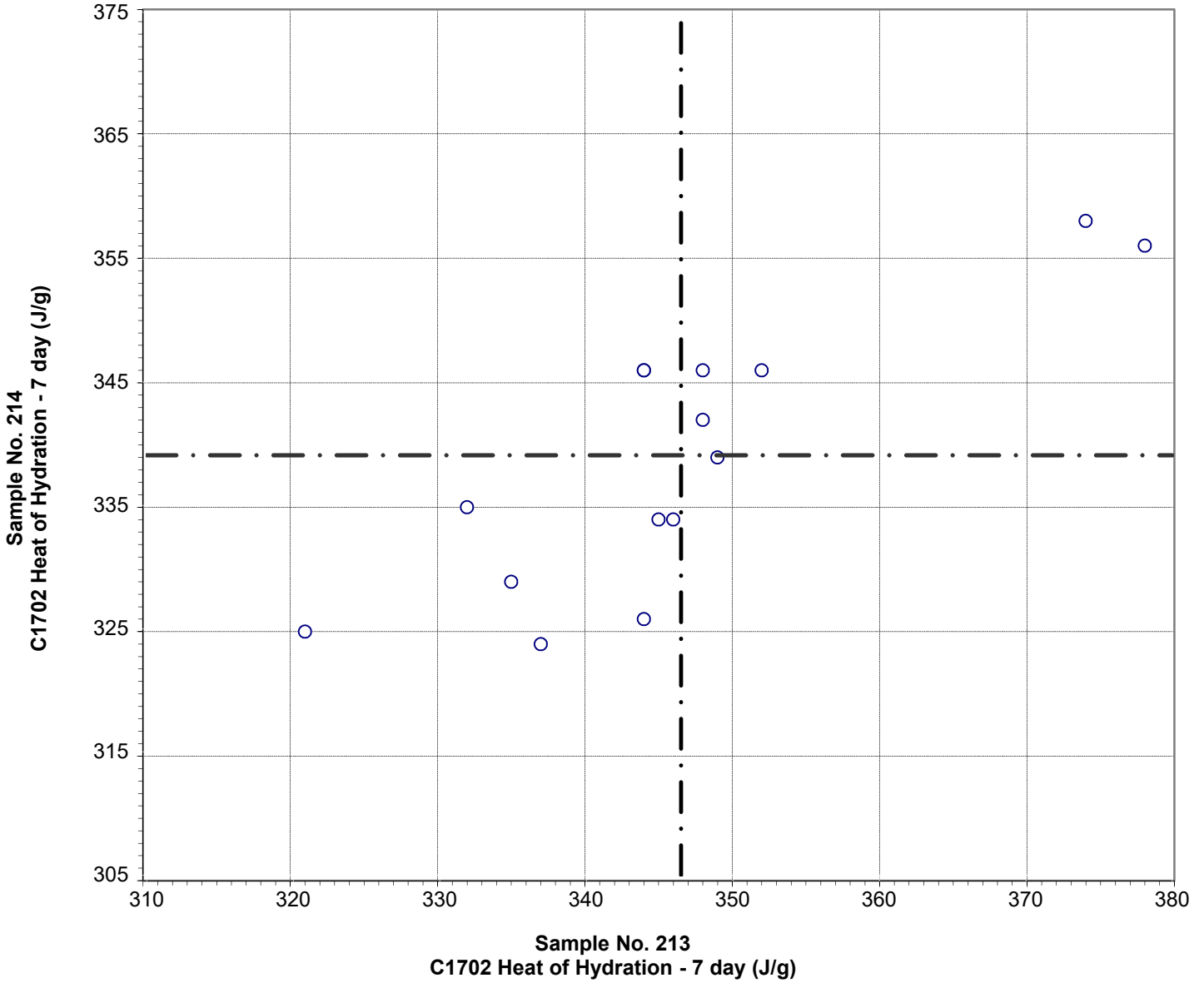


Test No. 500 C1702 Heat of Hydration - 3 day 14 Points

Sample No. 213	Ave 280.6	S.D. 13.3	C.V. 4.8
Sample No. 214	Ave 294.4	S.D. 11.6	C.V. 3.9

Labs Eliminated: 116

**CCRL Proficiency Sample Program
C1702 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 213 and No. 214**



Test No. 510 C1702 Heat of Hydration - 7 day 15 Points

Sample No. 213	Ave 346.5	S.D. 14.4	C.V. 4.1
Sample No. 214	Ave 339.1	S.D. 10.7	C.V. 3.2

Labs Eliminated: 116