CEMENT AND CONCRETE REFERENCE LABORATORY

PROFICIENCY SAMPLE PROGRAM

Final Report
Portland Cement Proficiency Samples
Number 209 and Number 210

CCRL
Cement and Concrete Reference Laboratory

September 2018

www.ccrl.us

September 14, 2018

TO: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 209 and No. 210

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in June 2018. Portland Cement Sample No. 209 was an ASTM C150 meeting the specifications of Type I and Type II, and contained limestone additions. Portland Cement Sample No. 210 was an ASTM C150 meeting the specifications of Type I, 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

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. 209 and No. 210

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 June 2018. 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 mortar mixing

[1]Youden, 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.*

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. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Silicon Dioxide (**percent**)							
	215	20.21	0.24	1.20	20.01	0.26	1.28
	*209	20.20	0.19	0.92	20.00	0.18	0.92
* Labs Eliminated - 48, 159, 206, 440, 694, 2522							
Aluminum Oxide (**percent**)							
	214	4.95	0.15	3.1	4.76	0.17	3.5
	*209	4.95	0.09	1.9	4.75	0.10	2.1
* Labs Eliminated - 95, 206, 694, 4099, 4297							
Ferric Oxide (**percent**)							
	214	3.38	0.07	2.2	3.53	0.07	1.9
	*208	3.37	0.05	1.5	3.53	0.05	1.5
* Labs Eliminated - 206, 694, 2293, 4080, 4099, 4316							
Calcium Oxide (**percent**)							
	215	63.68	0.67	1.05	64.41	0.70	1.09
	*211	63.67	0.50	0.79	64.38	0.53	0.83
* Labs Eliminated - 107, 3990, 4316, 4325							
Magnesium Oxide (**percent**)							
	214	1.26	0.07	5.5	0.98	0.08	8.1
	*211	1.26	0.05	3.6	0.99	0.04	4.4
* Labs Eliminated - 3661, 4099, 4297							
Sulfur Trioxide (**percent**)							
	217	2.98	0.10	3.4	2.85	0.10	3.4
	*212	2.98	0.06	2.1	2.85	0.08	2.8
* Labs Eliminated - 4, 92, 95, 159, 203							
Loss on Ignition (**percent**)							
	220	2.76	0.27	9.6	2.79	0.25	8.9
	*206	2.80	0.07	2.7	2.82	0.08	3.0
* Labs Eliminated - 50, 125, 137, 152, 416, 691, 692, 1054, 1715, 2466, 3279, 3368, 4099, 4325							

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Sodium Oxide (**percent**)							
	208	0.115	0.030	26	0.167	0.049	29
	*191	0.114	0.016	14	0.164	0.018	11
* Labs Eliminated - 4, 50, 78, 99, 246, 309, 881, 975, 1054, 2352, 2465, 3238, 3605, 3606, 3607, 4051, 4270							
Potassium Oxide (**percent**)							
	210	0.390	0.044	11.4	0.263	0.044	16.8
	*200	0.388	0.014	3.6	0.261	0.015	5.9
* Labs Eliminated - 36, 95, 2293, 2412, 3606, 3661, 4099, 4297, 4325, 4350							
Strontium Oxide (**percent**)							
	105	0.068	0.026	38	0.057	0.045	79
	*95	0.064	0.004	6	0.050	0.004	8
* Labs Eliminated - 20, 40, 43, 74, 95, 151, 309, 1657, 4099, 4325							
Titanium Dioxide (**percent**)							
	176	0.24	0.010	4.2	0.22	0.014	6.4
	*173	0.23	0.008	3.2	0.22	0.007	3.4
* Labs Eliminated - 246, 4099, 4325							
Phosphorus Pentoxide (**percent**)							
	172	0.137	0.016	11.6	0.098	0.015	14.9
	*153	0.138	0.005	3.5	0.098	0.004	3.9
* Labs Eliminated - 10, 48, 90, 93, 99, 134, 247, 407, 504, 881, 975, 1942, 2466, 2490, 2491, 4099, 4115, 4270, 4325							
Zinc Oxide (**percent**)							
	103	0.060	0.011	18.5	0.071	0.013	17.6
	*94	0.060	0.003	5.5	0.072	0.004	5.6
* Labs Eliminated - 25, 94, 309, 768, 881, 1916, 4099, 4297, 4325							

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Manganic Oxide (**percent**)							
	140	0.163	0.019	11.5	0.024	0.021	90.7
	*126	0.165	0.007	4.4	0.020	0.003	17.7
* Labs Eliminated - 47, 84, 94, 101, 181, 205, 413, 667, 768, 2466, 3297, 4099, 4297, 4325							
Chloride (**percent**)							
	135	0.018	0.008	45	0.021	0.009	44
	*132	0.018	0.007	39	0.020	0.008	39
* Labs Eliminated - 18, 94, 497							
Insoluble Residue (**percent**)							
	197	0.37	0.10	28	0.44	0.10	23
	*193	0.37	0.09	23	0.44	0.09	21
* Labs Eliminated - 206, 255, 1053, 4325							
Free Lime (**percent**)							
	163	0.65	0.32	49	0.97	0.30	31
	*160	0.62	0.17	27	0.96	0.20	21
* Labs Eliminated - 60, 416, 881							
Carbon Dioxide (**percent**)							
	194	1.44	0.22	15.5	2.01	0.26	13.1
	*185	1.44	0.14	9.8	2.03	0.20	9.8
* Labs Eliminated - 15, 50, 137, 416, 542, 958, 1435, 3368, 4080							
Limestone Content (**percent**)							
	189	3.4	0.7	20.1	4.8	0.7	15.3
	*171	3.5	0.3	9.6	4.9	0.5	9.9
* Labs Eliminated - 15, 24, 26, 50, 64, 99, 137, 169, 246, 413, 542, 958, 1053, 1435, 2491, 3368, 4080, 4325							
Chromium Oxide (**percent**)							
	97	0.029	0.024	84	0.019	0.017	88
	*91	0.026	0.006	22	0.016	0.004	26
* Labs Eliminated - 19, 116, 206, 415, 502, 3368							

CCRL PROFICIENCY SAMPLE PROGRAM

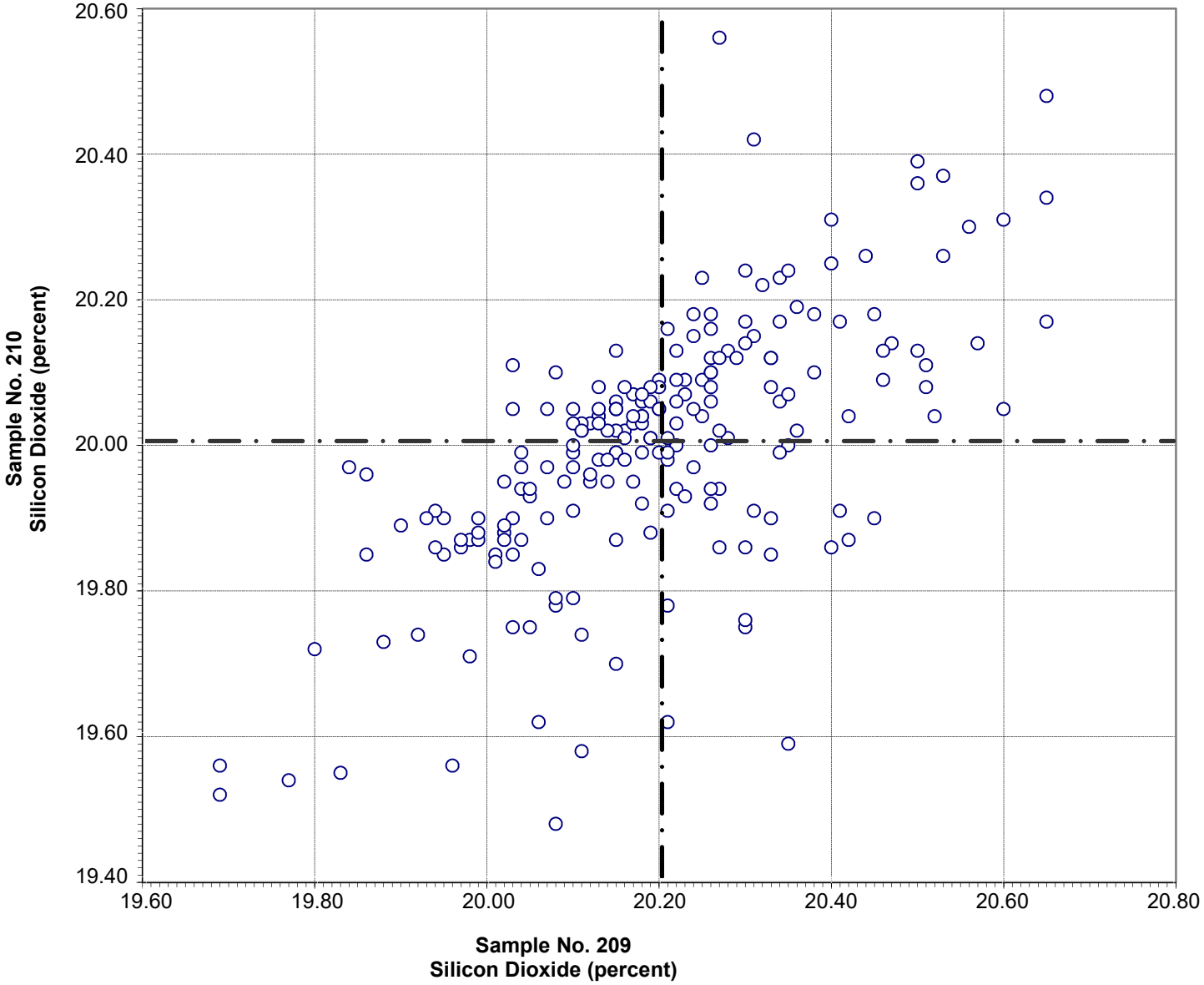
Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Tricalcium Silicate (**percent**)							
	189	50.9	4.6	9.1	57.9	4.6	8.0
	*182	50.7	3.3	6.5	57.7	3.2	5.6
* Labs Eliminated - 107, 159, 206, 779, 4297, 4316, 4325							
Dicalcium Silicate (**percent**)							
	189	18.9	3.6	19.3	13.1	3.8	29.0
	*178	19.1	2.3	11.9	13.2	2.4	18.0
* Labs Eliminated - 98, 107, 159, 206, 221, 694, 779, 3238, 4297, 4316, 4325							
Tricalcium Aluminate (**percent**)							
	189	7.2	0.5	7.0	6.5	0.5	7.4
	*186	7.2	0.3	4.2	6.5	0.3	4.8
* Labs Eliminated - 95, 3238, 4297							
Tetracalcium Aluminoferrite (**percent**)							
	189	10.1	0.3	2.5	10.6	0.2	2.0
	*181	10.1	0.2	1.8	10.7	0.2	1.6
* Labs Eliminated - 41, 206, 438, 694, 3238, 3368, 4080, 4316							

CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 209 and No. 210



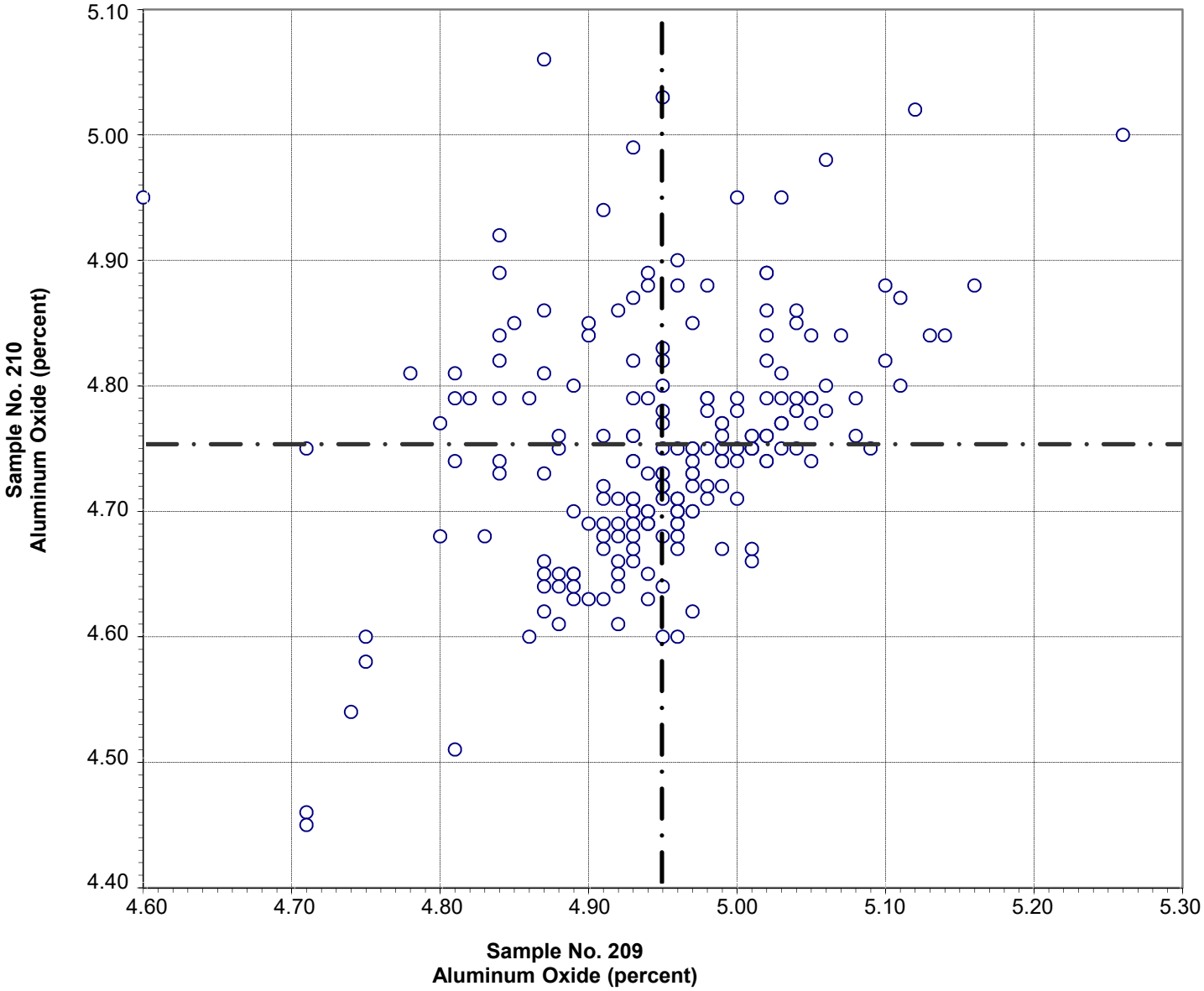
Test No. 10 Silicon Dioxide 207 Points

Sample No. 209	Ave	20.20	S.D.	0.19	C.V. 0.92
Sample No. 210	Ave	20.00	S.D.	0.18	C.V. 0.92

Labs Eliminated: 48, 159, 206, 440, 694, 2522

Labs off Diagram: 4297, 1079

CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 209 and No. 210



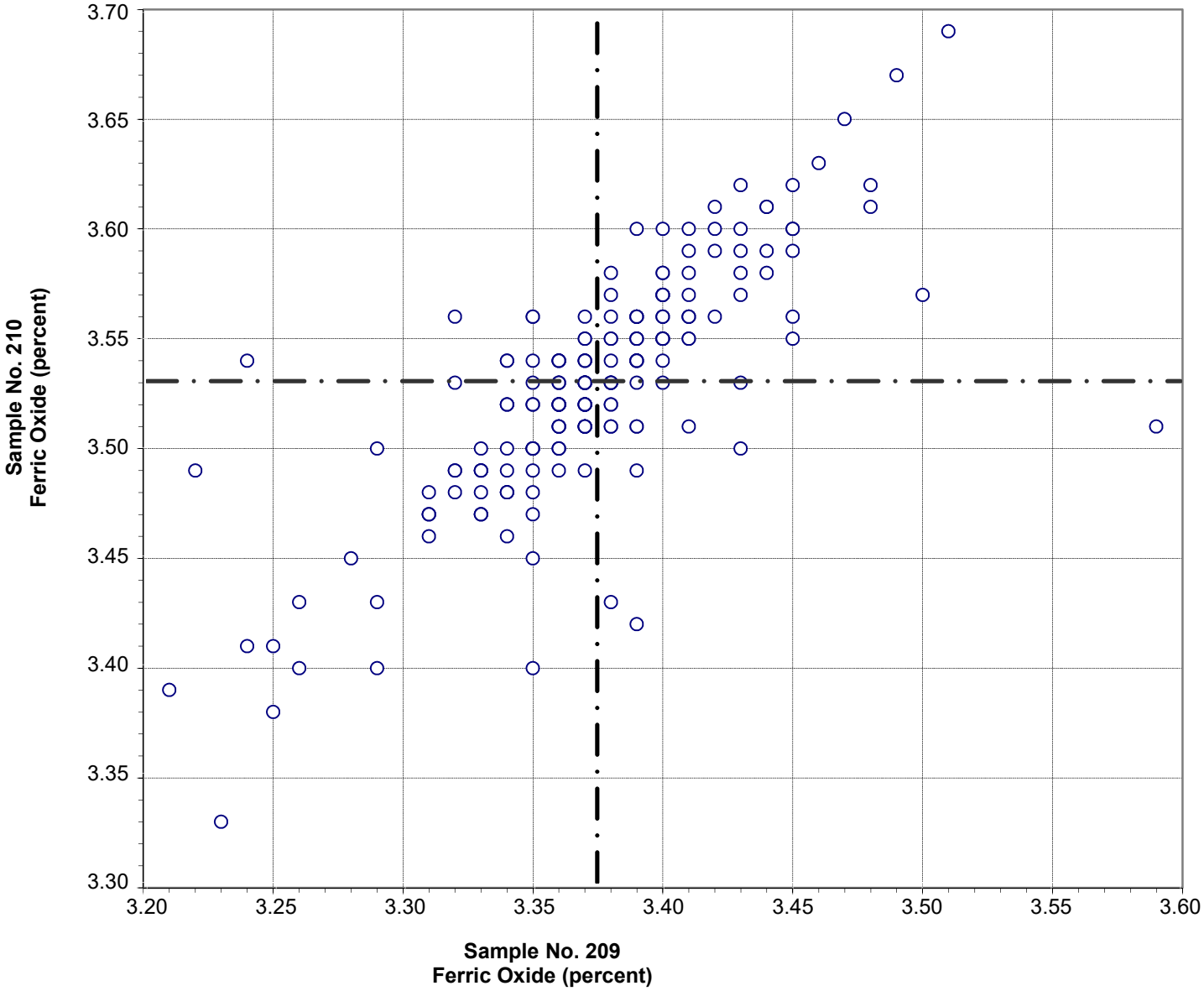
Test No. 21 Aluminum Oxide 207 Points

Sample No. 209	Ave	4.95	S.D.	0.09	C.V. 1.9
Sample No. 210	Ave	4.75	S.D.	0.10	C.V. 2.1

Labs Eliminated: 95, 206, 694, 4099, 4297

Labs off Diagram: 159, 3606

CCRL Proficiency Sample Program
Ferric Oxide
PORTLAND CEMENT Samples No. 209 and No. 210



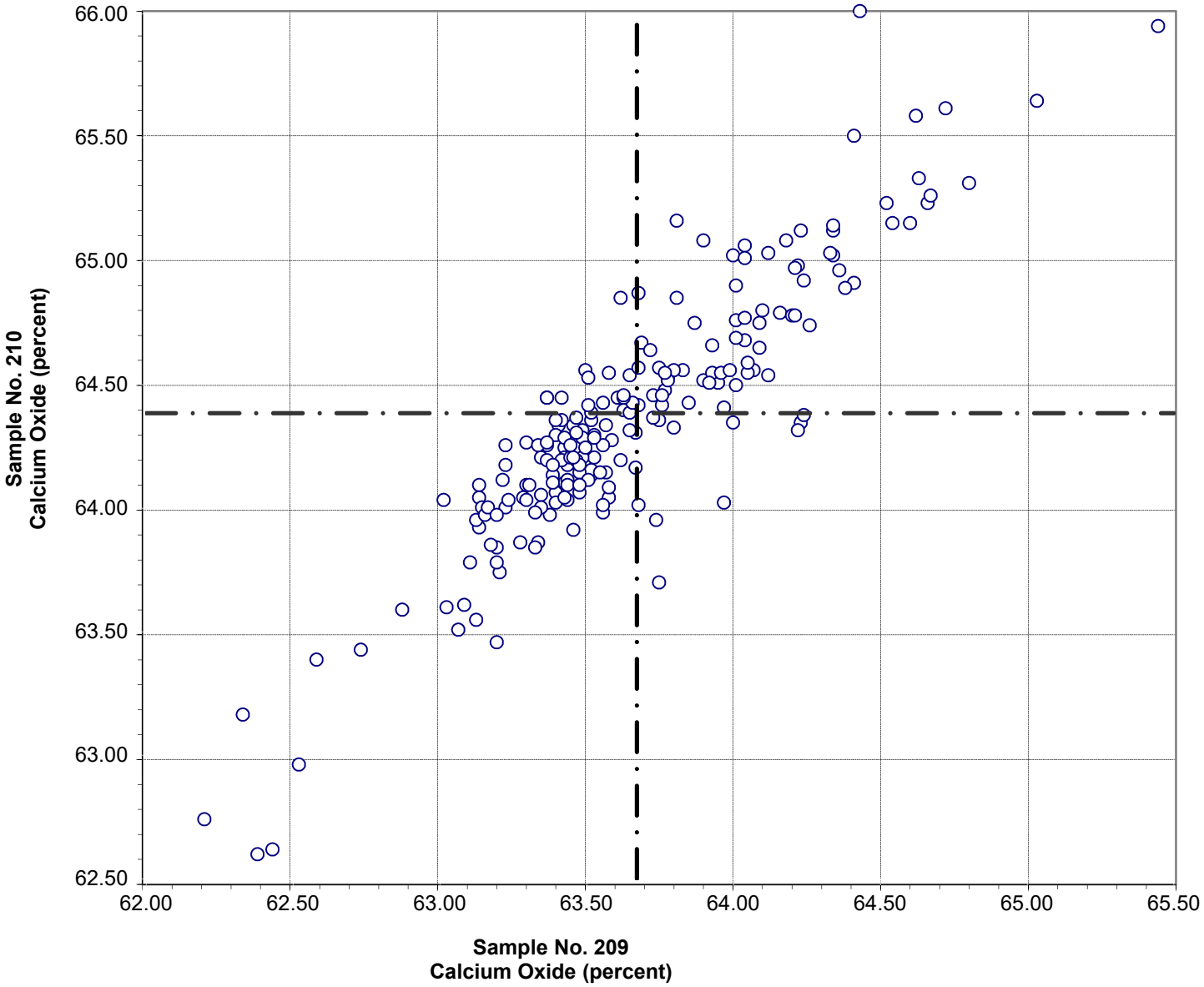
Test No. 30 Ferric Oxide 206 Points

Sample No. 209	Ave	3.37	S.D.	0.05	C.V.	1.5
Sample No. 210	Ave	3.53	S.D.	0.05	C.V.	1.5

Labs Eliminated: 206, 694, 2293, 4080, 4099, 4316

Labs off Diagram: 22, 440

CCRL Proficiency Sample Program
Calcium Oxide
PORTLAND CEMENT Samples No. 209 and No. 210



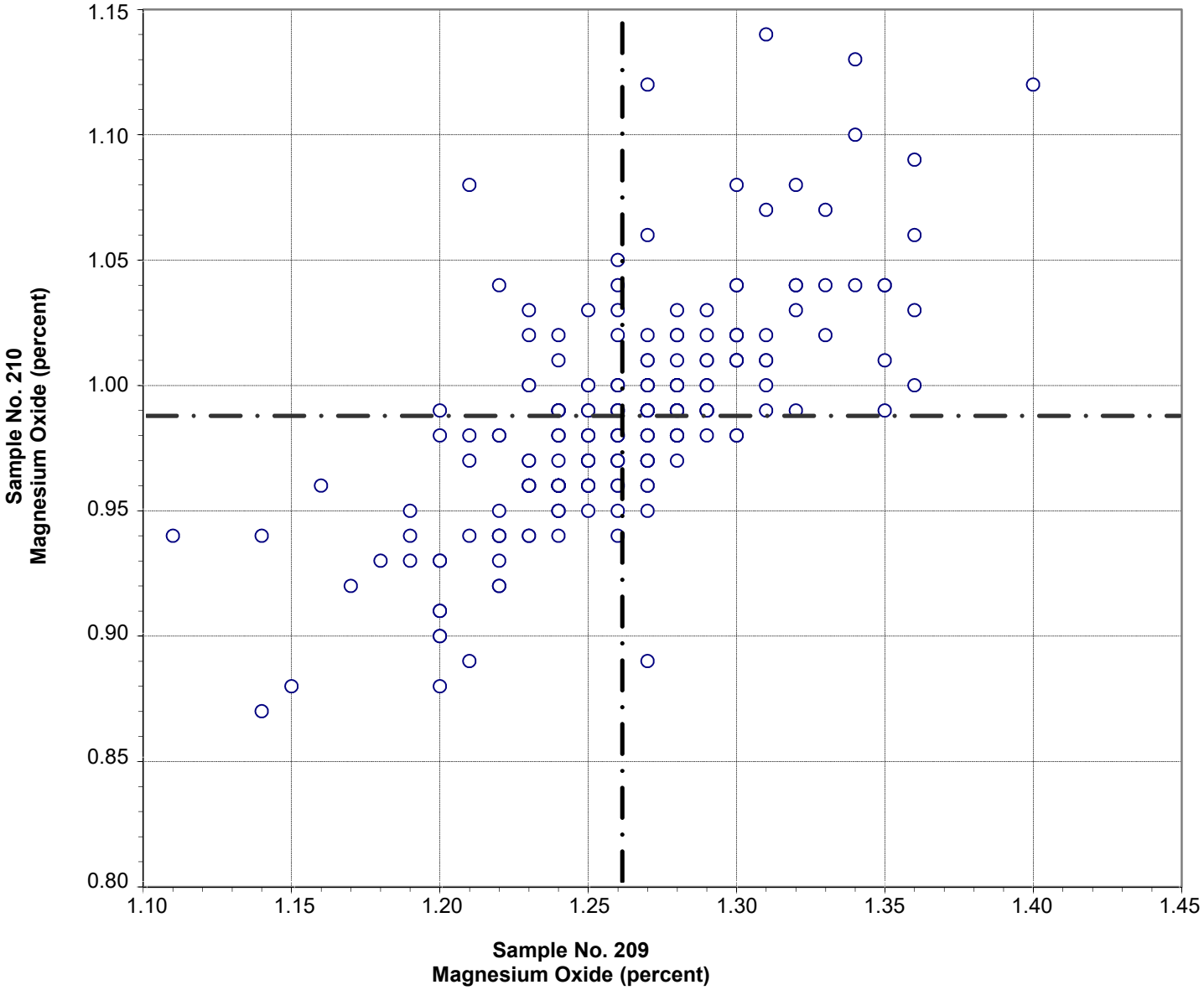
Test No. 40 Calcium Oxide 209 Points

Sample No. 209	Ave	63.67	S.D.	0.50	C.V.	0.79
Sample No. 210	Ave	64.38	S.D.	0.53	C.V.	0.83

Labs Eliminated: 107, 3990, 4316, 4325

Labs off Diagram: 4, 1054

CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 209 and No. 210



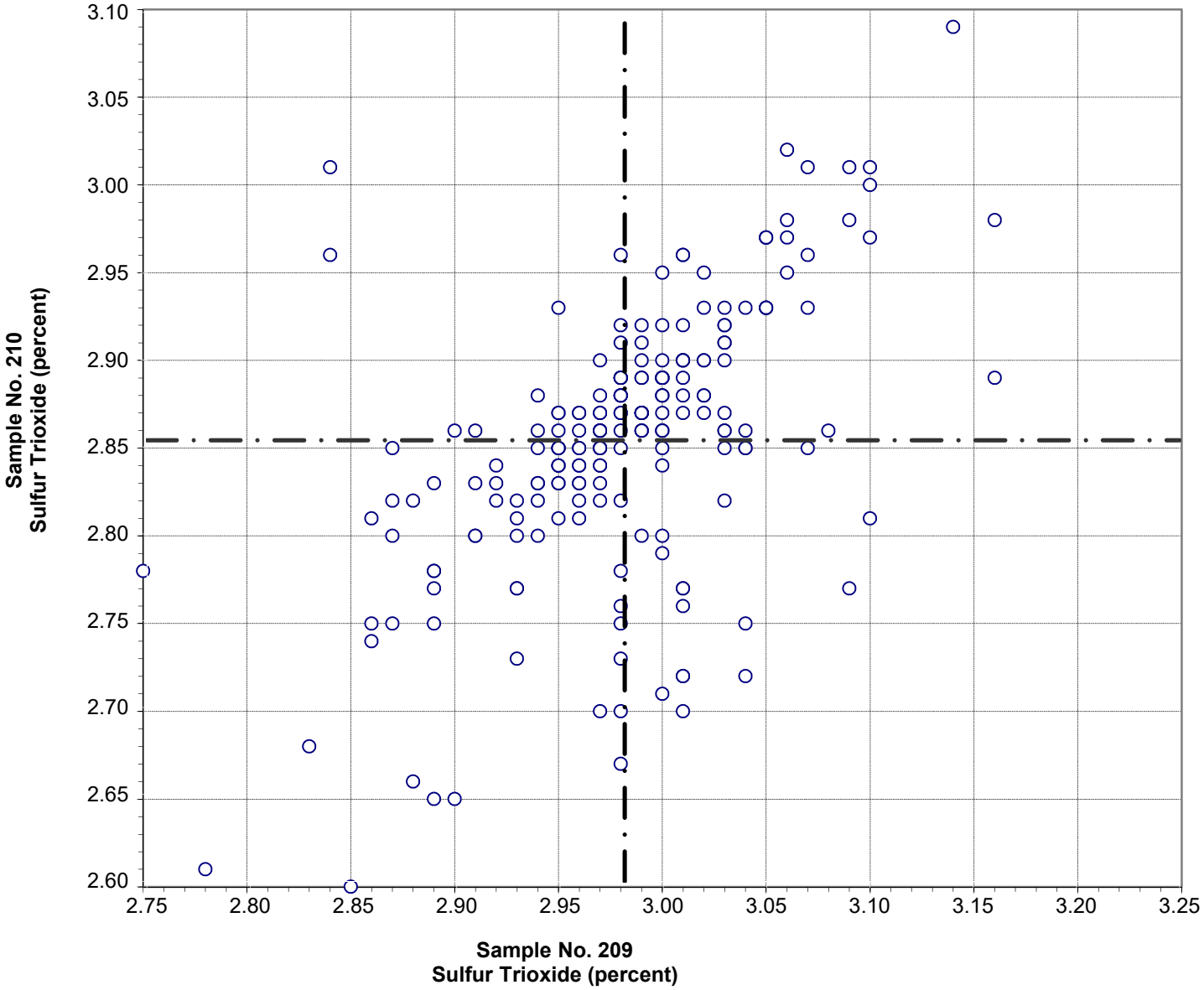
Test No. 50 Magnesium Oxide 210 Points

Sample No. 209	Ave	1.26	S.D.	0.05	C.V. 3.6
Sample No. 210	Ave	0.99	S.D.	0.04	C.V. 4.4

Labs Eliminated: 3661, 4099, 4297

Labs off Diagram: 2491

CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 209 and No. 210



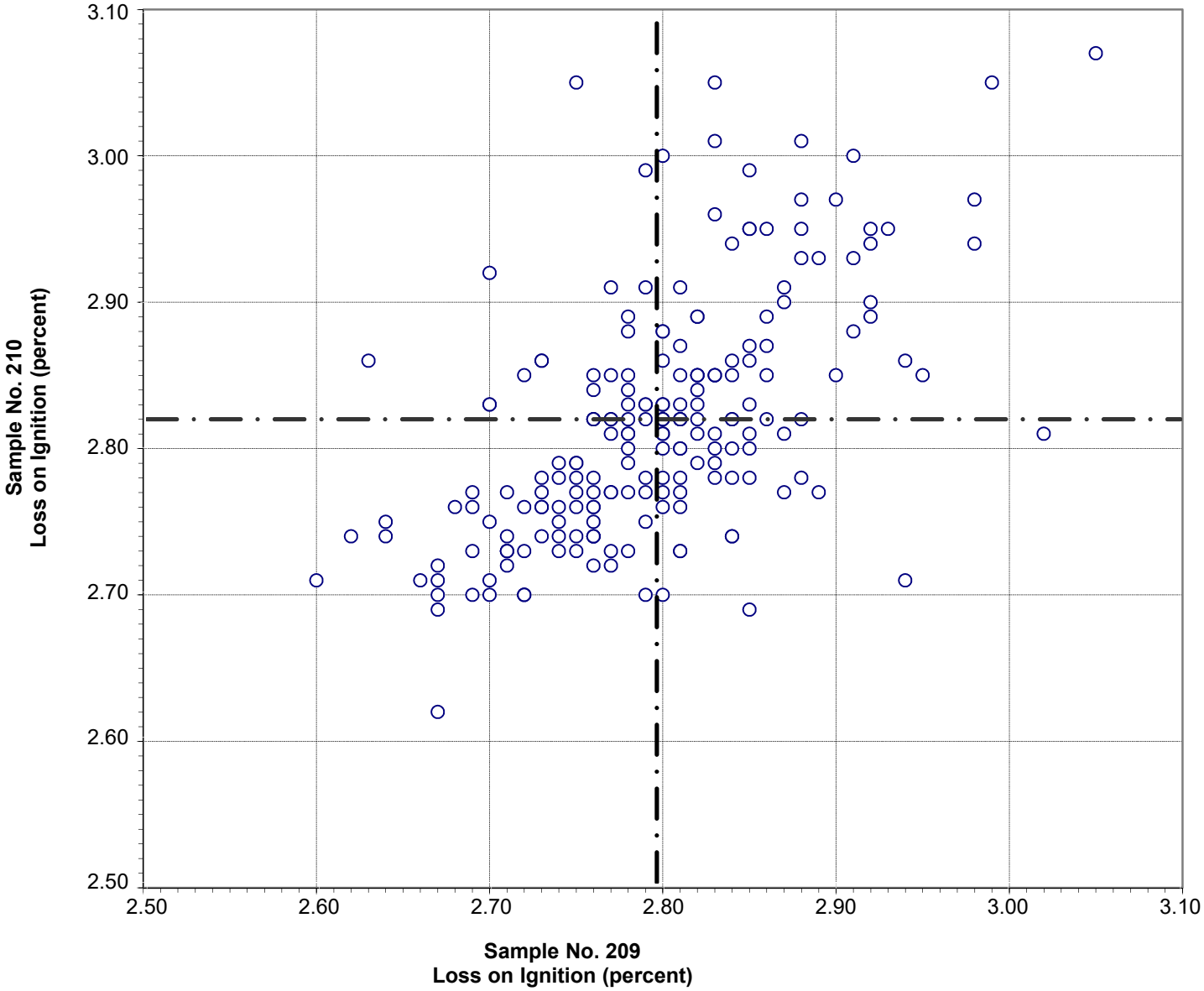
Test No. 60 Sulfur Trioxide 211 Points

Sample No. 209	Ave	2.98	S.D.	0.06	C.V. 2.1
Sample No. 210	Ave	2.85	S.D.	0.08	C.V. 2.8

Labs Eliminated: 4, 92, 95, 159, 203

Labs off Diagram: 438

CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 209 and No. 210



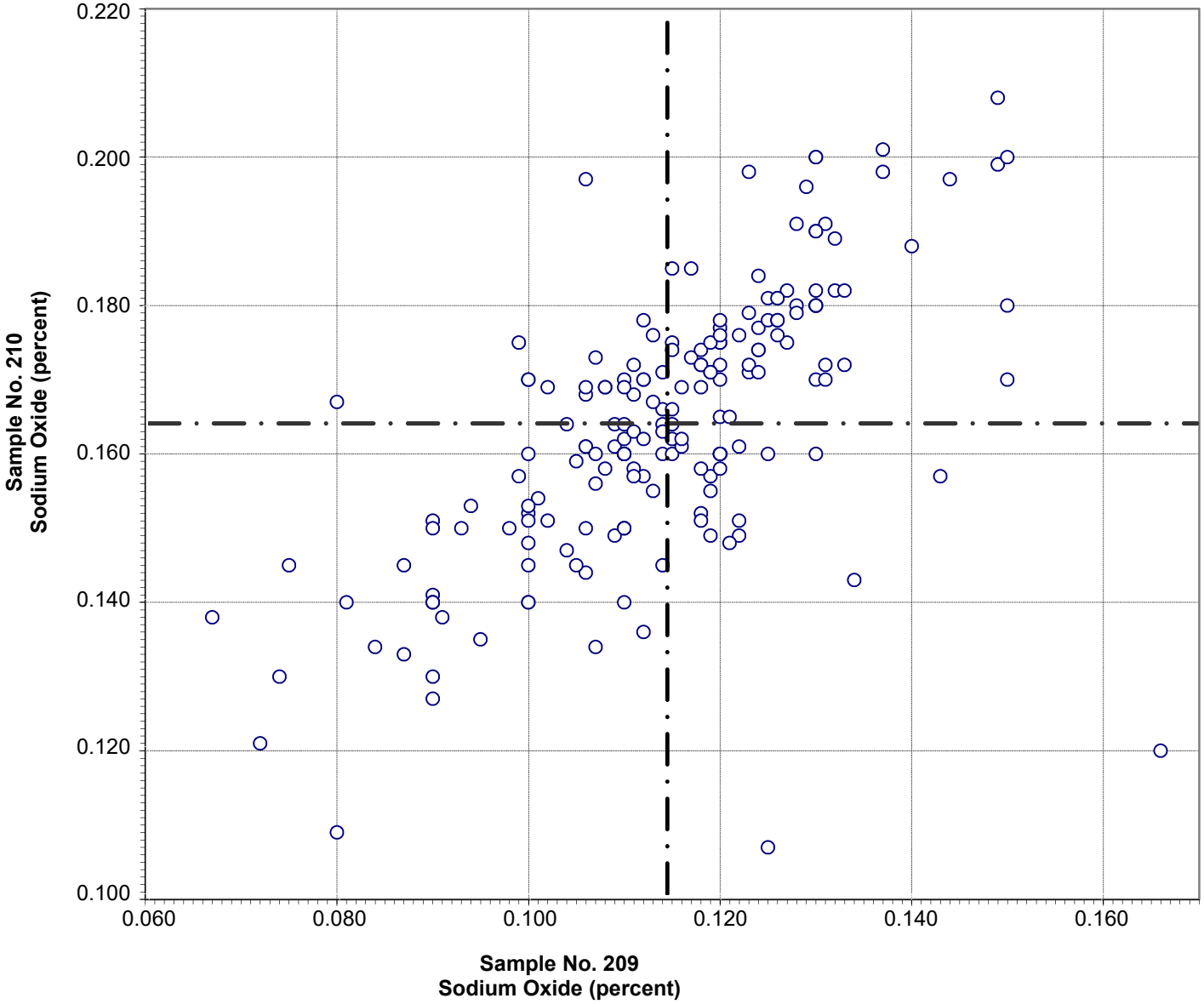
Test No. 70 Loss on Ignition 205 Points

Sample No. 209	Ave	2.80	S.D.	0.07	C.V. 2.7
Sample No. 210	Ave	2.82	S.D.	0.08	C.V. 3.0

Labs Eliminated: 50, 125, 137, 152, 416, 691, 692, 1054, 1715, 2466, 3279, 3368, 4099, 4325

Labs off Diagram: 92

CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 209 and No. 210

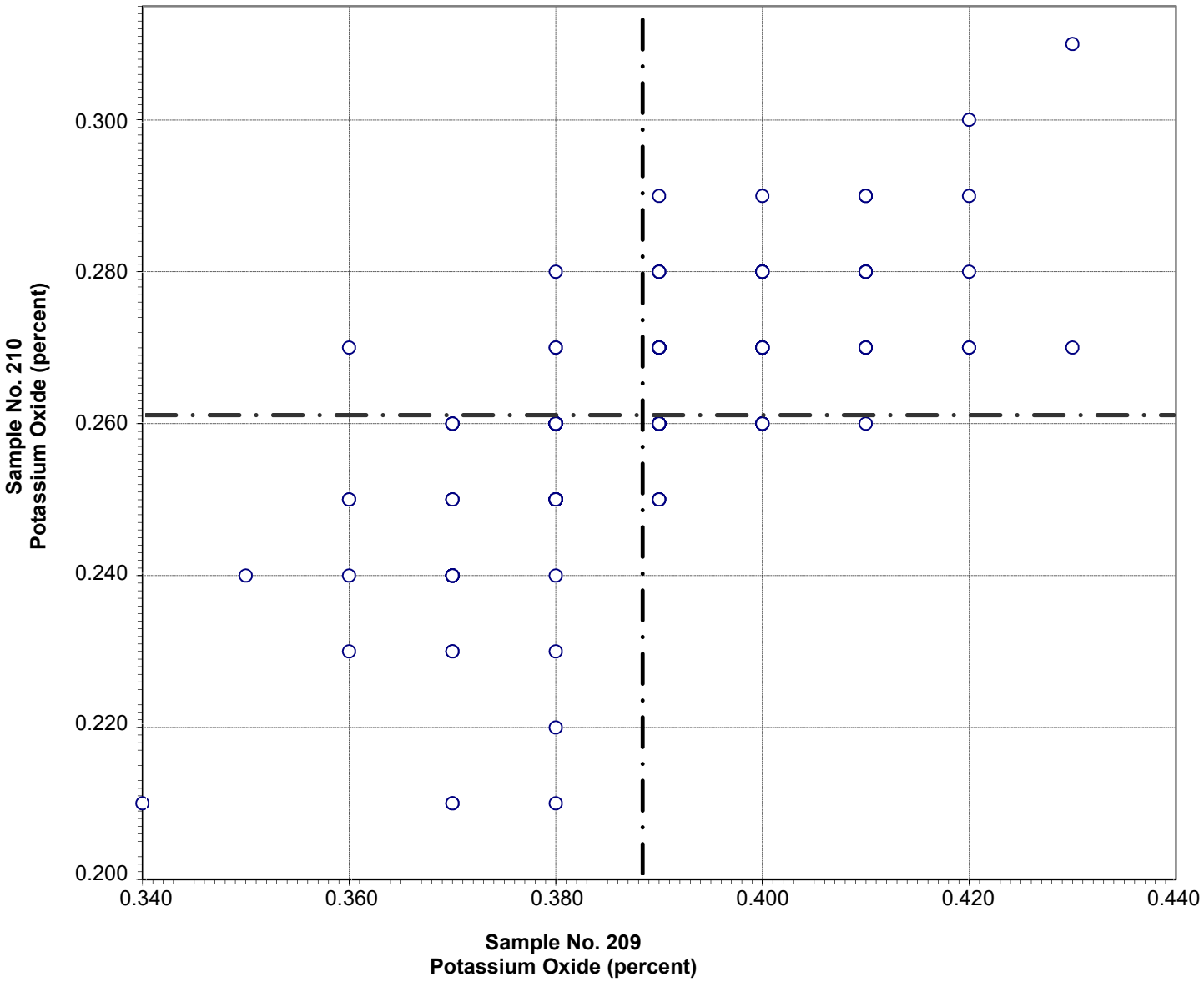


Test No. 90 Sodium Oxide 191 Points

Sample No. 209	Ave	0.114	S.D.	0.016	C.V. 14
Sample No. 210	Ave	0.164	S.D.	0.018	C.V. 11

Labs Eliminated: 4, 50, 78, 99, 246, 309, 881, 975, 1054, 2352, 2465, 3238, 3605, 3606, 3607, 4051, 4270

CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 209 and No. 210

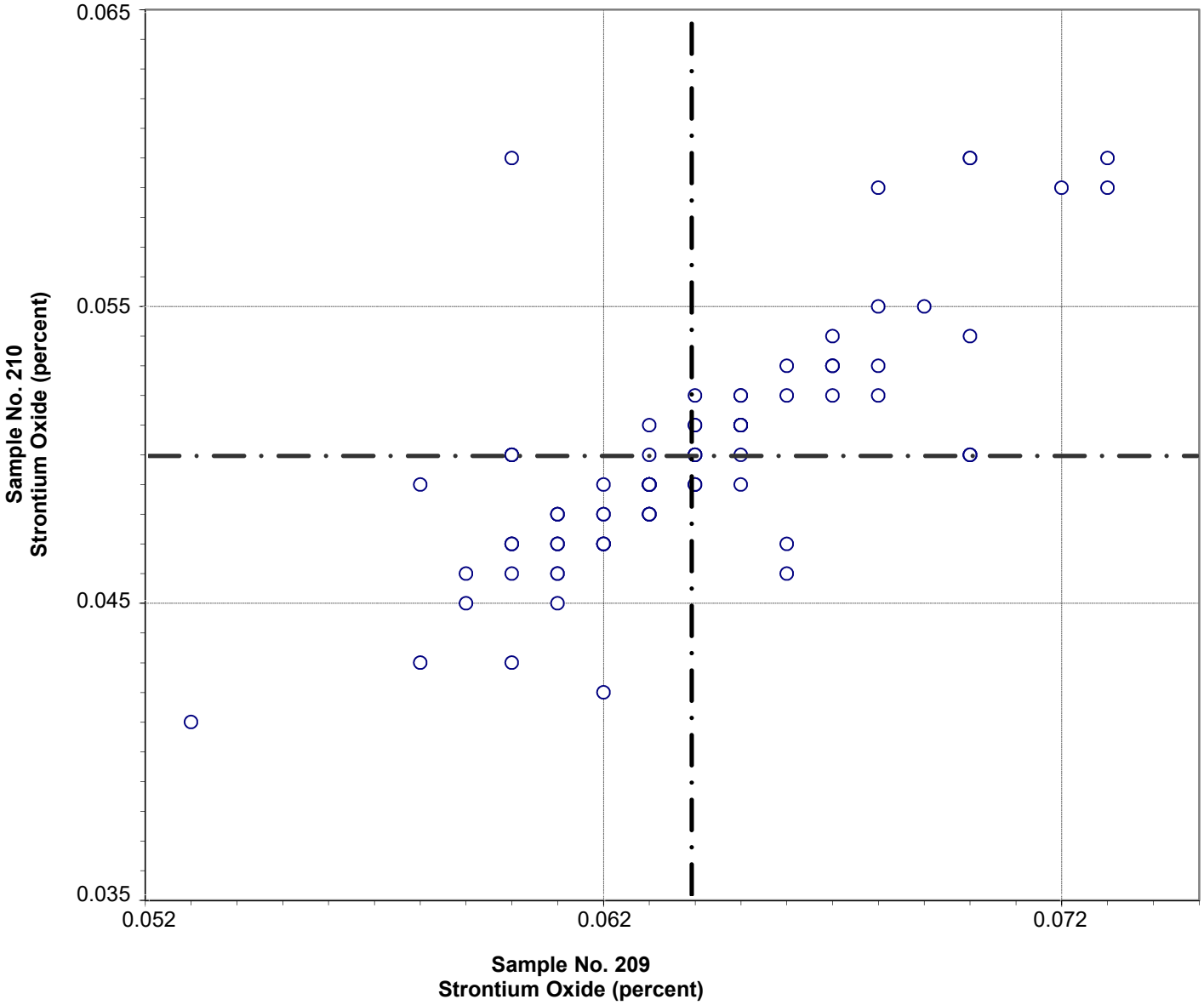


Test No. 100 Potassium Oxide 200 Points

Sample No. 209	Ave	0.388	S.D.	0.014	C.V. 3.6
Sample No. 210	Ave	0.261	S.D.	0.015	C.V. 5.9

Labs Eliminated: 36, 95, 2293, 2412, 3606, 3661, 4099, 4297, 4325, 4350

CCRL Proficiency Sample Program
Strontium Oxide
PORTLAND CEMENT Samples No. 209 and No. 210

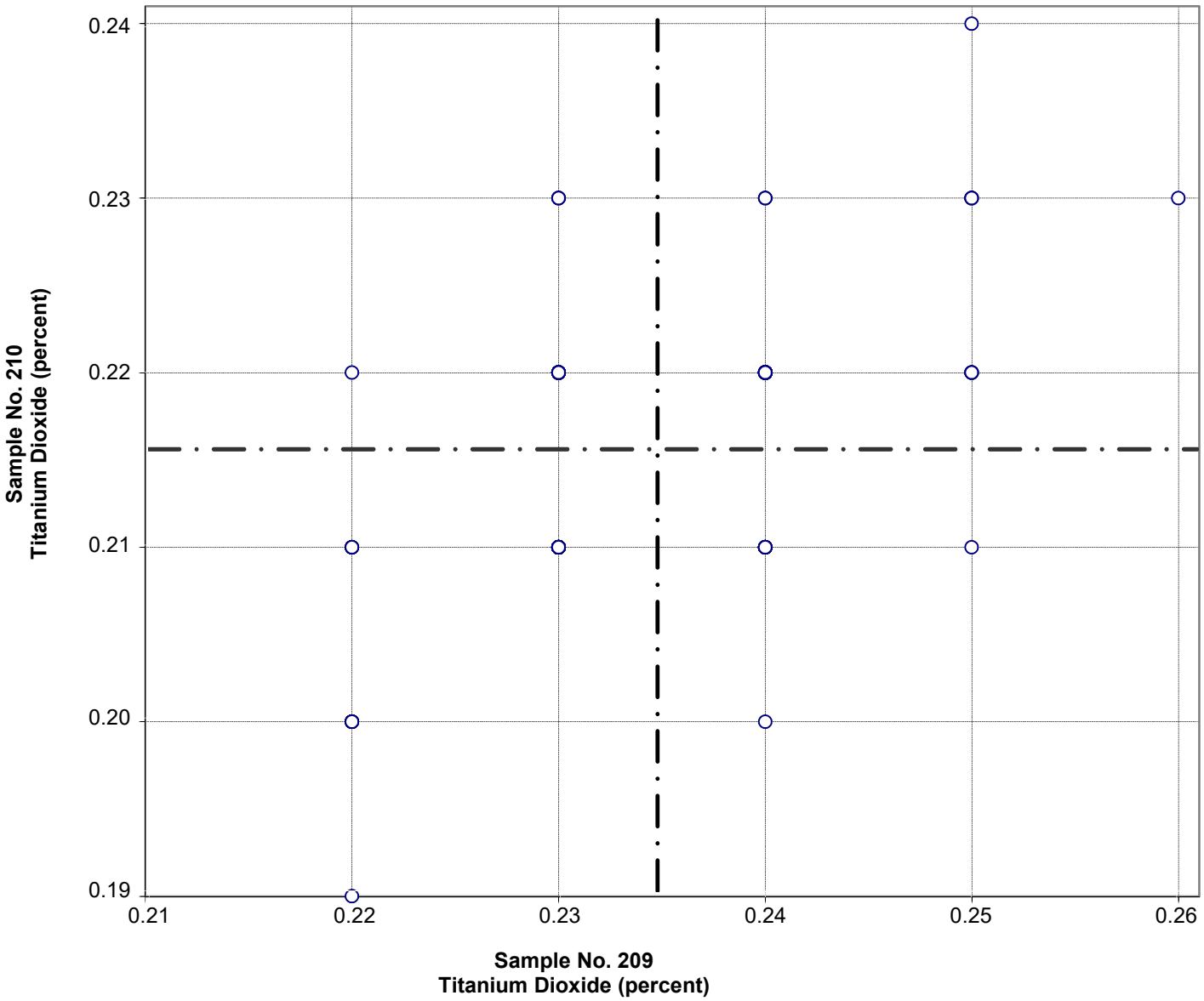


Test No. 92 Strontium Oxide 95 Points

Sample No. 209	Ave	0.064	S.D.	0.004	C.V.	6
Sample No. 210	Ave	0.050	S.D.	0.004	C.V.	8

Labs Eliminated: 20, 40, 43, 74, 95, 151, 309, 1657, 4099, 4325

CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 209 and No. 210

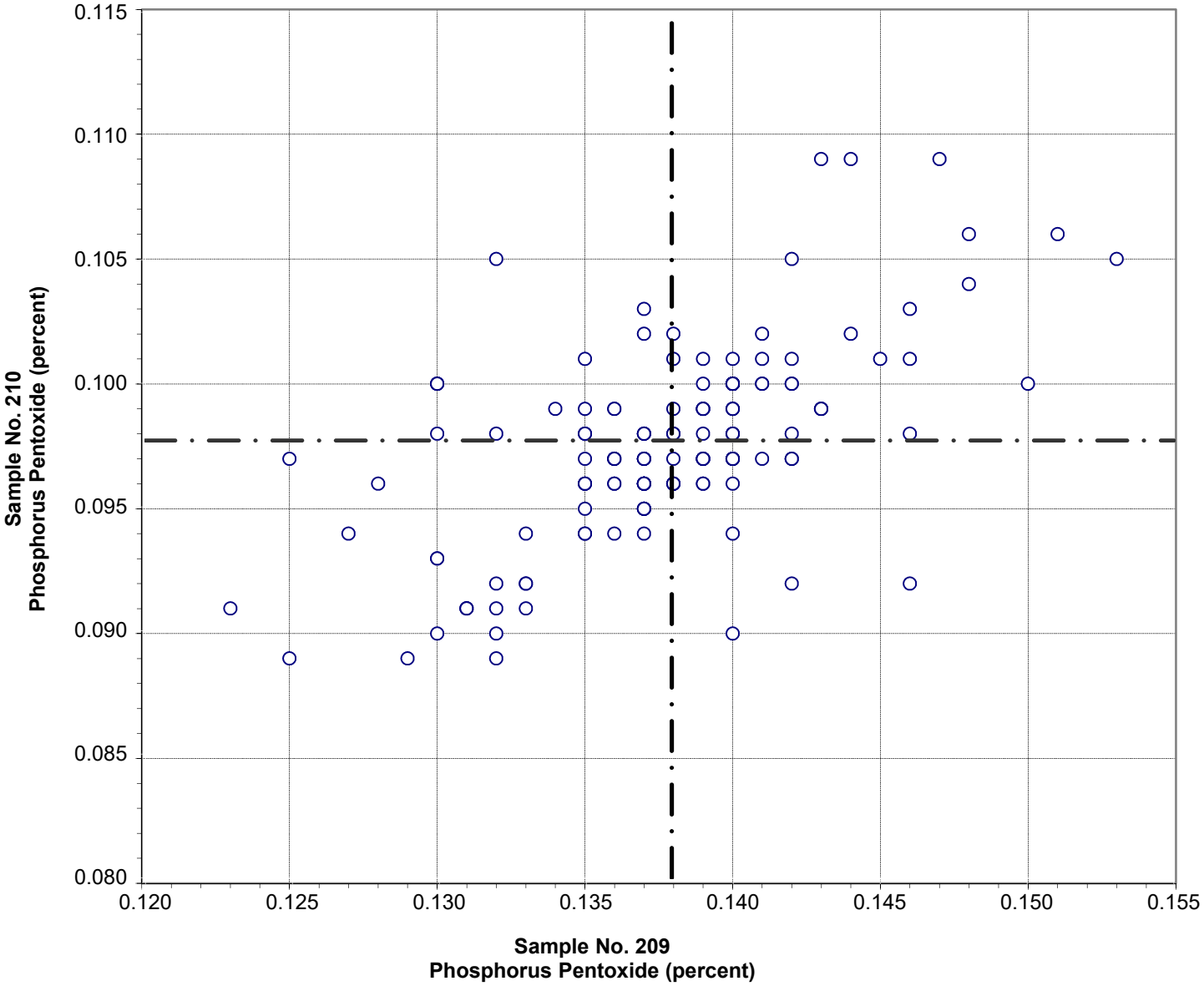


Test No. 103 Titanium Dioxide 173 Points

Sample No. 209	Ave	0.23	S.D.	0.008	C.V.	3.2
Sample No. 210	Ave	0.22	S.D.	0.007	C.V.	3.4

Labs Eliminated: 246, 4099, 4325

CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 209 and No. 210

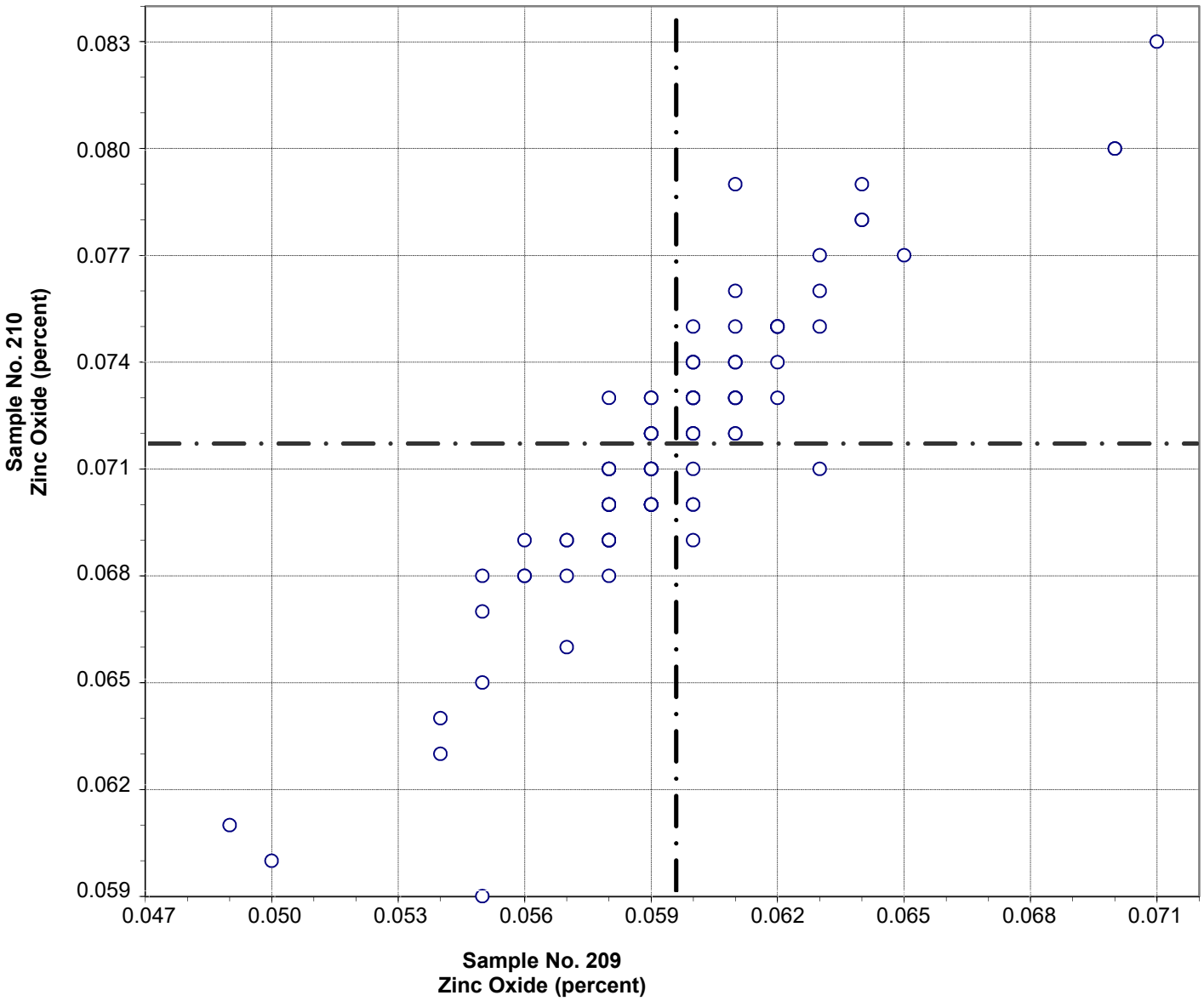


Test No. 102 Phosphorus Pentoxide 153 Points

Sample No. 209	Ave	0.138	S.D.	0.005	C.V. 3.5
Sample No. 210	Ave	0.098	S.D.	0.004	C.V. 3.9

Labs Eliminated: 10, 48, 90, 93, 99, 134, 247, 407, 504, 881, 975, 1942, 2466, 2490, 2491, 4099, 4115, 4270, 4325

CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 209 and No. 210

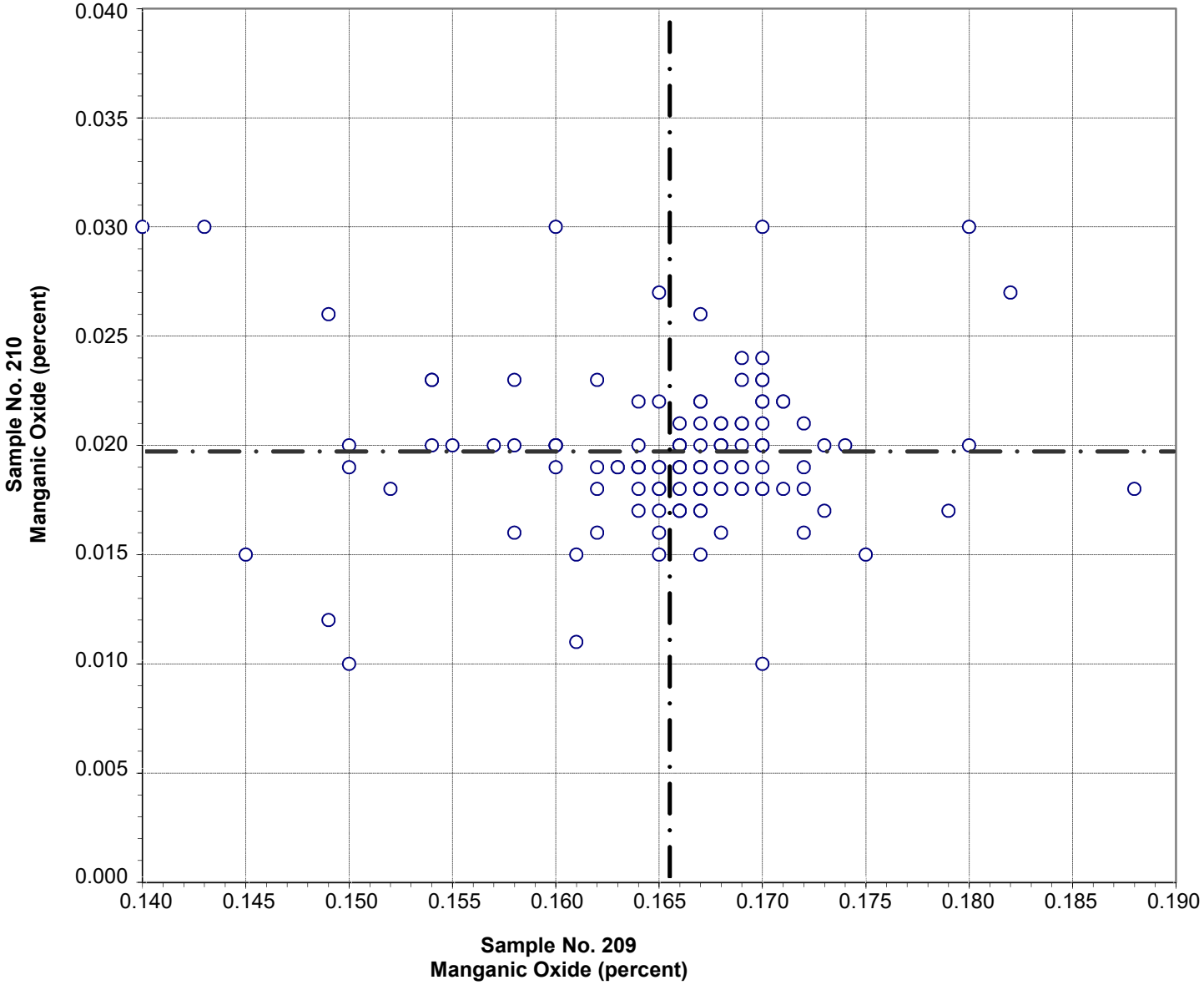


Test No. 99 Zinc Oxide 94 Points

Sample No. 209	Ave	0.060	S.D.	0.003	C.V. 5.5
Sample No. 210	Ave	0.072	S.D.	0.004	C.V. 5.6

Labs Eliminated: 25, 94, 309, 768, 881, 1916, 4099, 4297, 4325

CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 209 and No. 210

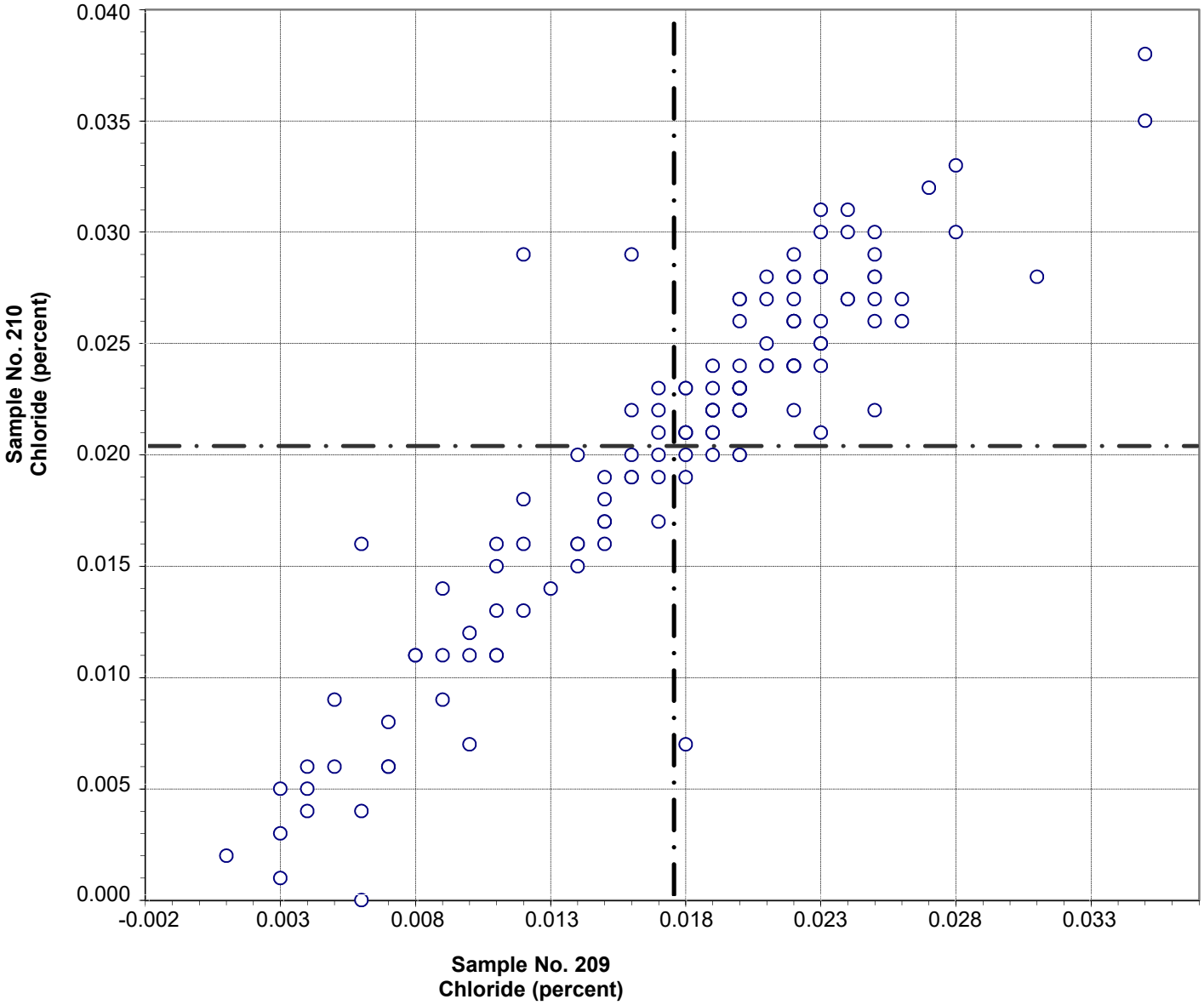


Test No. 101 Manganic Oxide 126 Points

Sample No. 209	Ave	0.165	S.D.	0.007	C.V. 4.4
Sample No. 210	Ave	0.020	S.D.	0.003	C.V. 17.7

Labs Eliminated: 47, 84, 94, 101, 181, 205, 413, 667, 768, 2466, 3297, 4099, 4297, 4325

CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 209 and No. 210

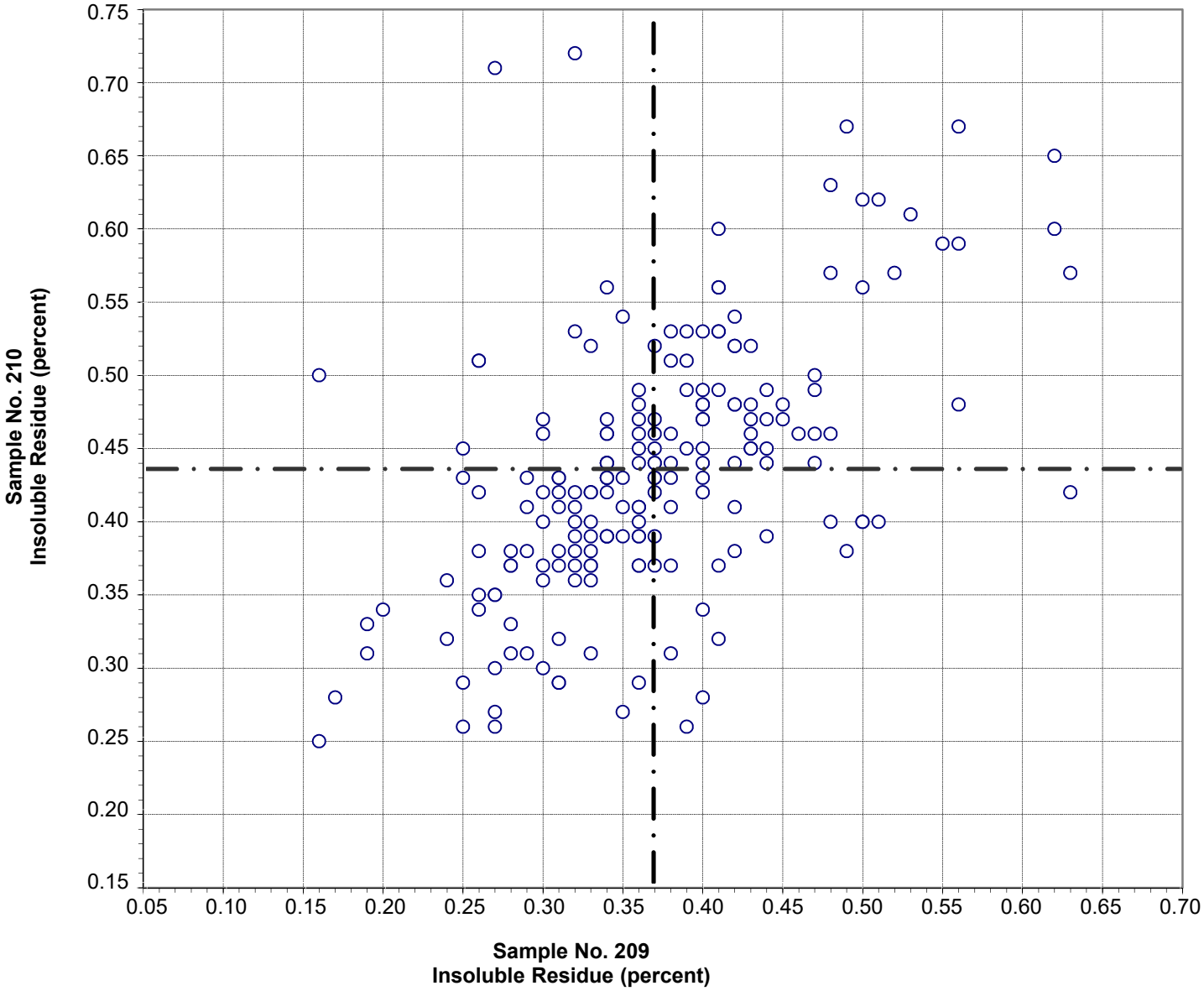


Test No. 104 Chloride 132 Points

Sample No. 209	Ave	0.018	S.D.	0.007	C.V. 39
Sample No. 210	Ave	0.020	S.D.	0.008	C.V. 39

Labs Eliminated: 18, 94, 497

CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 209 and No. 210

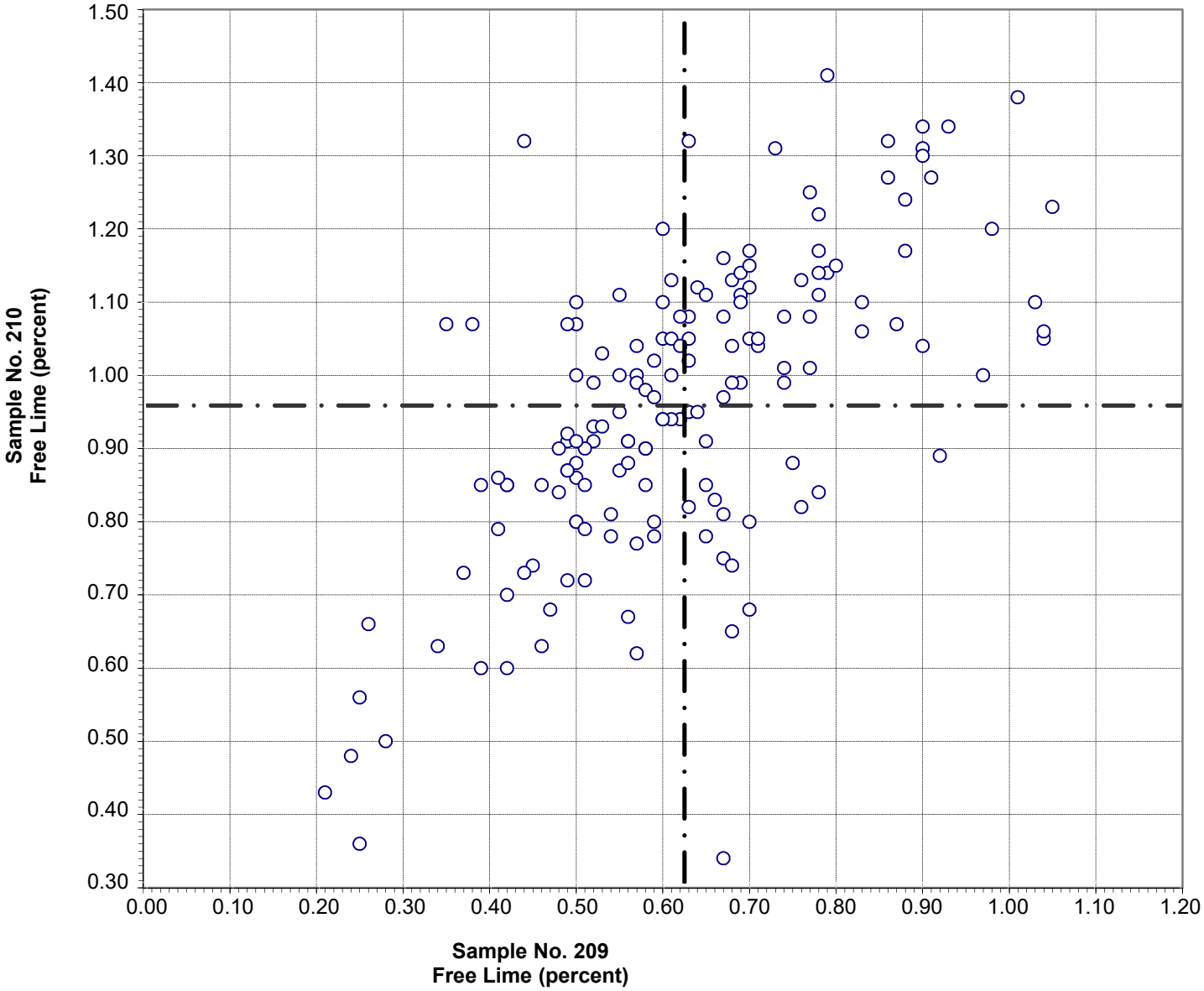


Test No. 80 Insoluble Residue 193 Points

Sample No. 209	Ave	0.37	S.D.	0.09	C.V.	23
Sample No. 210	Ave	0.44	S.D.	0.09	C.V.	21

Labs Eliminated: 206, 255, 1053, 4325

CCRL Proficiency Sample Program
Free Lime
PORTLAND CEMENT Samples No. 209 and No. 210

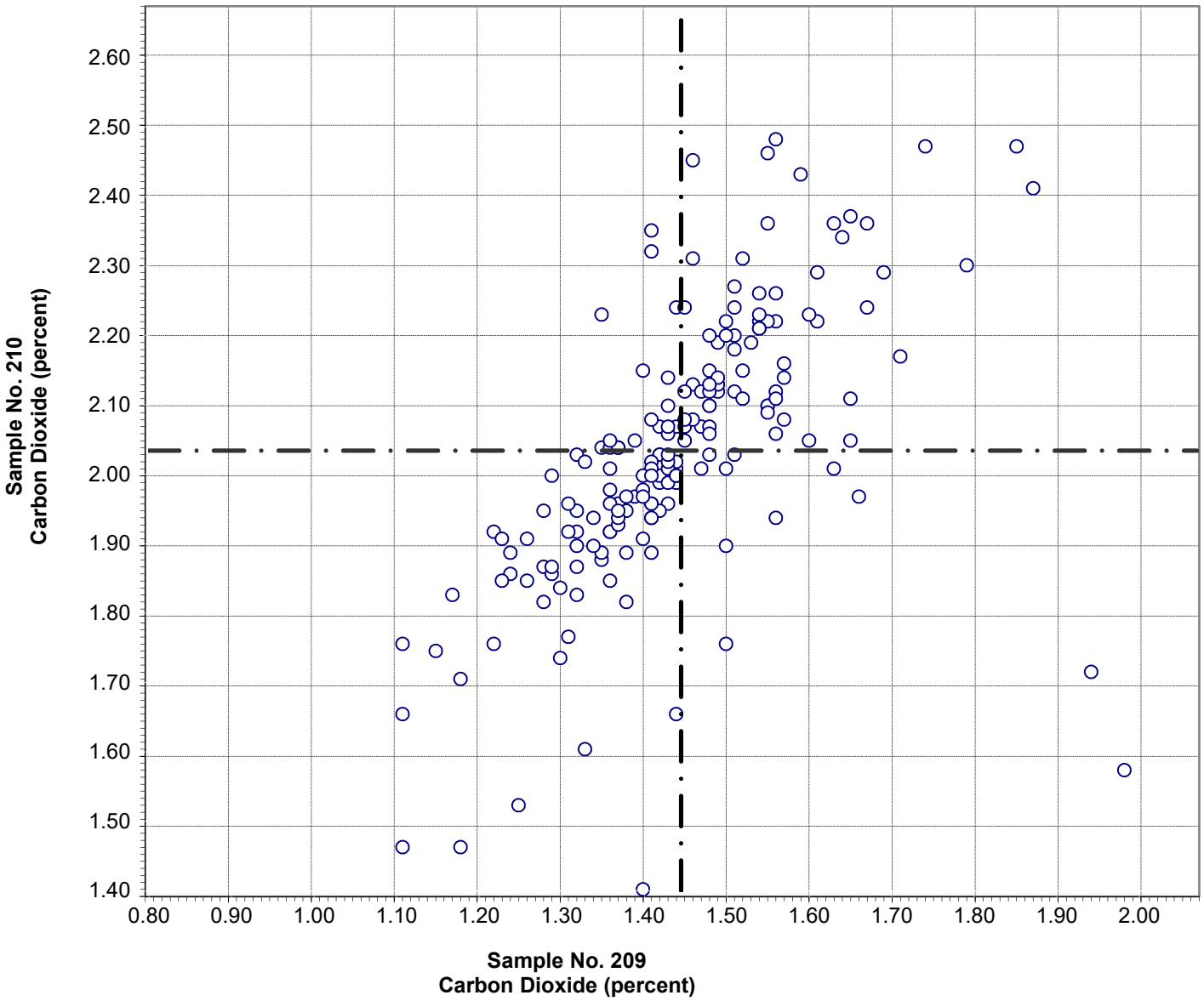


Test No. 41 Free Lime 160 Points

Sample No. 209	Ave	0.62	S.D.	0.17	C.V. 27
Sample No. 210	Ave	0.96	S.D.	0.20	C.V. 21

Labs Eliminated: 60, 416, 881

CCRL Proficiency Sample Program
Carbon Dioxide
PORTLAND CEMENT Samples No. 209 and No. 210



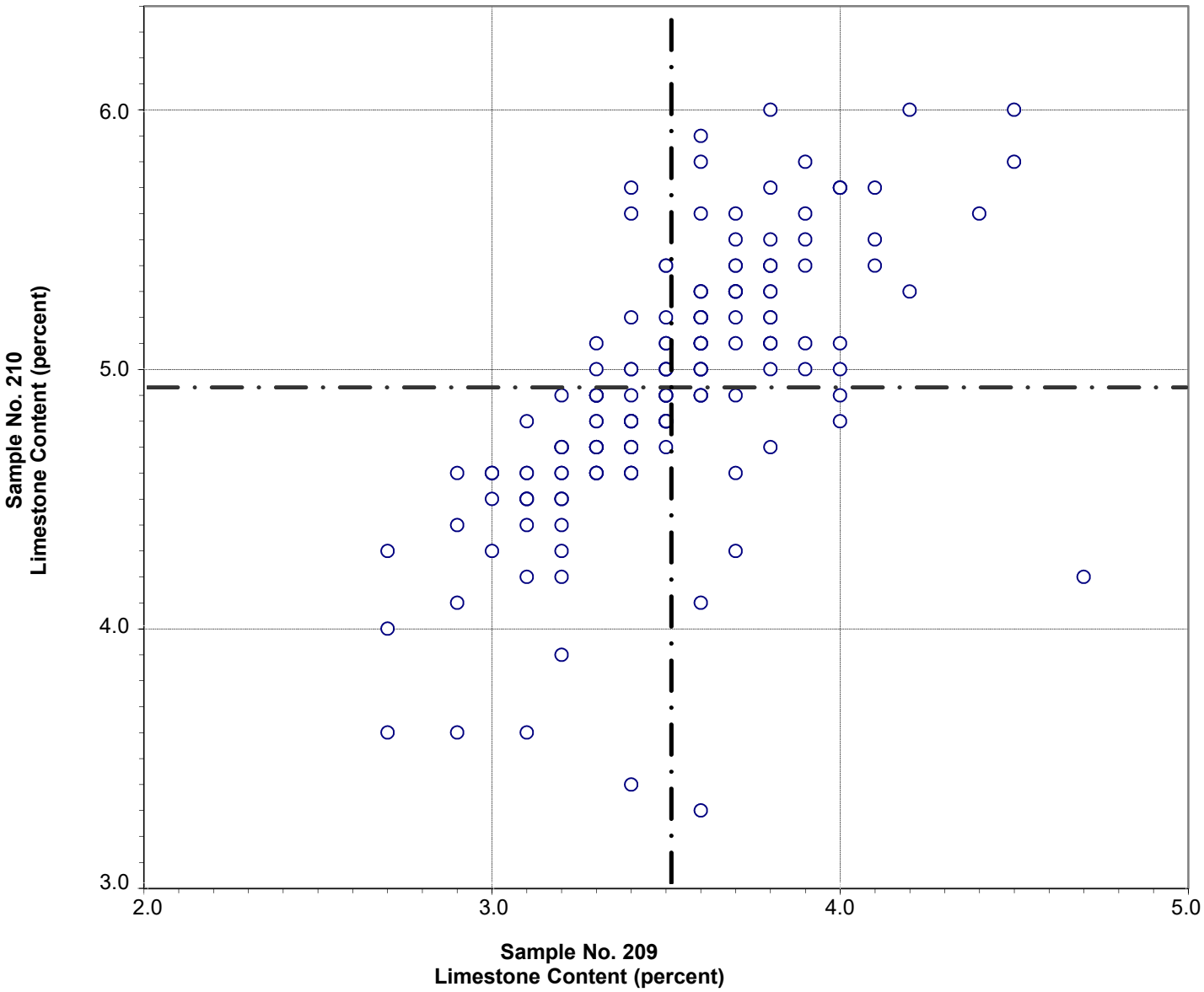
Test No. 97 Carbon Dioxide 184 Points

Sample No. 209	Ave	1.44	S.D.	0.14	C.V. 9.8
Sample No. 210	Ave	2.03	S.D.	0.20	C.V. 9.8

Labs Eliminated: 15, 50, 137, 416, 542, 958, 1435, 3368, 4080

Labs off Diagram: 42

CCRL Proficiency Sample Program
Limestone Content
PORTLAND CEMENT Samples No. 209 and No. 210

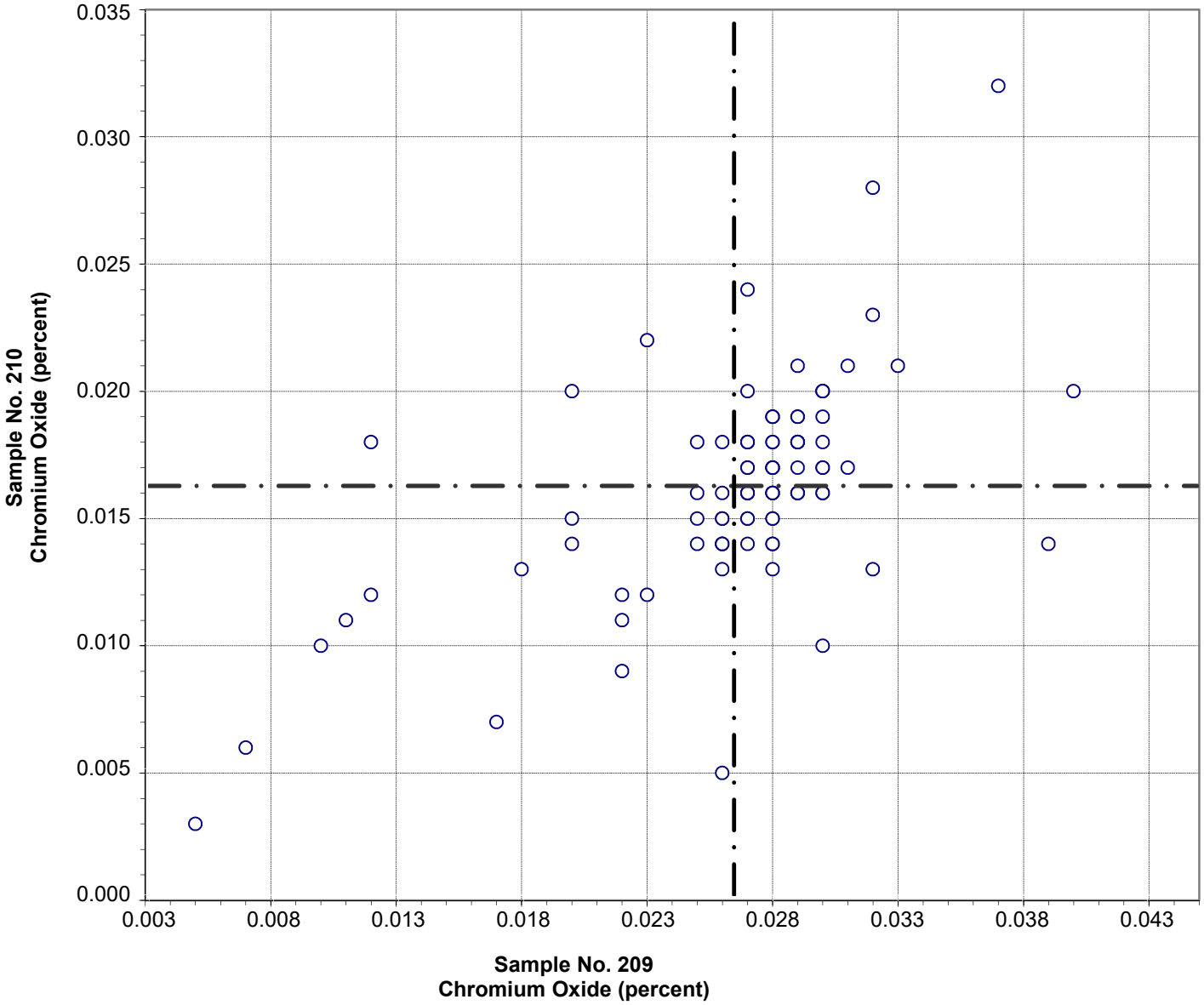


Test No. 98 Limestone Content 171 Points

Sample No. 209	Ave	3.5	S.D.	0.3	C.V. 9.6
Sample No. 210	Ave	4.9	S.D.	0.5	C.V. 9.9

Labs Eliminated: 15, 24, 26, 50, 64, 99, 137, 169, 246, 413, 542, 958, 1053, 1435, 2491, 3368, 4080, 4325

CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 209 and No. 210

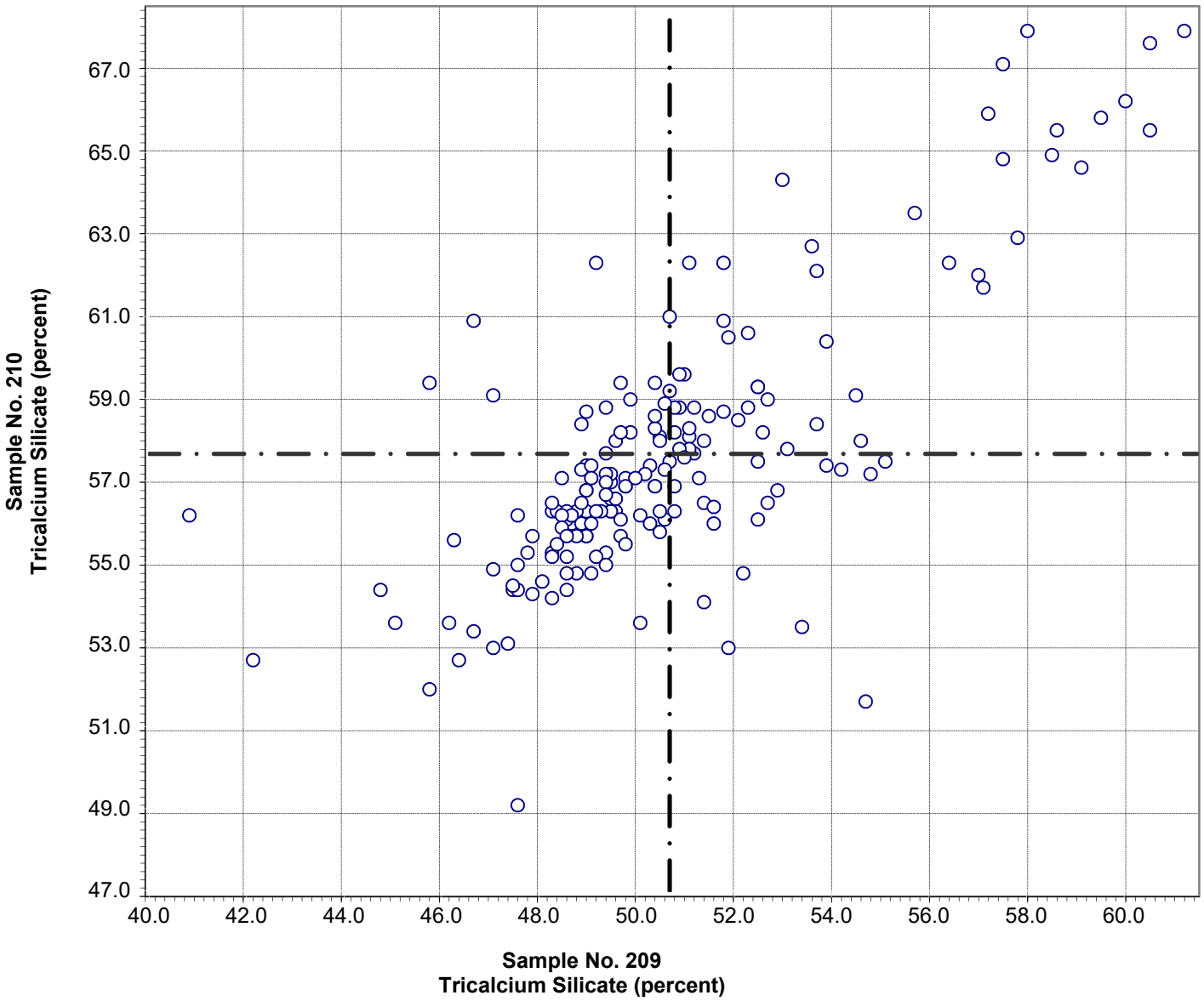


Test No. 105 Chromium Oxide 91 Points

Sample No. 209	Ave	0.026	S.D.	0.006	C.V.	22
Sample No. 210	Ave	0.016	S.D.	0.004	C.V.	26

Labs Eliminated: 19, 116, 206, 415, 502, 3368

CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 209 and No. 210

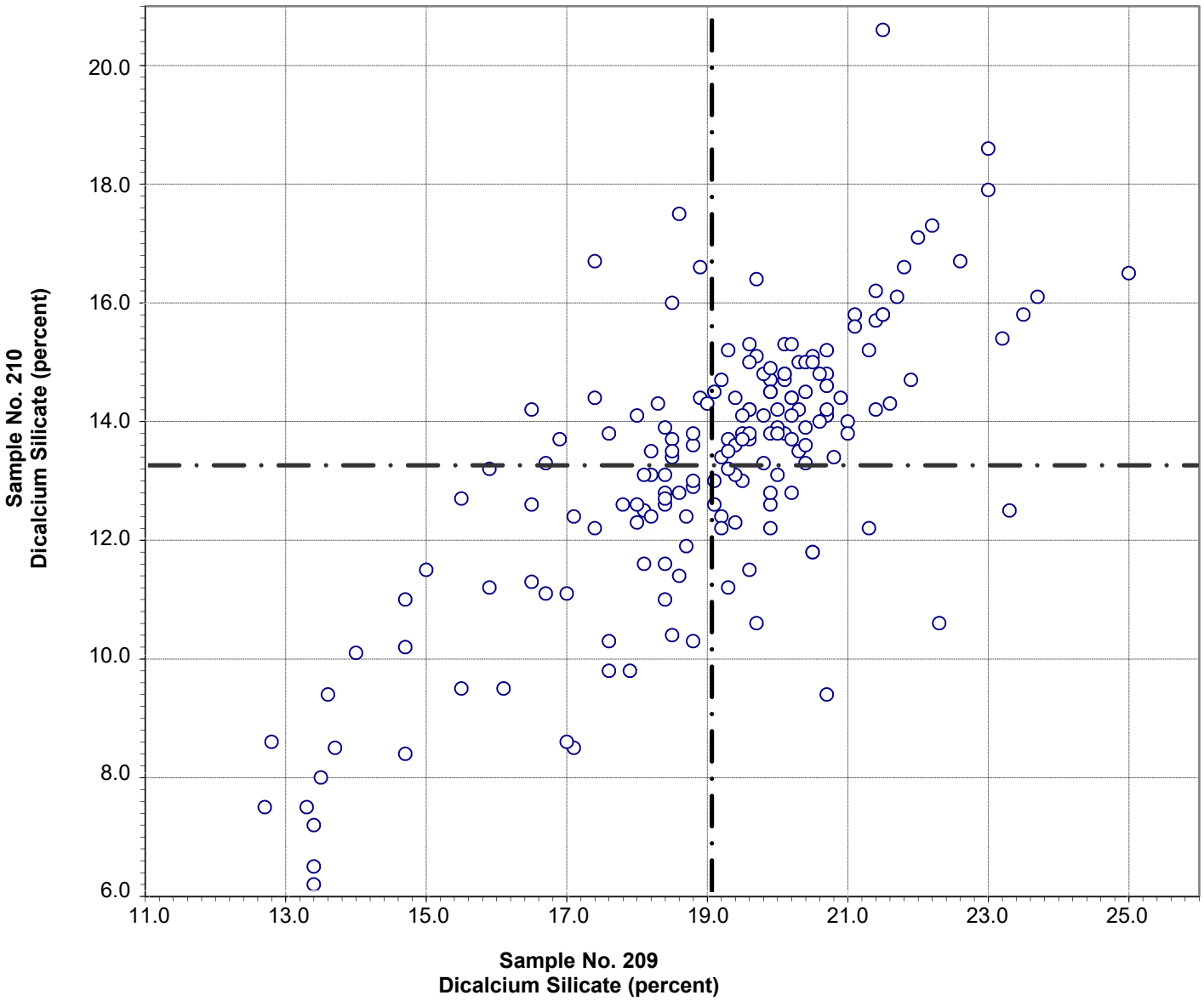


Test No. 106 Tricalcium Silicate 182 Points

Sample No. 209	Ave	50.7	S.D.	3.3	C.V.	6.5
Sample No. 210	Ave	57.7	S.D.	3.2	C.V.	5.6

Labs Eliminated: 107, 159, 206, 779, 4297, 4316, 4325

CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 209 and No. 210



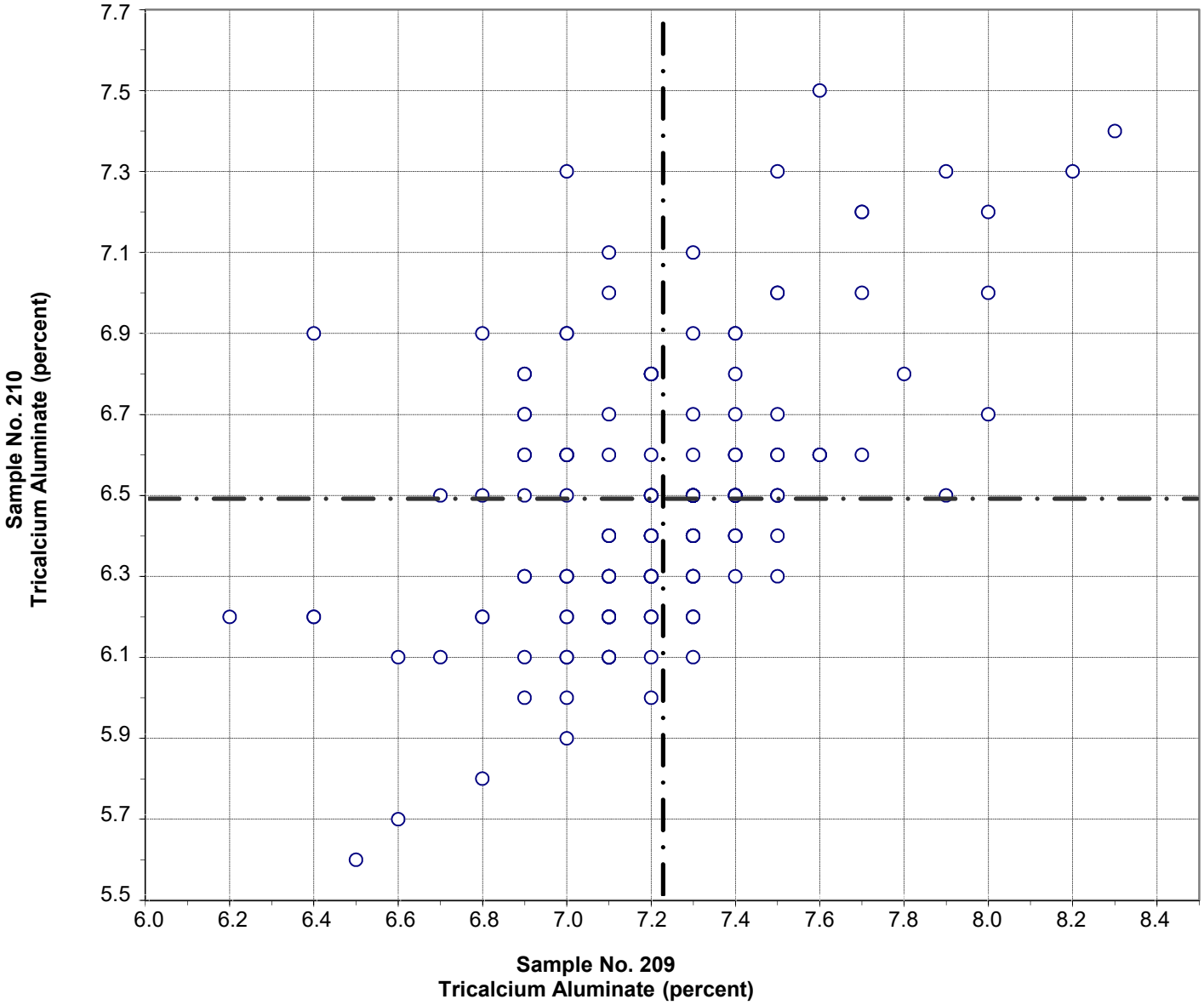
Test No. 107 Dicalcium Silicate 177 Points

Sample No. 209	Ave	19.1	S.D.	2.3	C.V. 11.9
Sample No. 210	Ave	13.2	S.D.	2.4	C.V. 18.0

Labs Eliminated: 98, 107, 159, 206, 221, 694, 779, 3238, 4297, 4316, 4325

Labs off Diagram: 142

CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 209 and No. 210

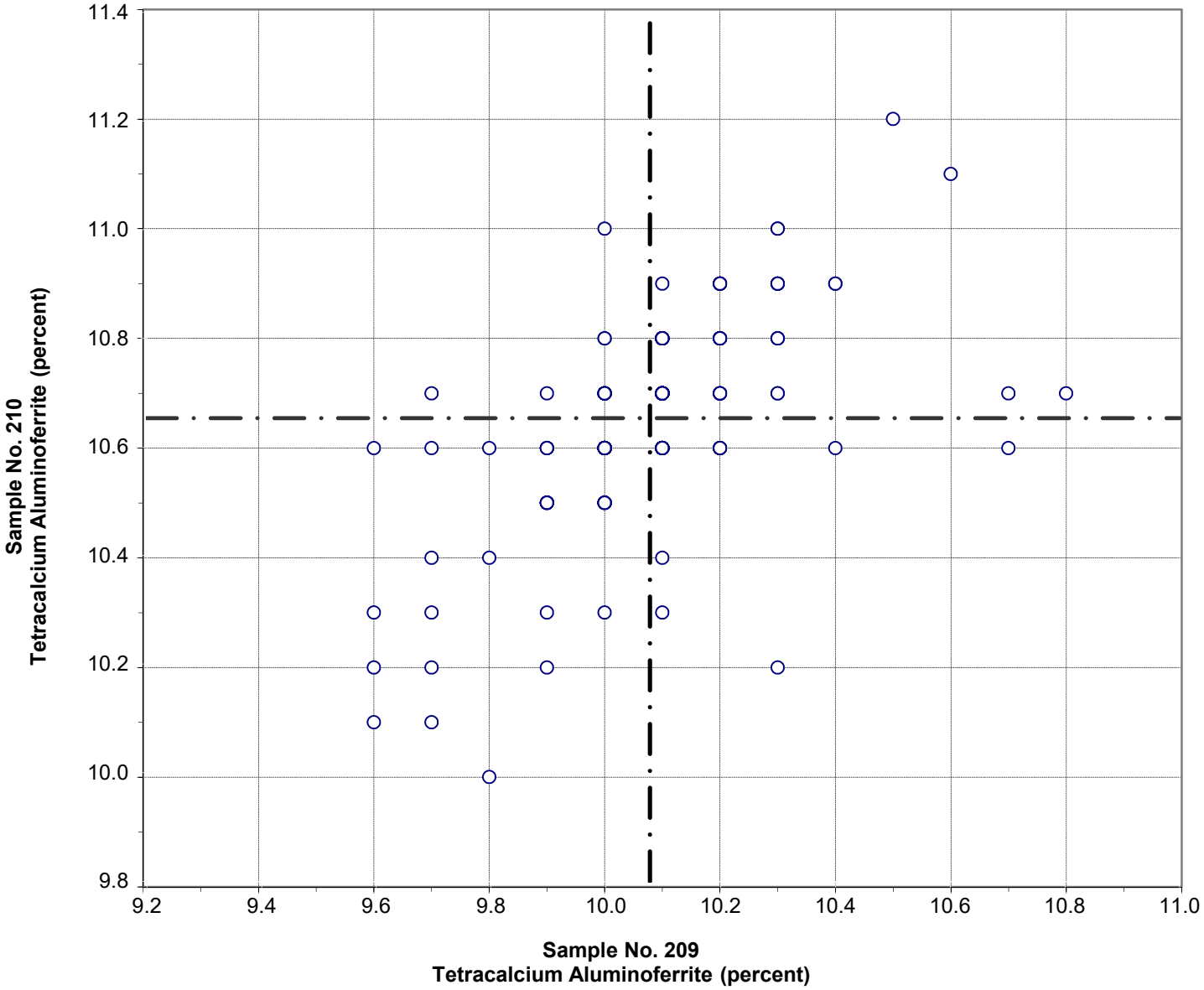


Test No. 108 Tricalcium Aluminate 186 Points

Sample No. 209	Ave	7.2	S.D.	0.3	C.V. 4.2
Sample No. 210	Ave	6.5	S.D.	0.3	C.V. 4.8

Labs Eliminated: 95, 3238, 4297

CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 209 and No. 210



Test No. 109 Tetracalcium Aluminoferrite 181 Points

Sample No. 209	Ave	10.1	S.D.	0.2	C.V. 1.8
Sample No. 210	Ave	10.7	S.D.	0.2	C.V. 1.6

Labs Eliminated: 41, 206, 438, 694, 3238, 3368, 4080, 4316

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Normal Consistency - % Water (**percent**)							
	236	25.0	0.91	3.60	26.1	0.91	3.50
	*235	24.9	0.43	1.70	26.0	0.55	2.10
* Labs Eliminated - 41							
Vicat Time of Set - Initial (**minutes**)							
	231	164	15	9	122	14	11
	*226	165	14	8	121	12	10
* Labs Eliminated - 156, 159, 557, 565, 2462							
Vicat Time of Set - Final (**minutes**)							
	222	271	33	12	220	26	12
	*219	272	30	11	221	26	12
* Labs Eliminated - 1, 557, 2462							
Gillmore Time of Set - Initial (**minutes**)							
	129	195	24	12	161	21	13
	*128	195	24	12	160	19	12
* Labs Eliminated - 51							
Gillmore Time of Set - Final (**minutes**)							
	129	304	36	12	256	35	13
	*127	304	32	11	256	31	12
* Labs Eliminated - 95, 450							
False Set - Paste Method (**percent**)							
	182	74	7.9	10.6	77	10.8	14.1
	*177	75	7.5	10.0	78	8.4	10.8
* Labs Eliminated - 25, 51, 103, 840, 4115							
Autoclave Expansion (**percent**)							
	223	-0.02	0.026	-185	-0.02	0.031	-233
	*212	-0.02	0.017	-117	-0.02	0.016	-119
* Labs Eliminated - 35, 56, 132, 148, 159, 176, 698, 996, 1054, 2352, 4350							

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Air Content % (**percent**)							
	221	8.1	1.4	17	7.9	1.2	15
	*218	8.1	1.2	15	7.9	1.2	15
* Labs Eliminated - 32, 52, 1251							
Air Content - % Water (**percent**)							
	214	68.1	4.6	6.8	68.6	4.1	6.0
	*206	67.9	2.5	3.8	68.6	2.5	3.7
* Labs Eliminated - 25, 35, 52, 209, 221, 407, 408, 3662							
Air Content - Flow (**percent**)							
	215	89	5.5	6.2	88	4.6	5.2
	*211	88	3.9	4.4	87	3.3	3.7
* Labs Eliminated - 175, 408, 1940, 3606							
Compressive Strength - 3 day (**psi**)							
	239	3461	296	8.5	4191	293	7.0
	*234	3442	266	7.7	4180	274	6.6
* Labs Eliminated - 38, 416, 3606, 3607, 4080							
Compressive Strength - 7 day (**psi**)							
	241	4411	362	8.2	5379	366	6.8
	*236	4413	318	7.2	5384	336	6.2
* Labs Eliminated - 36, 416, 1019, 2683, 4080							
Compressive Strength - 28 day (**psi**)							
	229	6010	444	7.4	6942	490	7.1
	*228	6001	425	7.1	6934	474	6.8
* Labs Eliminated - 4080							
Compressive Strengh - Flow (**percent**)							
	221	121	11	9.3	118	11	9.2
	*220	121	11	9.0	119	11	8.9
* Labs Eliminated - 254							

CCRL PROFICIENCY SAMPLE PROGRAM

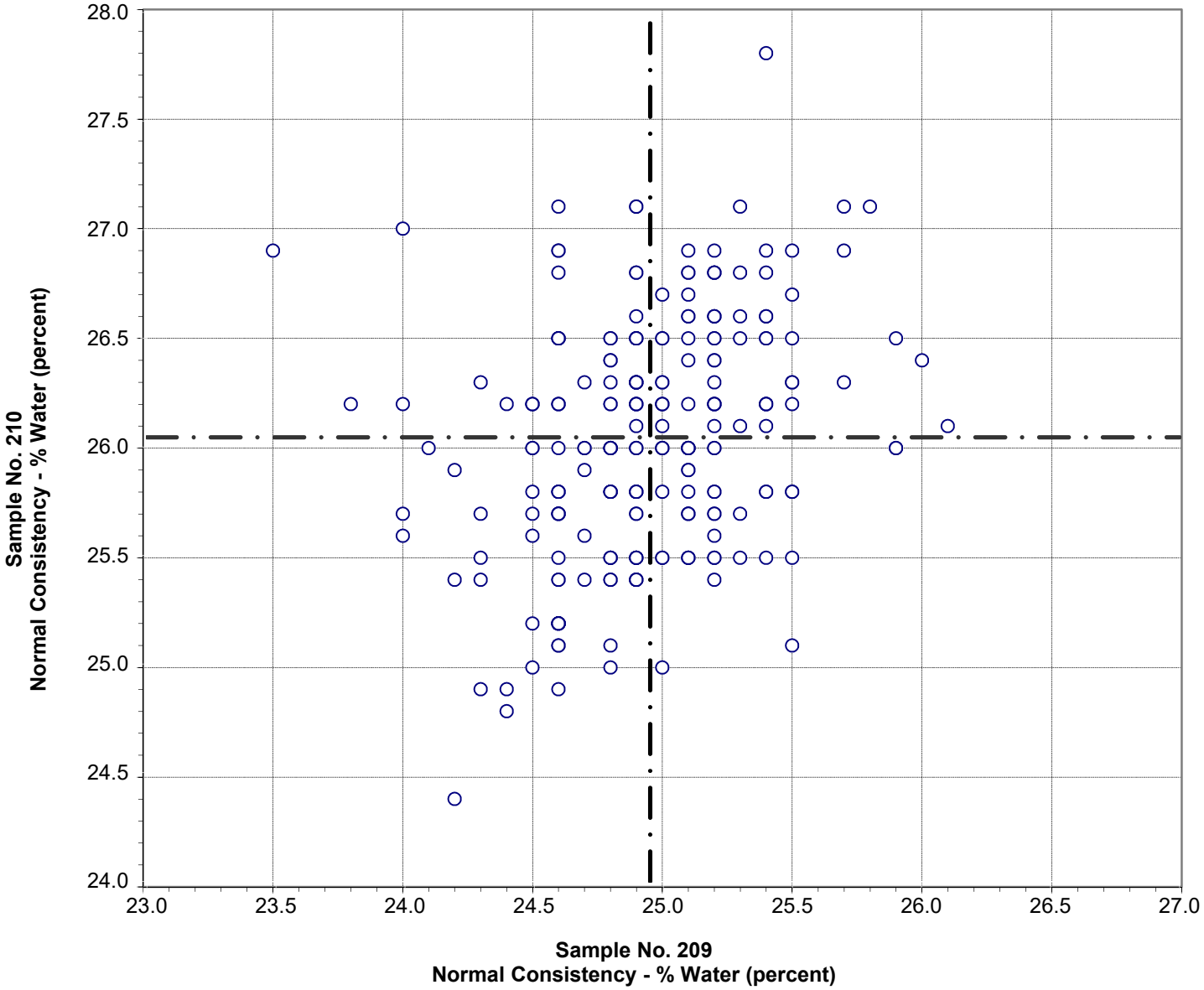
Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
Fineness - Air Permeability (**m²/kg**)							
	236	397	14	3.5	407	15	3.6
	*231	397	11	2.7	408	11	2.8
* Labs Eliminated - 1, 360, 1079, 1590, 3834							
Fineness - 45µm Sieve (**percent**)							
	221	97.05	0.67	0.69	98.48	0.48	0.49
	*215	97.08	0.53	0.55	98.53	0.32	0.32
* Labs Eliminated - 26, 116, 146, 222, 823, 4316							
C1038 Mortar Bar Expansion (**percent**)							
	153	0.004	0.007	188	0.004	0.007	164
	*149	0.003	0.003	108	0.004	0.004	95
* Labs Eliminated - 34, 143, 1054, 3297							

CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 209 and No. 210



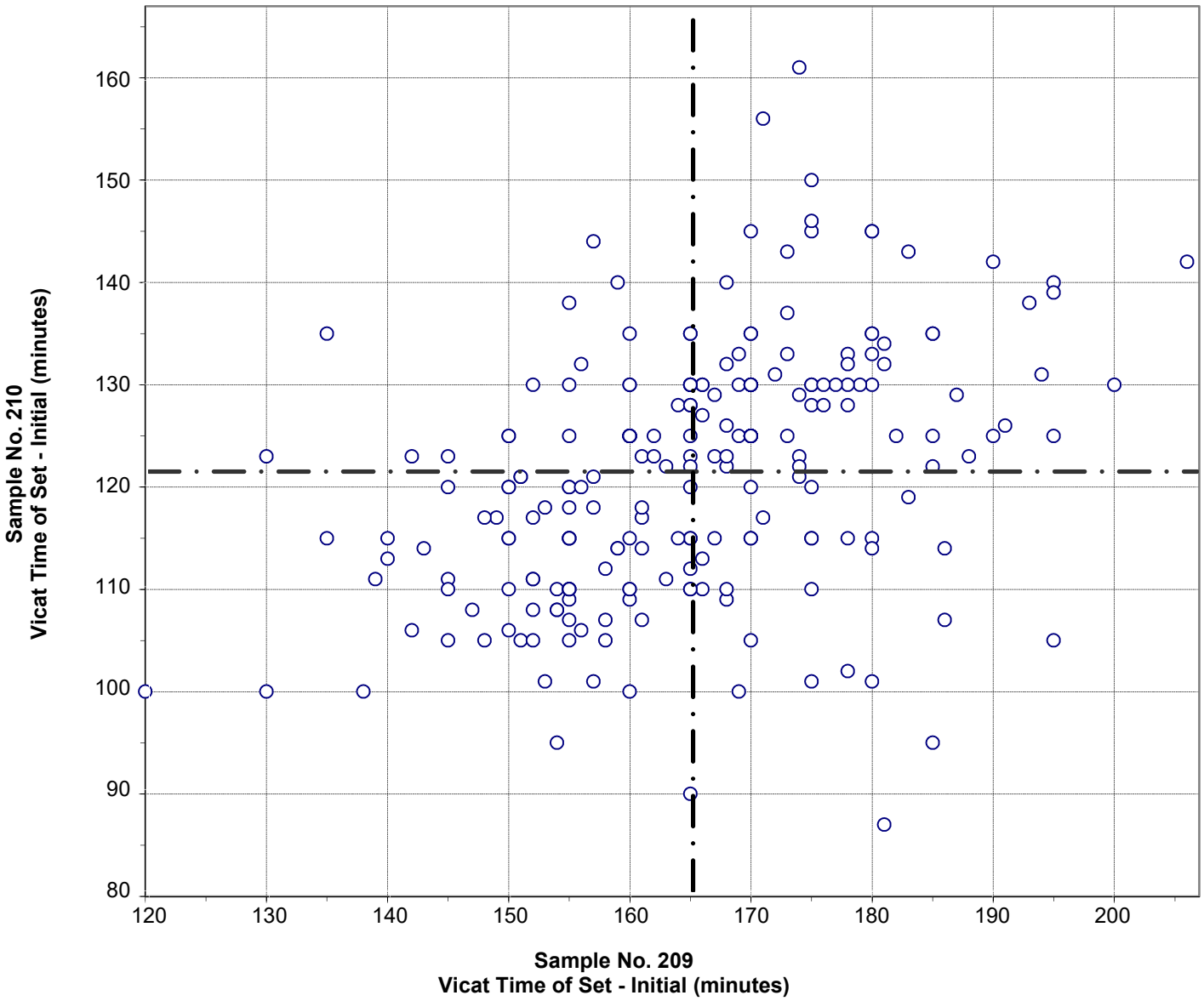
Test No. 110 Normal Consistency - % Water 234 Points

Sample No. 209	Ave	24.9	S.D.	0.43	C.V.	1.70
Sample No. 210	Ave	26.0	S.D.	0.55	C.V.	2.10

Labs Eliminated: 41

Labs off Diagram: 4080

CCRL Proficiency Sample Program
Vicat Time of Set - Initial
PORTLAND CEMENT Samples No. 209 and No. 210

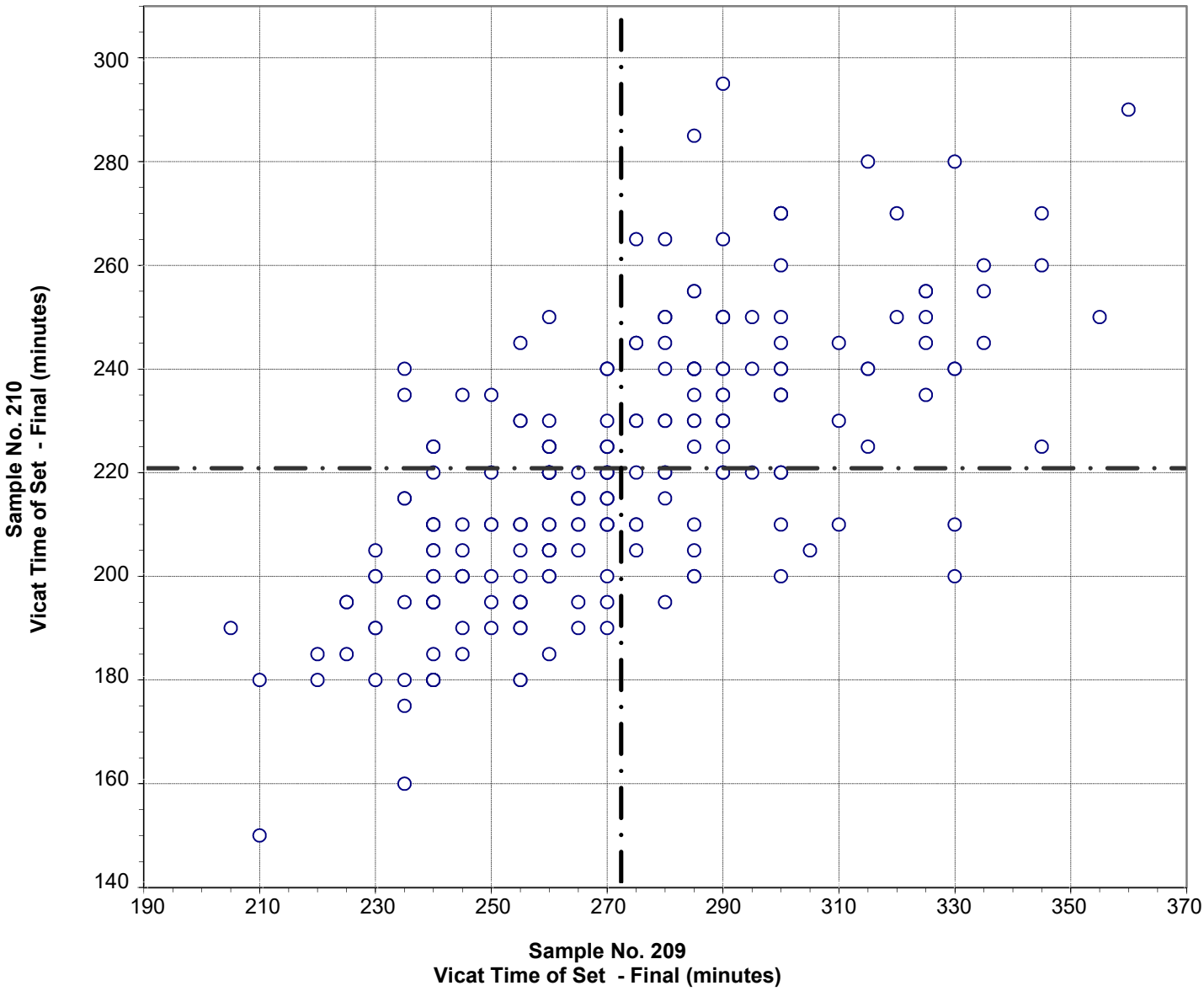


Test No. 120 Vicat Time of Set - Initial 226 Points

Sample No. 209	Ave	165	S.D.	14	C.V. 8
Sample No. 210	Ave	121	S.D.	12	C.V. 10

Labs Eliminated: 156, 159, 557, 565, 2462

CCRL Proficiency Sample Program
Vicat Time of Set - Final
PORTLAND CEMENT Samples No. 209 and No. 210

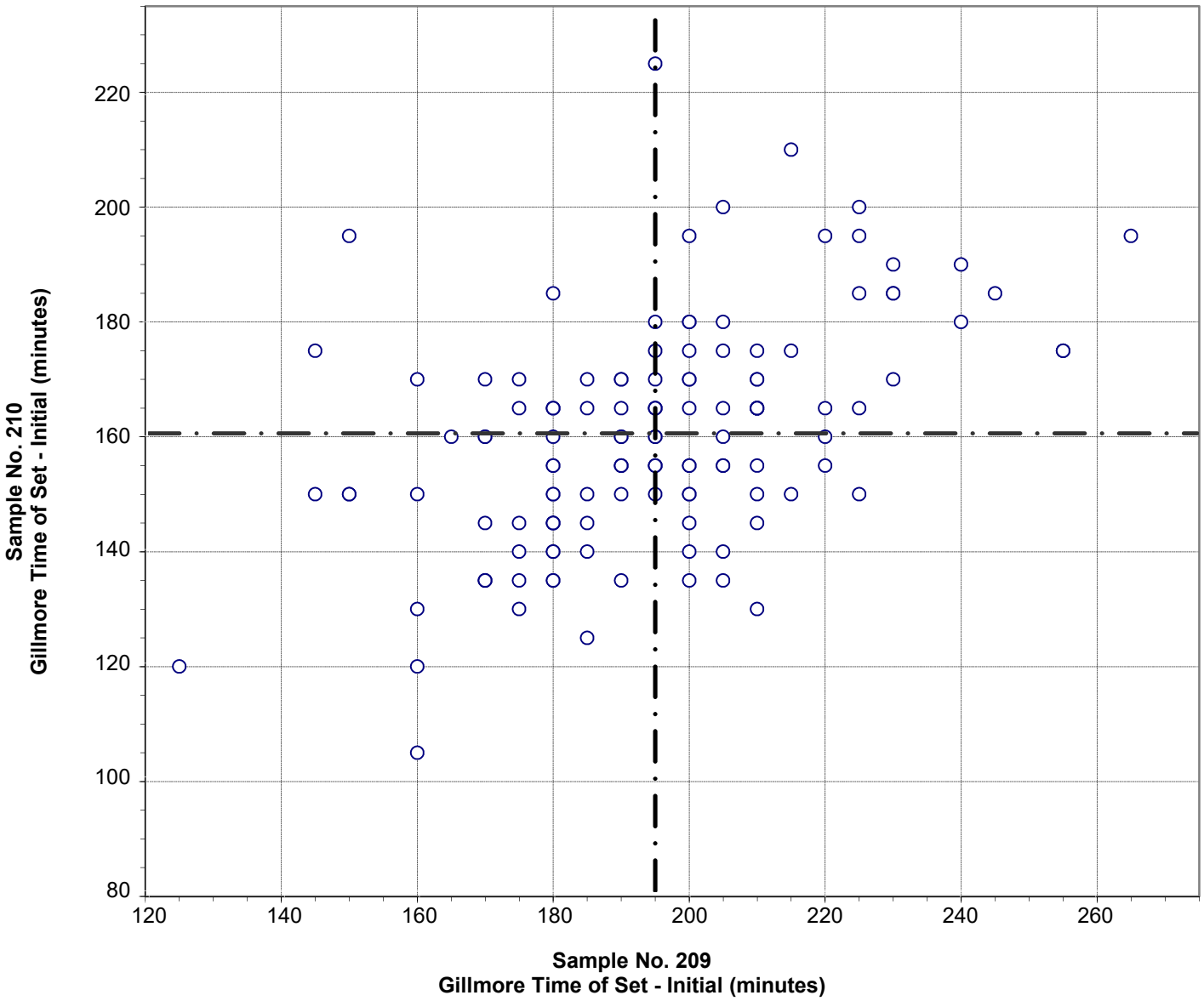


Test No. 121 Vicat Time of Set - Final 219 Points

Sample No. 209	Ave 272	S.D. 30	C.V. 11
Sample No. 210	Ave 221	S.D. 26	C.V. 12

Labs Eliminated: 1, 557, 2462

CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 209 and No. 210

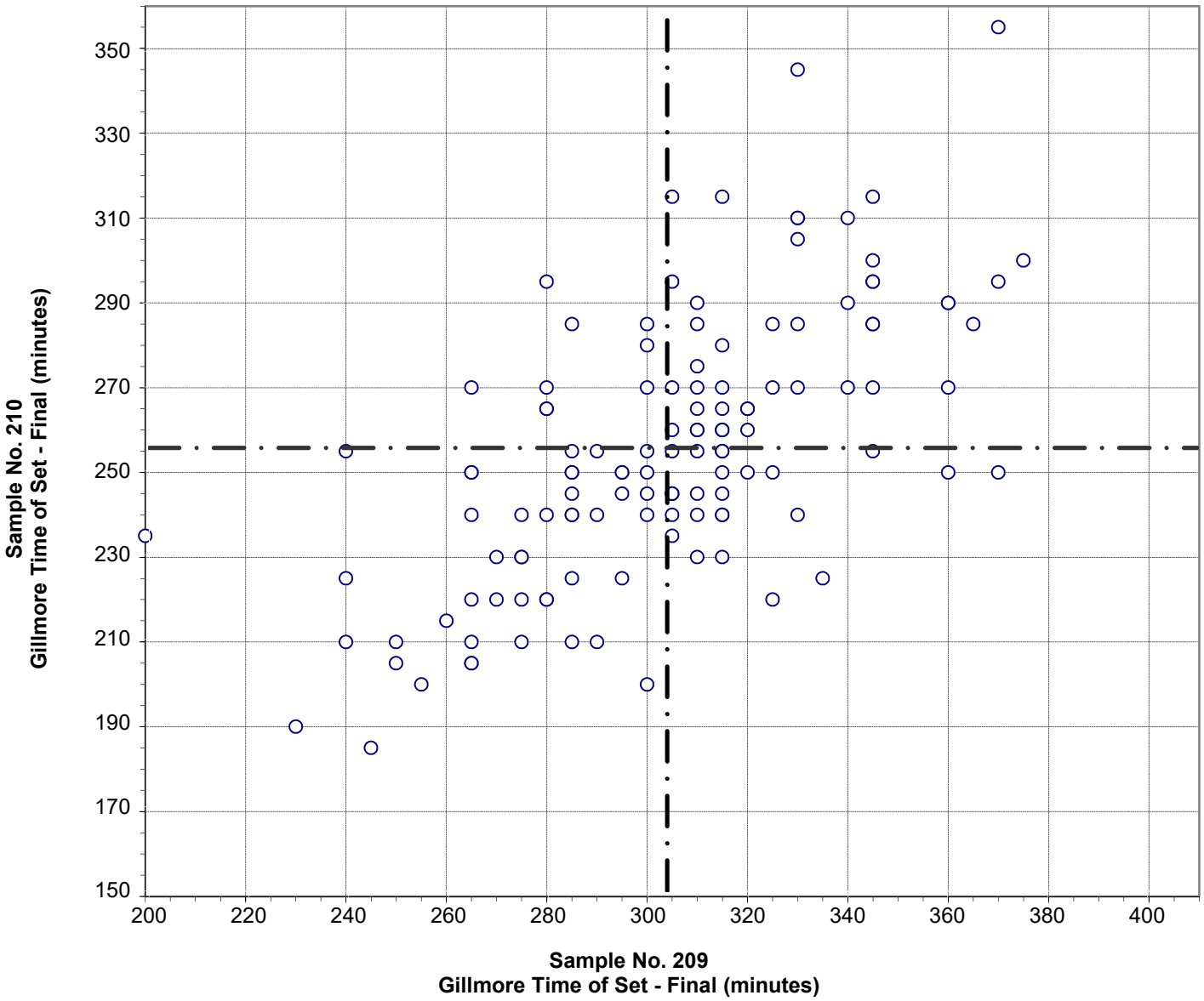


Test No. 130 Gillmore Time of Set - Initial 128 Points

Sample No. 209	Ave	195	S.D.	24	C.V.	12
Sample No. 210	Ave	160	S.D.	19	C.V.	12

Labs Eliminated: 51

CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 209 and No. 210

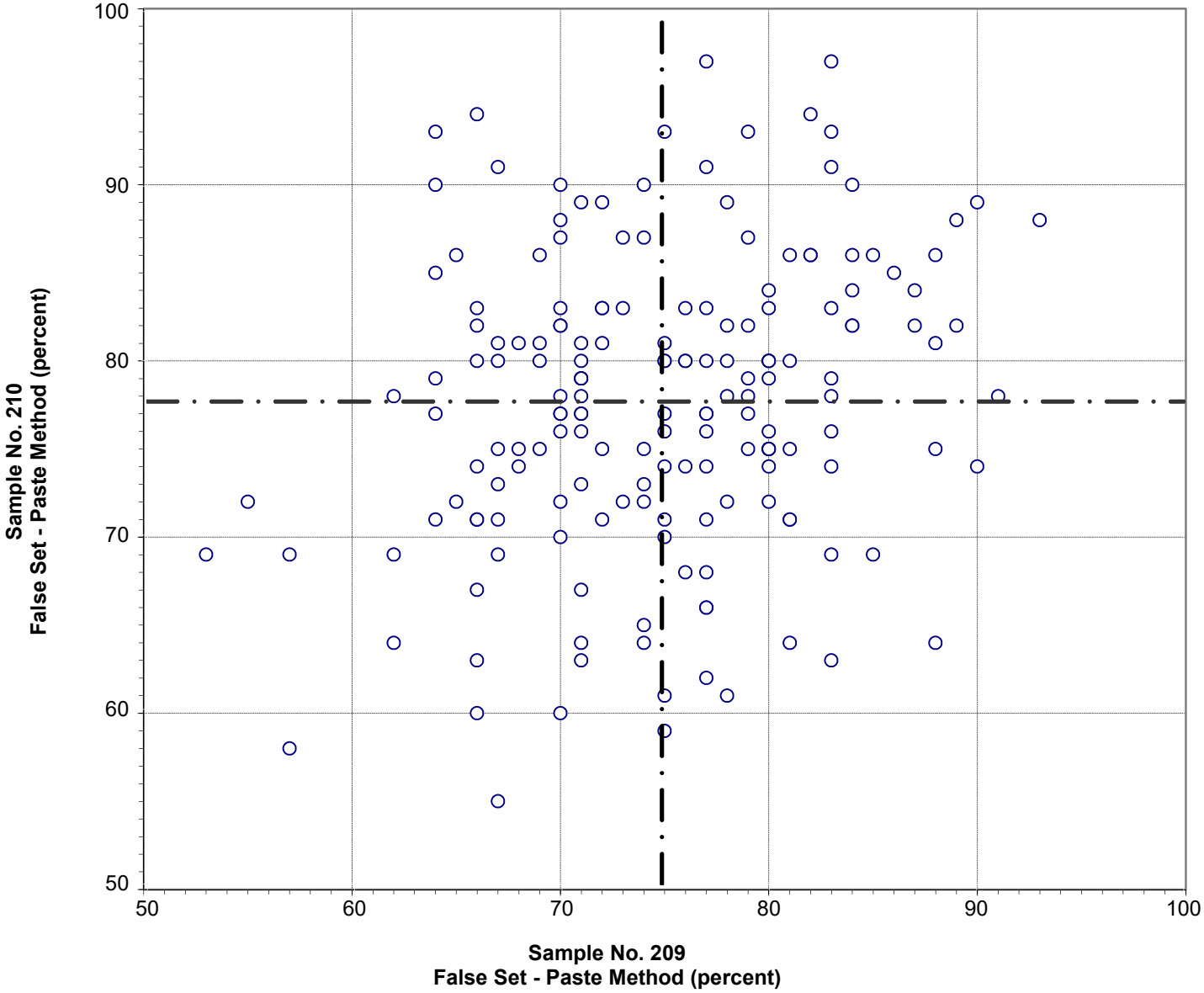


Test No. 140 Gillmore Time of Set - Final 127 Points

Sample No. 209	Ave	304	S.D.	32	C.V.	11
Sample No. 210	Ave	256	S.D.	31	C.V.	12

Labs Eliminated: 95, 450

CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 209 and No. 210

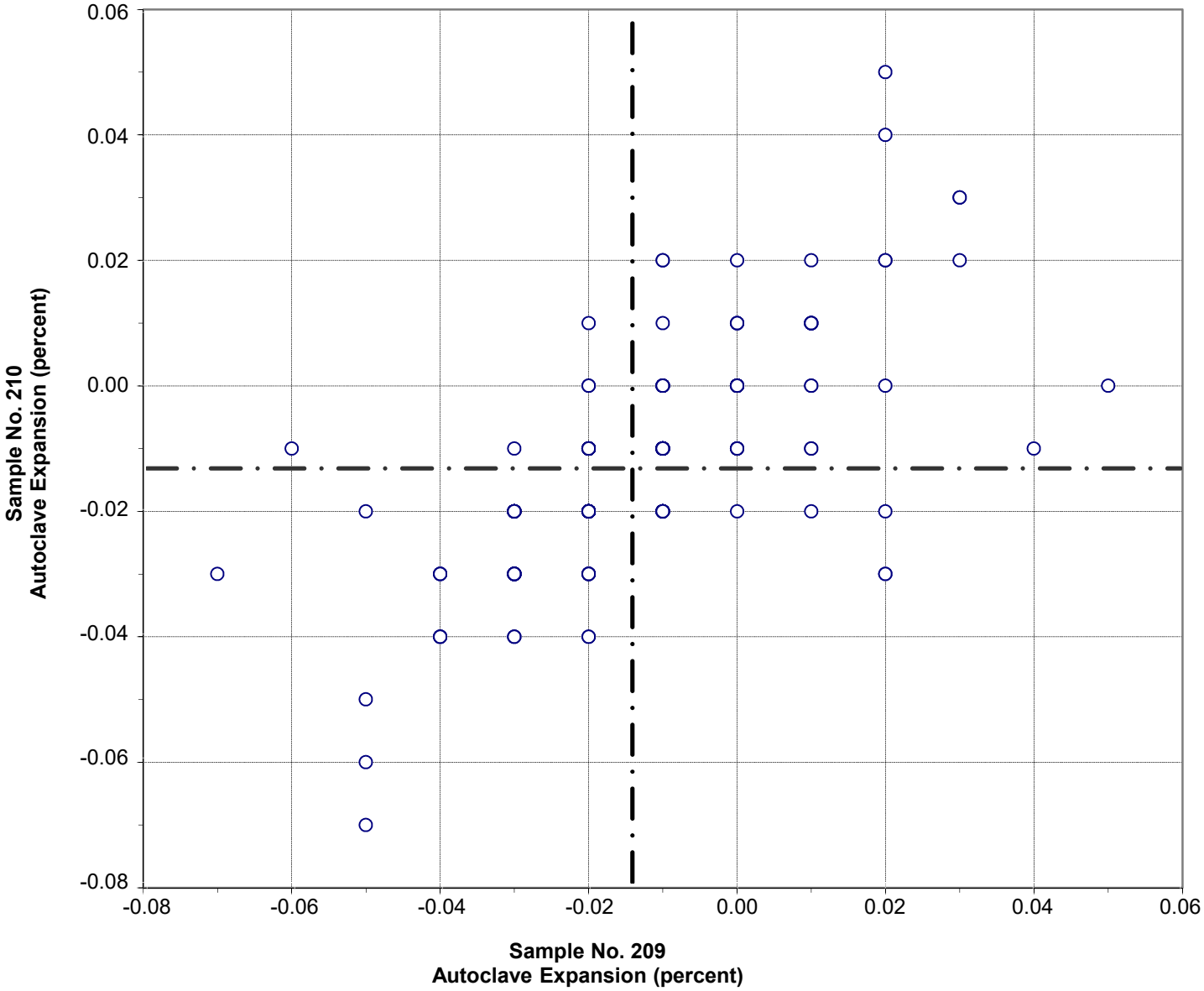


Test No. 150 False Set - Paste Method 177 Points

Sample No. 209	Ave 75	S.D. 7.5	C.V. 10.0
Sample No. 210	Ave 78	S.D. 8.4	C.V. 10.8

Labs Eliminated: 25, 51, 103, 840, 4115

CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 209 and No. 210

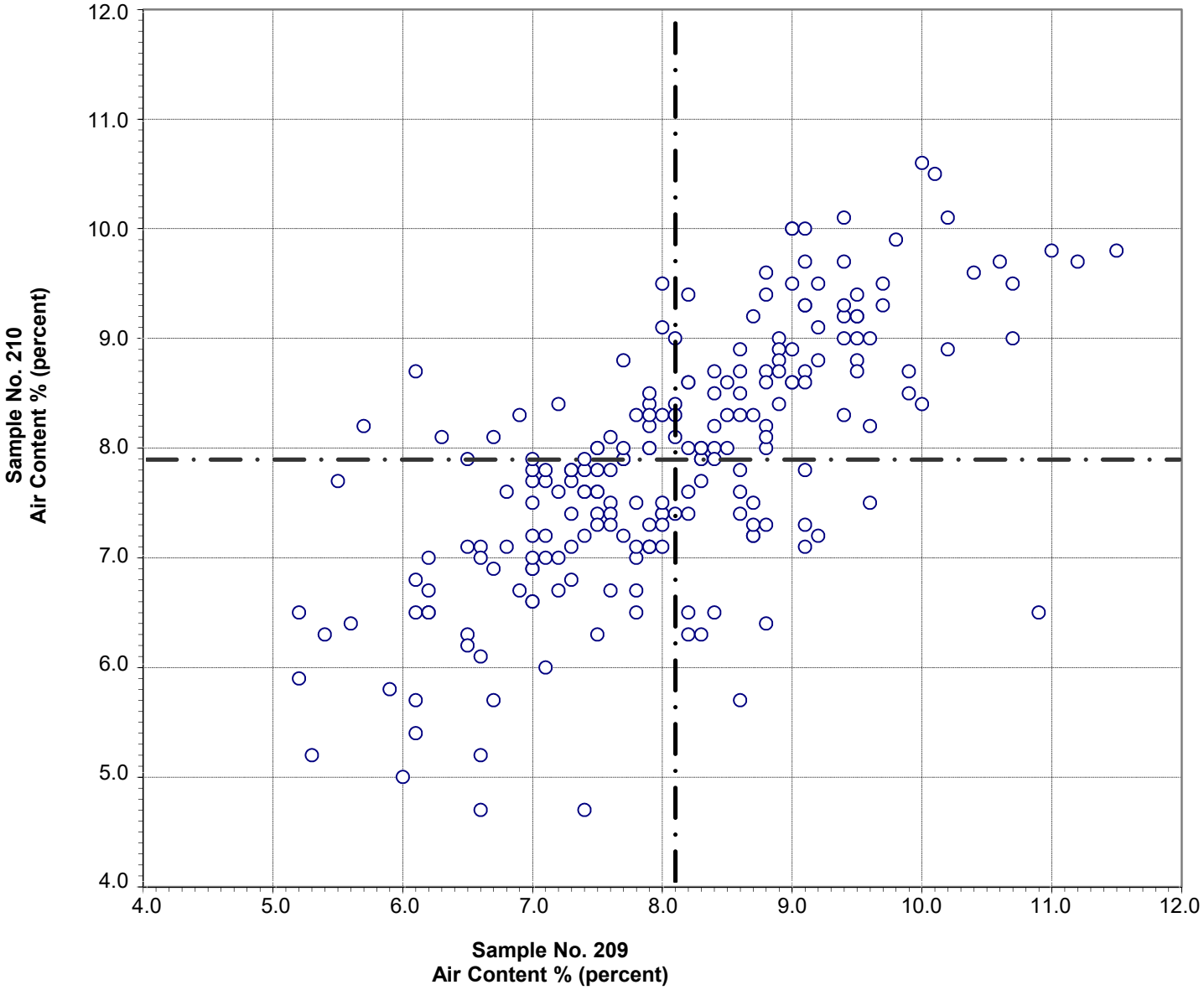


Test No. 160 Autoclave Expansion 212 Points

Sample No. 209	Ave -0.02	S.D. 0.017	C.V. -117
Sample No. 210	Ave -0.02	S.D. 0.016	C.V. -119

Labs Eliminated: 35, 56, 132, 148, 159, 176, 698, 996, 1054, 2352, 4350

CCRL Proficiency Sample Program
Air Content %
PORTLAND CEMENT Samples No. 209 and No. 210



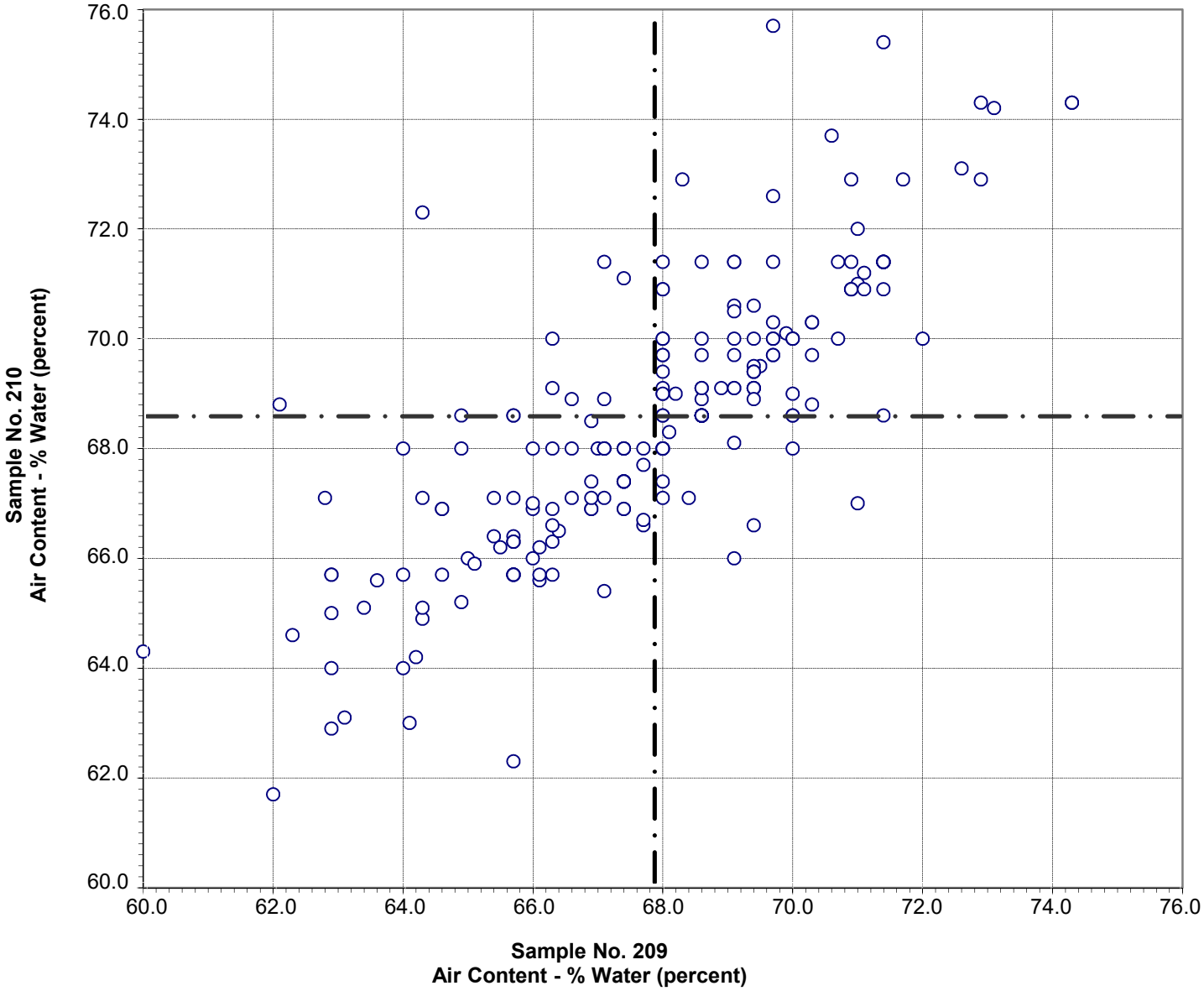
Test No. 170 Air Content % 217 Points

Sample No. 209	Ave	8.1	S.D.	1.2	C.V. 15
Sample No. 210	Ave	7.9	S.D.	1.2	C.V. 15

Labs Eliminated: 32, 52, 1251

Labs off Diagram: 35

CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 209 and No. 210



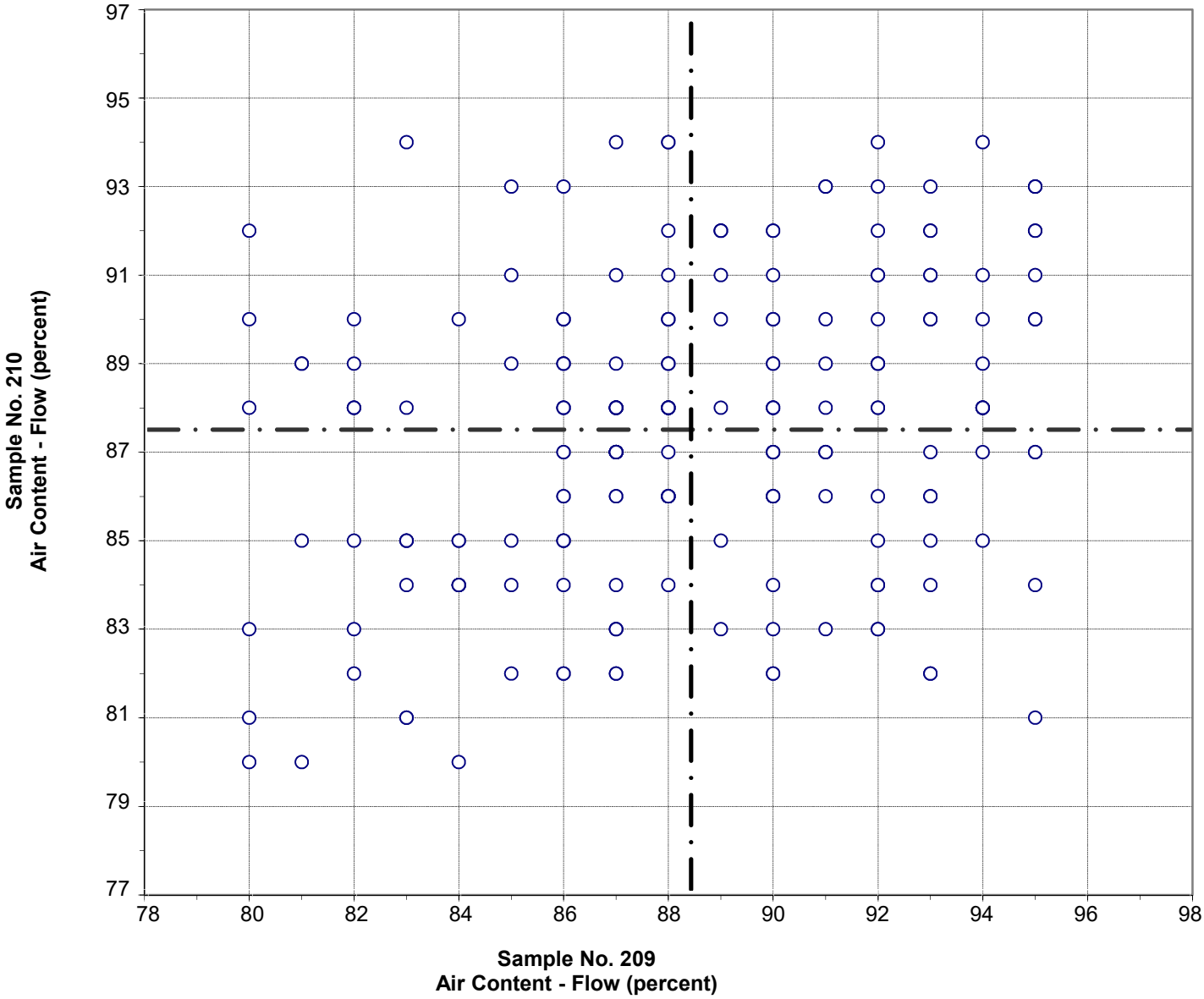
Test No. 180 Air Content - % Water 205 Points

Sample No. 209	Ave	67.9	S.D.	2.5	C.V. 3.8
Sample No. 210	Ave	68.6	S.D.	2.5	C.V. 3.7

Labs Eliminated: 25, 35, 52, 209, 221, 407, 408, 3662

Labs off Diagram: 3661

CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 209 and No. 210

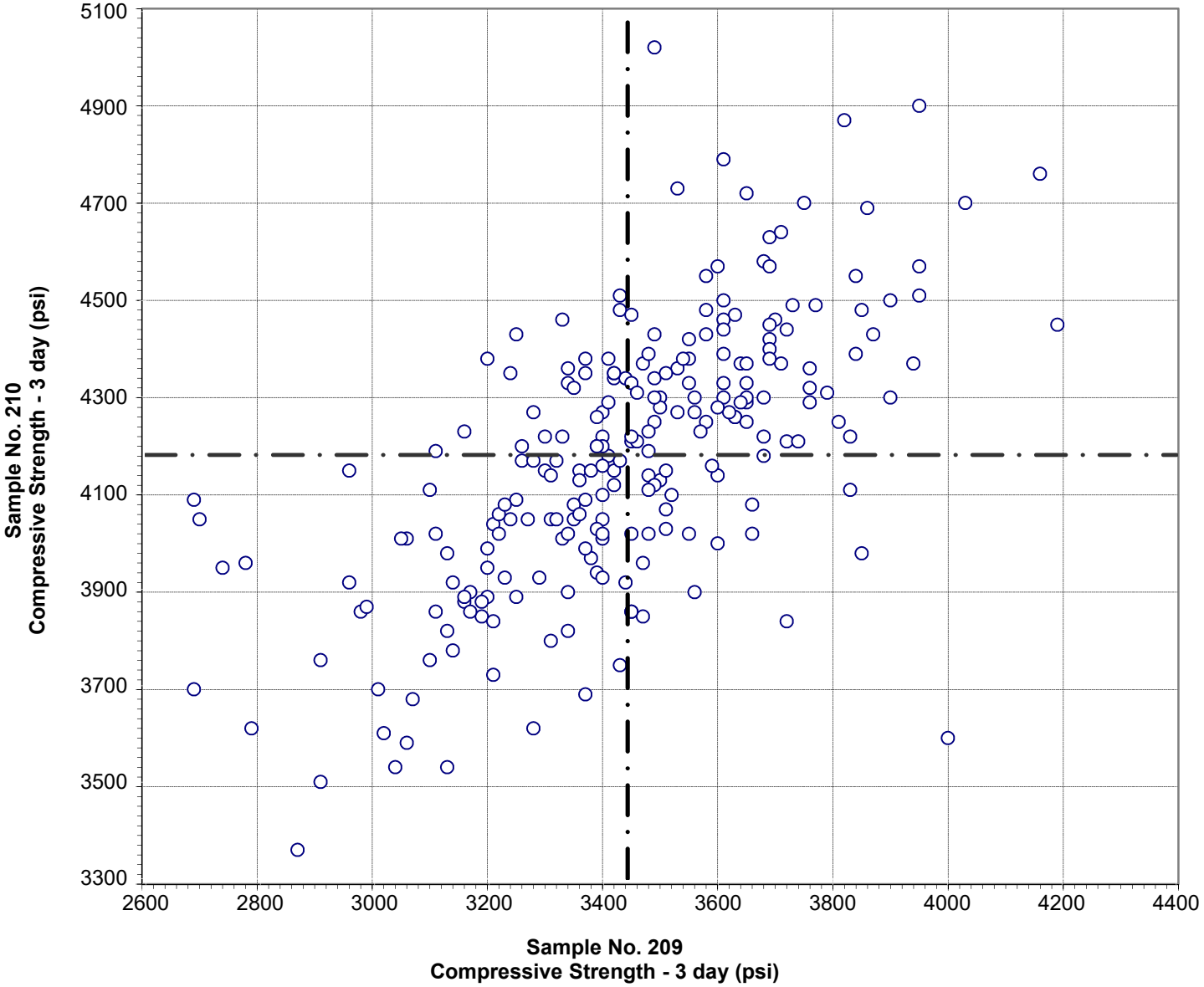


Test No. 190 Air Content - Flow 211 Points

Sample No. 209	Ave	88	S.D.	3.9	C.V. 4.4
Sample No. 210	Ave	87	S.D.	3.3	C.V. 3.7

Labs Eliminated: 175, 408, 1940, 3606

CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 209 and No. 210

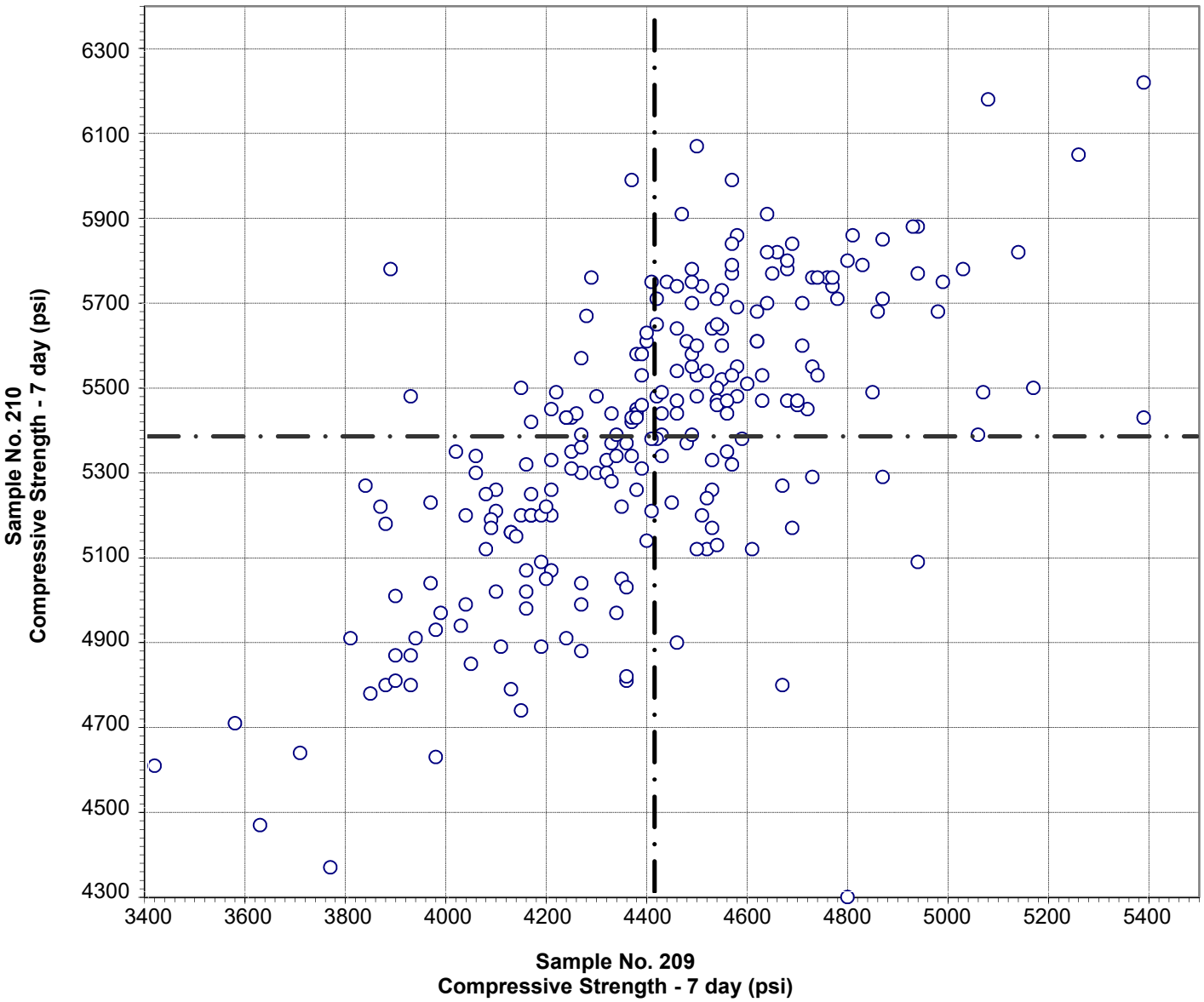


Test No. 200 Compressive Strength - 3 day 234 Points

Sample No. 209	Ave	3442	S.D.	266	C.V. 7.7
Sample No. 210	Ave	4180	S.D.	274	C.V. 6.6

Labs Eliminated: 38, 416, 3606, 3607, 4080

CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 209 and No. 210

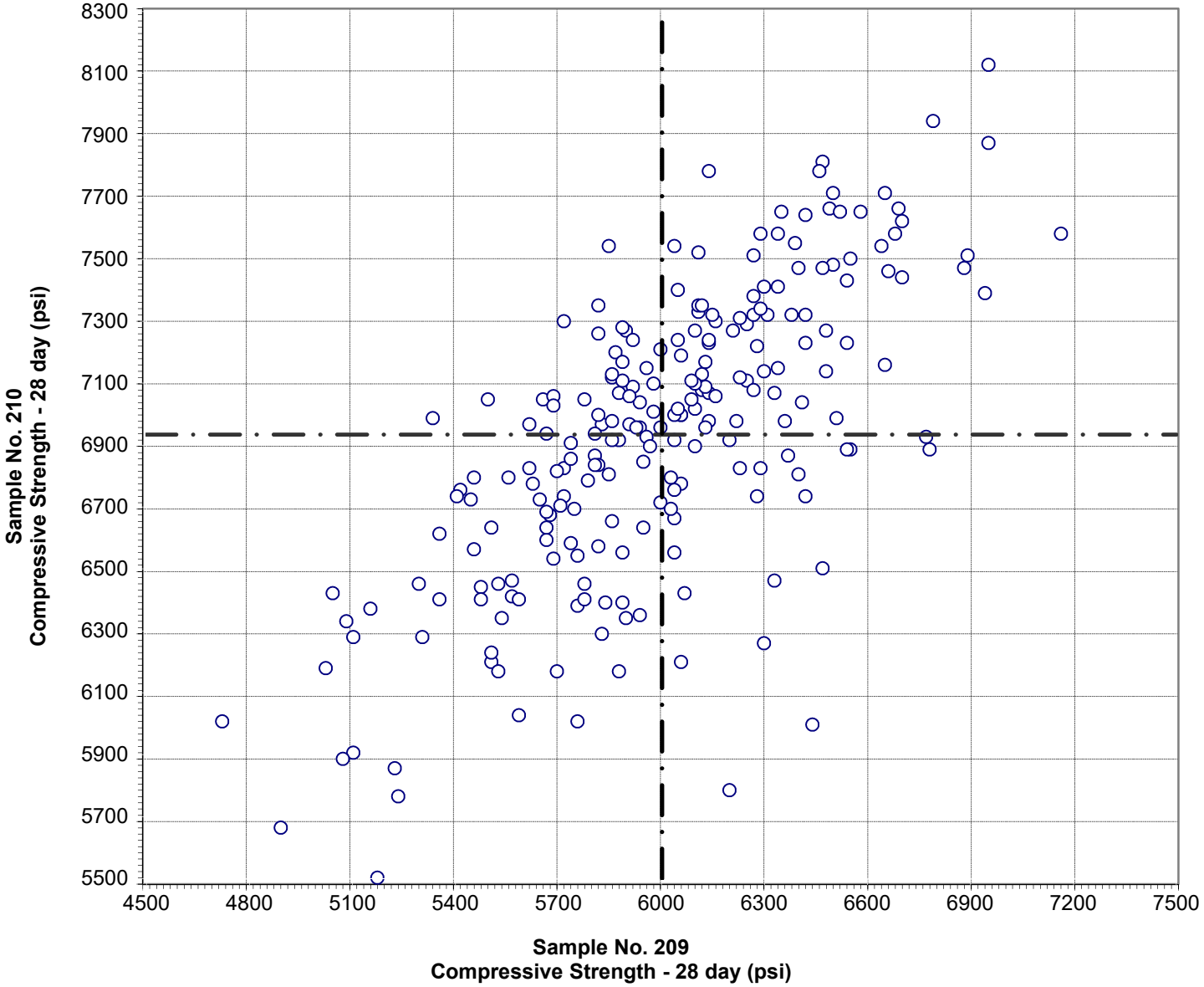


Test No. 210 Compressive Strength - 7 day 236 Points

Sample No. 209	Ave 4413	S.D. 318	C.V. 7.2
Sample No. 210	Ave 5384	S.D. 336	C.V. 6.2

Labs Eliminated: 36, 416, 1019, 2683, 4080

CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 209 and No. 210



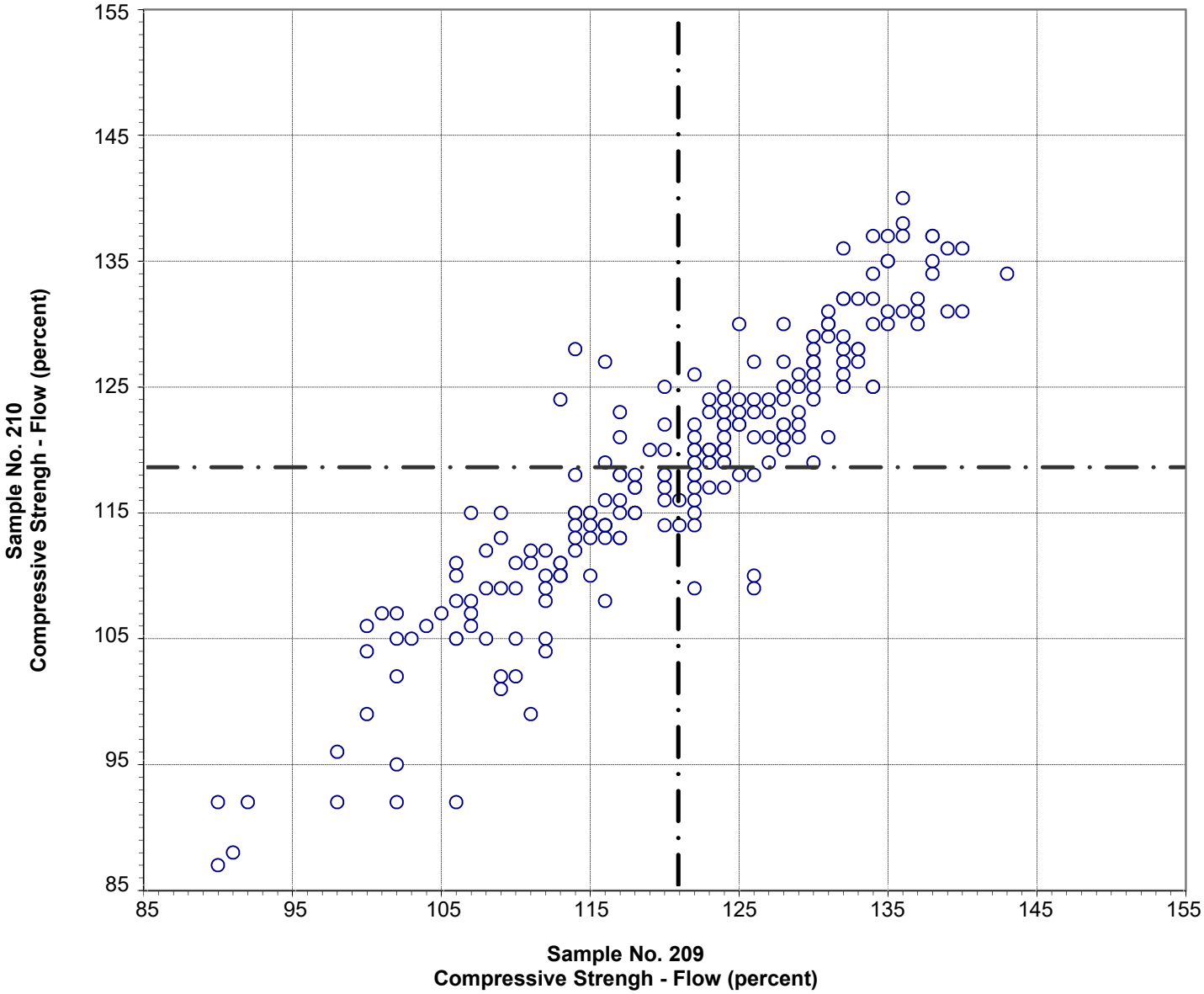
Test No. 211 Compressive Strength - 28 day 227 Points

Sample No. 209	Ave	6001	S.D.	425	C.V. 7.1
Sample No. 210	Ave	6934	S.D.	474	C.V. 6.8

Labs Eliminated: 4080

Labs off Diagram: 9

CCRL Proficiency Sample Program
Compressive Strengh - Flow
PORTLAND CEMENT Samples No. 209 and No. 210

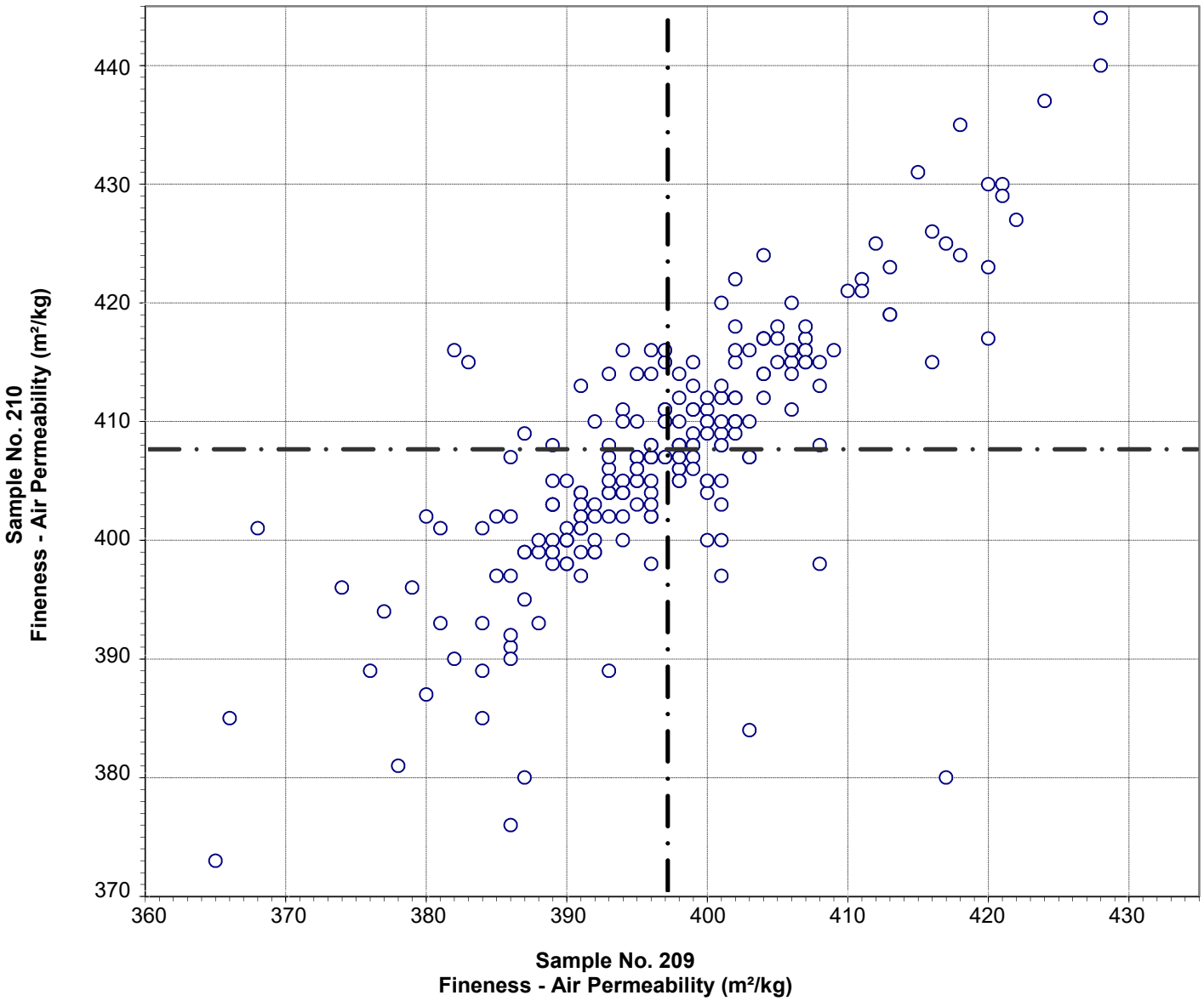


Test No. 230 Compressive Strengh - Flow 220 Points

Sample No. 209	Ave	121	S.D.	11	C.V.	9.0
Sample No. 210	Ave	119	S.D.	11	C.V.	8.9

Labs Eliminated: 254

CCRL Proficiency Sample Program
Fineness - Air Permeability
PORTLAND CEMENT Samples No. 209 and No. 210



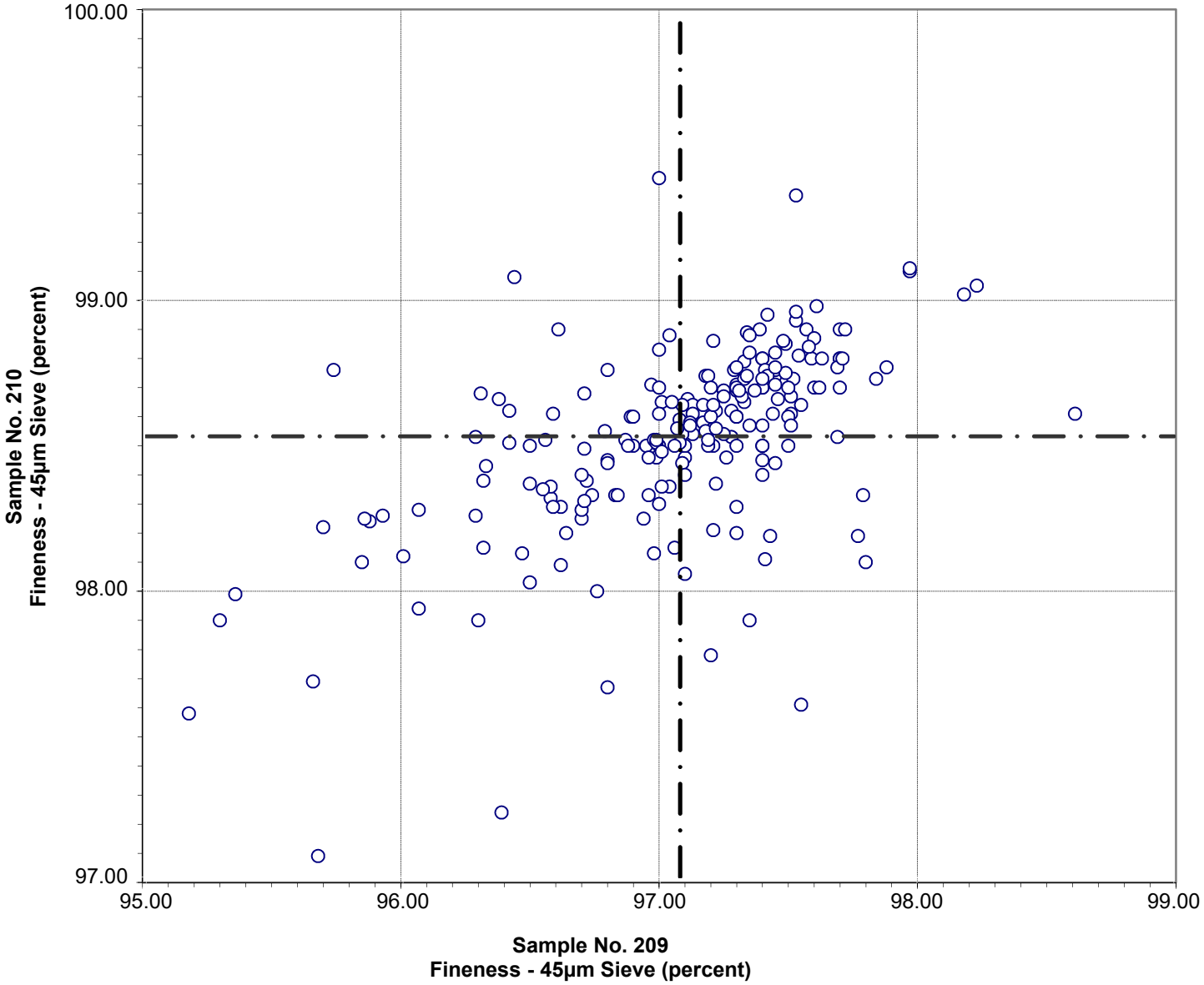
Test No. 270 Fineness - Air Permeability 229 Points

Sample No. 209 Ave 397 S.D. 11 C.V. 2.7
Sample No. 210 Ave 408 S.D. 11 C.V. 2.8

Labs Eliminated: 1, 360, 1079, 1590, 3834

Labs off Diagram: 36, 69

CCRL Proficiency Sample Program
Fineness - 45µm Sieve
PORTLAND CEMENT Samples No. 209 and No. 210

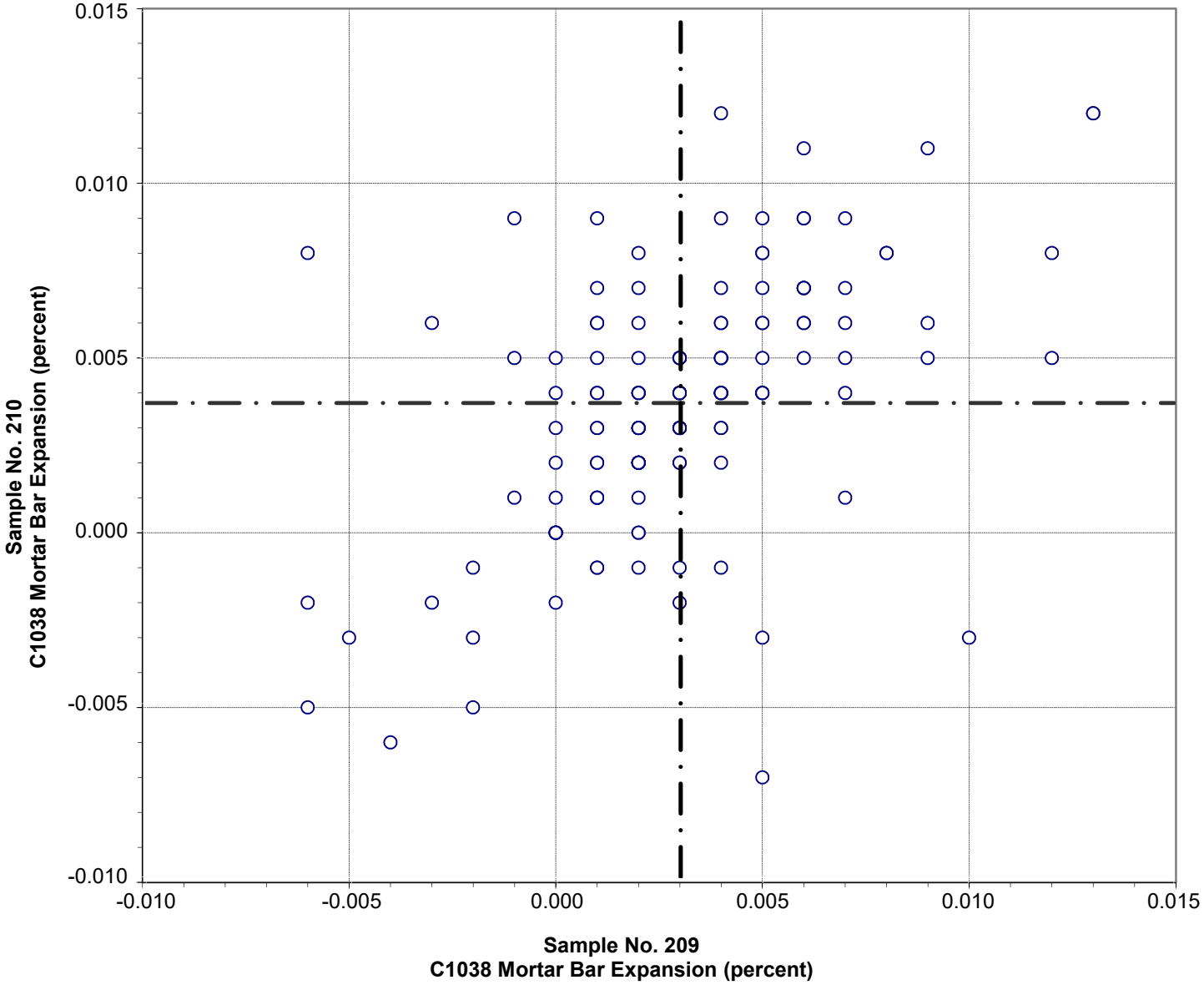


Test No. 281 Fineness - 45µm Sieve 215 Points

Sample No. 209	Ave	97.08	S.D.	0.53	C.V.	0.55
Sample No. 210	Ave	98.53	S.D.	0.32	C.V.	0.32

Labs Eliminated: 26, 116, 146, 222, 823, 4316

CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 209 and No. 210



Test No. 400 C1038 Mortar Bar Expansion 149 Points

Sample No. 209	Ave	0.003	S.D.	0.003	C.V. 108
Sample No. 210	Ave	0.004	S.D.	0.004	C.V. 95

Labs Eliminated: 34, 143, 1054, 3297

CCRL PROFICIENCY SAMPLE PROGRAM

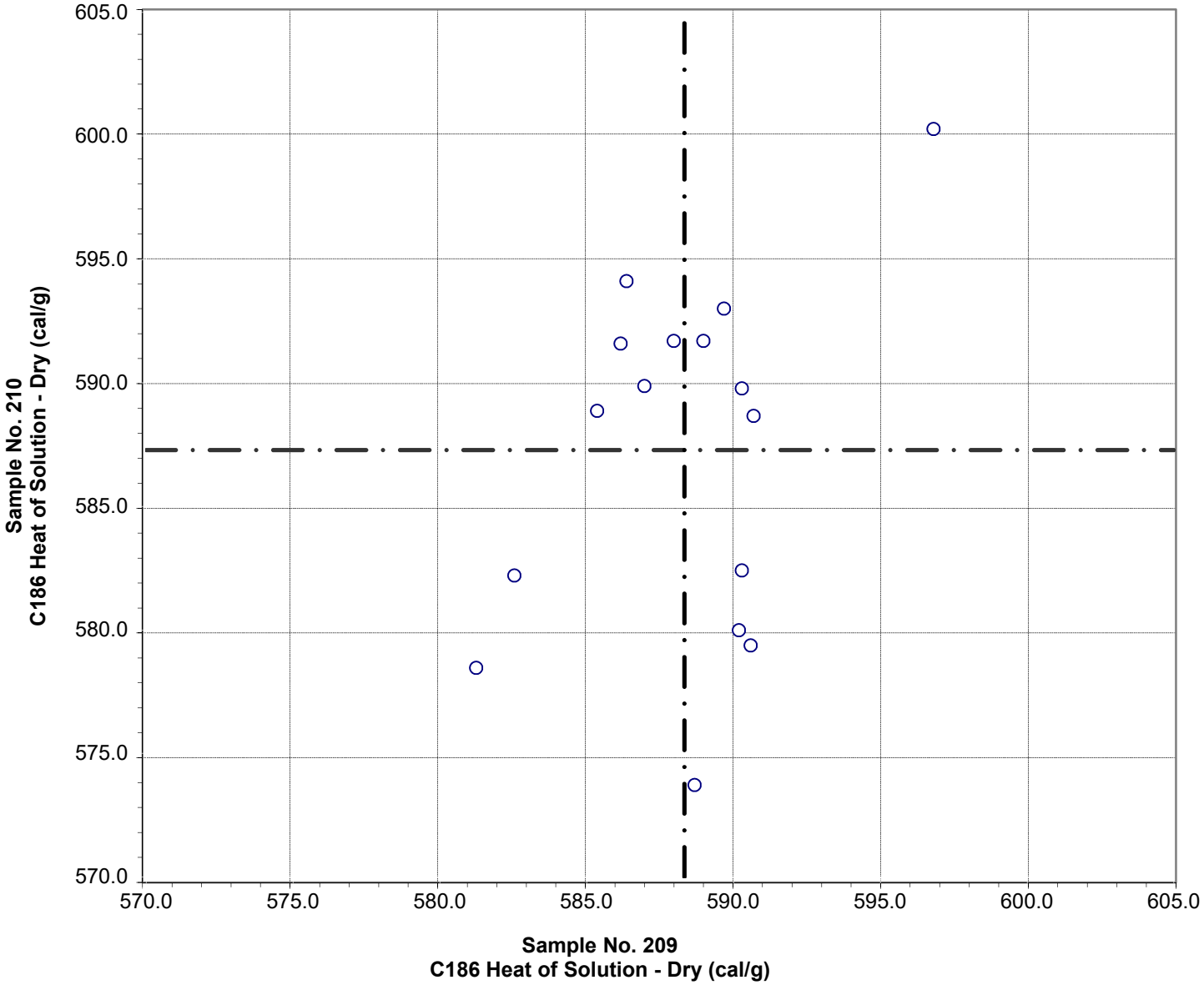
Portland Cement Proficiency Samples No. 209 and No. 210

Final Report – September 14, 2018

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 209 Average	S.D.	C.V.	Sample No. 210 Average	S.D.	C.V.
C186 Heat of Solution - Dry (**cal/g**)							
	17	588.0	3.8	0.6	585.0	11.5	2.0
	*16	588.3	3.6	0.6	587.3	7.0	1.2
* Labs Eliminated - 1916							
C186 Heat of Solution - 7 day (**cal/g**)							
	17	512.1	5.9	1.2	506.8	21.8	4.3
No Labs Eliminated for This Test							
C186 Heat of Solution 28 day (**cal/g**)							
	15	503.7	6.4	1.3	496.0	10.3	2.1
No Labs Eliminated for This Test							
C186 Heat of Hydration - 7 day (**cal/g**)							
	20	77.4	7.0	9.1	82.6	12.0	14.5
	*18	75.7	4.7	6.2	79.4	6.7	8.4
* Labs Eliminated - 176, 3834							
C186 Heat of Hydration - 28 day (**cal/g**)							
	17	85.5	6.8	7.9	88.6	5.6	6.3
No Labs Eliminated for This Test							
C1702 Heat of Hydration - 3 day (**J/g**)							
	16	278	25	9.1	275	25	9.1
	*15	283	15	5.5	280	15	5.5
* Labs Eliminated - 116							
C1702 Heat of Hydration - 7 day (**J/g**)							
	16	318	28	8.9	322	28	8.7
	*15	324	16	5.0	328	15	4.6
* Labs Eliminated - 116							

CCRL Proficiency Sample Program
C186 Heat of Solution - Dry
PORTLAND CEMENT Samples No. 209 and No. 210

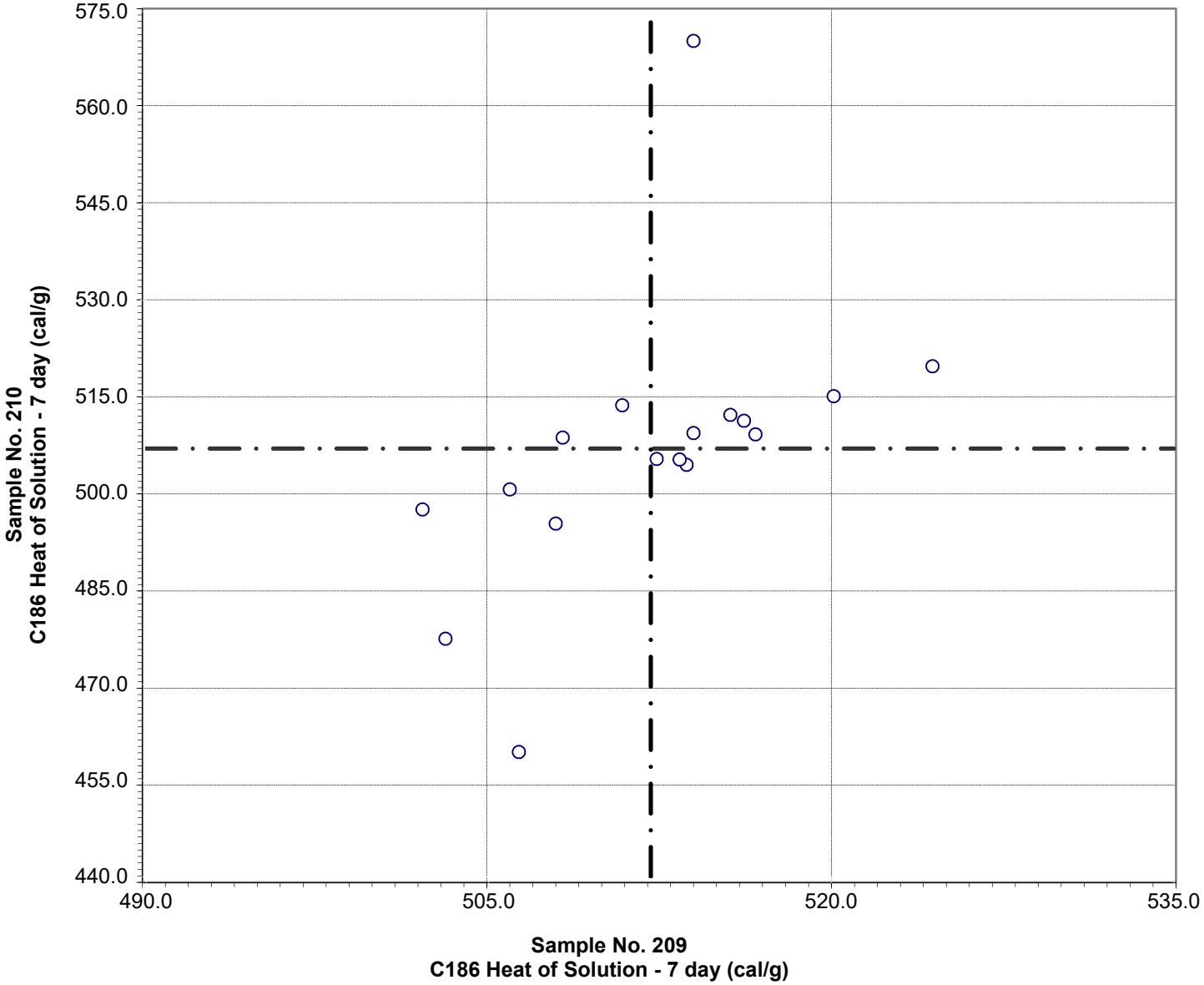


Test No. 291 C186 Heat of Solution - Dry 16 Points

Sample No. 209	Ave	588.3	S.D.	3.6	C.V.	0.6
Sample No. 210	Ave	587.3	S.D.	7.0	C.V.	1.2

Labs Eliminated: 1916

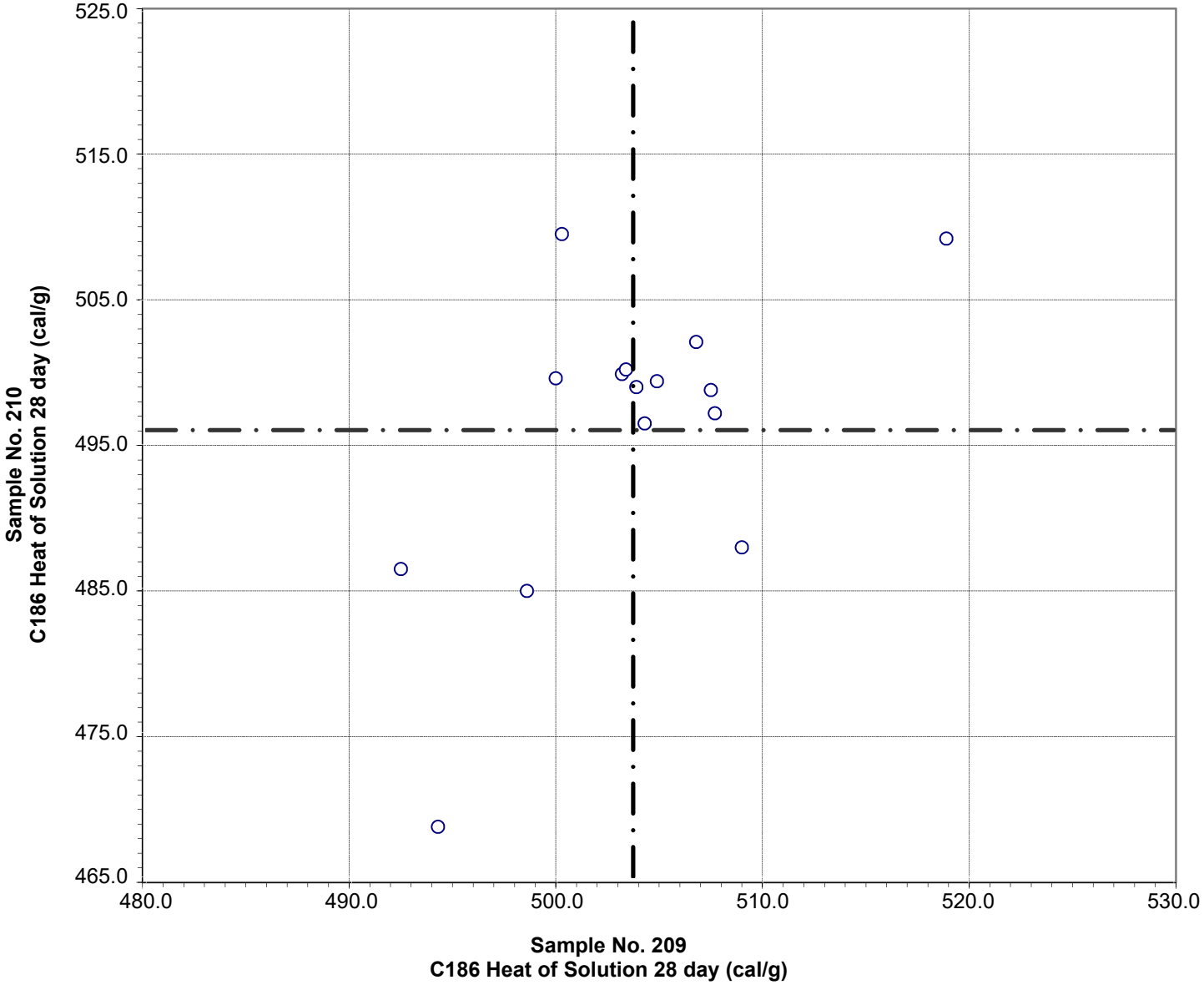
CCRL Proficiency Sample Program
C186 Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 209 and No. 210



Test No. 292 C186 Heat of Solution - 7 day 17 Points

Sample No. 209	Ave	512.1	S.D.	5.9	C.V. 1.2
Sample No. 210	Ave	506.8	S.D.	21.8	C.V. 4.3

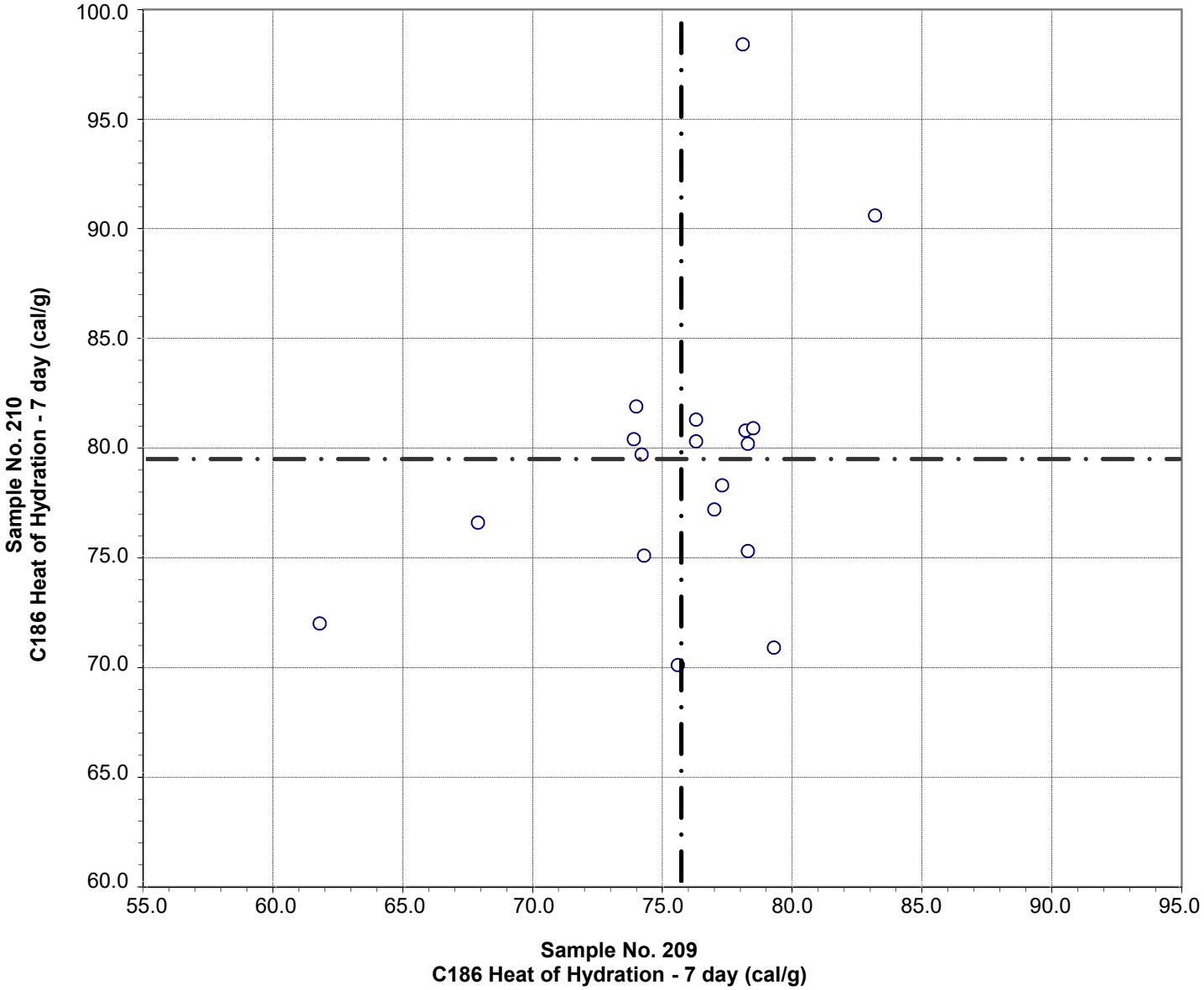
CCRL Proficiency Sample Program
C186 Heat of Solution 28 day
PORTLAND CEMENT Samples No. 209 and No. 210



Test No. 301 C186 Heat of Solution 28 day 15 Points

Sample No. 209	Ave	503.7	S.D.	6.4	C.V. 1.3
Sample No. 210	Ave	496.0	S.D.	10.3	C.V. 2.1

CCRL Proficiency Sample Program
C186 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 209 and No. 210

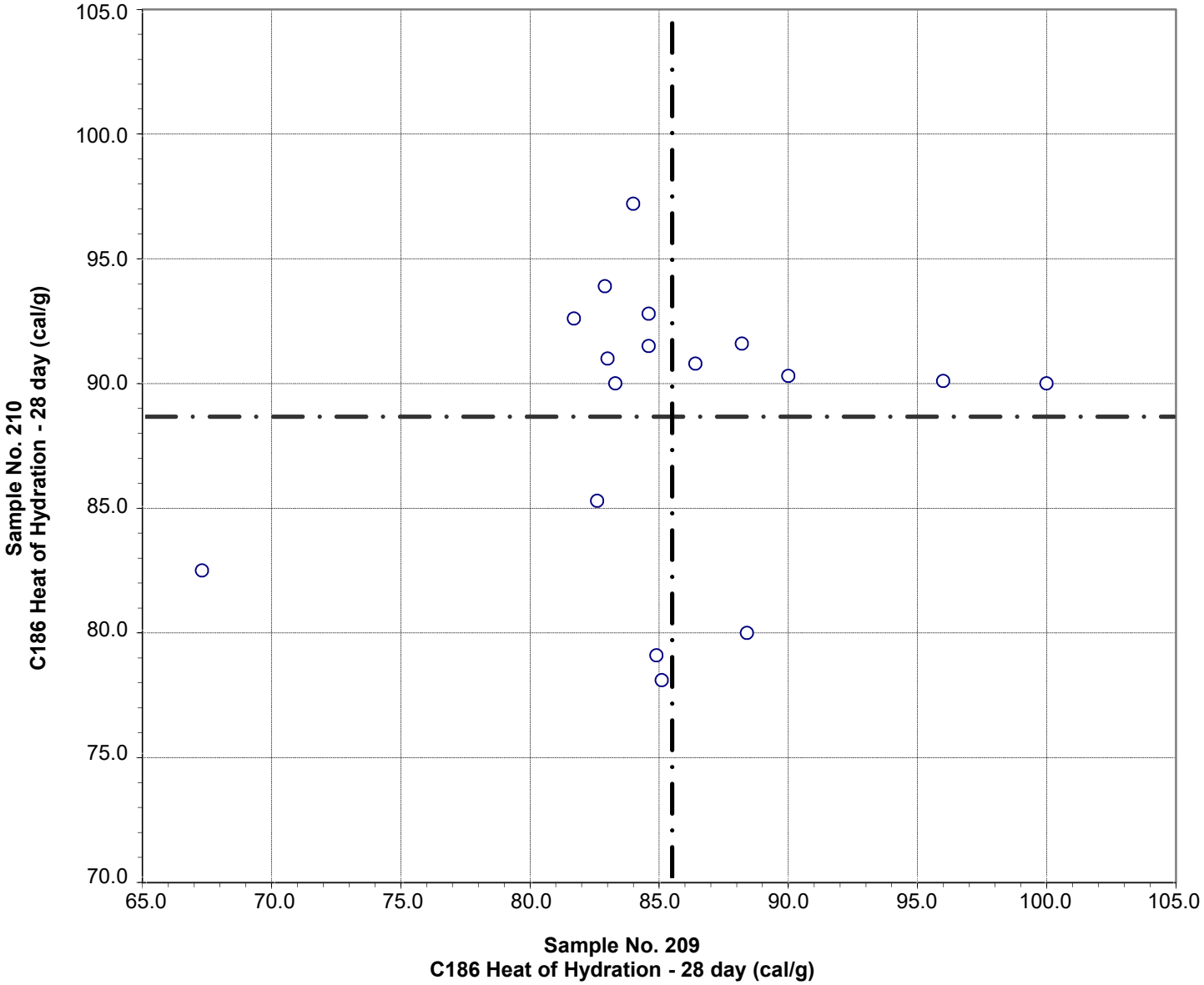


Test No. 290 C186 Heat of Hydration - 7 day 18 Points

Sample No. 209	Ave	75.7	S.D.	4.7	C.V. 6.2
Sample No. 210	Ave	79.4	S.D.	6.7	C.V. 8.4

Labs Eliminated: 176, 3834

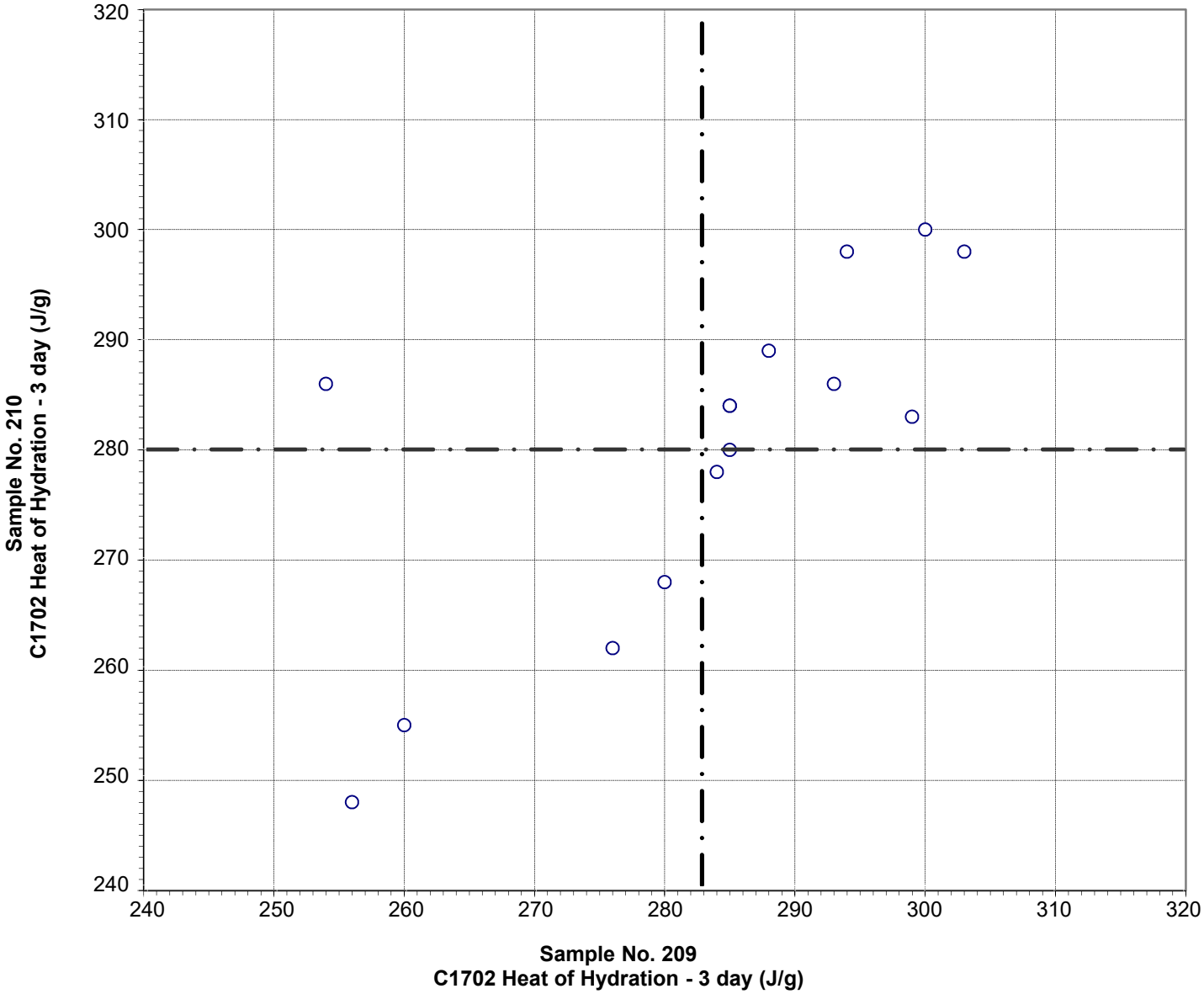
CCRL Proficiency Sample Program
C186 Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 209 and No. 210



Test No. 300 C186 Heat of Hydration - 28 day 17 Points

Sample No. 209	Ave	85.5	S.D.	6.8	C.V.	7.9
Sample No. 210	Ave	88.6	S.D.	5.6	C.V.	6.3

CCRL Proficiency Sample Program
C1702 Heat of Hydration - 3 day
PORTLAND CEMENT Samples No. 209 and No. 210

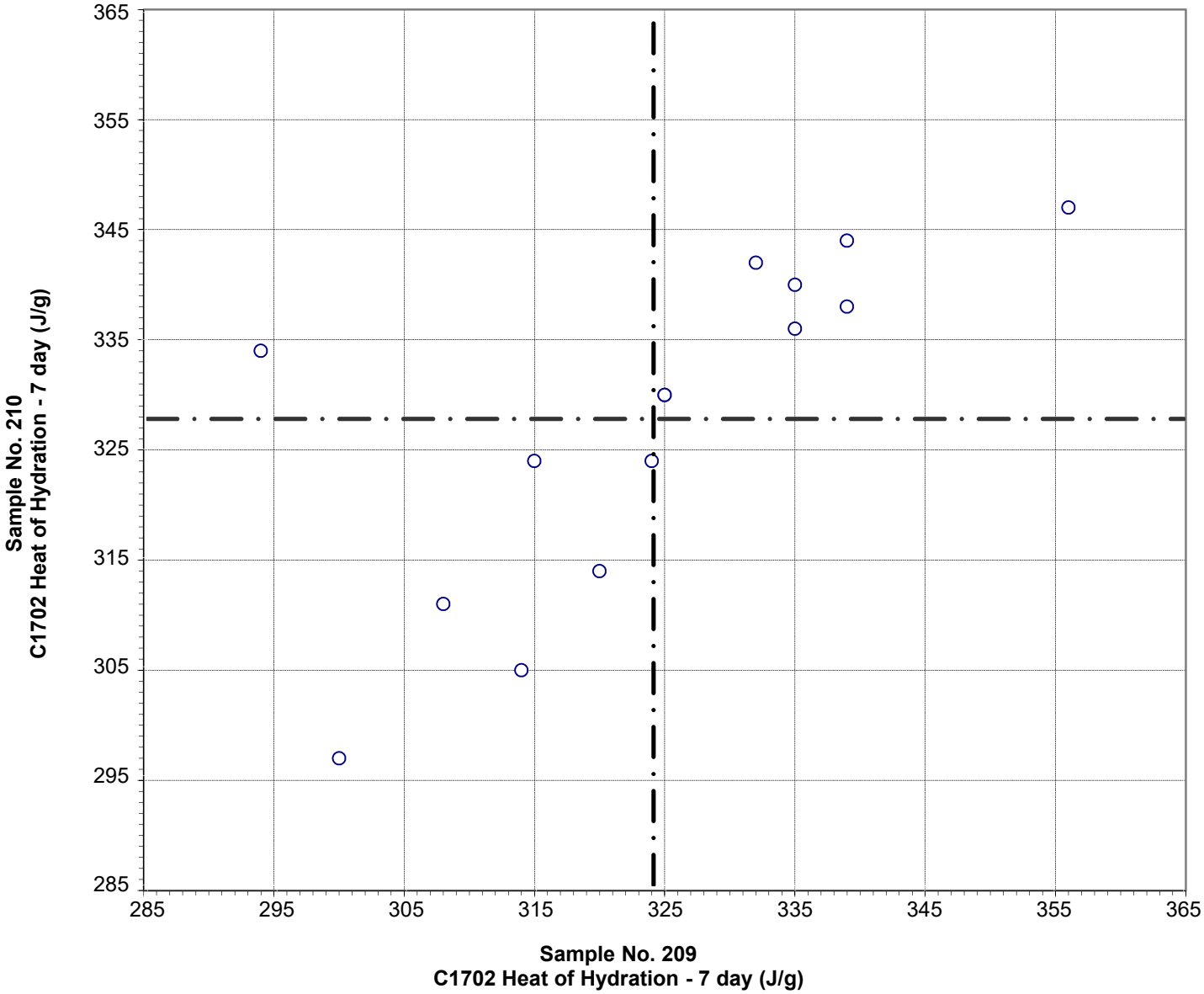


Test No. 500 C1702 Heat of Hydration - 3 day 15 Points

Sample No. 209	Ave	283	S.D.	15	C.V.	5.5
Sample No. 210	Ave	280	S.D.	15	C.V.	5.5

Labs Eliminated: 116

CCRL Proficiency Sample Program
C1702 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 209 and No. 210



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

Sample No. 209	Ave	324	S.D.	16	C.V.	5.0
Sample No. 210	Ave	328	S.D.	15	C.V.	4.6

Labs Eliminated: 116