CEMENT AND CONCRETE REFERENCE LABORATORY

PROFICIENCY SAMPLE PROGRAM

Final Report
Portland Cement Proficiency Samples
Number 199 and Number 200

March 2016

CCRL CEMENT AND CONCRETE REFERENCE LABORATORY

CCRL
Cement and Concrete Reference Laboratory

www.ccrl.us

March 16, 2016

TO: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 199 and No. 200

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in January 2016. Portland Cement Samples No. 199 was an ASTM C150 meeting the specifications of Type I and Type II and contained a limestone addition. Portland Cement No. 200 was an ASTM C150 meeting the specifications of Type I and Type II and contained a limestone addition.

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.

Potential Cement Phase Calculations: Individual laboratory ratings have not been assigned for Sample No. 200. The analysis of the limestone for Portland Sample No. 200 that was provided in the original instructions was incorrect. The correct analysis was provided at a later date. However the possibility exists that the correct analysis was not used by all laboratories. For this reason the decision was made to suppress ratings for Sample No. 200.

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 2016.

Sincerely,

Robin K. Haupt

Robin K. Haupt
Supervisor, 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: Robin K. Haupt, Supervisor PSP

SUBJECT: Explanation of Final Report on Results of Tests for Portland Cement Proficiency Samples No. 199 and No. 200

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 2016. 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 which can be viewed and printed on the CCRL website..

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

[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.*

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. 199 and No. 200

Final Report – Primary Chemical Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
Silicon Dioxide (**percent**)							
	231	20.22	0.36	1.80	19.99	0.28	1.41
	*220	20.23	0.16	0.80	19.97	0.17	0.86
* Labs Eliminated - 23, 48, 50, 116, 206, 698, 2437, 2463, 2466, 3297, 4042							
Aluminum Oxide (**percent**)							
	229	4.29	0.13	3.0	5.05	0.13	2.6
	*216	4.29	0.07	1.7	5.05	0.09	1.8
* Labs Eliminated - 15, 23, 42, 116, 975, 2437, 2466, 3297, 3605, 3606, 3819, 3948, 4099							
Ferric Oxide (**percent**)							
	230	2.91	0.10	3.3	3.39	0.07	2.0
	*218	2.92	0.04	1.3	3.38	0.04	1.2
* Labs Eliminated - 15, 23, 84, 95, 116, 206, 694, 1079, 1956, 3948, 4080, 4099							
Calcium Oxide (**percent**)							
	229	62.67	1.14	1.82	62.34	0.46	0.74
	*224	62.74	0.39	0.62	62.34	0.37	0.60
* Labs Eliminated - 48, 50, 107, 116, 2466							
Magnesium Oxide (**percent**)							
	230	3.55	0.13	3.6	2.26	0.17	7.3
	*214	3.54	0.07	1.9	2.25	0.06	2.4
* Labs Eliminated - 48, 107, 116, 176, 206, 246, 494, 551, 1676, 1956, 2464, 3661, 3695, 3819, 4050, 4099							
Sulfur Trioxide (**percent**)							
	232	2.87	0.08	2.8	3.74	0.13	3.4
	*226	2.87	0.06	2.2	3.74	0.09	2.4
* Labs Eliminated - 34, 107, 116, 289, 3297, 4042							

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Primary Chemical Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
Loss on Ignition (**percent**)							
	236	2.32	1.16	50.0	2.04	0.20	9.8
	*218	2.24	0.07	3.0	2.05	0.07	3.6
* Labs Eliminated - 84, 90, 116, 137, 203, 243, 255, 687, 1053, 1251, 1435, 1940, 2982, 3695, 3807, 4042, 4050, 4099							
Sodium Oxide (**percent**)							
	219	0.113	0.034	30	0.133	0.039	30
	*207	0.113	0.025	22	0.132	0.024	18
* Labs Eliminated - 56, 284, 289, 440, 2305, 2308, 2462, 3059, 3297, 3695, 4042, 4099							
Potassium Oxide (**percent**)							
	225	0.725	0.073	10.1	0.632	0.045	7.1
	*212	0.736	0.021	2.8	0.638	0.019	2.9
* Labs Eliminated - 36, 56, 107, 116, 690, 975, 2308, 2360, 2465, 3057, 3279, 3661, 4099							
Strontium Oxide (**percent**)							
	100	0.063	0.004	7	0.048	0.008	16
	*95	0.063	0.004	6	0.047	0.004	8
* Labs Eliminated - 116, 178, 491, 493, 3297							
Titanium Dioxide (**percent**)							
	184	0.27	0.031	11.3	0.29	0.016	5.6
	*171	0.27	0.008	3.0	0.29	0.009	3.1
* Labs Eliminated - 93, 107, 116, 175, 246, 438, 494, 1054, 1644, 2352, 2491, 4042, 4099							
Phosphorus Pentoxide (**percent**)							
	174	0.118	0.110	92.9	0.188	0.027	14.3
	*162	0.109	0.006	5.7	0.188	0.008	4.3
* Labs Eliminated - 48, 56, 107, 116, 289, 494, 2491, 3235, 3279, 3413, 3695, 4099							

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Primary Chemical Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
Zinc Oxide (**percent**)							
	100	0.030	0.026	87.7	0.007	0.010	129.6
	*88	0.028	0.002	5.5	0.008	0.002	22.1
* Labs Eliminated - 23, 95, 116, 165, 178, 219, 502, 605, 768, 1054, 2477, 4099							
Manganic Oxide (**percent**)							
	145	0.058	0.009	14.7	0.132	0.019	14.6
	*133	0.057	0.004	6.7	0.134	0.006	4.2
* Labs Eliminated - 27, 107, 116, 178, 203, 354, 457, 491, 768, 1916, 2360, 4099							
Chloride (**percent**)							
	129	0.009	0.007	77	0.021	0.031	142
	*121	0.008	0.004	46	0.017	0.006	34
* Labs Eliminated - 64, 130, 142, 309, 493, 886, 3662, 4080							
Insoluble Residue (**percent**)							
	212	0.56	0.31	55	0.32	0.11	36
	*205	0.53	0.11	20	0.31	0.09	30
* Labs Eliminated - 4, 36, 206, 246, 309, 687, 2477							
Free Lime (**percent**)							
	177	0.45	0.23	50	0.80	0.22	28
	*166	0.42	0.16	38	0.78	0.16	21
* Labs Eliminated - 78, 132, 142, 181, 206, 246, 431, 551, 1940, 1942, 2466							
Carbon Dioxide (**percent**)							
	195	1.65	0.25	15.1	0.71	0.21	29.4
	*181	1.69	0.13	7.7	0.70	0.15	21.7
* Labs Eliminated - 50, 60, 74, 96, 137, 203, 252, 438, 692, 886, 1251, 1799, 2363, 4051							
Limestone Content (**percent**)							
	194	4.4	0.7	15.8	1.9	0.6	32.9
	*178	4.5	0.4	7.8	1.9	0.4	21.8
* Labs Eliminated - 50, 60, 74, 96, 137, 203, 252, 438, 692, 886, 1251, 1799, 1942, 2363, 3233, 4051							

CCRL PROFICIENCY SAMPLE PROGRAM

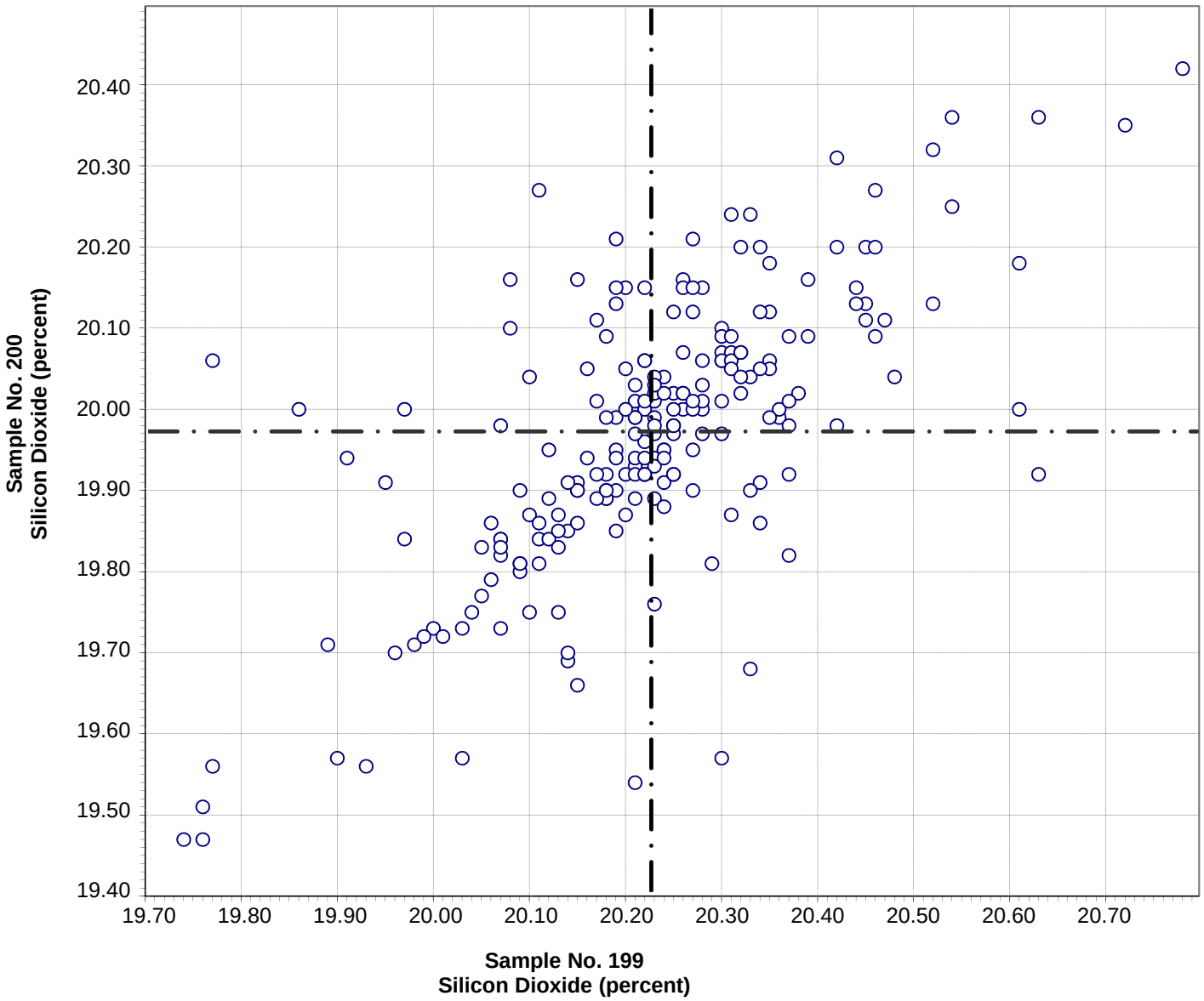
Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Primary Chemical Results
March 16, 2016

SUMMARY OF RESULTS

		Sample No.199			Sample No. 200		
Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Chromium Oxide (**percent**)							
	94	0.012	0.007	58	0.011	0.007	60
	*88	0.010	0.004	37	0.010	0.004	38
* Labs Eliminated - 66, 98, 116, 438, 493, 2462							
Tricalcium Silicate (**percent**)							
	204	55.7	3.8	6.8	50.9	3.6	7.0
	*198	55.6	3.1	5.7	50.7	2.1	4.1
* Labs Eliminated - 8, 50, 107, 116, 3059, 3297							
Dicalcium Silicate (**percent**)							
	204	15.2	2.8	18.6	18.4	3.3	17.7
	*193	15.4	2.2	14.1	18.5	1.8	9.5
* Labs Eliminated - 8, 15, 23, 50, 107, 162, 165, 2466, 3059, 3297, 3779							
Tricalcium Aluminate (**percent**)							
	205	6.3	0.3	5.2	7.6	0.4	4.7
	*197	6.3	0.2	3.8	7.6	0.3	3.6
* Labs Eliminated - 42, 98, 116, 165, 975, 3059, 3297, 4080							
Tetracalcium Aluminoferrite (**percent**)							
	205	8.8	0.3	3.4	10.3	0.2	2.4
	*196	8.8	0.2	1.8	10.2	0.2	1.5
* Labs Eliminated - 23, 47, 98, 116, 165, 206, 1956, 3059, 4080							

CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 199 and No. 200



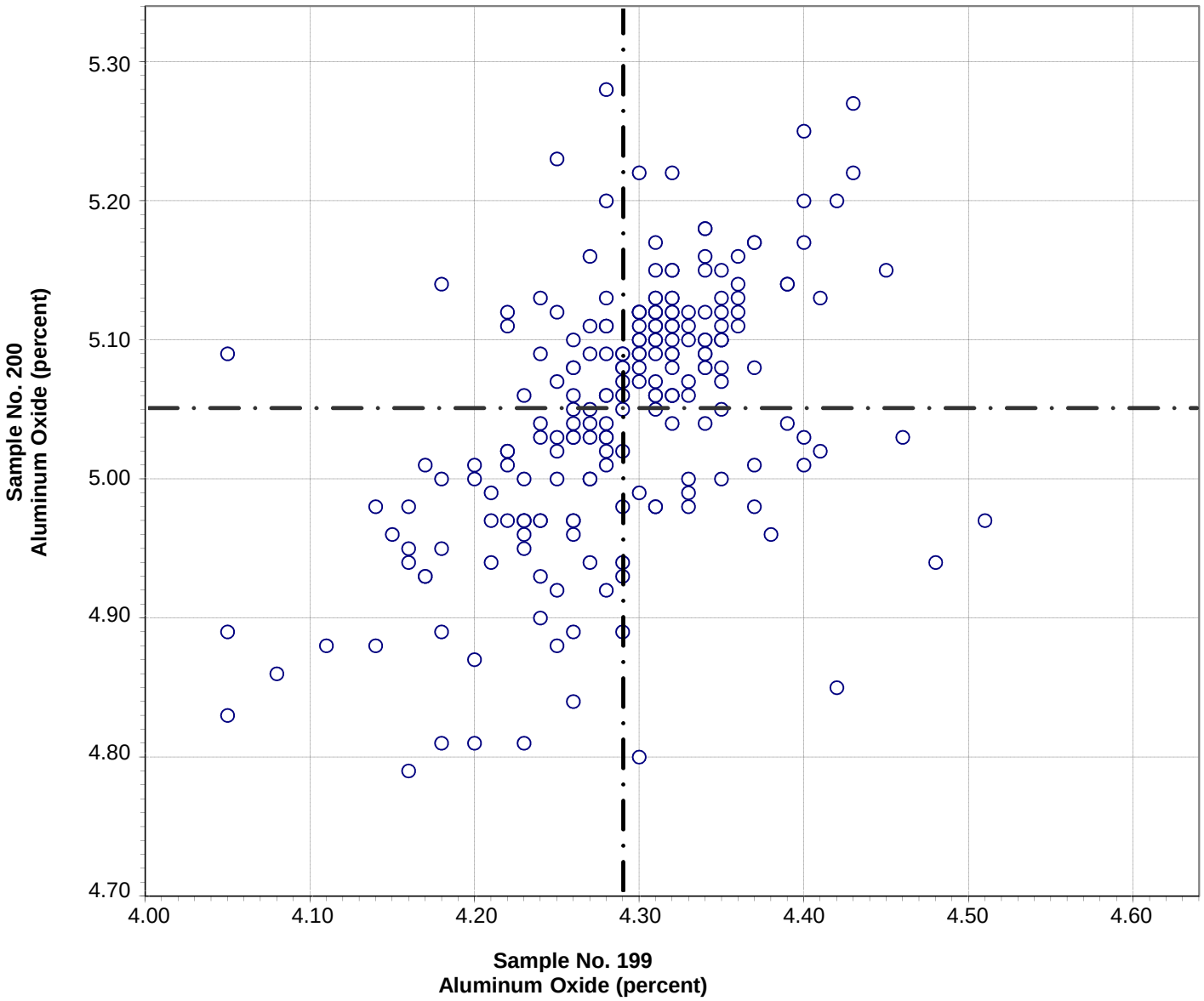
Test No. 10 Silicon Dioxide 219 Points

Sample No. 199	Ave	20.23	S.D.	0.16	C.V. 0.80
Sample No. 200	Ave	19.97	S.D.	0.17	C.V. 0.86

Labs Eliminated: 23, 48, 50, 116, 206, 698, 2437, 2463, 2466, 3297, 4042

Labs off Diagram: 1942

CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

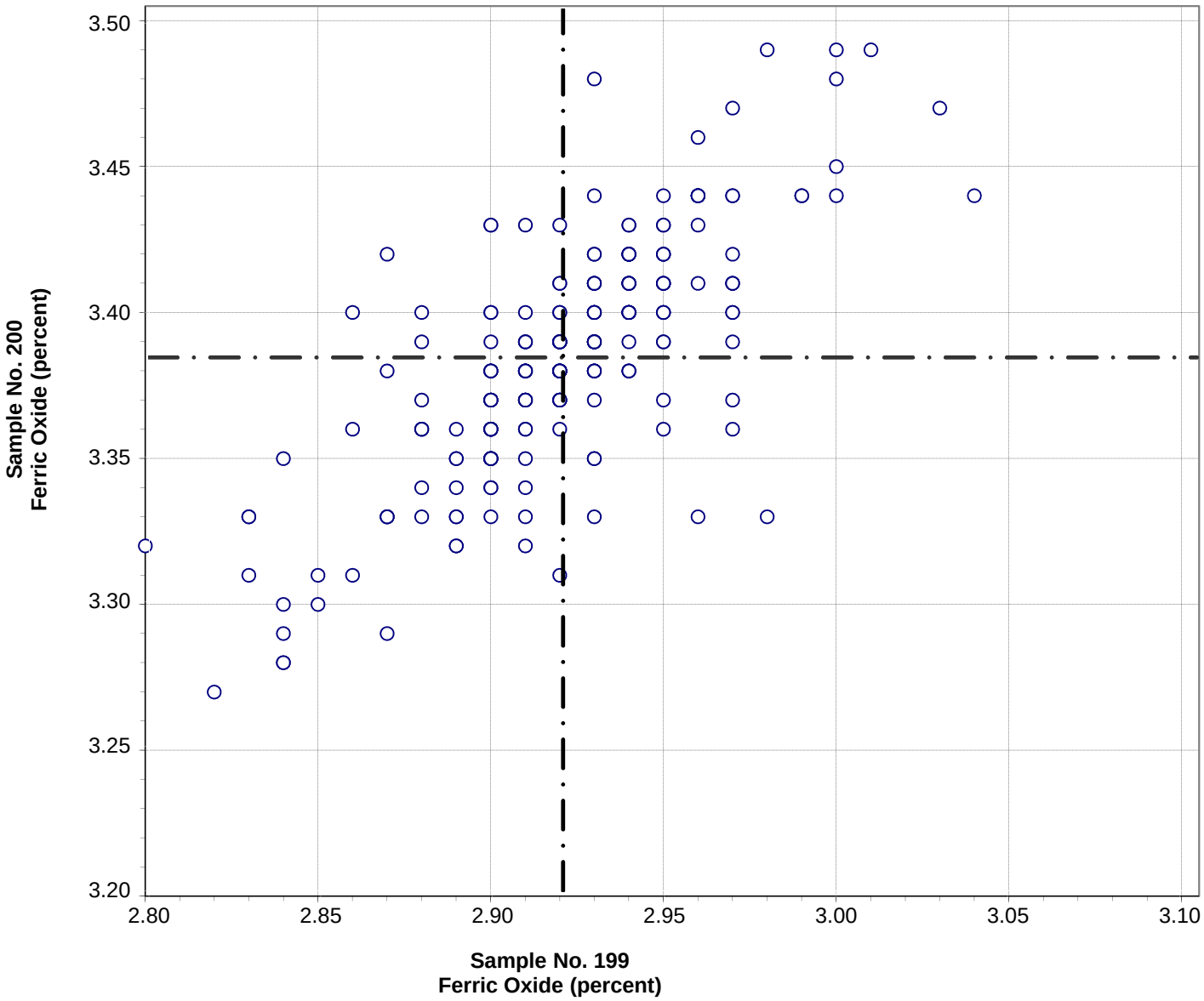


Test No. 21 Aluminum Oxide 216 Points

Sample No. 199	Ave	4.29	S.D.	0.07	C.V. 1.7
Sample No. 200	Ave	5.05	S.D.	0.09	C.V. 1.8

Labs Eliminated: 15, 23, 42, 116, 975, 2437, 2466, 3297, 3605, 3606, 3819, 3948, 4099

CCRL Proficiency Sample Program
Ferric Oxide
PORTLAND CEMENT Samples No. 199 and No. 200



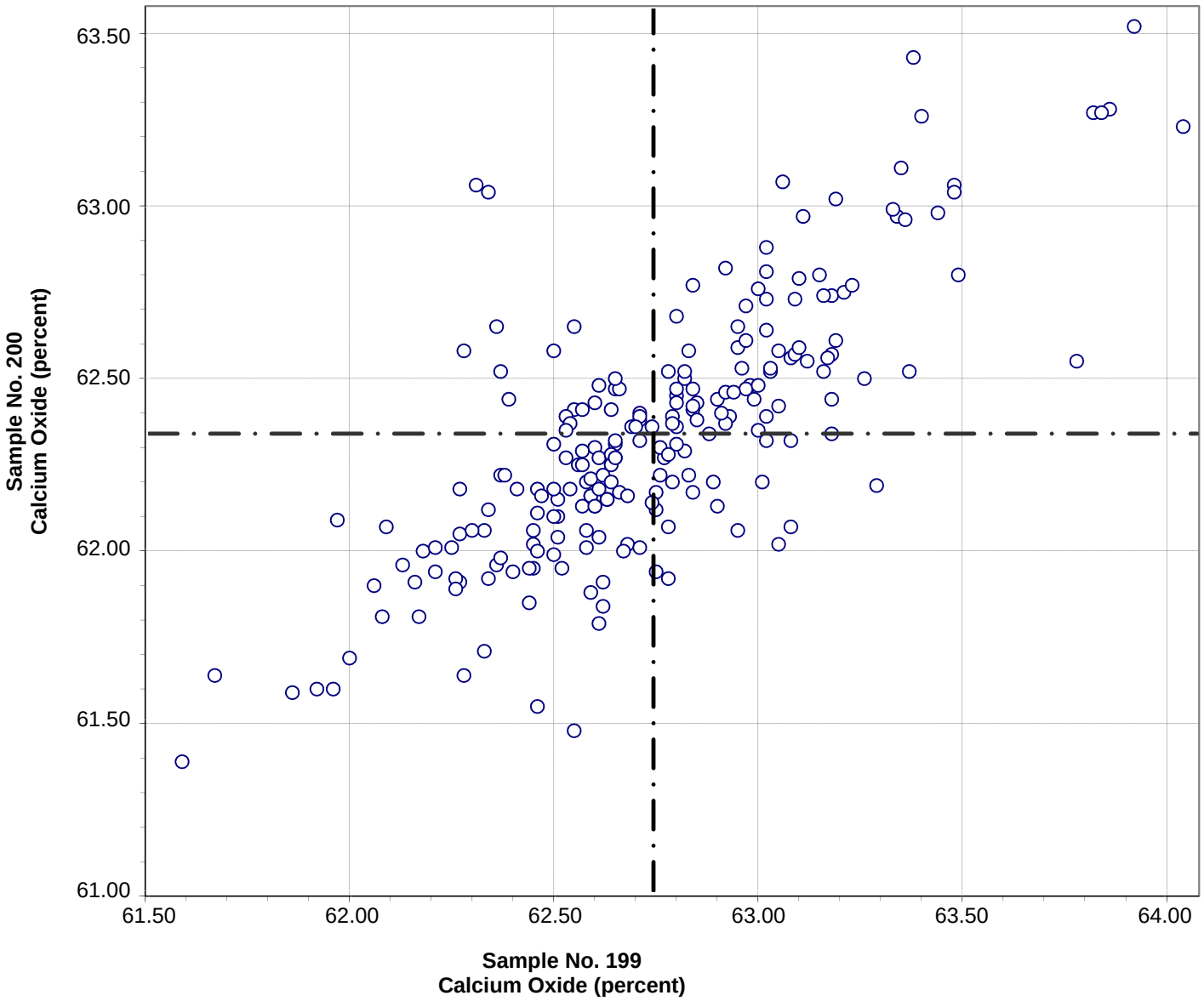
Test No. 30 Ferric Oxide 217 Points

Sample No. 199	Ave	2.92	S.D.	0.04	C.V.	1.3
Sample No. 200	Ave	3.38	S.D.	0.04	C.V.	1.2

Labs Eliminated: 15, 23, 84, 95, 116, 206, 694, 1079, 1956, 3948, 4080, 4099

Labs off Diagram: 3607

CCRL Proficiency Sample Program
Calcium Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

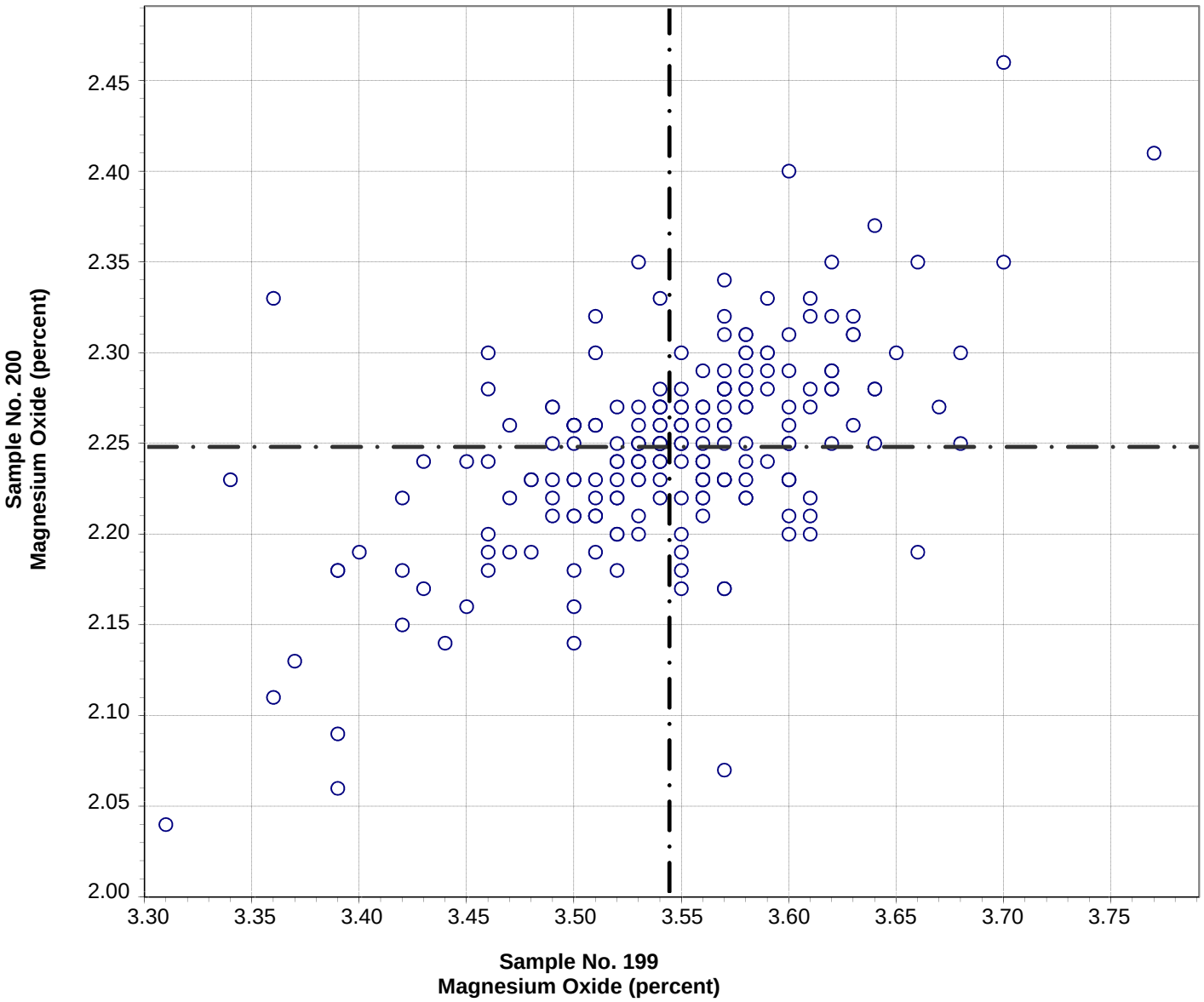


Test No. 40 Calcium Oxide 224 Points

Sample No. 199	Ave	62.74	S.D.	0.39	C.V. 0.62
Sample No. 200	Ave	62.34	S.D.	0.37	C.V. 0.60

Labs Eliminated: 48, 50, 107, 116, 2466

CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

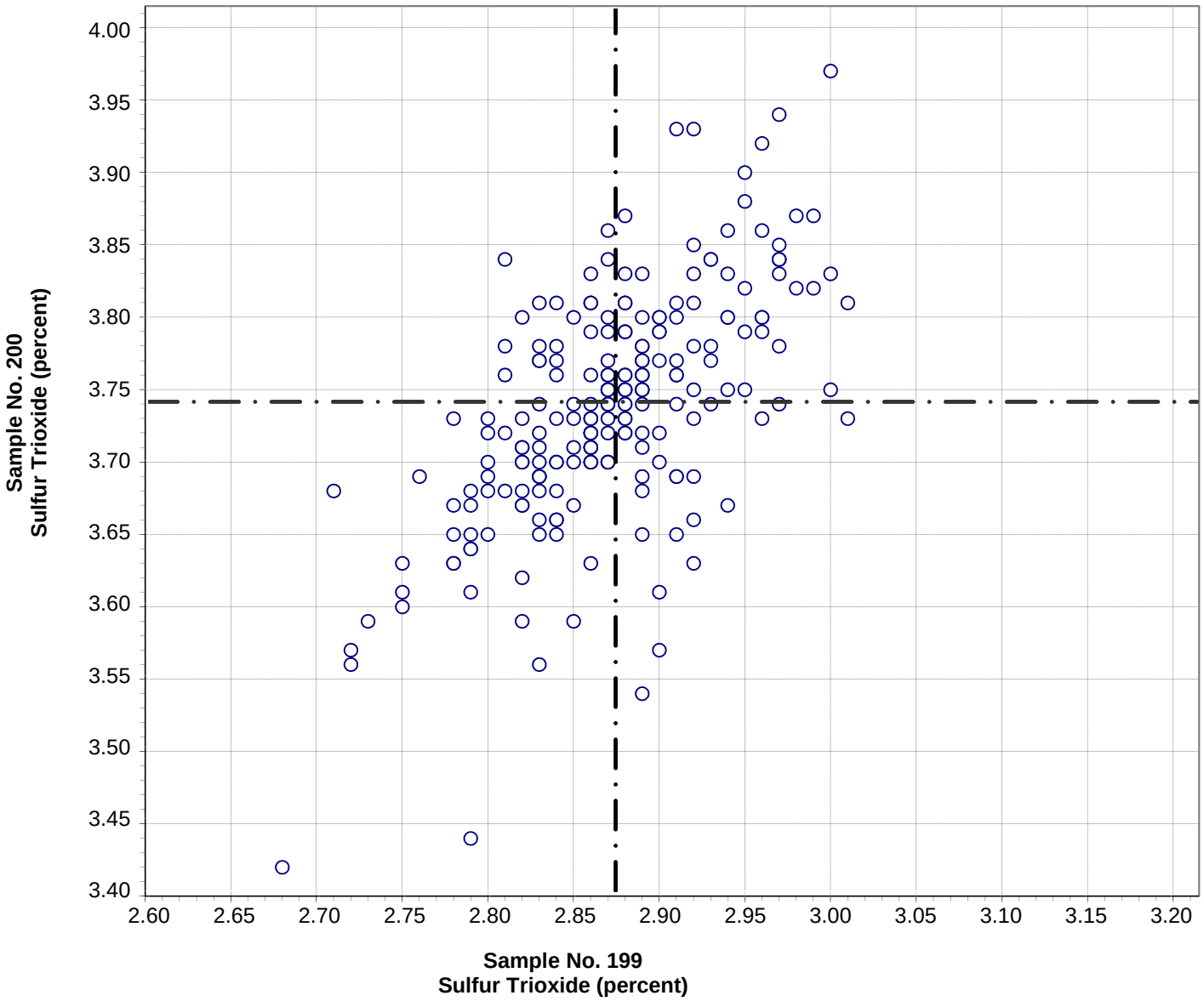


Test No. 50 Magnesium Oxide 214 Points

Sample No. 199	Ave	3.54	S.D.	0.07	C.V. 1.9
Sample No. 200	Ave	2.25	S.D.	0.06	C.V. 2.4

Labs Eliminated: 48, 107, 116, 176, 206, 246, 494, 551, 1676, 1956, 2464, 3661, 3695, 3819, 4050, 4099

CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 199 and No. 200



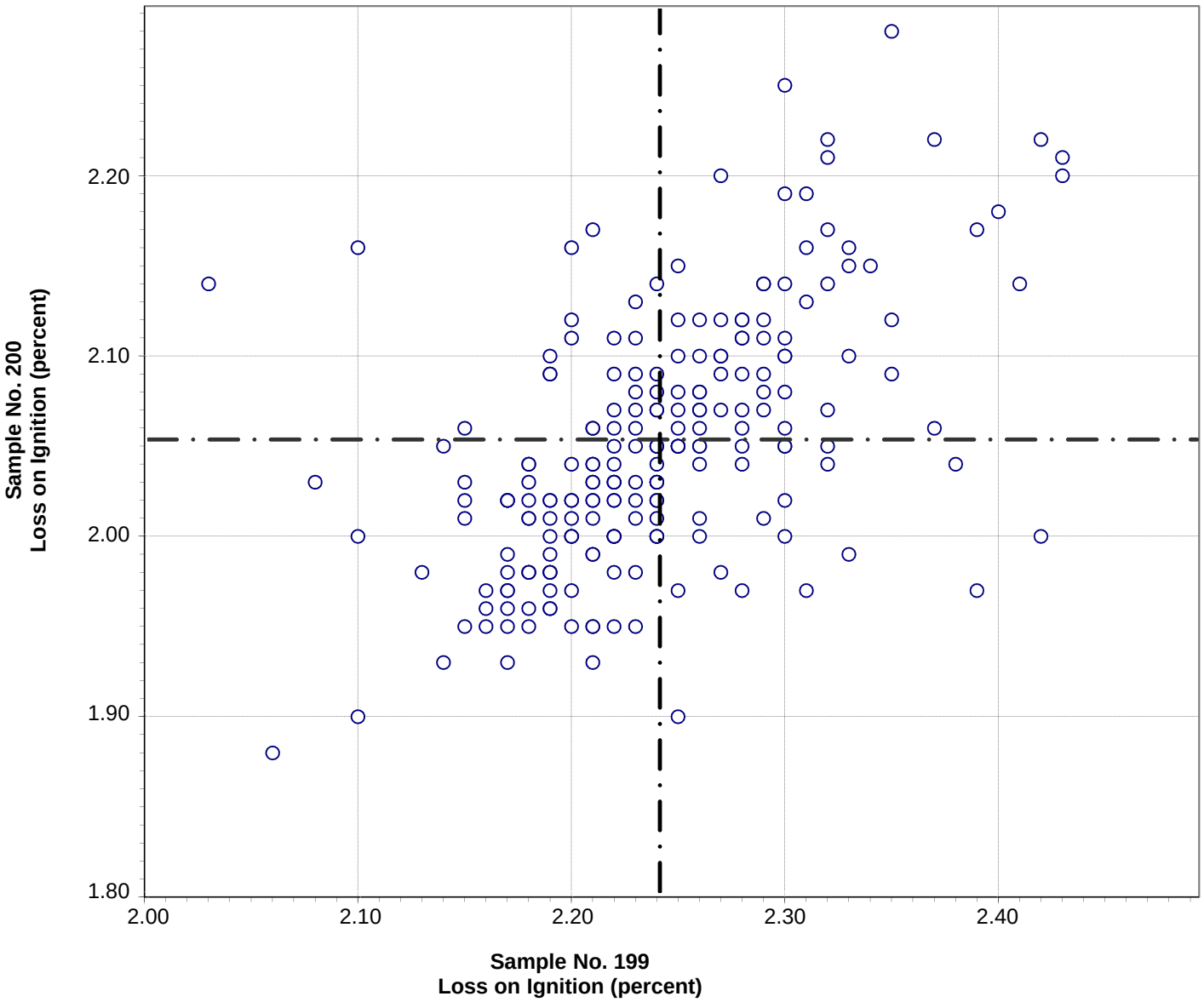
Test No. 60 Sulfur Trioxide 222 Points

Sample No. 199	Ave	2.87	S.D.	0.06	C.V. 2.2
Sample No. 200	Ave	3.74	S.D.	0.09	C.V. 2.4

Labs Eliminated: 34, 107, 116, 289, 3297, 4042

Labs off Diagram: 23, 159, 221, 3819

CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 199 and No. 200



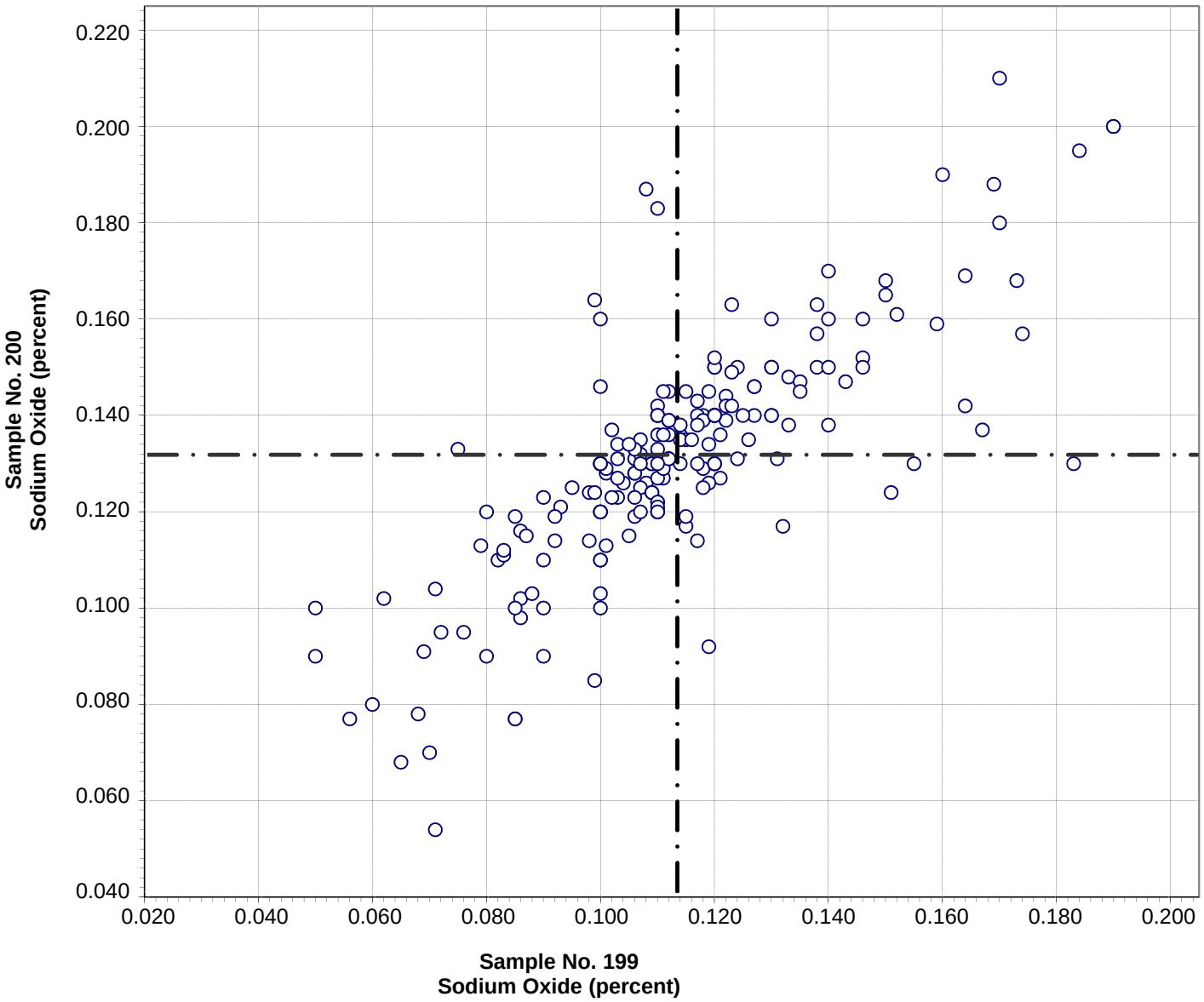
Test No. 70 Loss on Ignition 216 Points

Sample No. 199	Ave	2.24	S.D.	0.07	C.V. 3.0
Sample No. 200	Ave	2.05	S.D.	0.07	C.V. 3.6

Labs Eliminated: 84, 90, 116, 137, 203, 243, 255, 687, 1053, 1251, 1435, 1940, 2982, 3695, 3807, 4042, 4050, 4099

Labs off Diagram: 92, 3059

CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

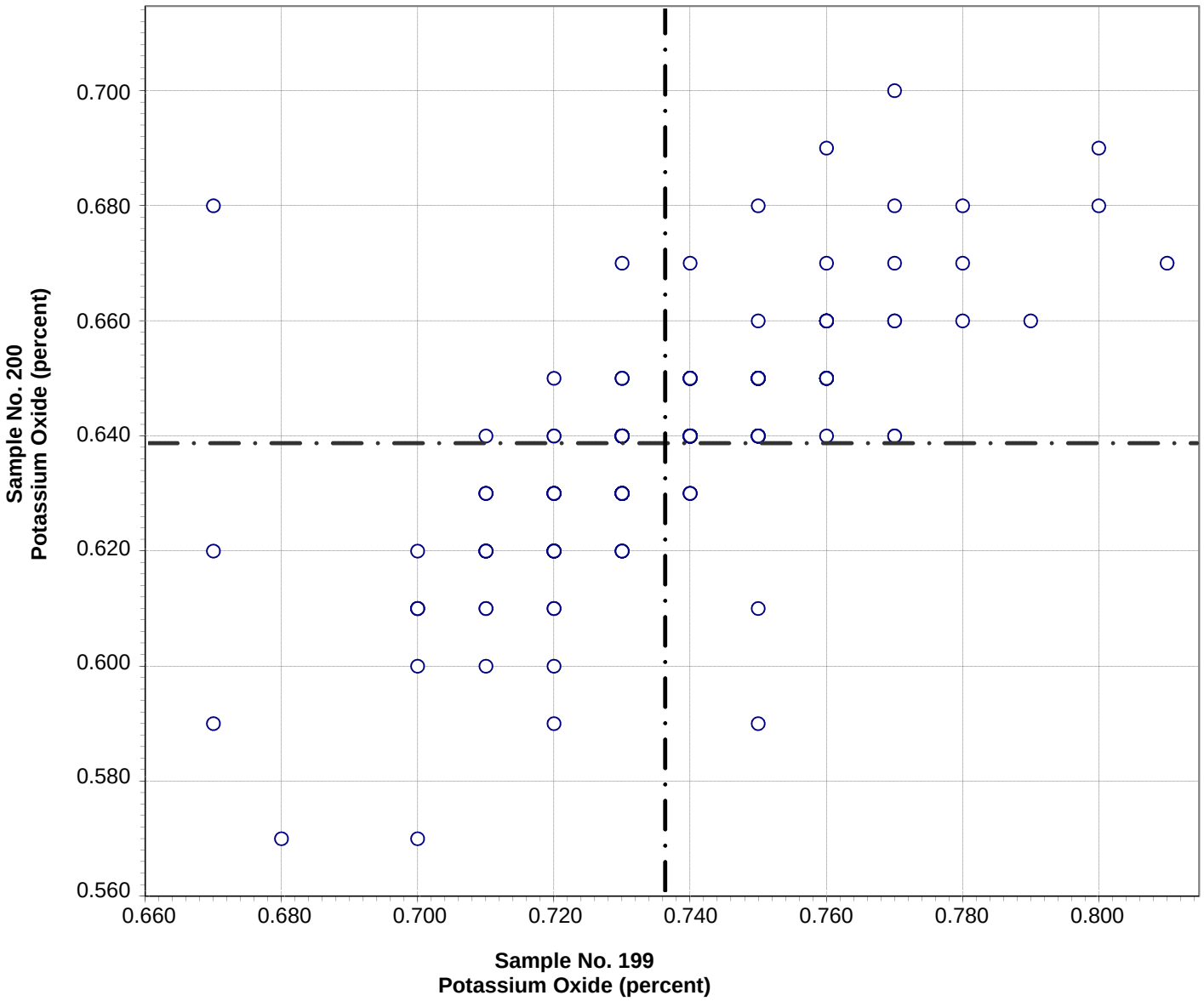


Test No. 90 Sodium Oxide 207 Points

Sample No. 199	Ave	0.113	S.D.	0.025	C.V.	22
Sample No. 200	Ave	0.132	S.D.	0.024	C.V.	18

Labs Eliminated: 56, 284, 289, 440, 2305, 2308, 2462, 3059, 3297, 3695, 4042, 4099

CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

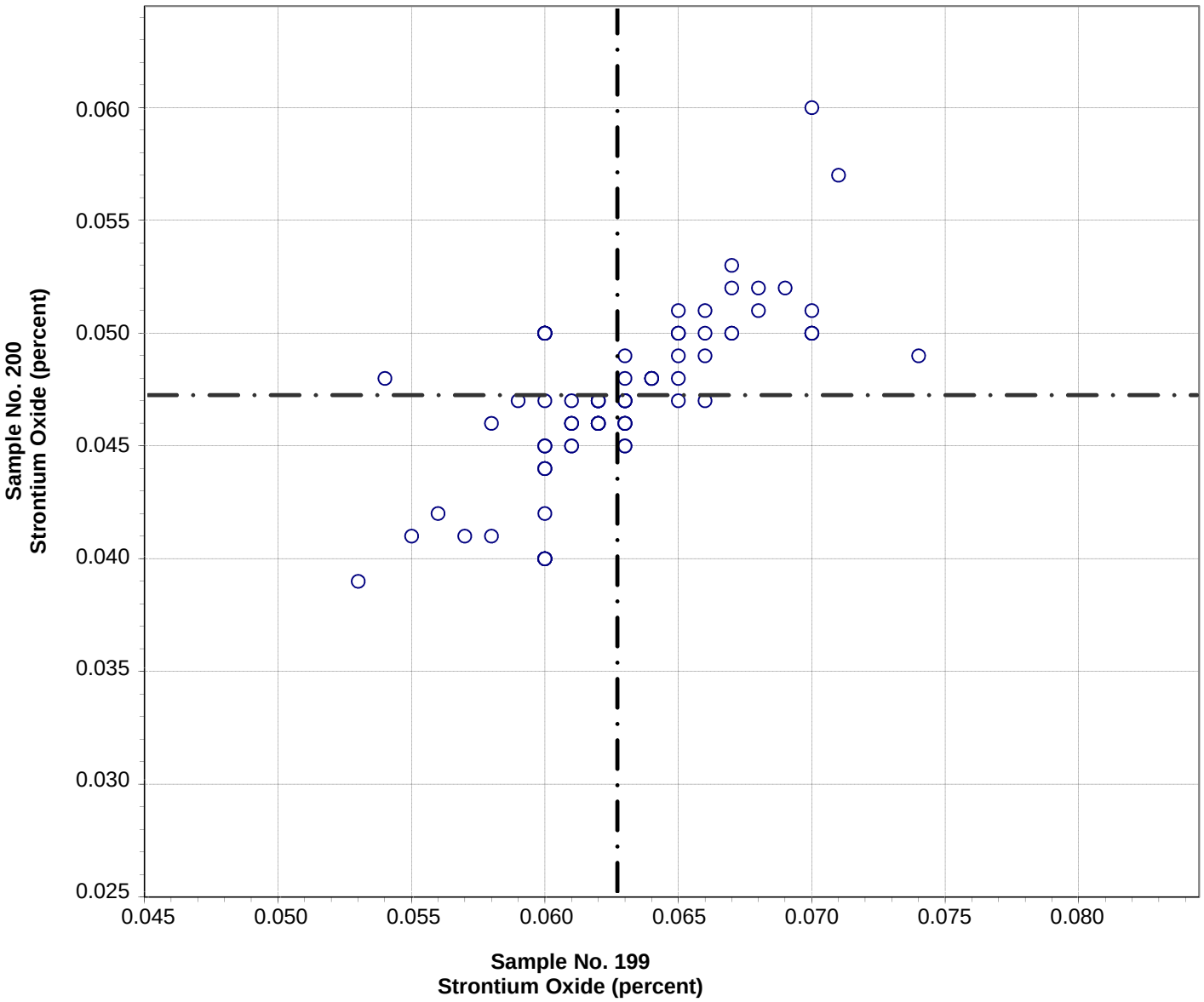


Test No. 100 Potassium Oxide 212 Points

Sample No. 199	Ave	0.736	S.D.	0.021	C.V.	2.8
Sample No. 200	Ave	0.638	S.D.	0.019	C.V.	2.9

Labs Eliminated: 36, 56, 107, 116, 690, 975, 2308, 2360, 2465, 3057, 3279, 3661, 4099

CCRL Proficiency Sample Program
Strontium Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

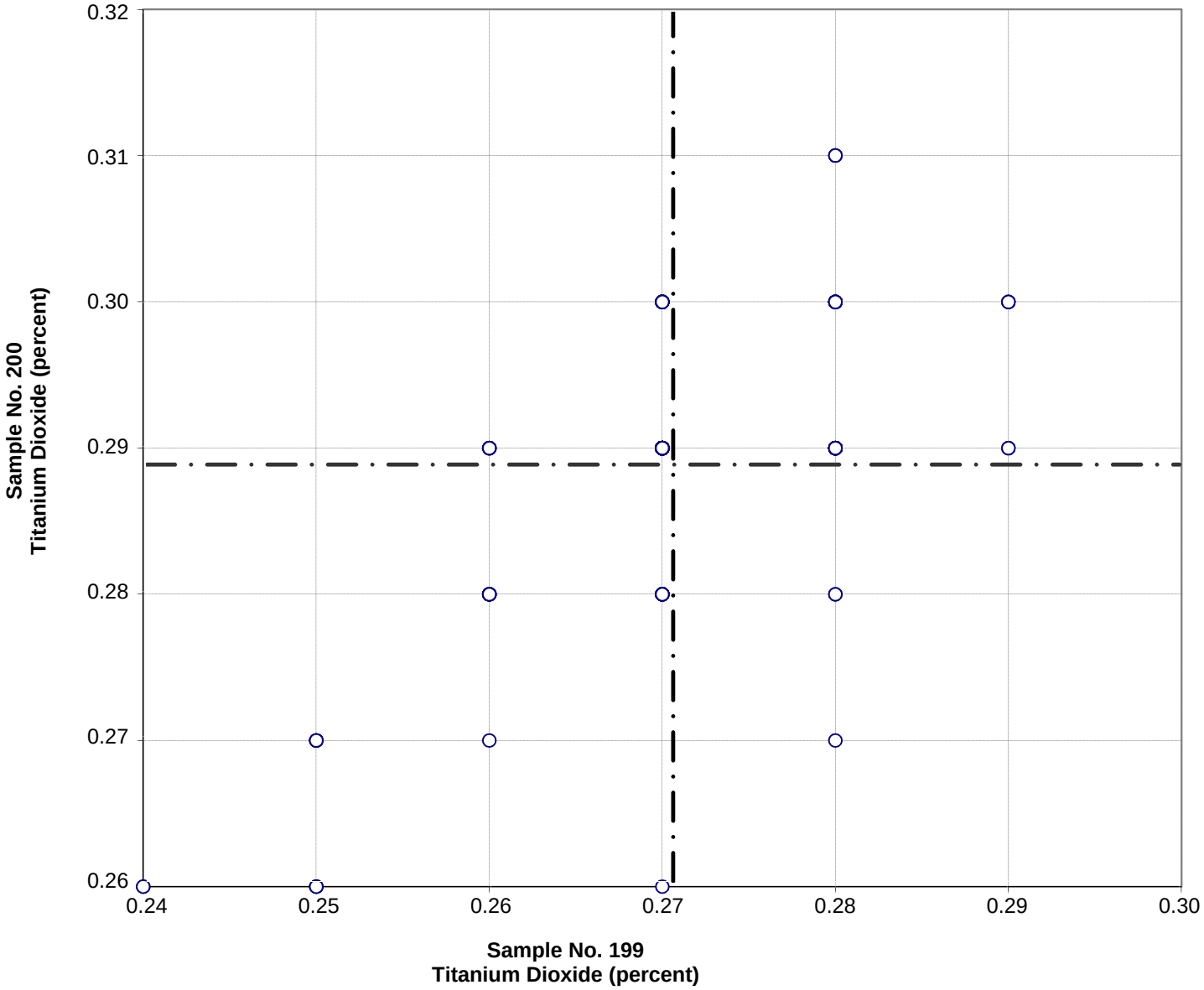


Test No. 92 Strontium Oxide 95 Points

Sample No. 199	Ave	0.063	S.D.	0.004	C.V. 6
Sample No. 200	Ave	0.047	S.D.	0.004	C.V. 8

Labs Eliminated: 116, 178, 491, 493, 3297

CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 199 and No. 200

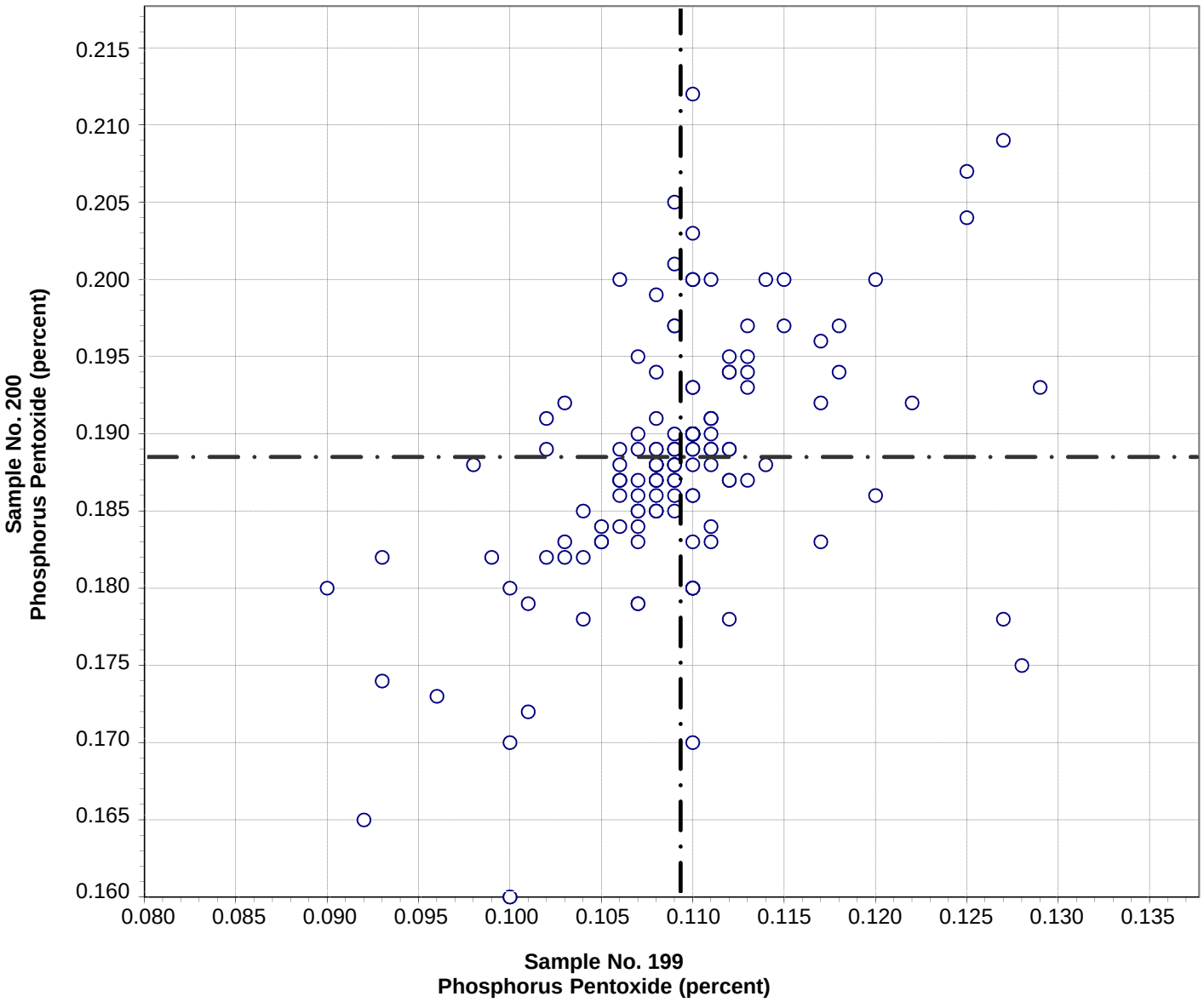


Test No. 103 Titanium Dioxide 171 Points

Sample No. 199	Ave	0.27	S.D.	0.008	C.V.	3.0
Sample No. 200	Ave	0.29	S.D.	0.009	C.V.	3.1

Labs Eliminated: 93, 107, 116, 175, 246, 438, 494, 1054, 1644, 2352, 2491, 4042, 4099

CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 199 and No. 200



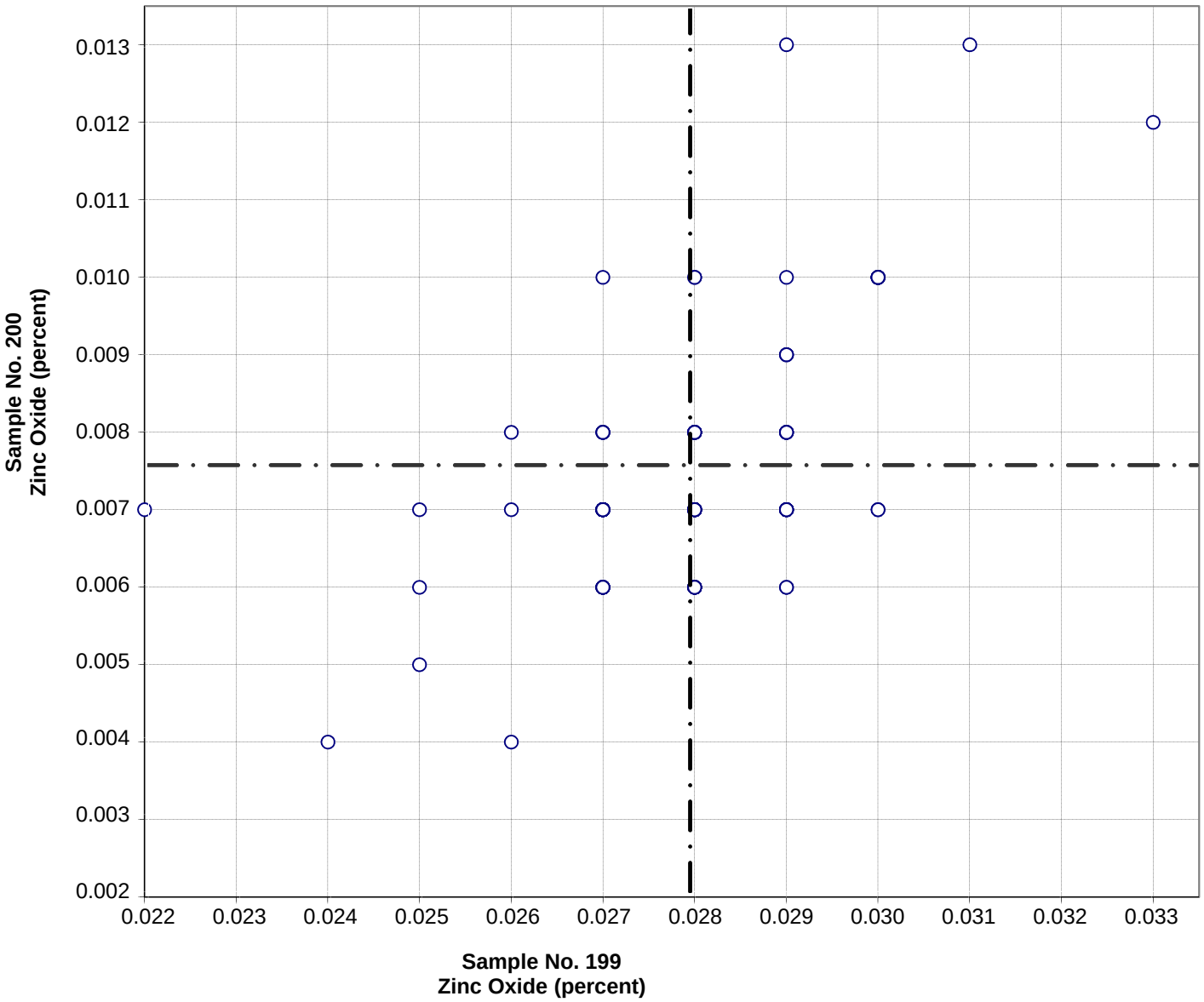
Test No. 102 Phosphorus Pentoxide 161 Points

Sample No. 199	Ave	0.109	S.D.	0.006	C.V. 5.7
Sample No. 200	Ave	0.188	S.D.	0.008	C.V. 4.3

Labs Eliminated: 48, 56, 107, 116, 289, 494, 2491, 3235, 3279, 3413, 3695, 4099

Labs off Diagram: 134

CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

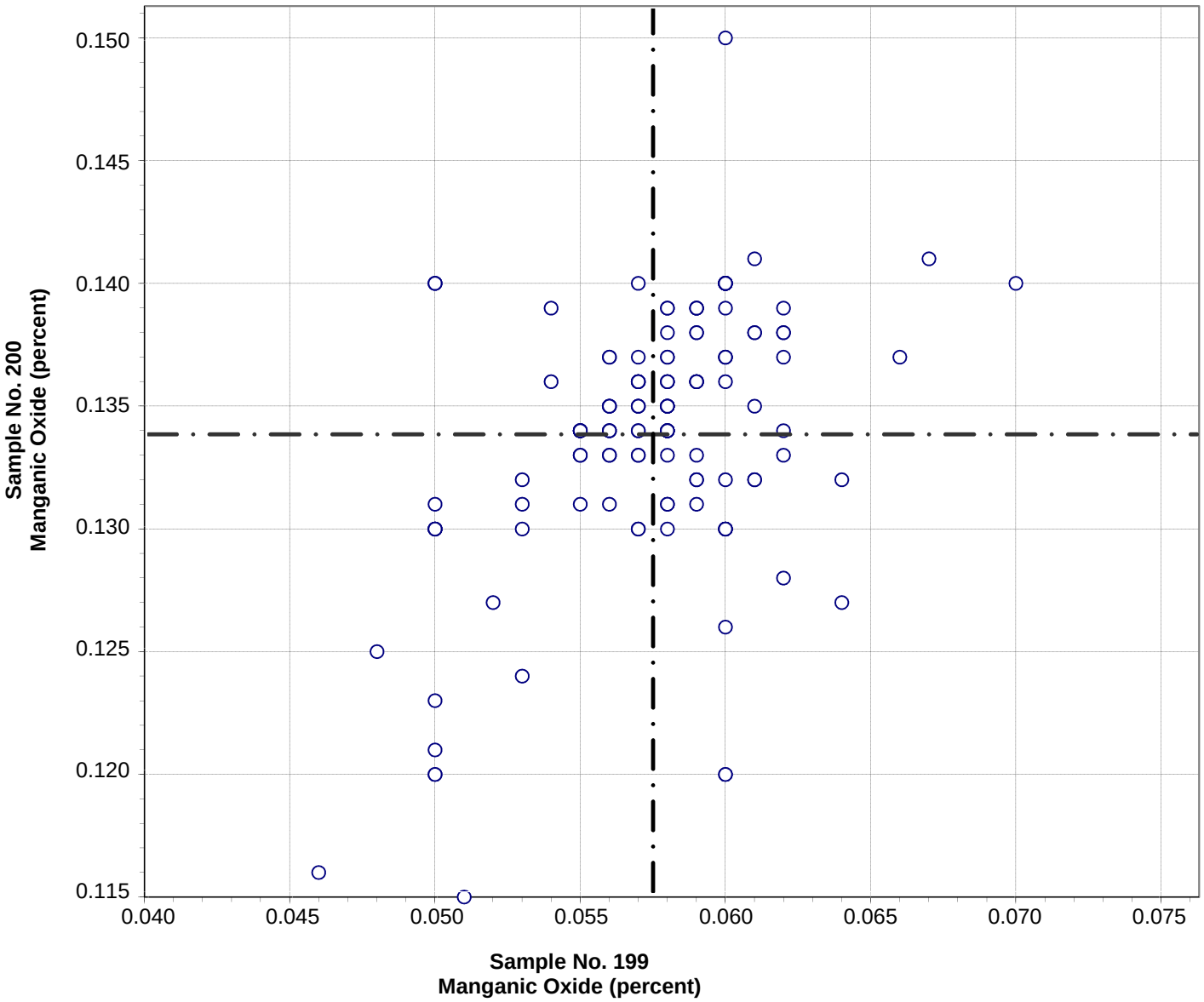


Test No. 99 Zinc Oxide 88 Points

Sample No. 199	Ave	0.028	S.D.	0.002	C.V. 5.5
Sample No. 200	Ave	0.008	S.D.	0.002	C.V. 22.1

Labs Eliminated: 23, 95, 116, 165, 178, 219, 502, 605, 768, 1054, 2477, 4099

CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 199 and No. 200



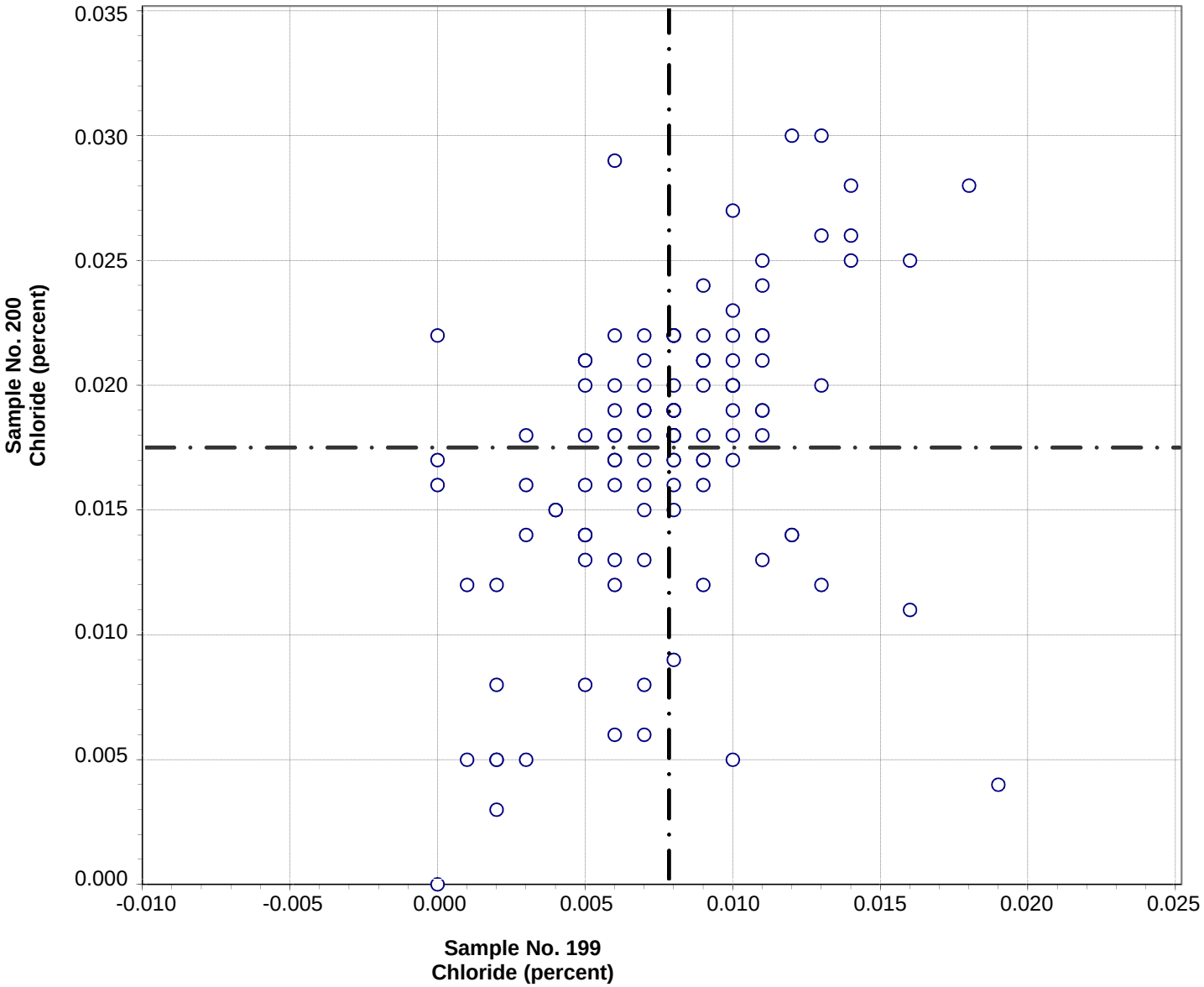
Test No. 101 Manganic Oxide 132 Points

Sample No. 199	Ave	0.057	S.D.	0.004	C.V.	6.7
Sample No. 200	Ave	0.134	S.D.	0.006	C.V.	4.2

Labs Eliminated: 27, 107, 116, 178, 203, 354, 457, 491, 768, 1916, 2360, 4099

Labs off Diagram: 3059

CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 199 and No. 200

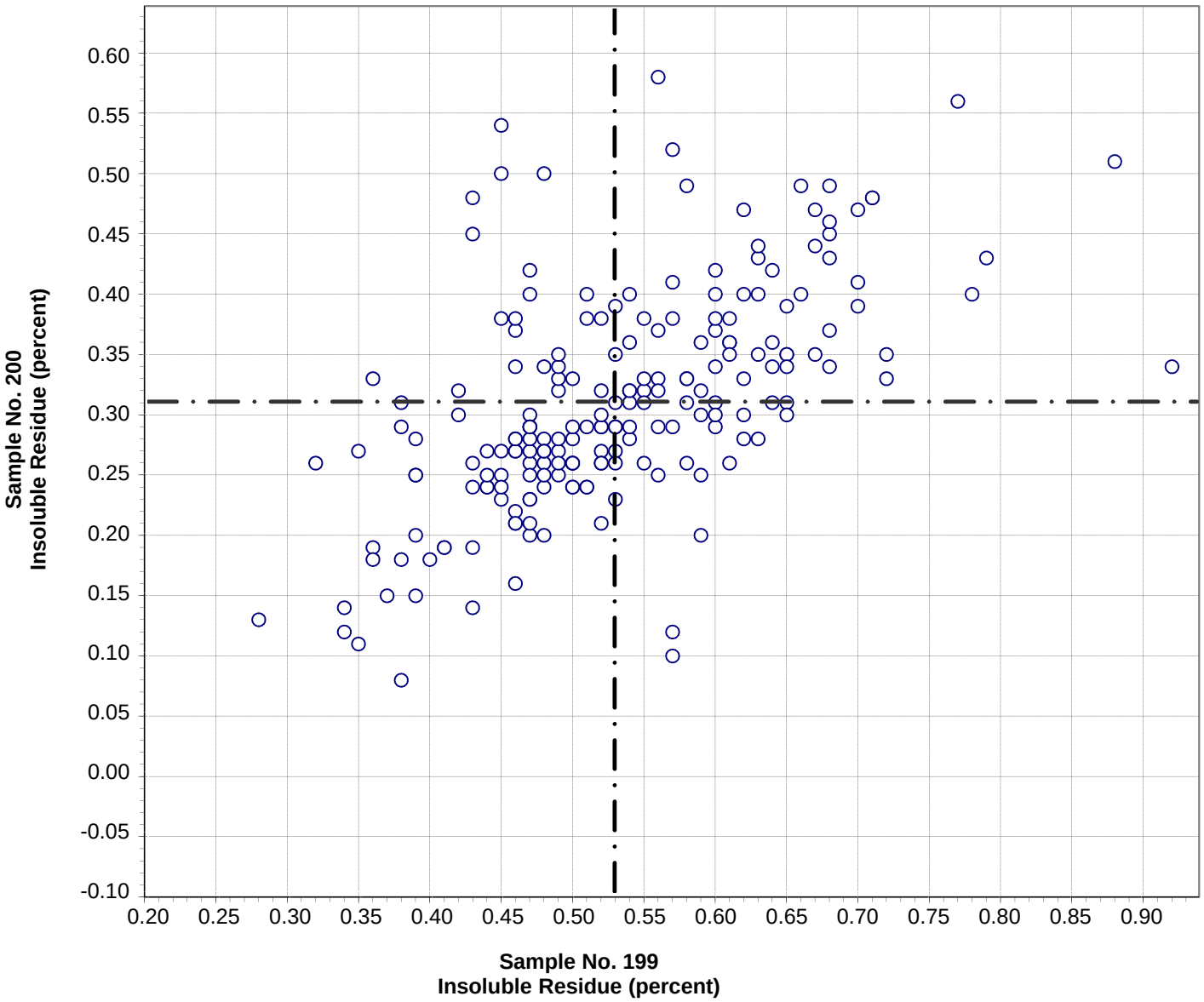


Test No. 104 Chloride 121 Points

Sample No. 199	Ave	0.008	S.D.	0.004	C.V. 46
Sample No. 200	Ave	0.017	S.D.	0.006	C.V. 34

Labs Eliminated: 64, 130, 142, 309, 493, 886, 3662, 4080

CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 199 and No. 200



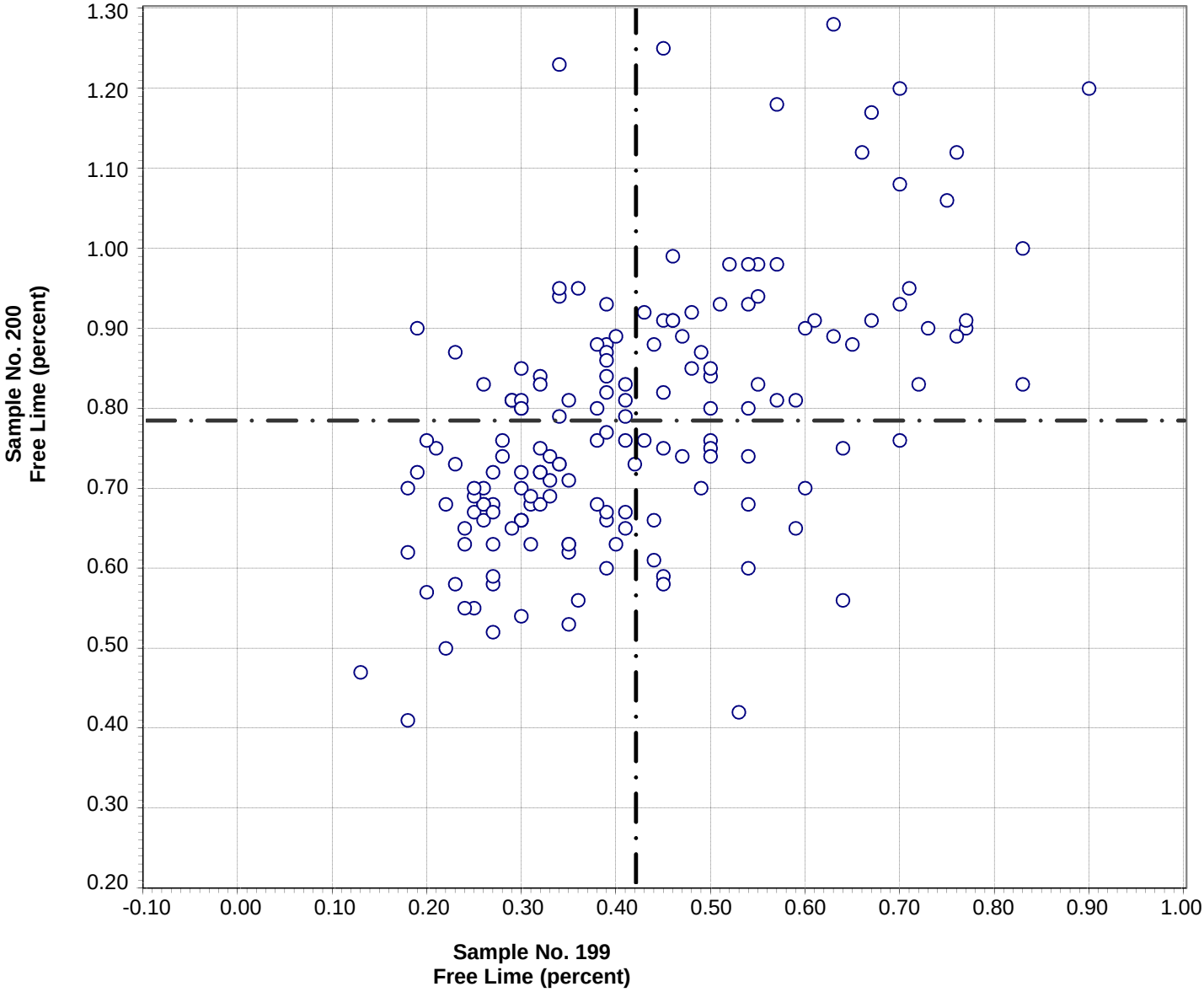
Test No. 80 Insoluble Residue 203 Points

Sample No. 199	Ave	0.53	S.D.	0.11	C.V.	20
Sample No. 200	Ave	0.31	S.D.	0.09	C.V.	30

Labs Eliminated: 4, 36, 206, 246, 309, 687, 2477

Labs off Diagram: 416, 698

CCRL Proficiency Sample Program
Free Lime
PORTLAND CEMENT Samples No. 199 and No. 200

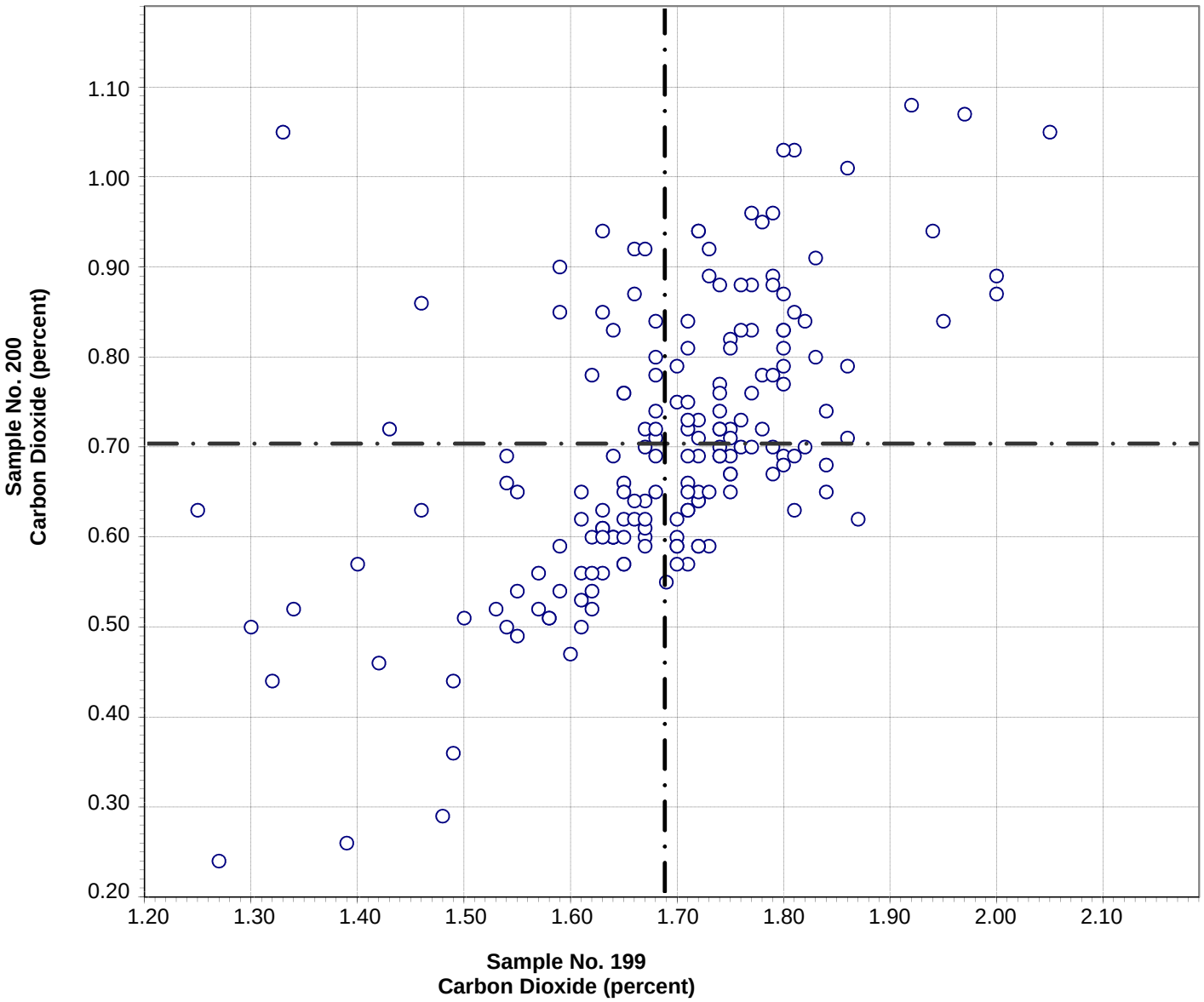


Test No. 41 Free Lime 166 Points

Sample No. 199	Ave	0.42	S.D.	0.16	C.V. 38
Sample No. 200	Ave	0.78	S.D.	0.16	C.V. 21

Labs Eliminated: 78, 132, 142, 181, 206, 246, 431, 551, 1940, 1942, 2466

CCRL Proficiency Sample Program
Carbon Dioxide
PORTLAND CEMENT Samples No. 199 and No. 200

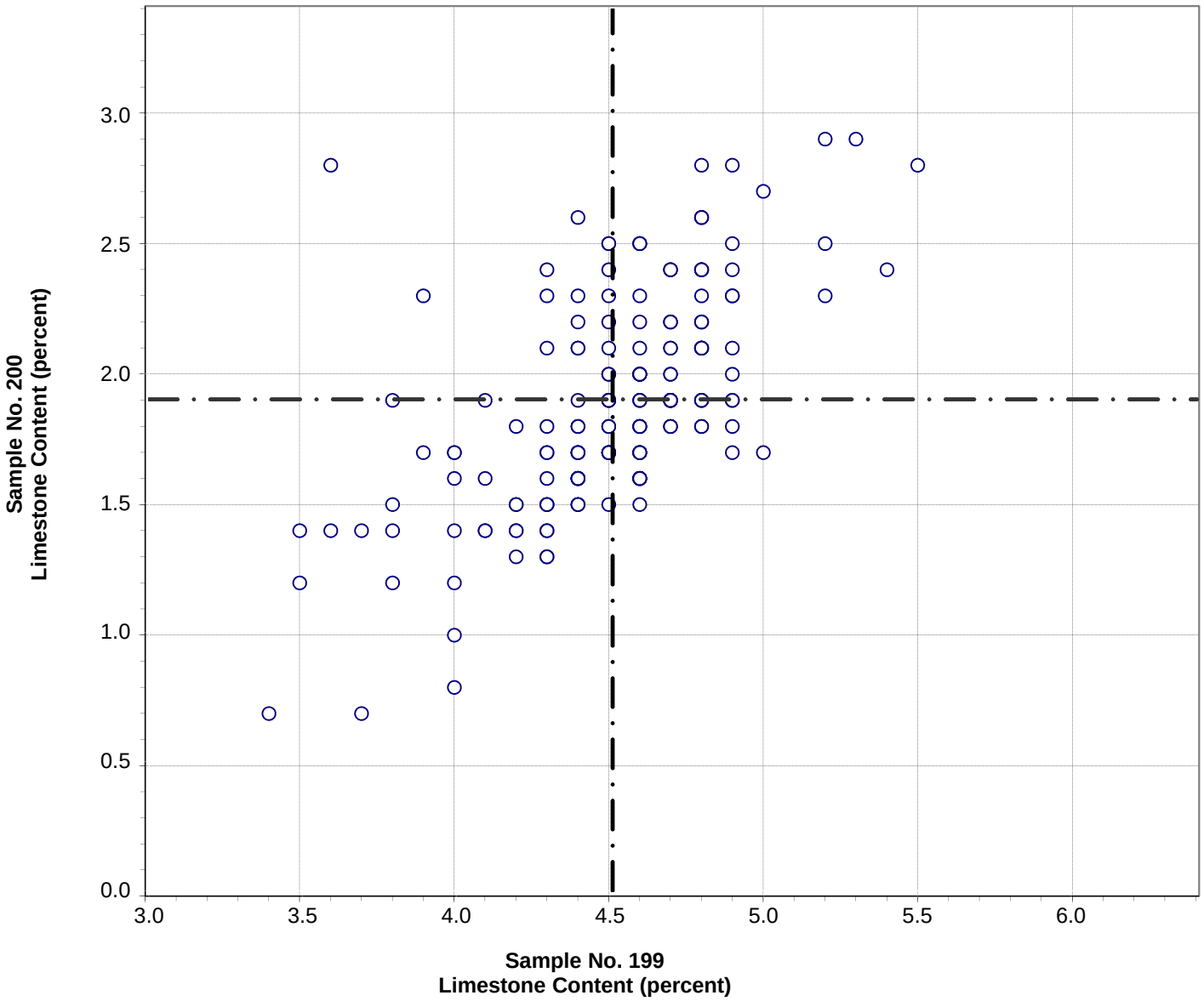


Test No. 97 Carbon Dioxide 181 Points

Sample No. 199	Ave	1.69	S.D.	0.13	C.V. 7.7
Sample No. 200	Ave	0.70	S.D.	0.15	C.V. 21.7

Labs Eliminated: 50, 60, 74, 96, 137, 203, 252, 438, 692, 886, 1251, 1799, 2363, 4051

CCRL Proficiency Sample Program
Limestone Content
PORTLAND CEMENT Samples No. 199 and No. 200

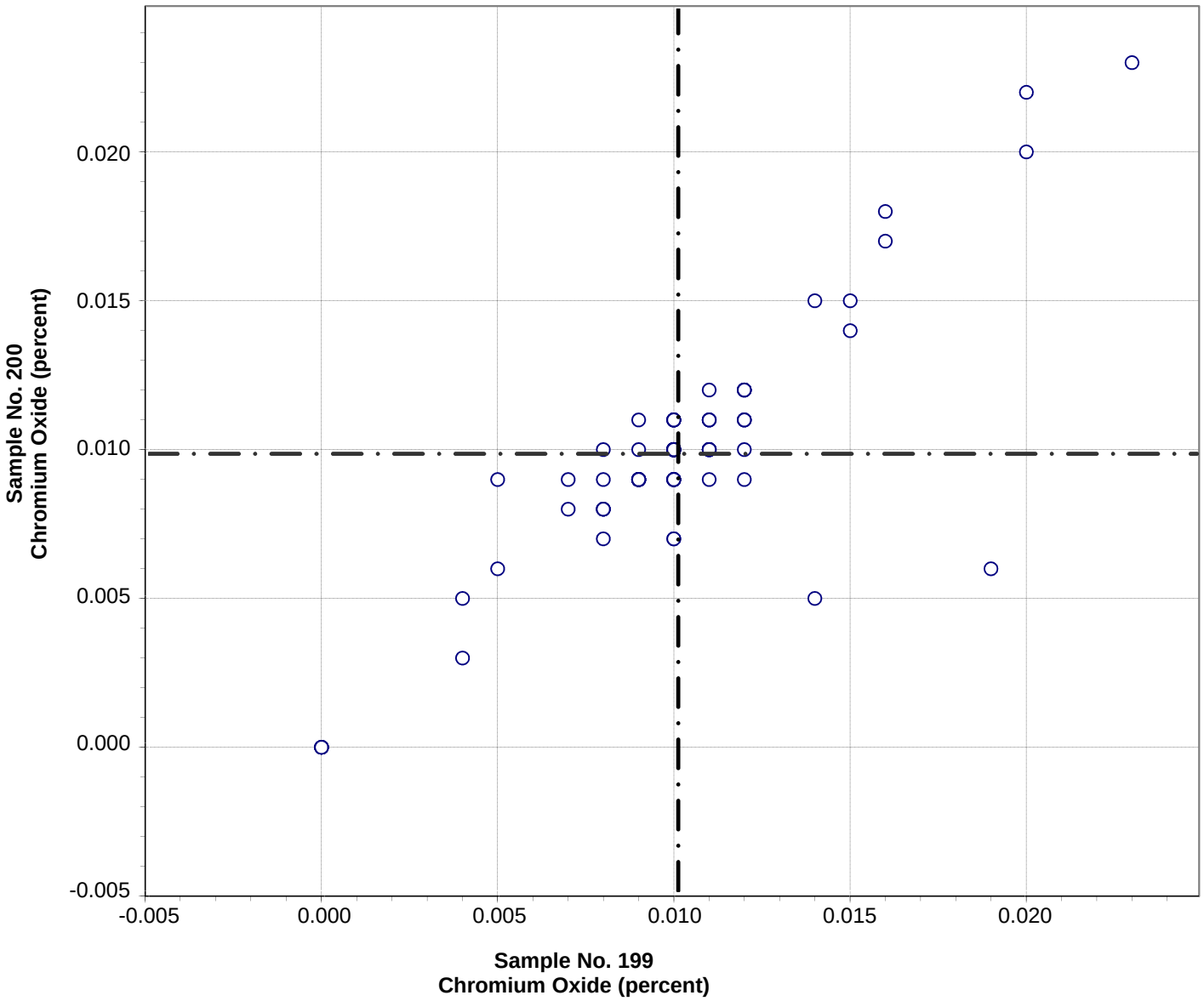


Test No. 98 Limestone Content 178 Points

Sample No. 199	Ave	4.5	S.D.	0.4	C.V.	7.8
Sample No. 200	Ave	1.9	S.D.	0.4	C.V.	21.8

Labs Eliminated: 50, 60, 74, 96, 137, 203, 252, 438, 692, 886, 1251, 1799, 1942, 2363, 3233, 4051

CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 199 and No. 200

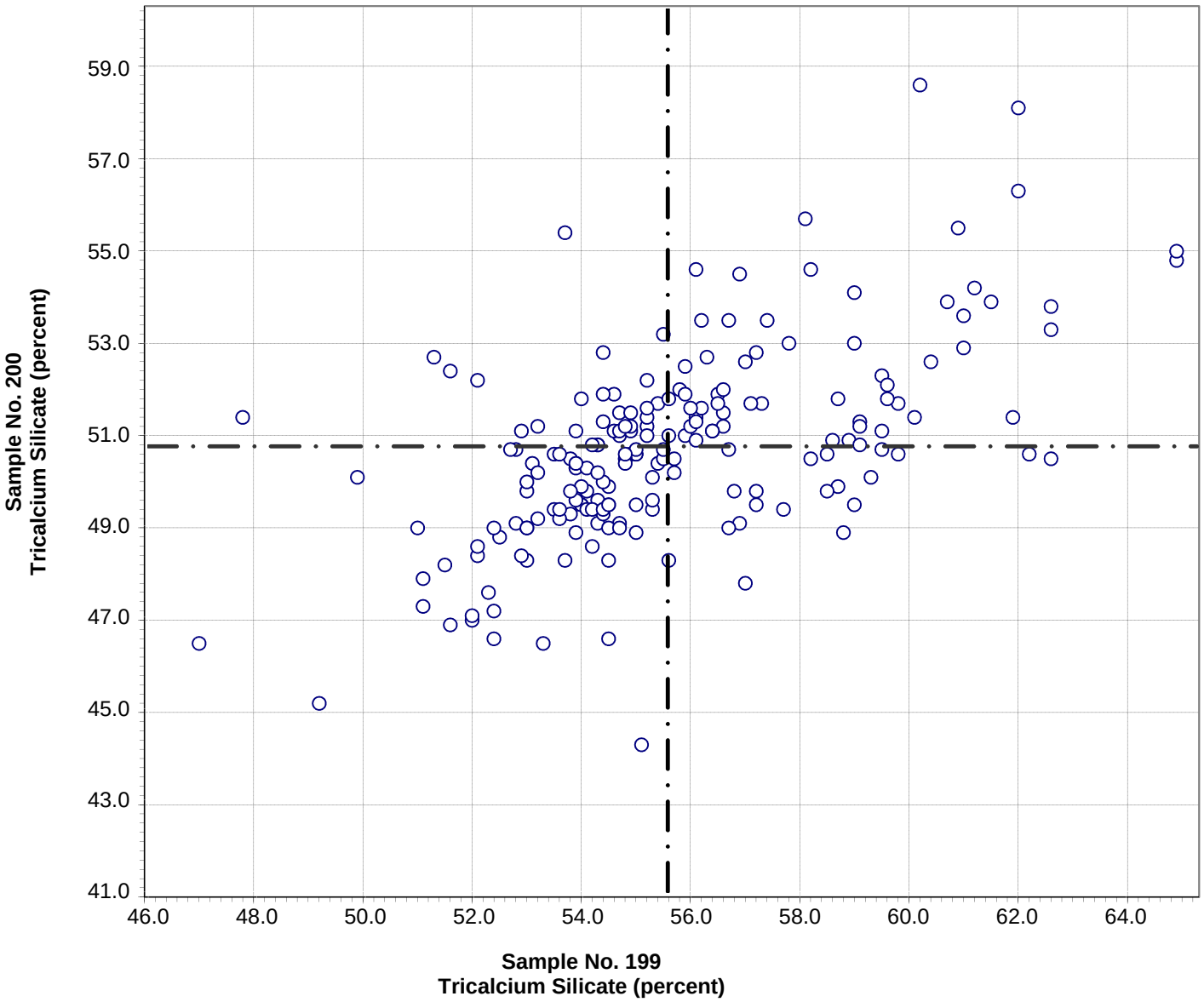


Test No. 105 Chromium Oxide 88 Points

Sample No. 199	Ave	0.010	S.D.	0.004	C.V.	37
Sample No. 200	Ave	0.010	S.D.	0.004	C.V.	38

Labs Eliminated: 66, 98, 116, 438, 493, 2462

CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 199 and No. 200



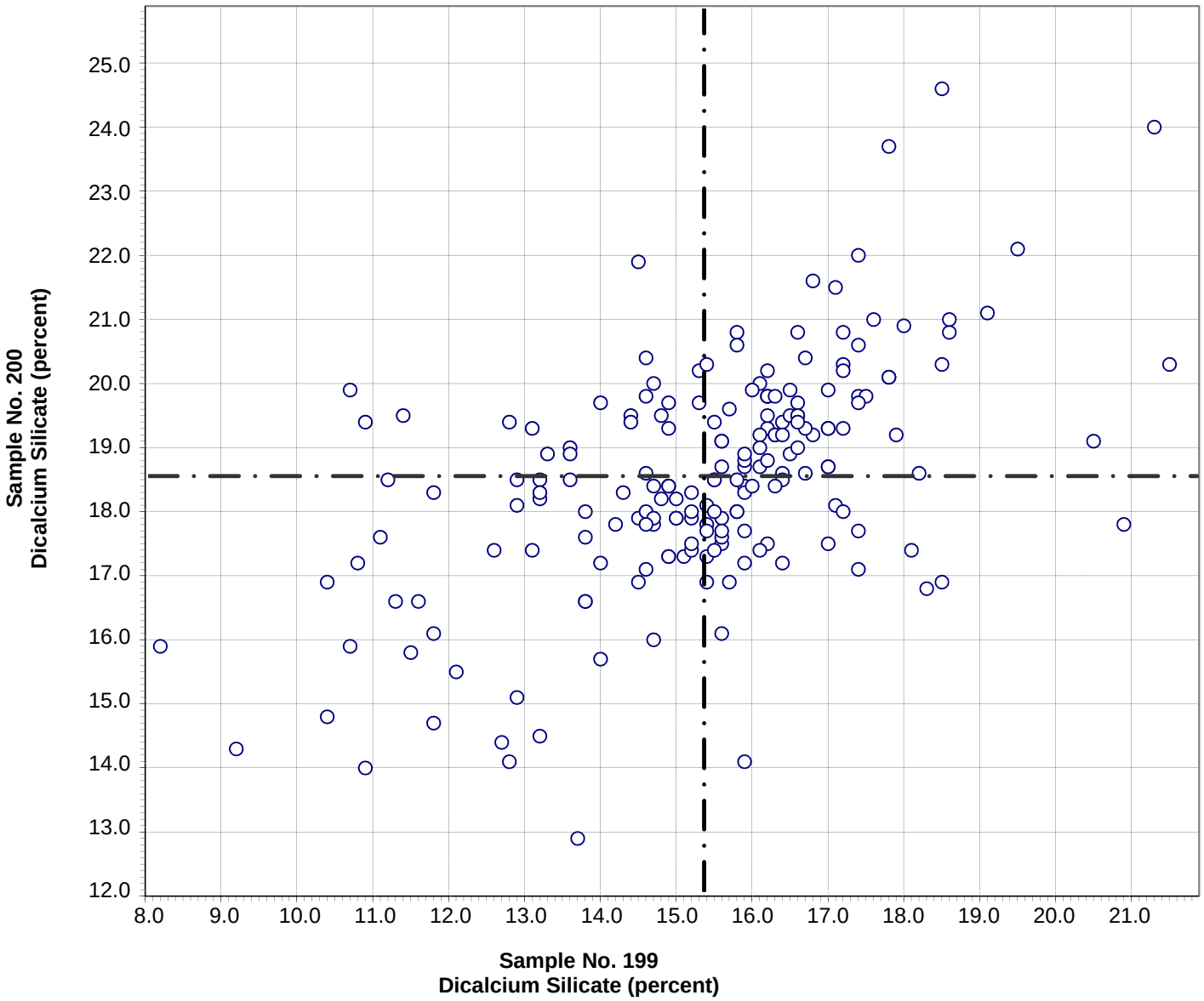
Test No. 106 Tricalcium Silicate 196 Points

Sample No. 199	Ave	55.6	S.D.	3.1	C.V.	5.7
Sample No. 200	Ave	50.7	S.D.	2.1	C.V.	4.1

Labs Eliminated: 8, 50, 107, 116, 3059, 3297

Labs off Diagram: 162, 165

CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 199 and No. 200

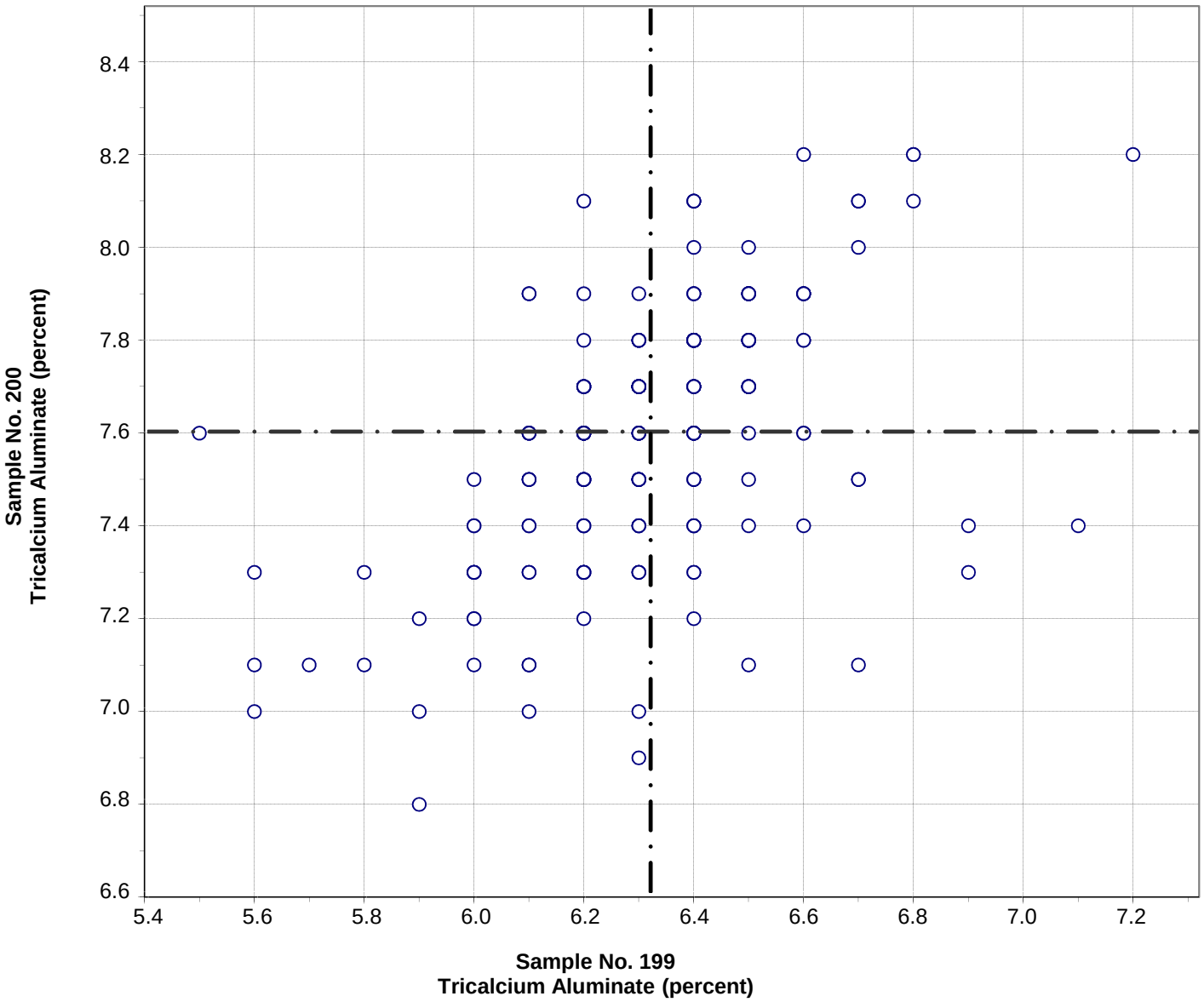


Test No. 107 Dicalcium Silicate 193 Points

Sample No. 199	Ave	15.4	S.D.	2.2	C.V. 14.1
Sample No. 200	Ave	18.5	S.D.	1.8	C.V. 9.5

Labs Eliminated: 8, 15, 23, 50, 107, 162, 165, 2466, 3059, 3297, 3779

CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 199 and No. 200

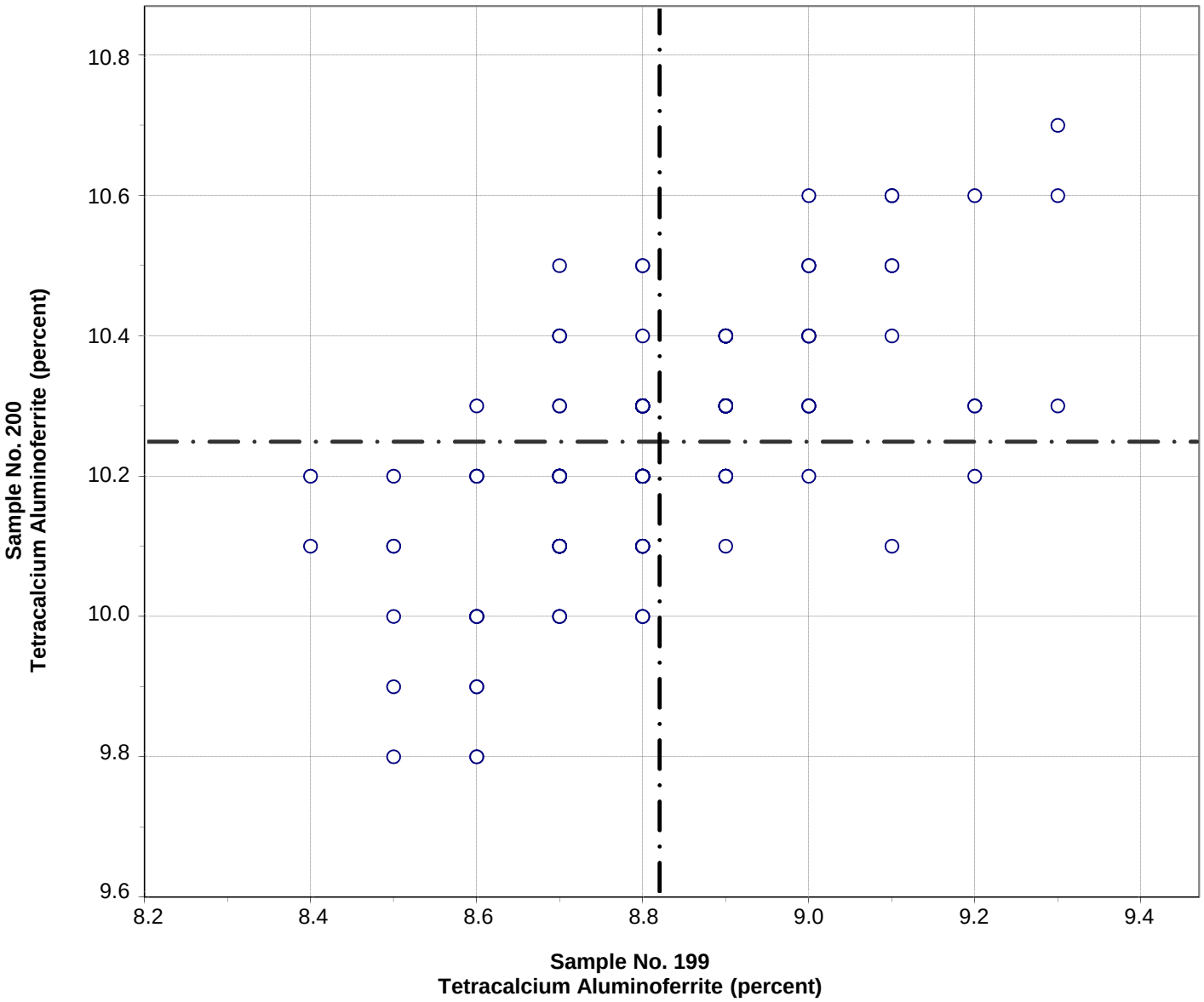


Test No. 108 Tricalcium Aluminate 197 Points

Sample No. 199	Ave	6.3	S.D.	0.2	C.V.	3.8
Sample No. 200	Ave	7.6	S.D.	0.3	C.V.	3.6

Labs Eliminated: 42, 98, 116, 165, 975, 3059, 3297, 4080

CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 199 and No. 200



Test No. 109 Tetracalcium Aluminoferrite 196 Points

Sample No. 199 Ave 8.8 S.D. 0.2 C.V. 1.8
Sample No. 200 Ave 10.2 S.D. 0.2 C.V. 1.5

Labs Eliminated: 23, 47, 98, 116, 165, 206, 1956, 3059, 4080

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Physical Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
Normal Consistency - % Water (**percent**)							
	252	24.9	0.51	2.10	24.2	0.43	1.80
	*250	24.9	0.46	1.90	24.2	0.40	1.70
* Labs Eliminated - 2477, 4080							
Vicat Time of Set - Initial (**minutes**)							
	250	140	17	12	132	17	13
	*245	139	13	10	131	13	10
* Labs Eliminated - 26, 779, 3297, 3859, 4042							
Vicat Time of Set - Final (**minutes**)							
	245	246	31	12	235	29	12
	*243	246	30	12	235	28	12
* Labs Eliminated - 779, 4042							
Gillmore Time of Set - Initial (**minutes**)							
	145	173	22	13	161	22	14
	*143	173	19	11	161	20	13
* Labs Eliminated - 23, 840							
Gillmore Time of Set - Final (**minutes**)							
	145	272	38	14	262	34	13
	*143	271	32	12	262	34	13
* Labs Eliminated - 222, 690							
False Set - Paste Method (**percent**)							
	192	75	11.3	15.0	79	8.1	10.2
	*189	76	10.6	13.9	79	7.5	9.5
* Labs Eliminated - 51, 440, 1956							
Autoclave Expansion (**percent**)							
	228	0.02	0.024	107	0.00	0.071	20283
	*211	0.02	0.014	57	-0.01	0.014	400
* Labs Eliminated - 24, 32, 36, 49, 93, 95, 176, 493, 494, 551, 823, 1799, 1940, 2491, 2955, 3233, 3607							

CCRL PROFICIENCY SAMPLE PROGRAM

Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Physical Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
Air Content % (percent)							
	234	9.2	1.3	14	8.7	1.5	18
	*228	9.2	1.1	12	8.6	1.2	14
* Labs Eliminated - 42, 180, 1251, 1644, 2352, 3859							
Air Content - % Water (percent)							
	222	67.5	10.2	15.1	67.1	10.2	15.2
	*212	69.4	2.1	3.1	68.9	2.4	3.5
* Labs Eliminated - 64, 129, 209, 440, 823, 932, 3279, 3662, 3850, 3859							
Air Content - Flow (percent)							
	229	87	3.7	4.2	87	4.4	5.0
	*225	87	3.5	4.0	87	3.7	4.3
* Labs Eliminated - 86, 360, 2683, 2955							
Compressive Strength - 3 day (psi)							
	259	3915	317	8.1	3134	326	10.4
	*255	3917	240	6.1	3134	246	7.8
* Labs Eliminated - 51, 2360, 4042, 4097							
Compressive Strength - 7 day (psi)							
	258	4693	330	7.0	4125	344	8.3
	*255	4694	274	5.8	4123	283	6.9
* Labs Eliminated - 51, 3003, 4097							
Compressive Strength - 28 day (psi)							
	242	5958	393	6.6	5602	403	7.2
	*238	5954	337	5.7	5594	364	6.5
* Labs Eliminated - 15, 3819, 4042, 4097							

CCRL PROFICIENCY SAMPLE PROGRAM

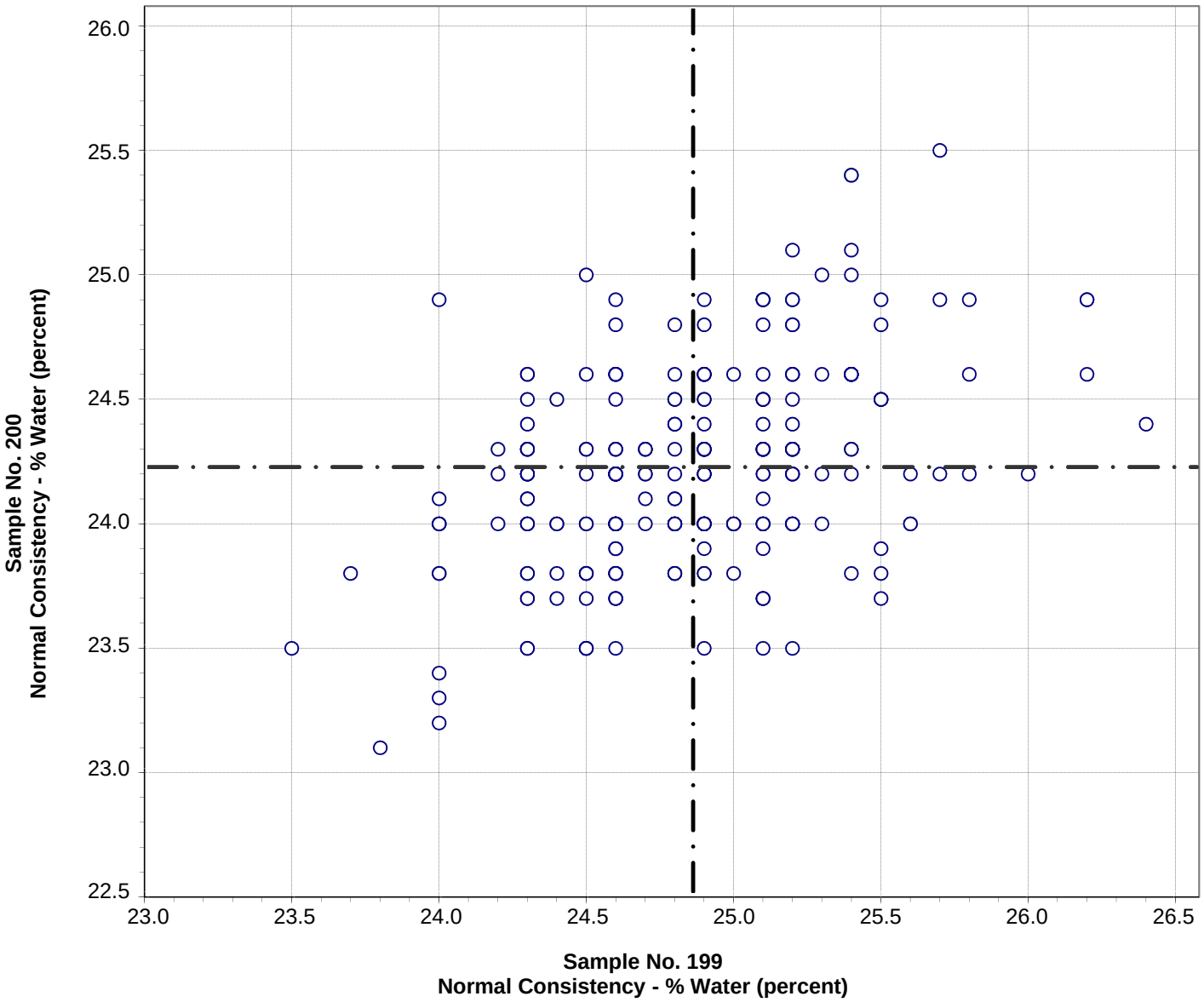
Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Physical Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
Compressive Strengh - Flow (**percent**)							
	228	112	9	7.9	117	10	8.2
	*225	112	8	7.5	118	9	7.7
* Labs Eliminated - 35, 84, 180							
Fineness - Air Permeability (**m²/kg**)							
	251	411	24	5.8	364	18	4.9
	*233	410	12	2.8	363	10	2.7
* Labs Eliminated - 24, 25, 26, 38, 43, 46, 51, 95, 494, 1466, 2462, 2466, 2683, 3249, 3788, 4042, 4051, 4097							
Fineness - Wagner Turbidimeter (**m²/kg**)							
	2	207	7	3.4	196	4	1.8
No Labs Eliminated for This Test							
Fineness - 45µm Sieve (**percent**)							
	237	92.13	4.74	5.15	94.50	5.77	6.11
	*218	92.48	0.83	0.90	95.22	0.61	0.64
* Labs Eliminated - 3, 8, 26, 36, 42, 69, 107, 116, 143, 169, 360, 415, 416, 1819, 2477, 2484, 3607, 3661, 3752							
C1038 Mortar Bar Expansion (**percent**)							
	167	0.005	0.007	134	0.012	0.025	202
	*159	0.004	0.003	69	0.009	0.004	48
* Labs Eliminated - 36, 51, 56, 252, 491, 2293, 3057, 3233							

CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 199 and No. 200

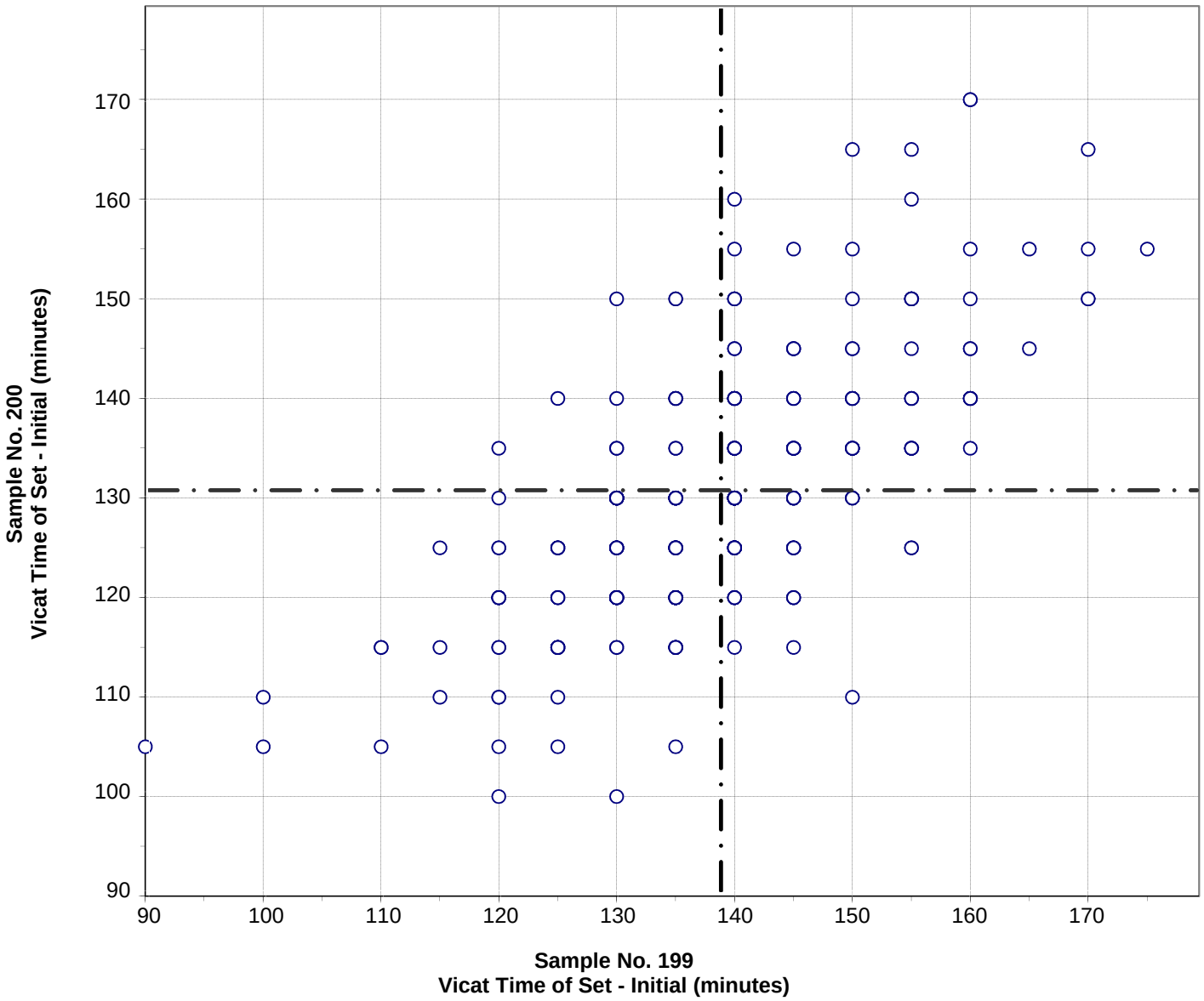


Test No. 110 Normal Consistency - % Water 250 Points

Sample No. 199	Ave	24.9	S.D.	0.46	C.V.	1.90
Sample No. 200	Ave	24.2	S.D.	0.40	C.V.	1.70

Labs Eliminated: 2477, 4080

CCRL Proficiency Sample Program
Vicat Time of Set - Initial
PORTLAND CEMENT Samples No. 199 and No. 200



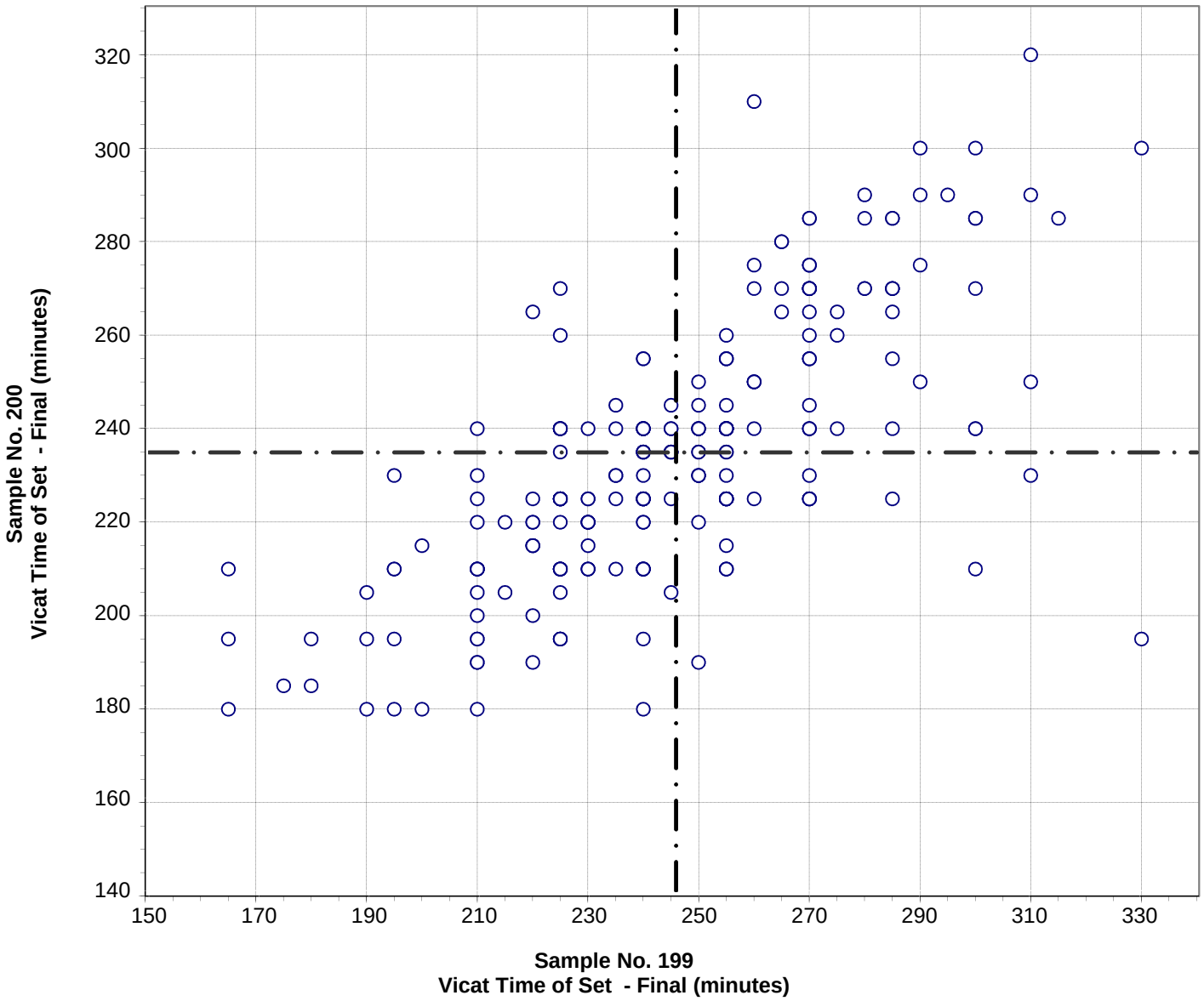
Test No. 120 Vicat Time of Set - Initial 243 Points

Sample No. 199	Ave 139	S.D. 13	C.V. 10
Sample No. 200	Ave 131	S.D. 13	C.V. 10

Labs Eliminated: 26, 779, 3297, 3859, 4042

Labs off Diagram: 415, 1079

CCRL Proficiency Sample Program
Vicat Time of Set - Final
PORTLAND CEMENT Samples No. 199 and No. 200

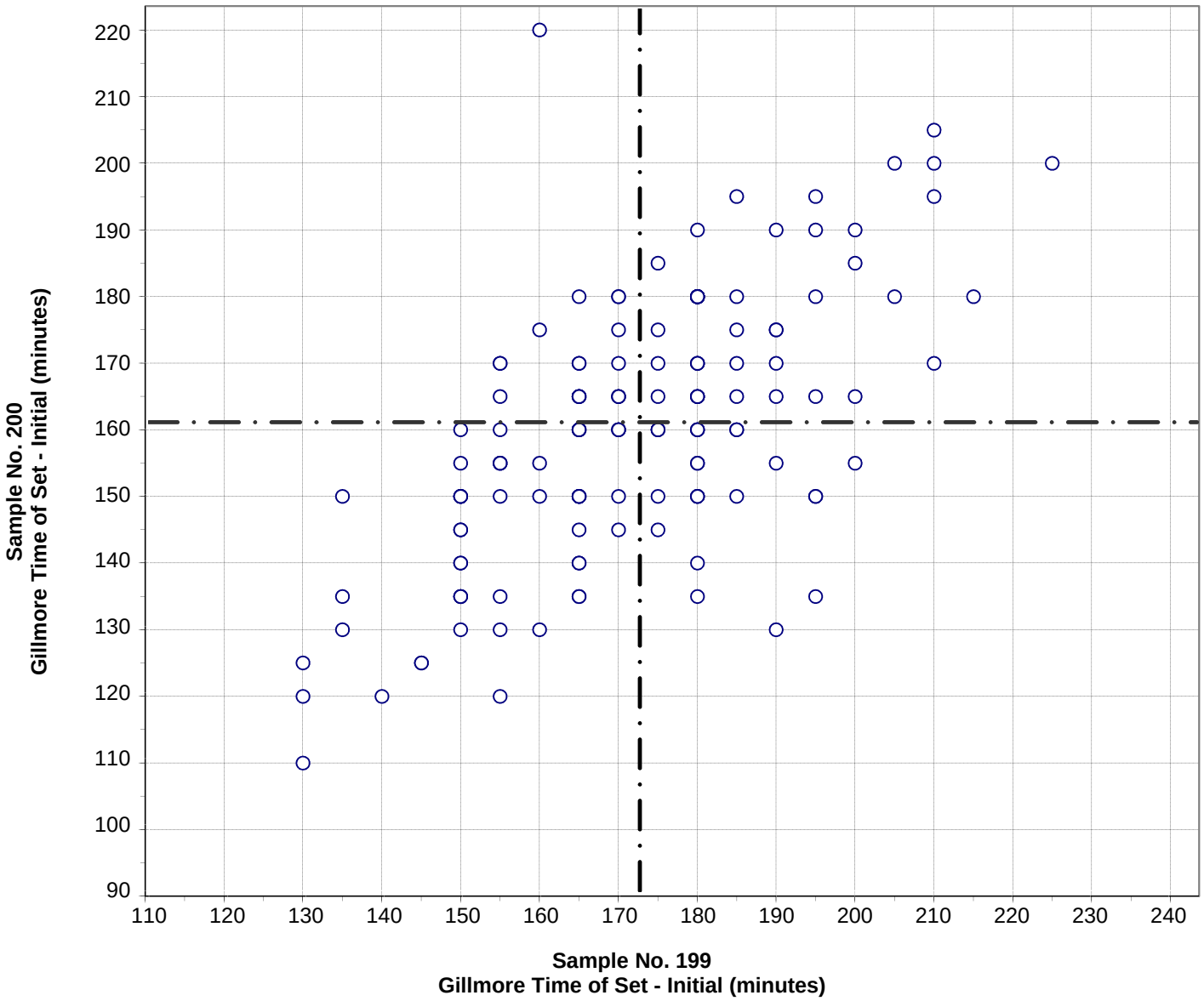


Test No. 121 Vicat Time of Set - Final 243 Points

Sample No. 199	Ave 246	S.D. 30	C.V. 12
Sample No. 200	Ave 235	S.D. 28	C.V. 12

Labs Eliminated: 779, 4042

CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 199 and No. 200



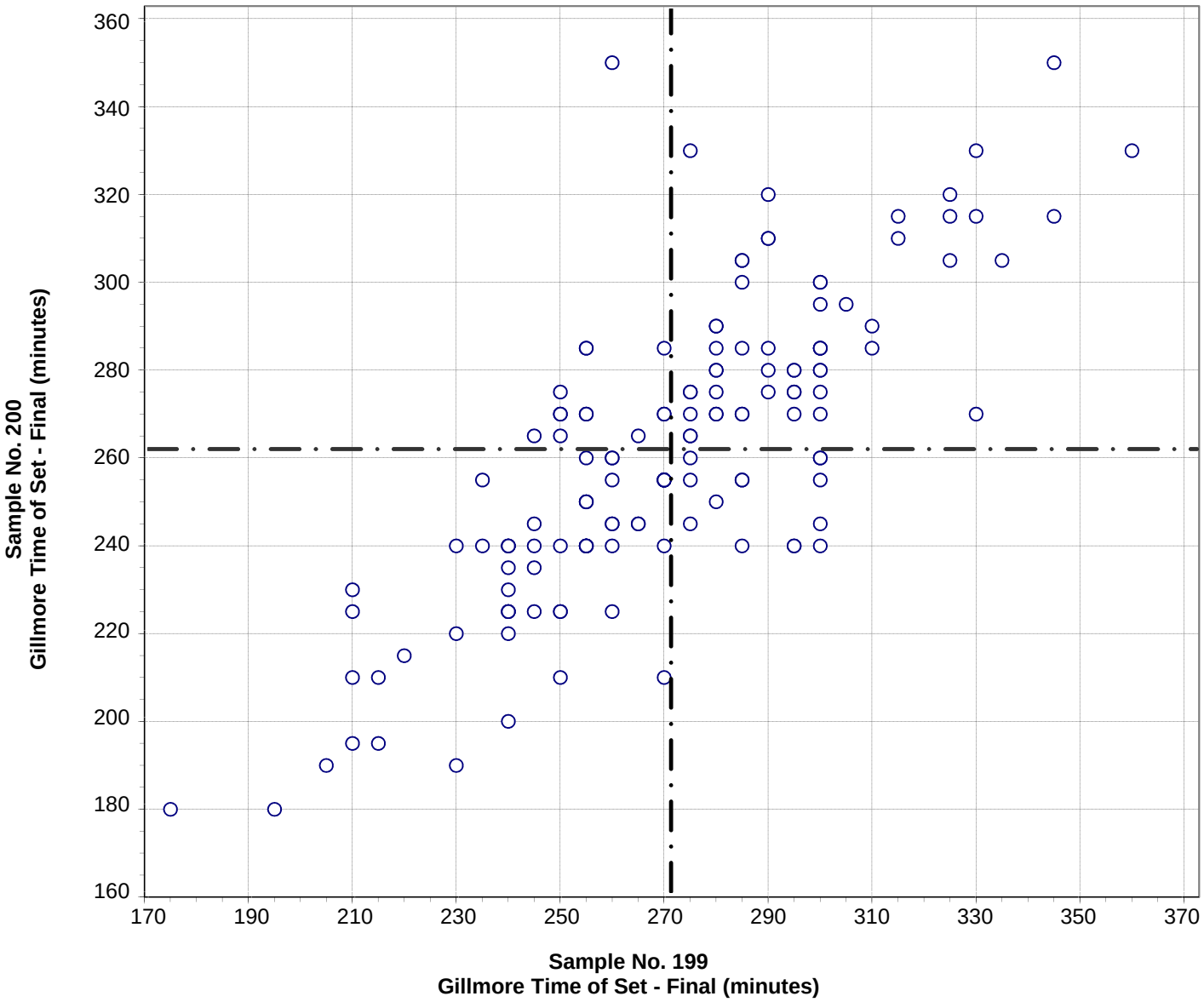
Test No. 130 Gillmore Time of Set - Initial 142 Points

Sample No. 199	Ave	173	S.D.	19	C.V.	11
Sample No. 200	Ave	161	S.D.	20	C.V.	13

Labs Eliminated: 23, 840

Labs off Diagram: 205

CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 199 and No. 200

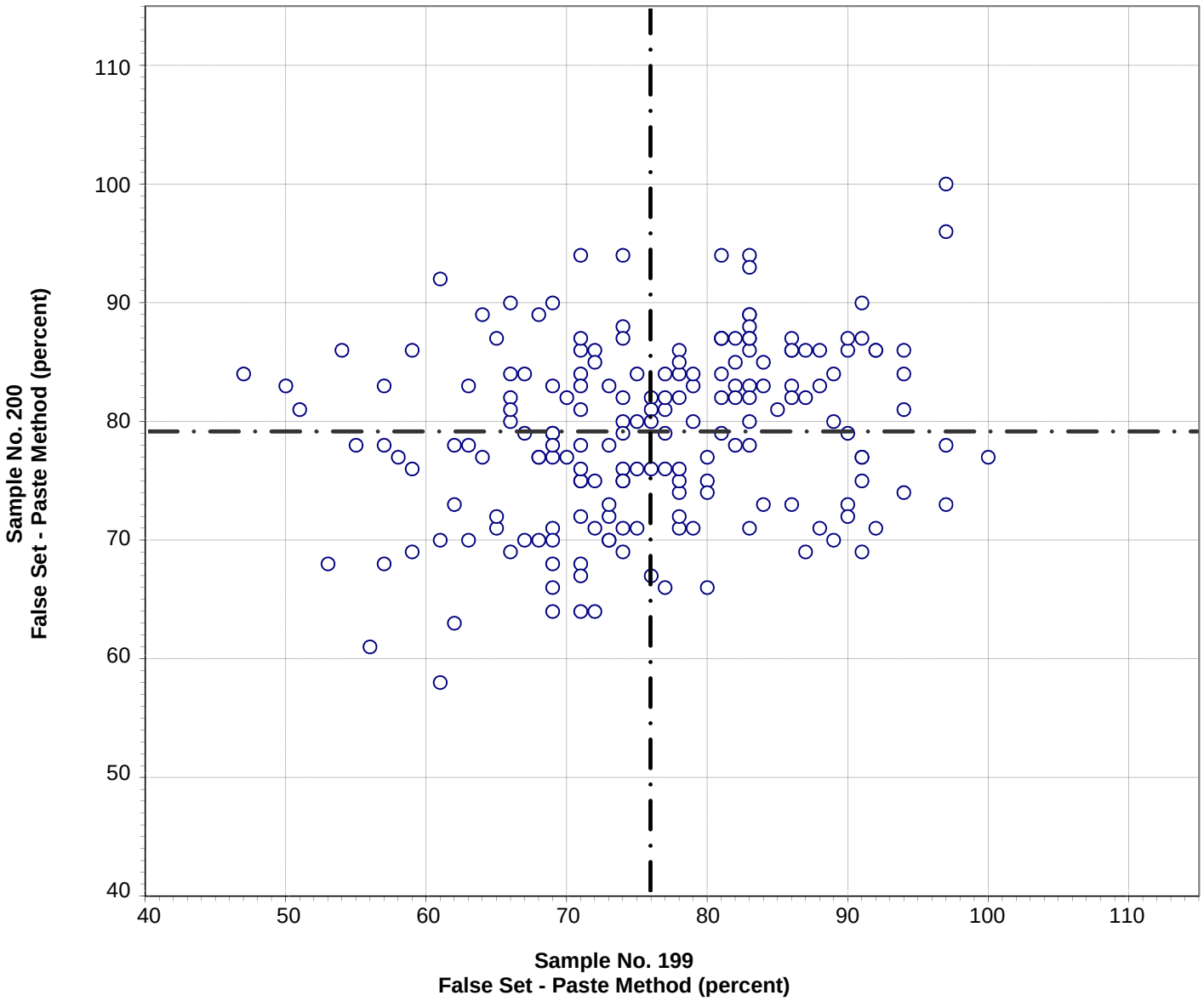


Test No. 140 Gillmore Time of Set - Final 143 Points

Sample No. 199	Ave 271	S.D. 32	C.V. 12
Sample No. 200	Ave 262	S.D. 34	C.V. 13

Labs Eliminated: 222, 690

CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 199 and No. 200

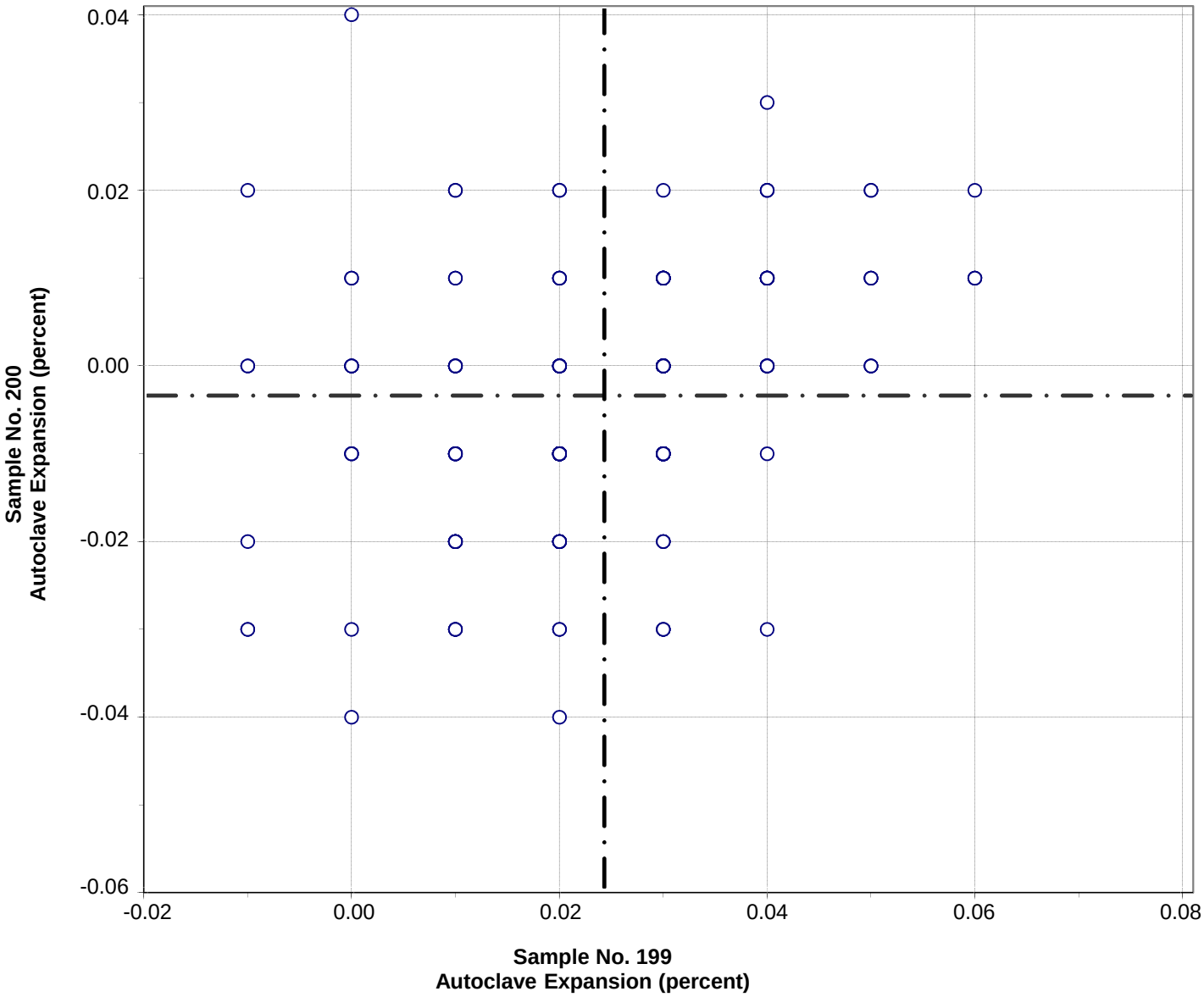


Test No. 150 False Set - Paste Method 189 Points

Sample No. 199 Ave 76 S.D. 10.6 C.V. 13.9
Sample No. 200 Ave 79 S.D. 7.5 C.V. 9.5

Labs Eliminated: 51, 440, 1956

CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 199 and No. 200



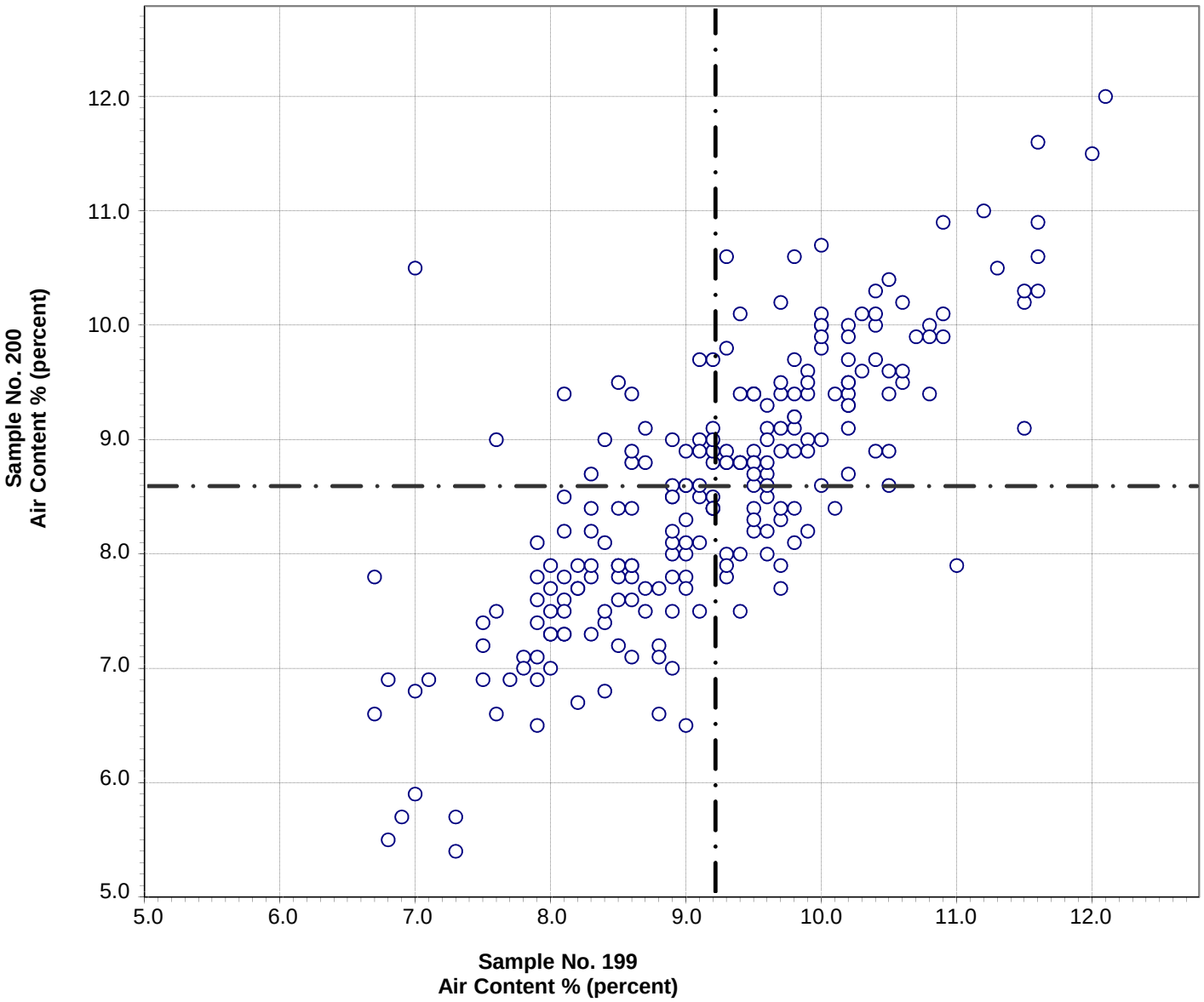
Test No. 160 Autoclave Expansion 210 Points

Sample No. 199 Ave 0.02 S.D. 0.014 C.V. 57
Sample No. 200 Ave -0.01 S.D. 0.014 C.V. 400

Labs Eliminated: 24, 32, 36, 49, 93, 95, 176, 493, 494, 551, 823, 1799, 1940, 2491, 2955, 3233, 3607

Labs off Diagram: 4042

CCRL Proficiency Sample Program
Air Content %
PORTLAND CEMENT Samples No. 199 and No. 200

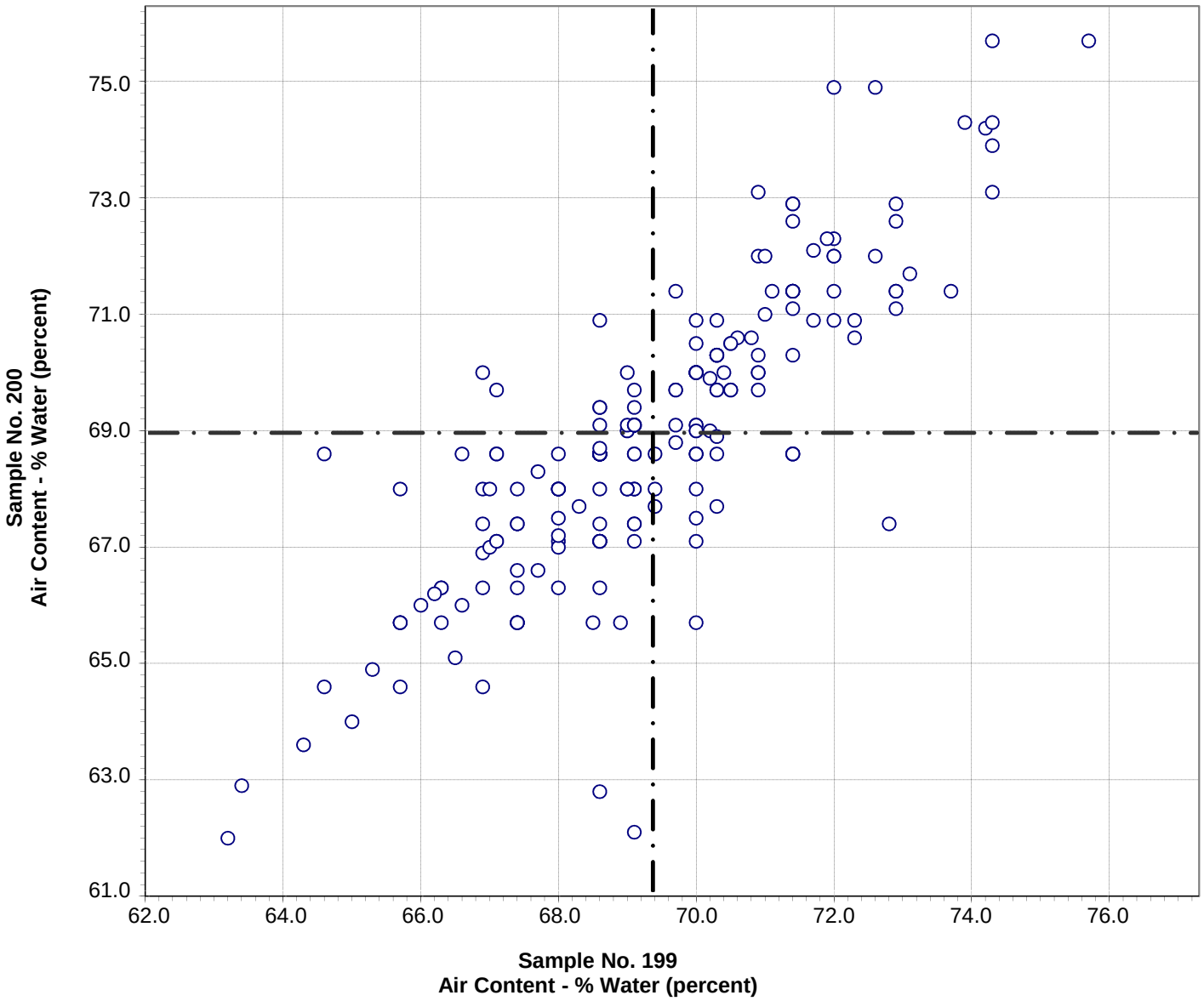


Test No. 170 Air Content % 228 Points

Sample No. 199	Ave	9.2	S.D.	1.1	C.V. 12
Sample No. 200	Ave	8.6	S.D.	1.2	C.V. 14

Labs Eliminated: 42, 180, 1251, 1644, 2352, 3859

CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 199 and No. 200

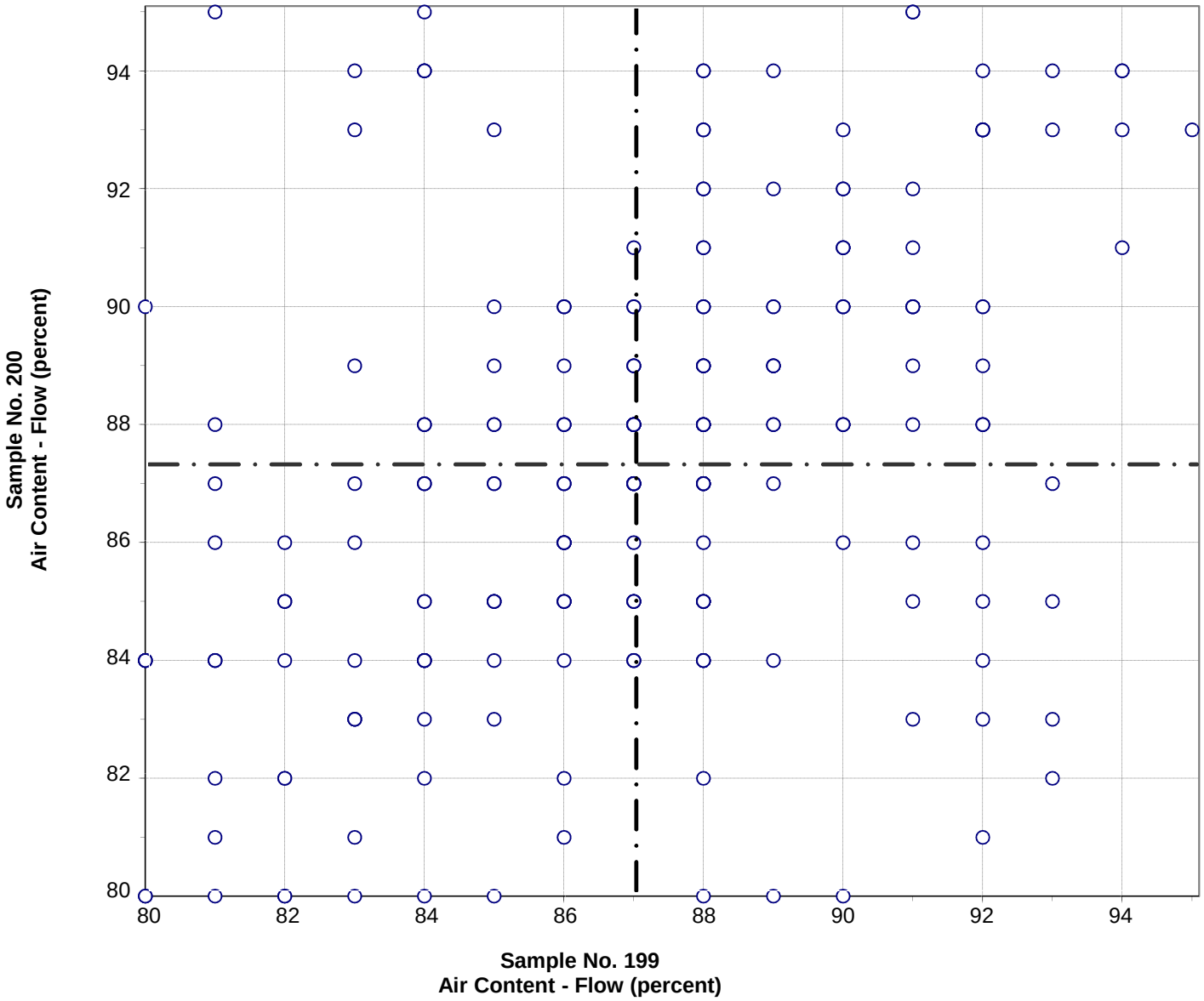


Test No. 180 Air Content - % Water 212 Points

Sample No. 199	Ave	69.4	S.D.	2.1	C.V. 3.1
Sample No. 200	Ave	68.9	S.D.	2.4	C.V. 3.5

Labs Eliminated: 64, 129, 209, 440, 823, 932, 3279, 3662, 3850, 3859

CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 199 and No. 200

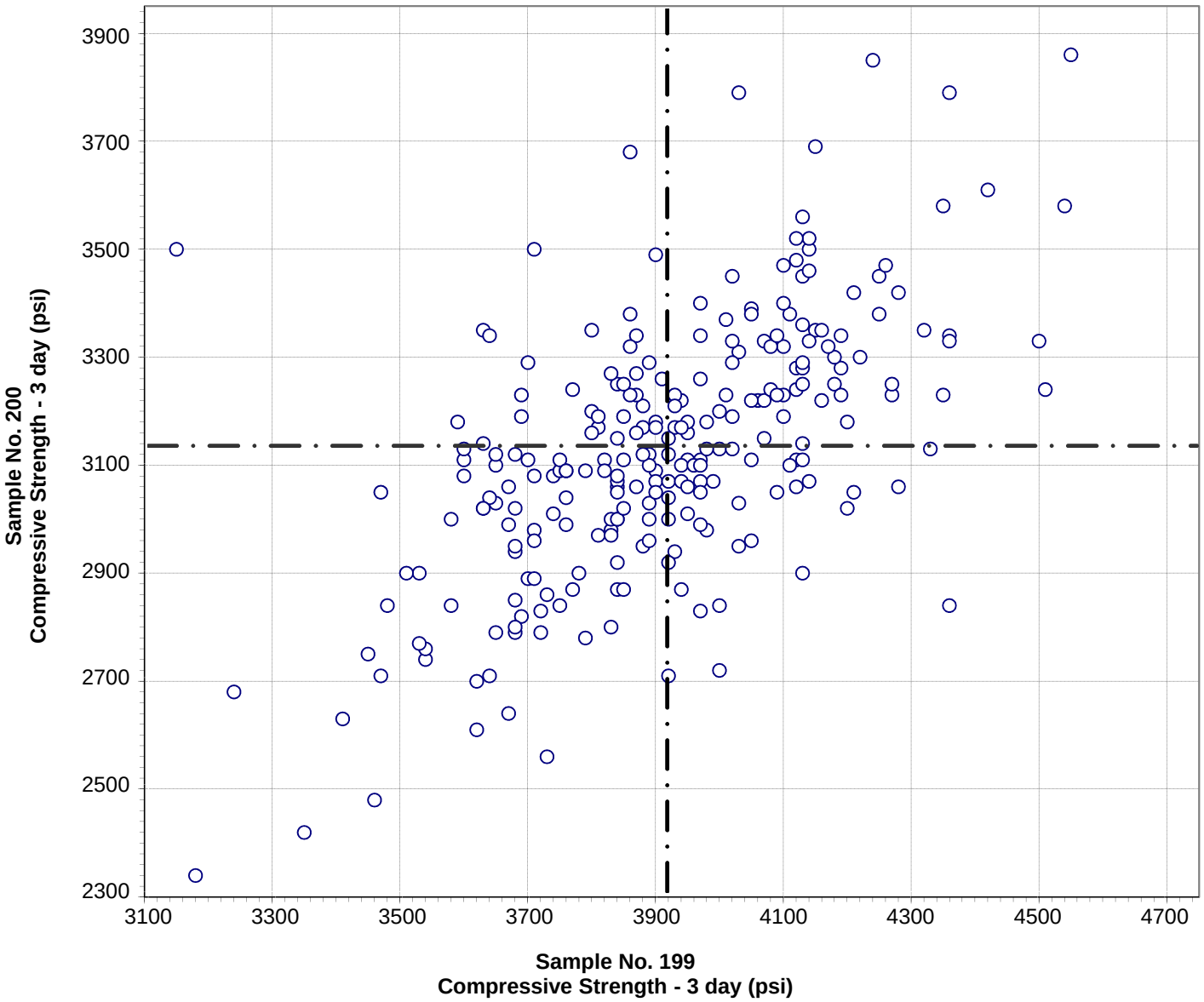


Test No. 190 Air Content - Flow 225 Points

Sample No. 199	Ave	87	S.D.	3.5	C.V. 4.0
Sample No. 200	Ave	87	S.D.	3.7	C.V. 4.3

Labs Eliminated: 86, 360, 2683, 2955

CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 199 and No. 200



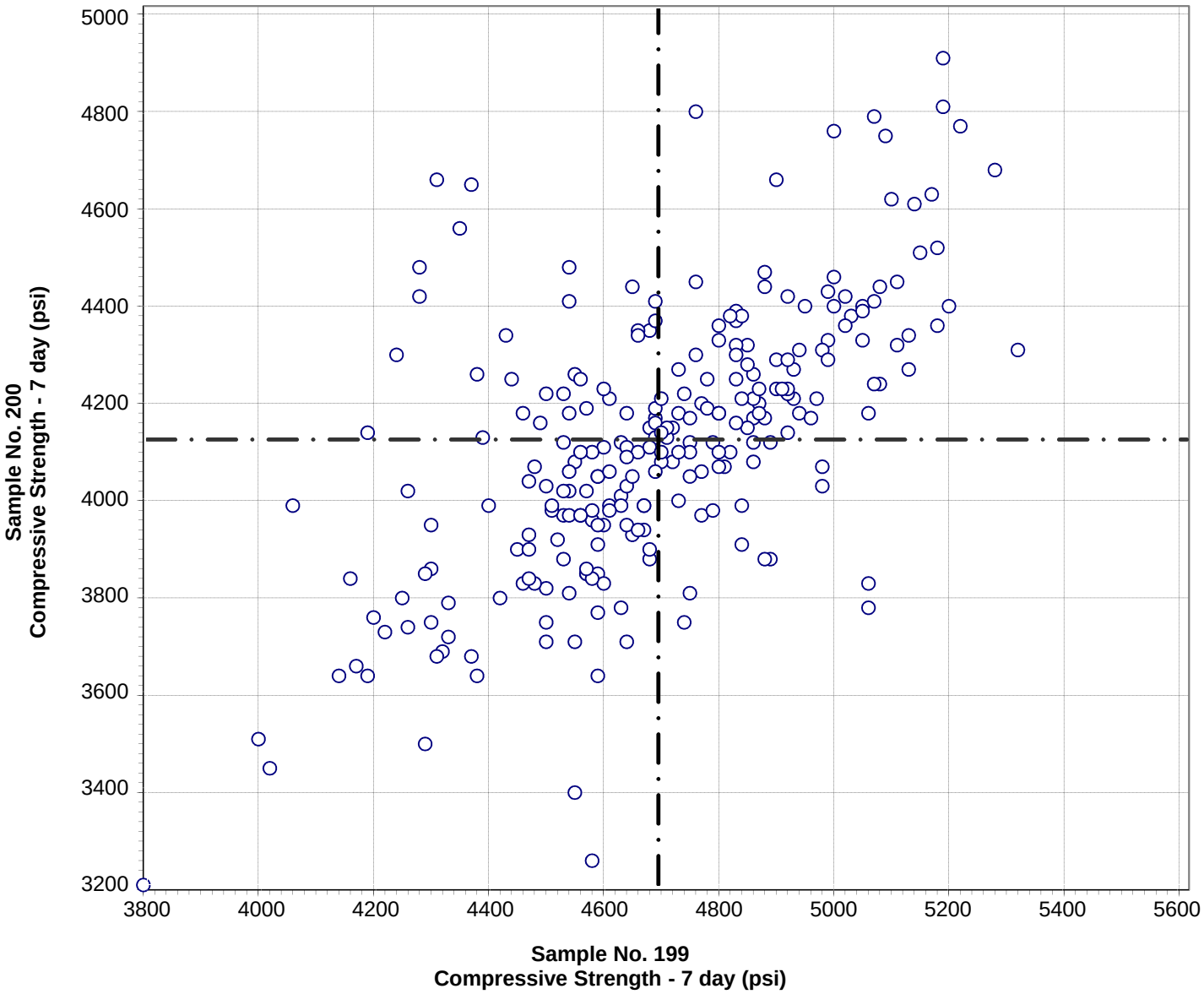
Test No. 200 Compressive Strength - 3 day 254 Points

Sample No. 199	Ave	3917	S.D.	240	C.V.	6.1
Sample No. 200	Ave	3134	S.D.	246	C.V.	7.8

Labs Eliminated: 51, 2360, 4042, 4097

Labs off Diagram: 4051

CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 199 and No. 200



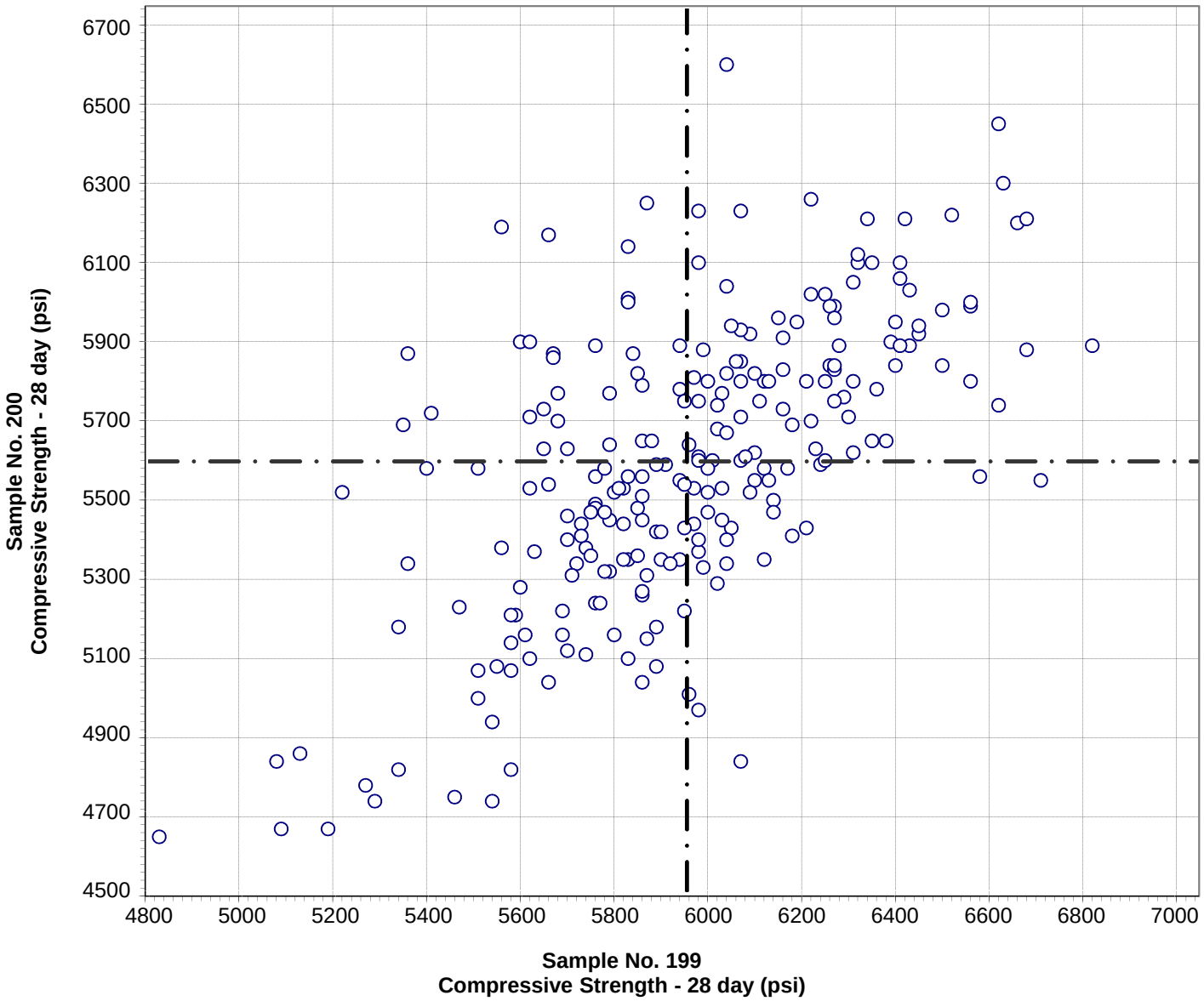
Test No. 210 Compressive Strength - 7 day 253 Points

Sample No. 199	Ave	4694	S.D.	274	C.V. 5.8
Sample No. 200	Ave	4123	S.D.	283	C.V. 6.9

Labs Eliminated: 51, 3003, 4097

Labs off Diagram: 4, 4042

CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 199 and No. 200

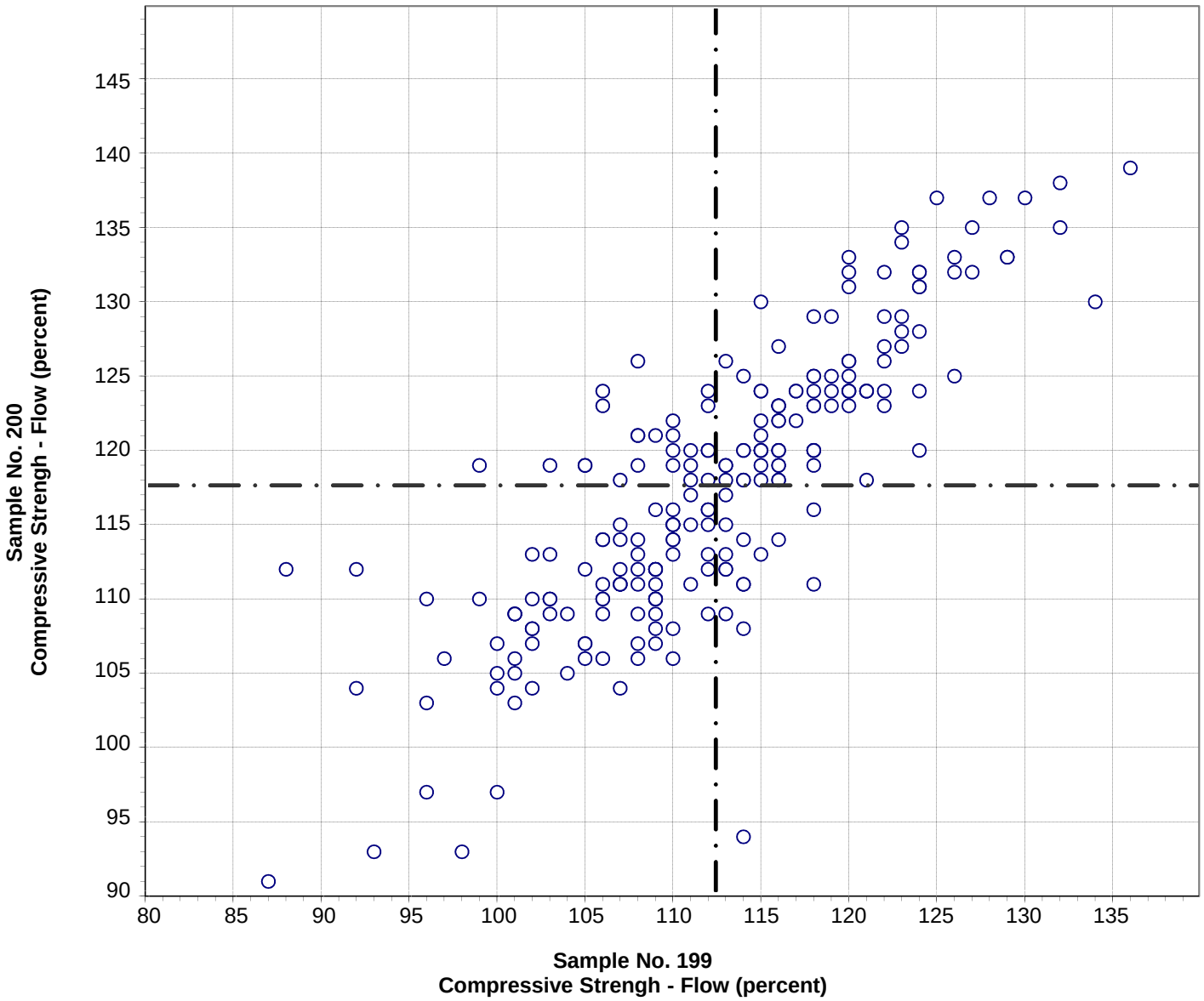


Test No. 211 Compressive Strength - 28 day 238 Points

Sample No. 199	Ave	5954	S.D.	337	C.V.	5.7
Sample No. 200	Ave	5594	S.D.	364	C.V.	6.5

Labs Eliminated: 15, 3819, 4042, 4097

CCRL Proficiency Sample Program
Compressive Strengh - Flow
PORTLAND CEMENT Samples No. 199 and No. 200

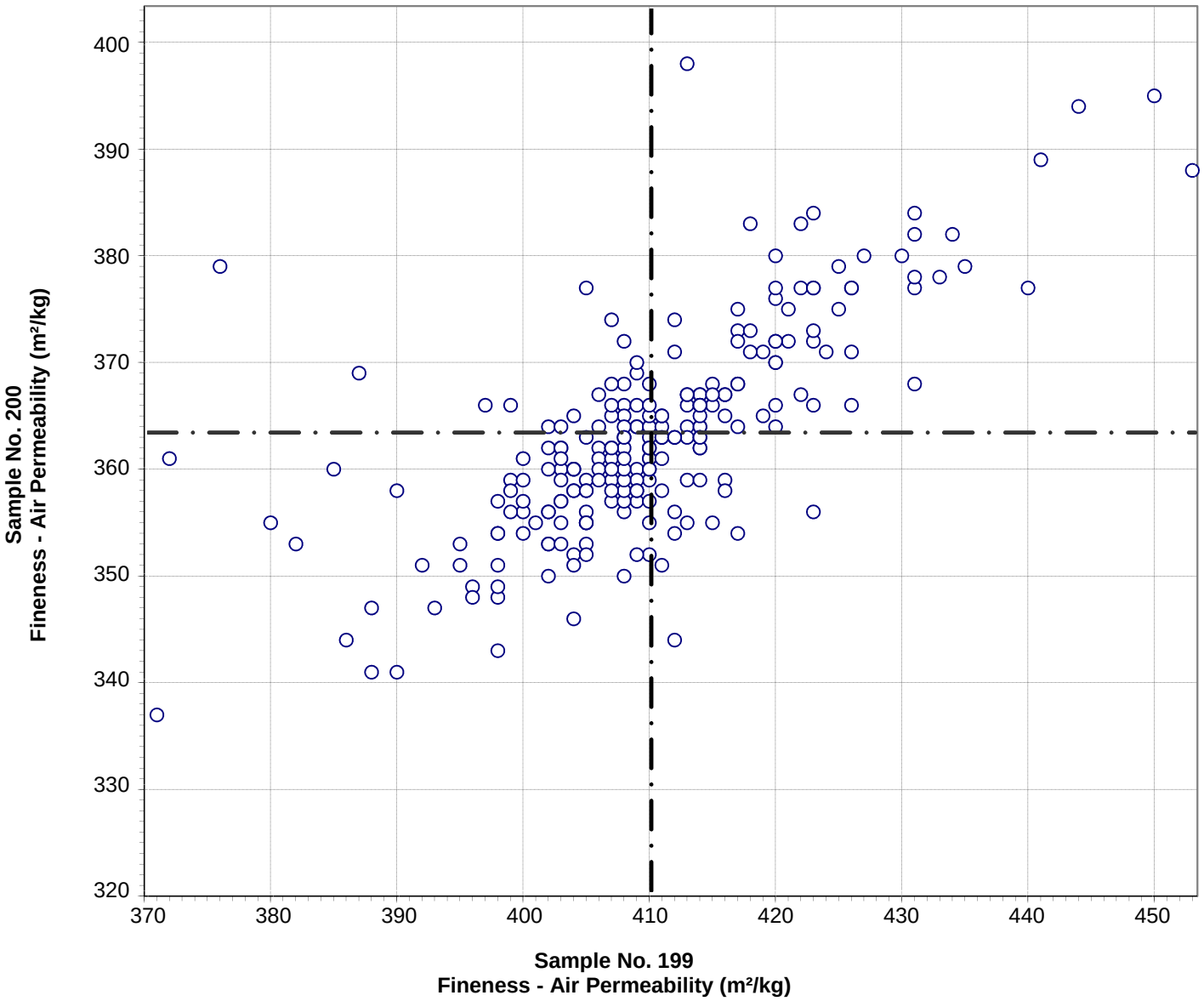


Test No. 230 Compressive Strengh - Flow 225 Points

Sample No. 199	Ave	112	S.D.	8	C.V.	7.5
Sample No. 200	Ave	118	S.D.	9	C.V.	7.7

Labs Eliminated: 35, 84, 180

CCRL Proficiency Sample Program
Fineness - Air Permeability
PORTLAND CEMENT Samples No. 199 and No. 200

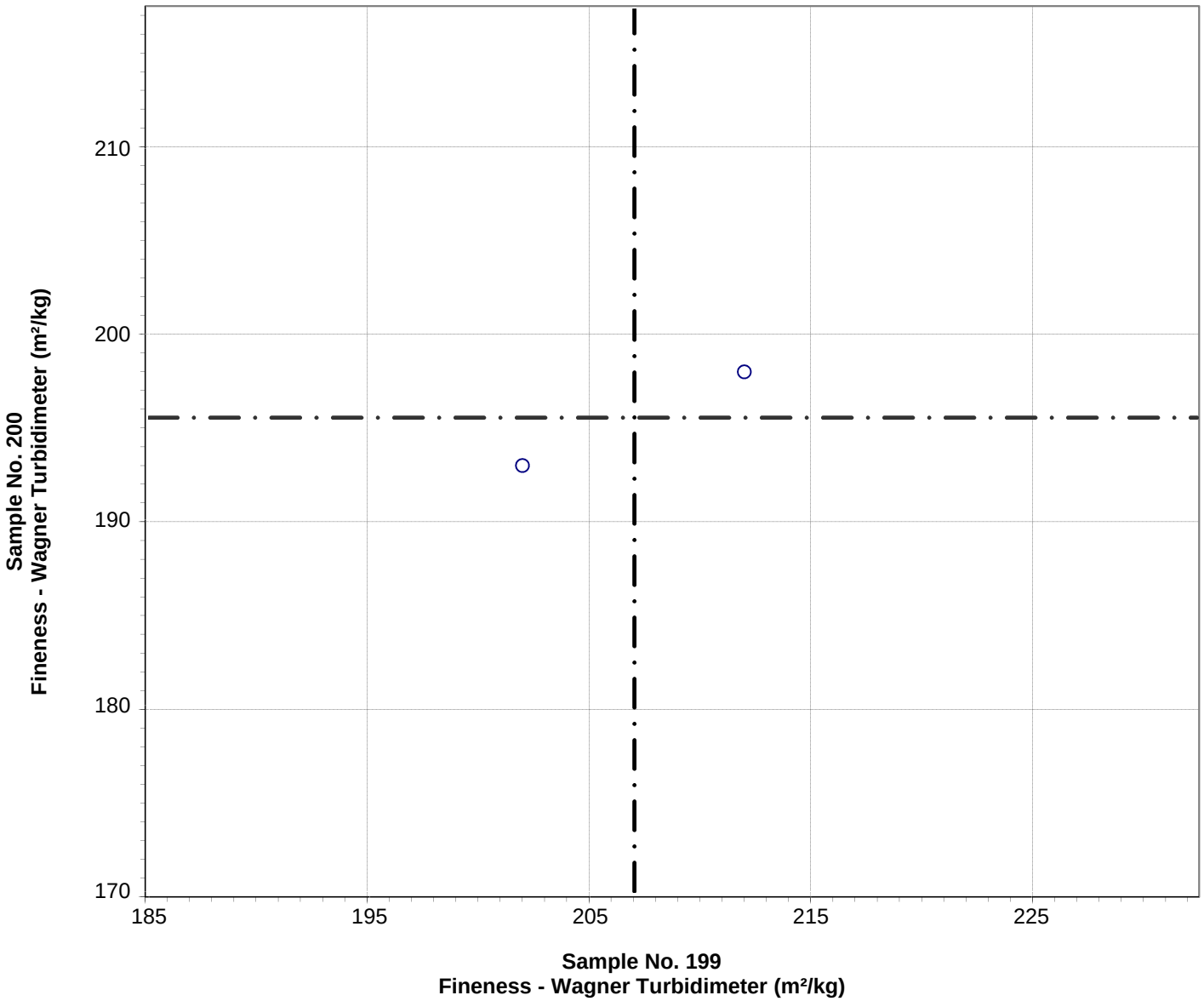


Test No. 270 Fineness - Air Permeability 233 Points

Sample No. 199	Ave 410	S.D. 12	C.V. 2.8
Sample No. 200	Ave 363	S.D. 10	C.V. 2.7

Labs Eliminated: 24, 25, 26, 38, 43, 46, 51, 95, 494, 1466, 2462, 2466, 2683, 3249, 3788, 4042, 4051, 4097

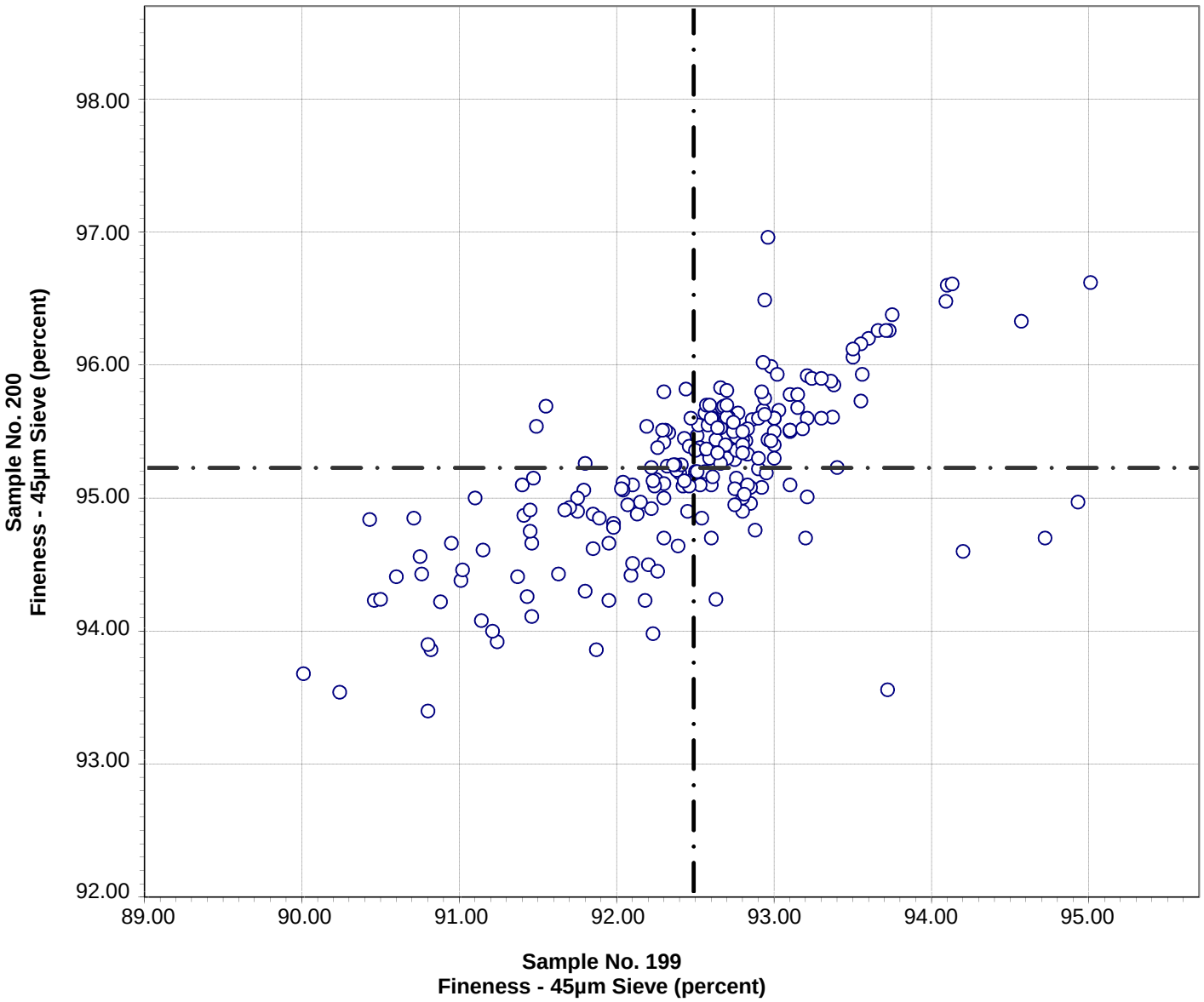
CCRL Proficiency Sample Program
Fineness - Wagner Turbidimeter
PORTLAND CEMENT Samples No. 199 and No. 200



Test No. 280 Fineness - Wagner Turbidimeter 2 Points

Sample No. 199	Ave	207	S.D.	7	C.V.	3.4
Sample No. 200	Ave	196	S.D.	4	C.V.	1.8

CCRL Proficiency Sample Program
Fineness - 45µm Sieve
PORTLAND CEMENT Samples No. 199 and No. 200

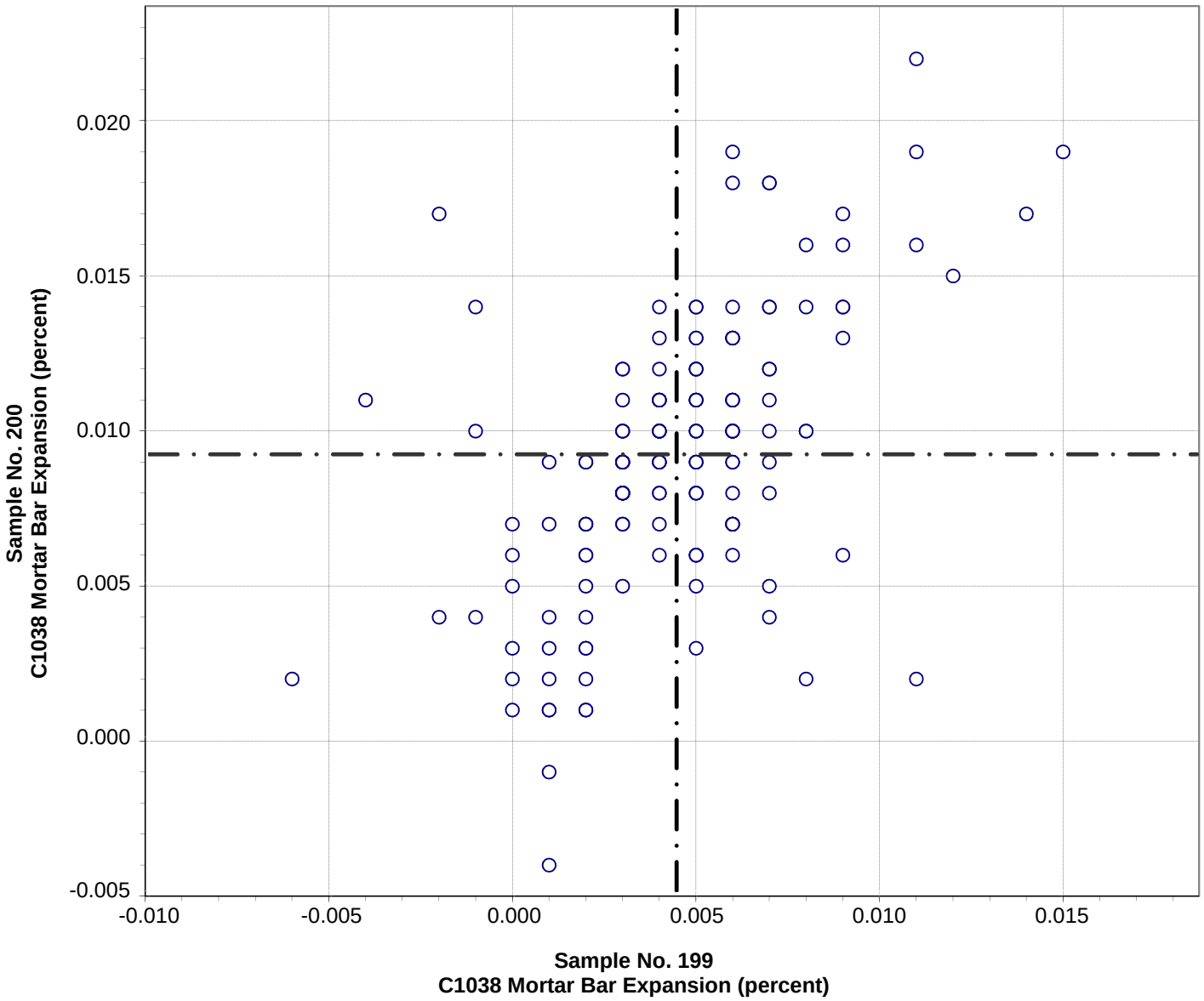


Test No. 281 Fineness - 45µm Sieve 218 Points

Sample No. 199	Ave	92.48	S.D.	0.83	C.V. 0.90
Sample No. 200	Ave	95.22	S.D.	0.61	C.V. 0.64

Labs Eliminated: 3, 8, 26, 36, 42, 69, 107, 116, 143, 169, 360, 415, 416, 1819, 2477, 2484, 3607, 3661, 3752

CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 199 and No. 200



Test No. 400 C1038 Mortar Bar Expansion 159 Points

Sample No. 199	Ave	0.004	S.D.	0.003	C.V.	69
Sample No. 200	Ave	0.009	S.D.	0.004	C.V.	48

Labs Eliminated: 36, 51, 56, 252, 491, 2293, 3057, 3233

CCRL PROFICIENCY SAMPLE PROGRAM

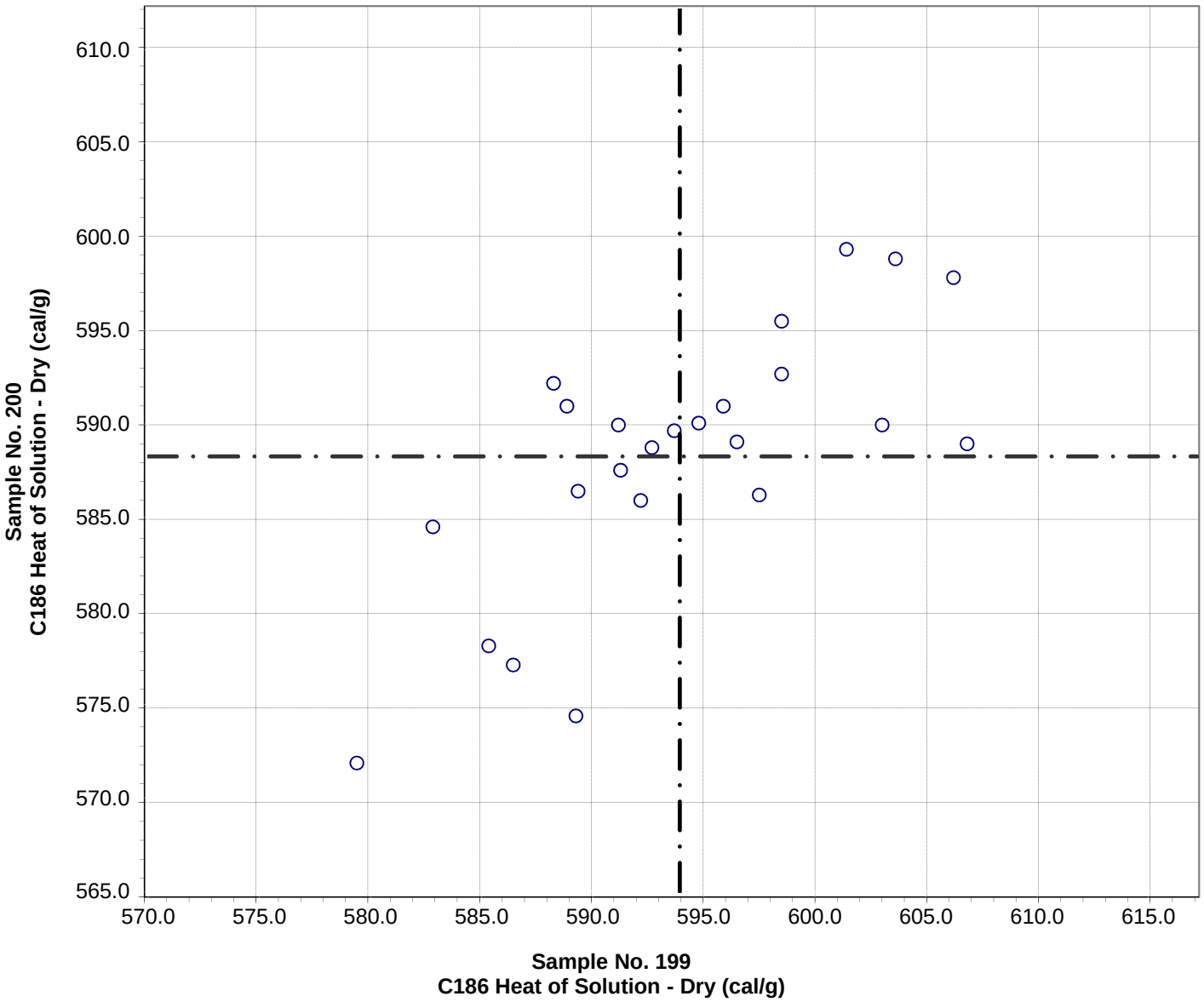
Portland Cement Proficiency Samples No. 199 and No. 200

Final Report – Heat of Hydration Results
March 16, 2016

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No.199 Average	S.D.	C.V.	Sample No. 200 Average	S.D.	C.V.
C186 Heat of Solution - Dry (**cal/g**)							
	27	591.0	12.5	2.1	583.0	16.2	2.8
	*24	594.0	7.2	1.2	588.0	7.0	1.2
* Labs Eliminated - 491, 1435, 1644							
C186 Heat of Solution - 7 day (**cal/g**)							
	27	510.6	10.0	2.0	507.1	13.8	2.7
	*22	514.5	3.7	0.7	512.5	4.7	0.9
* Labs Eliminated - 143, 491, 1435, 1644, 4051							
C186 Heat of Solution 28 day (**cal/g**)							
	21	501.2	11.9	2.4	498.6	9.2	1.9
No Labs Eliminated for This Test							
C186 Heat of Hydration - 7 day (**cal/g**)							
	30	80.1	9.5	11.9	77.3	8.1	10.5
	*29	80.8	8.8	10.9	76.3	6.1	8.0
* Labs Eliminated - 3057							
C186 Heat of Hydration - 28 day (**cal/g**)							
	24	90.6	14.7	16.2	87.5	7.3	8.4
	*22	91.3	7.4	8.1	88.8	4.4	5.0
* Labs Eliminated - 1644, 3057							
C1702 Heat of Hydration - 3 day (**J/g**)							
	9	290	36	12.7	260	30	11.5
No Labs Eliminated for This Test							
C1702 Heat of Hydration - 7 day (**J/g**)							
	8	314	39	12.5	297	41	13.7
No Labs Eliminated for This Test							

CCRL Proficiency Sample Program
C186 Heat of Solution - Dry
PORTLAND CEMENT Samples No. 199 and No. 200

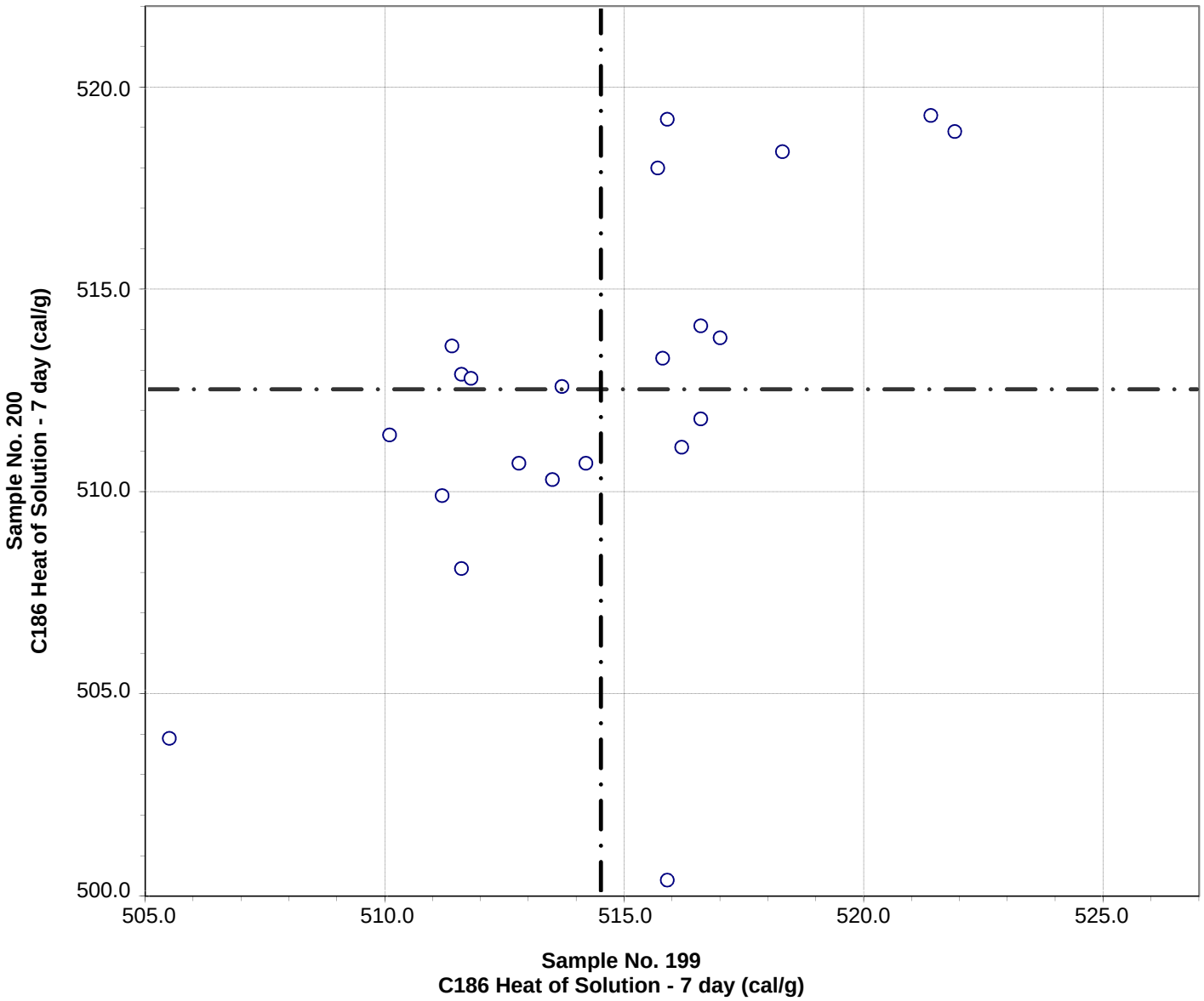


Test No. 291 C186 Heat of Solution - Dry 24 Points

Sample No. 199	Ave	594.0	S.D.	7.2	C.V.	1.2
Sample No. 200	Ave	588.0	S.D.	7.0	C.V.	1.2

Labs Eliminated: 491, 1435, 1644

CCRL Proficiency Sample Program
C186 Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 199 and No. 200

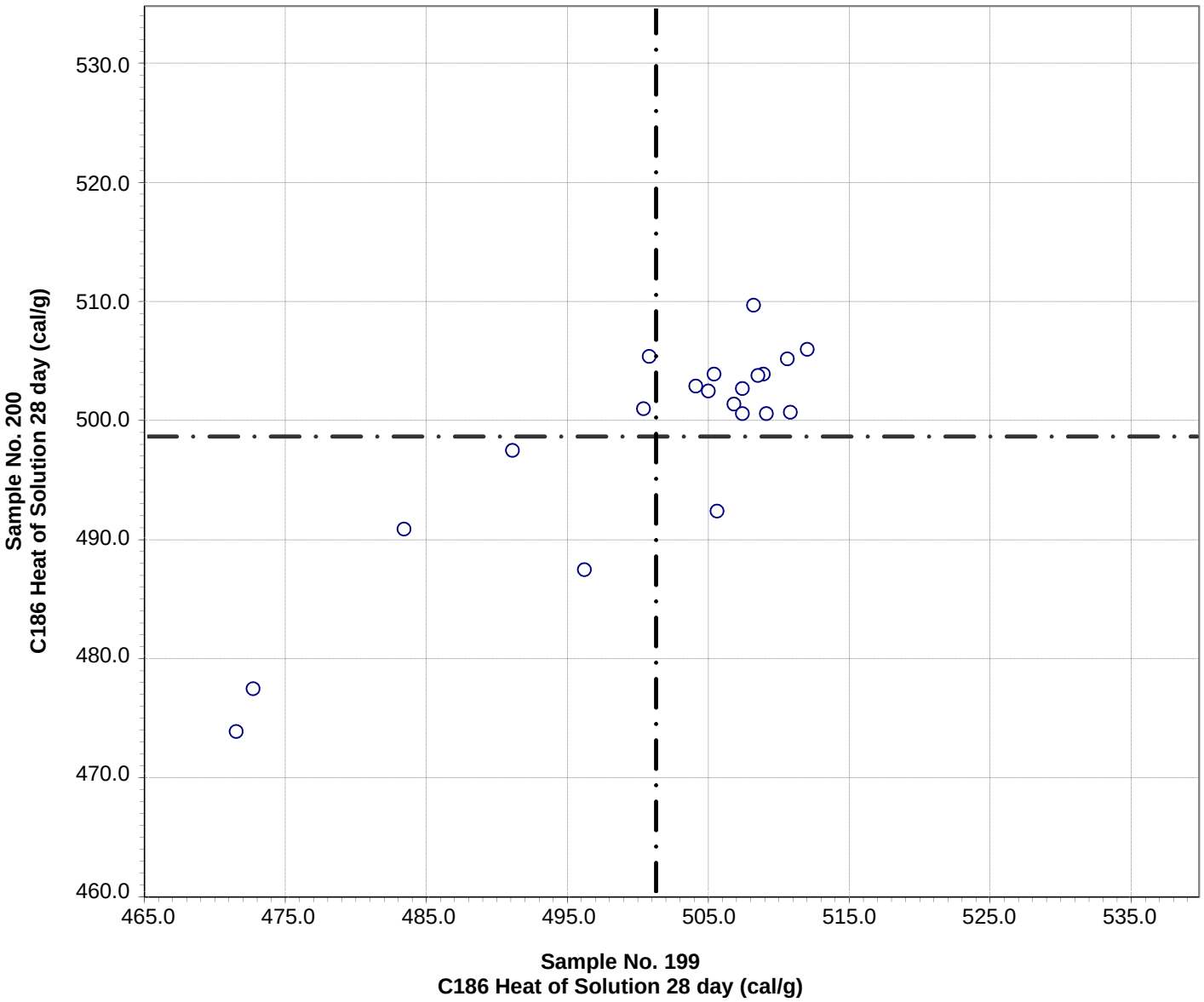


Test No. 292 C186 Heat of Solution - 7 day 22 Points

Sample No. 199	Ave	514.5	S.D.	3.7	C.V.	0.7
Sample No. 200	Ave	512.5	S.D.	4.7	C.V.	0.9

Labs Eliminated: 143, 491, 1435, 1644, 4051

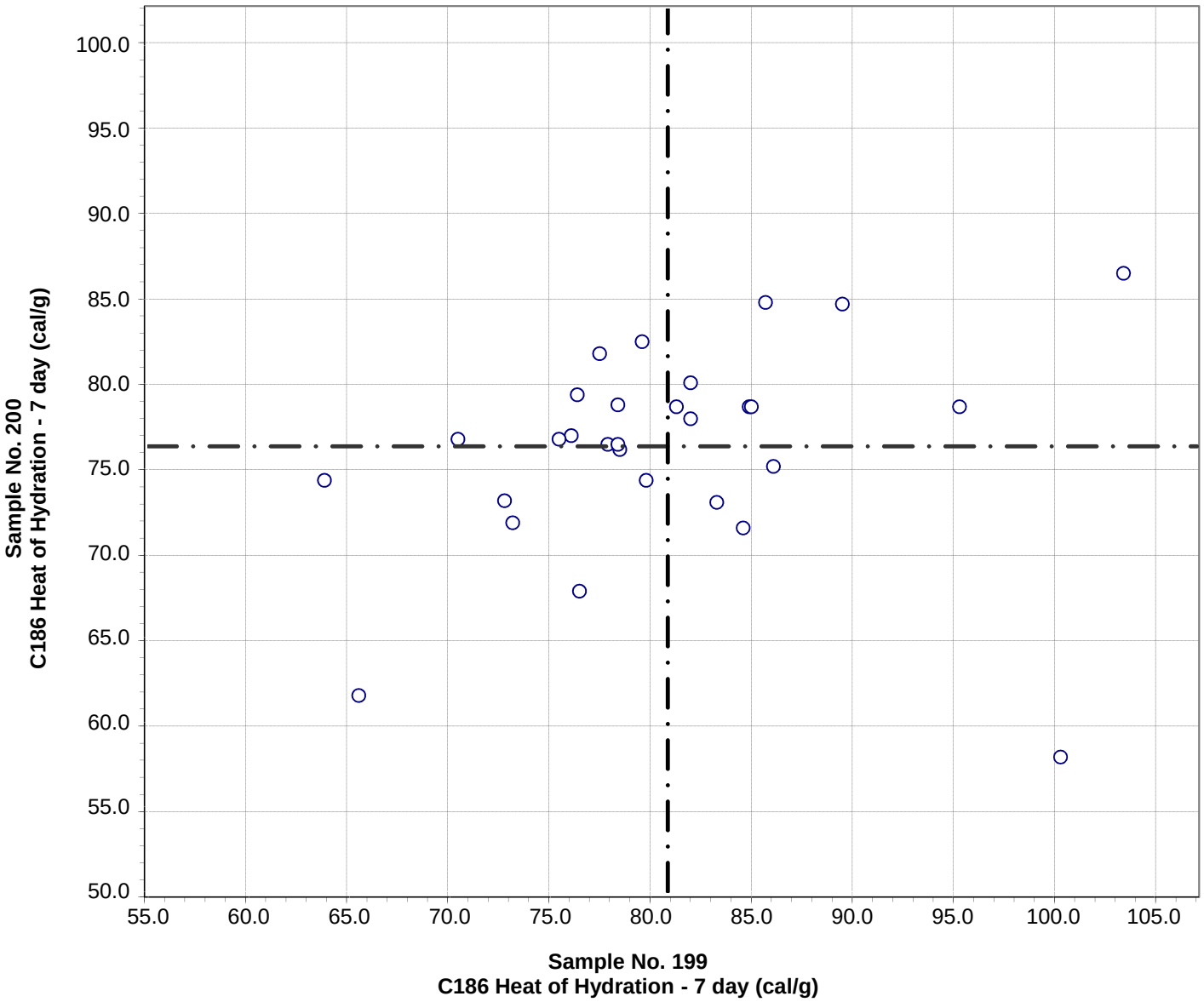
CCRL Proficiency Sample Program
C186 Heat of Solution 28 day
PORTLAND CEMENT Samples No. 199 and No. 200



Test No. 301 C186 Heat of Solution 28 day 21 Points

Sample No. 199	Ave 501.2	S.D. 11.9	C.V. 2.4
Sample No. 200	Ave 498.6	S.D. 9.2	C.V. 1.9

CCRL Proficiency Sample Program
C186 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 199 and No. 200

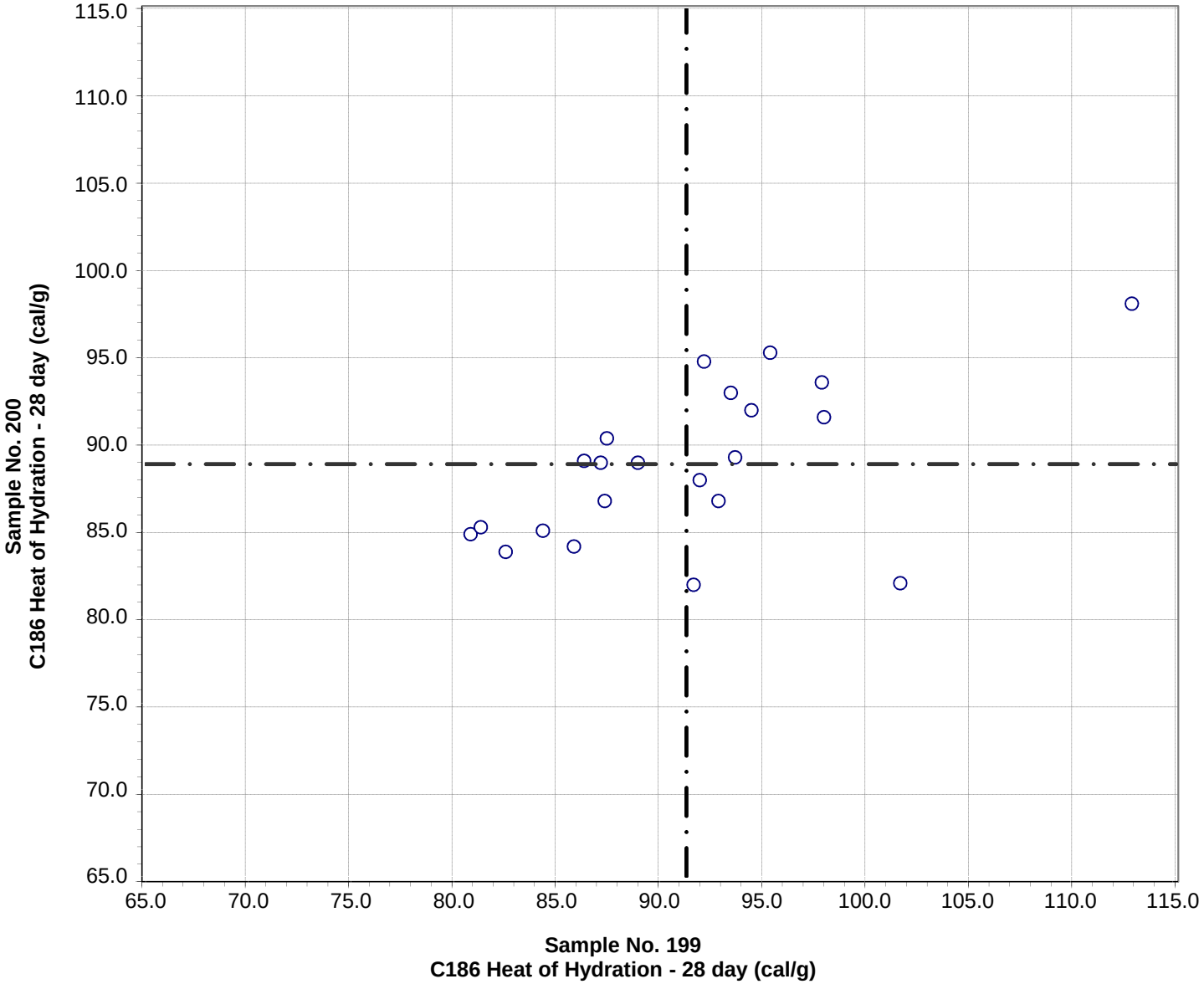


Test No. 290 C186 Heat of Hydration - 7 day 29 Points

Sample No. 199	Ave	80.8	S.D.	8.8	C.V.	10.9
Sample No. 200	Ave	76.3	S.D.	6.1	C.V.	8.0

Labs Eliminated: 3057

CCRL Proficiency Sample Program
C186 Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 199 and No. 200

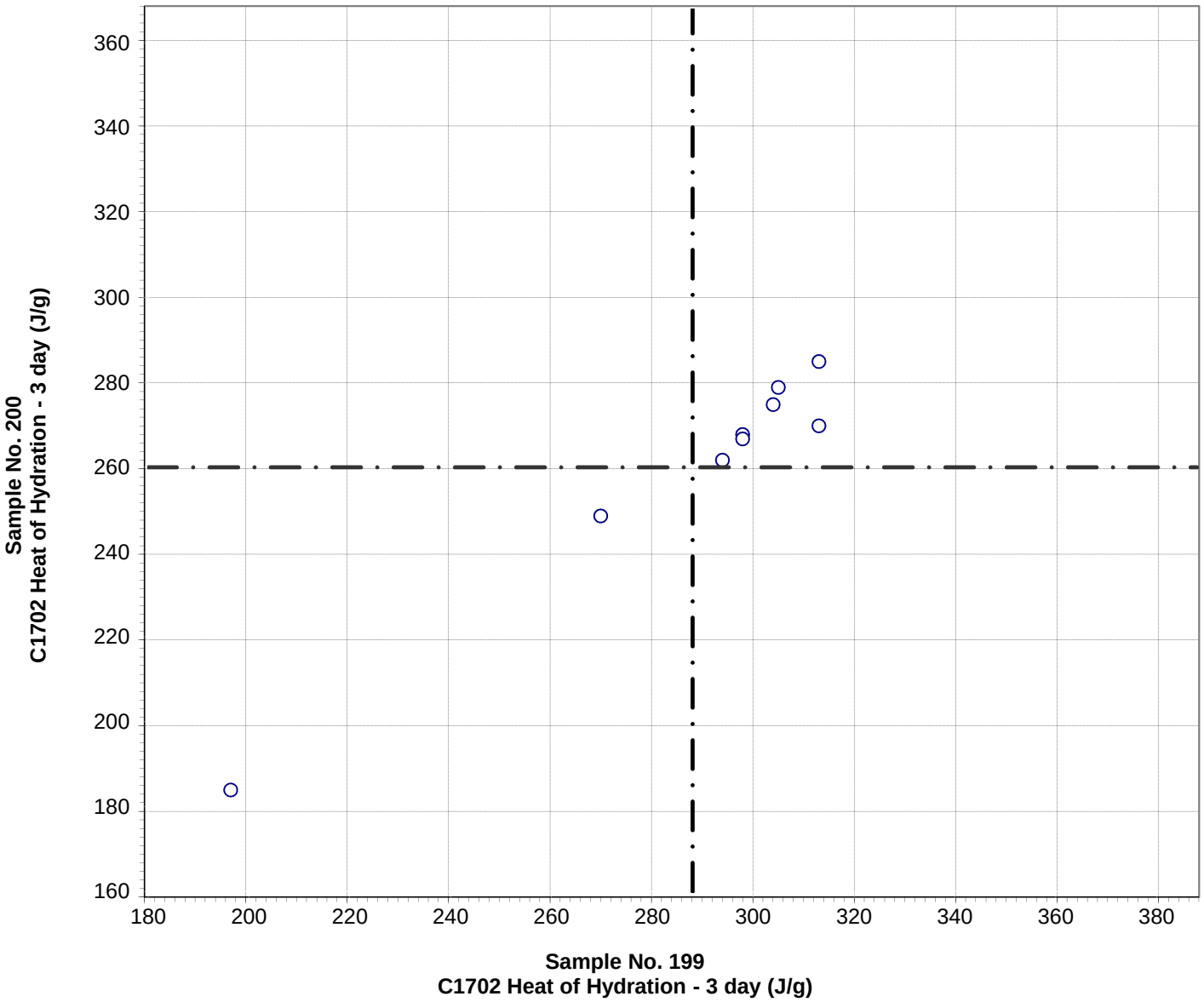


Test No. 300 C186 Heat of Hydration - 28 day 22 Points

Sample No. 199	Ave	91.3	S.D.	7.4	C.V.	8.1
Sample No. 200	Ave	88.8	S.D.	4.4	C.V.	5.0

Labs Eliminated: 1644, 3057

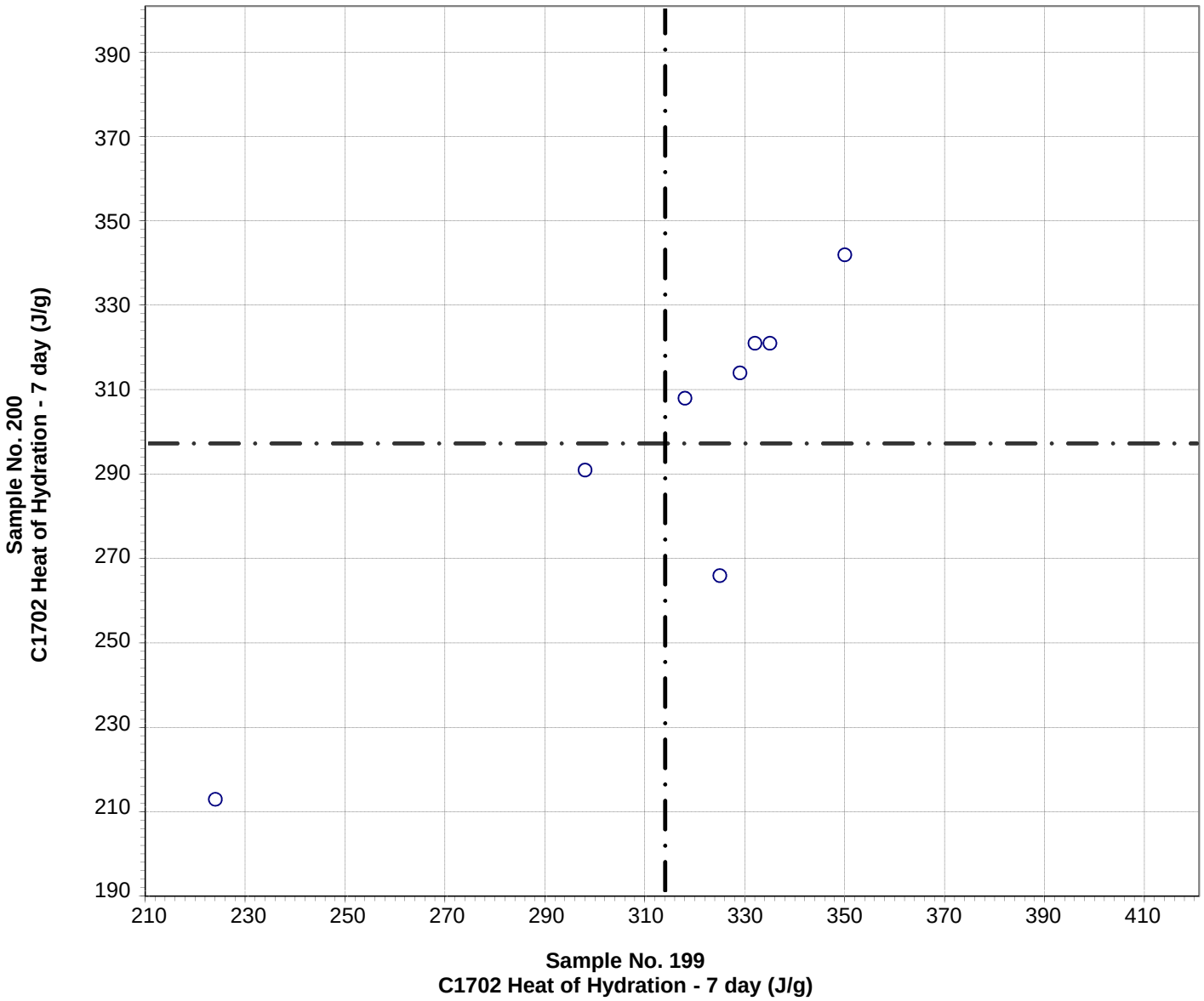
CCRL Proficiency Sample Program
C1702 Heat of Hydration - 3 day
PORTLAND CEMENT Samples No. 199 and No. 200



Test No. 500 C1702 Heat of Hydration - 3 day 9 Points

Sample No. 199	Ave	290	S.D.	36	C.V.	12.7
Sample No. 200	Ave	260	S.D.	30	C.V.	11.5

CCRL Proficiency Sample Program
C1702 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 199 and No. 200



Test No. 510 C1702 Heat of Hydration - 7 day 8 Points

Sample No. 199	Ave	314	S.D.	39	C.V.	12.5
Sample No. 200	Ave	297	S.D.	41	C.V.	13.7