

CEMENT AND CONCRETE REFERENCE LABORATORY

PROFICIENCY SAMPLE PROGRAM

Final Report

Portland Cement Proficiency Samples

Number 203 and Number 204



CCRL
Cement and Concrete
Reference Laboratory

March 2017

www.crl.us



March 15, 2017

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 203 and No. 204

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in January 2017. Portland Cement Samples No. 203 was an ASTM C150 meeting the specifications of Type I and contained a limestone addition. Portland Cement No. 204 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.

An informational summary on Air Jet Sieve Study is found on the following page.

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 2017.

Sincerely,

Robin K. Haupt
Supervisor, Proficiency Sample Programs
Cement and Concrete Reference Laboratory

CCRL Portland Cement Samples No. 203 & No. 204
 Informational Summary
 Air Jet Sieve Study

For this set of CCRL Portland Cement Samples, ASTM C01.25 Subcommittee requested laboratories perform 45µm sieve fineness using air jet sieve apparatus. Results were reported by 44 laboratories. These results have been provided to the Subcommittee for their evaluation. Below is an informational summary of these results.

	Minimum value reported	Maximum value reported	Average	Standard deviation
Vacuum pressure, kPa	1.0	10.0	4.4	
Time, seconds	30	300	184	
Sieve correction factor	-31.0	73.6	13.7	
Sample 203-All data Corrected % passing	76.7	98.9	95.2	3.1
Sample 204- All Data Corrected % passing	64.3	99.5	96.4	5.1
Sample 203 Outlying data removed Corrected % passing	91.7	98.9	95.7	1.2
Sample 204 Outlying data removed Corrected % passing	91.7	99.5	97.1	1.1

Sieve Calibration Standard used (number reported using)	
SRM 46h	18
Internal secondary standard	13
SRM 114	12
None reported	1

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. 203 and No. 204

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 2017. 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 "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

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.*

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. 203 and No. 204

Final Report – Primary Chemical Results
 March 15, 2017

SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Silicon Dioxide (percent)							
	232	19.48	0.20	1.05	19.67	1.11	5.62
	*224	19.48	0.16	0.82	19.75	0.18	0.91
* Labs Eliminated - 48, 50, 95, 98, 284, 684, 1644, 4142							
Aluminum Oxide (percent)							
	229	4.96	0.13	2.6	4.20	0.11	2.6
	*218	4.96	0.08	1.6	4.18	0.08	1.8
* Labs Eliminated - 14, 42, 50, 134, 157, 698, 1956, 2477, 4099, 4137, 4206							
Ferric Oxide (percent)							
	229	3.85	0.08	2.0	3.45	0.07	1.9
	*216	3.86	0.04	1.1	3.45	0.04	1.2
* Labs Eliminated - 22, 126, 134, 162, 206, 416, 2477, 2491, 4051, 4080, 4099, 4150, 4206							
Calcium Oxide (percent)							
	229	63.27	0.42	0.66	62.72	0.49	0.78
	*226	63.30	0.34	0.54	62.74	0.47	0.75
* Labs Eliminated - 98, 284, 4206							
Magnesium Oxide (percent)							
	230	1.17	0.20	16.8	3.09	0.22	7.2
	*219	1.15	0.05	4.0	3.11	0.09	2.8
* Labs Eliminated - 14, 84, 134, 206, 222, 493, 779, 2463, 2477, 4039, 4099							
Sulfur Trioxide (percent)							
	233	3.31	0.10	2.9	2.56	0.10	3.8
	*219	3.32	0.06	1.9	2.56	0.06	2.4
* Labs Eliminated - 93, 134, 146, 159, 169, 203, 246, 694, 883, 2360, 2463, 3279, 3297, 4142							
Loss on Ignition (percent)							
	236	2.71	0.15	5.4	3.42	0.18	5.1
	*221	2.71	0.08	2.9	3.43	0.08	2.3
* Labs Eliminated - 4, 47, 95, 131, 137, 159, 493, 1054, 1644, 1799, 1942, 1956, 3368, 4080, 4099							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Primary Chemical Results
 March 15, 2017

SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
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Sodium Oxide (percent)

220	0.070	0.051	73	0.113	0.047	41
*207	0.064	0.020	32	0.110	0.021	19

* Labs Eliminated - 86, 94, 99, 134, 221, 284, 494, 1054, 1644, 2352, 2463, 3368, 4099

Potassium Oxide (percent)

225	0.674	0.024	3.5	0.730	0.029	4.0
*212	0.675	0.015	2.2	0.733	0.018	2.4

* Labs Eliminated - 47, 95, 125, 134, 246, 694, 1956, 2308, 2412, 4080, 4099, 4137, 4206

Strontium Oxide (percent)

112	0.115	0.020	18	0.036	0.011	30
*103	0.120	0.006	5	0.036	0.004	10

* Labs Eliminated - 7, 34, 134, 493, 1657, 2293, 2491, 4099, 4137

Titanium Dioxide (percent)

182	0.26	0.110	42.1	0.26	0.108	41.5
*173	0.25	0.008	3.3	0.25	0.008	3.2

* Labs Eliminated - 175, 246, 493, 1054, 1644, 3707, 4099, 4131, 4137

Phosphorus Pentoxide (percent)

177	0.160	0.037	22.8	0.067	0.028	41.7
*156	0.159	0.006	3.5	0.064	0.005	7.9

* Labs Eliminated - 8, 47, 48, 78, 90, 134, 247, 407, 493, 494, 1799, 2463, 2477, 2483, 2490, 2491, 2522, 4093, 4099, 4115, 4131

Zinc Oxide (percent)

110	0.014	0.014	97.3	0.013	0.011	90.4
*100	0.012	0.002	12.7	0.011	0.001	12.7

* Labs Eliminated - 19, 101, 440, 493, 2462, 2477, 2483, 2491, 2522, 4099

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Primary Chemical Results
 March 15, 2017

SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Manganic Oxide (percent)							
	151	0.154	0.022	14.3	0.063	0.017	26.6
	*131	0.157	0.005	3.5	0.061	0.004	6.4
* Labs Eliminated - 47, 84, 134, 137, 203, 284, 354, 493, 768, 2293, 2463, 2466, 2477, 2484, 2491, 3238, 3297, 3707, 4099, 4131							
Chloride (percent)							
	138	0.006	0.007	119	0.010	0.009	91
	*130	0.005	0.003	67	0.008	0.004	49
* Labs Eliminated - 60, 219, 692, 1644, 1942, 2491, 3057, 3607							
Insoluble Residue (percent)							
	220	0.39	0.17	43	0.58	0.16	28
	*204	0.36	0.09	25	0.56	0.10	18
* Labs Eliminated - 8, 24, 26, 36, 159, 206, 209, 246, 493, 768, 2465, 3249, 3368, 3658, 4155, 4200							
Free Lime (percent)							
	181	1.58	0.32	20	1.27	0.28	22
	*174	1.62	0.25	15	1.29	0.25	19
* Labs Eliminated - 126, 415, 450, 768, 881, 3297, 4206							
Carbon Dioxide (percent)							
	206	1.81	0.32	17.7	2.51	0.38	15.2
	*190	1.84	0.18	10.0	2.57	0.17	6.7
* Labs Eliminated - 129, 137, 142, 169, 206, 415, 416, 457, 1054, 2490, 3607, 4051, 4093, 4150, 4155, 4206							
Limestone Content (percent)							
	202	4.5	0.8	17.3	5.9	0.9	15.4
	*188	4.6	0.5	11.0	6.1	0.5	7.7
* Labs Eliminated - 129, 137, 142, 169, 206, 219, 415, 457, 886, 1435, 4051, 4093, 4150, 4155							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Primary Chemical Results
 March 15, 2017

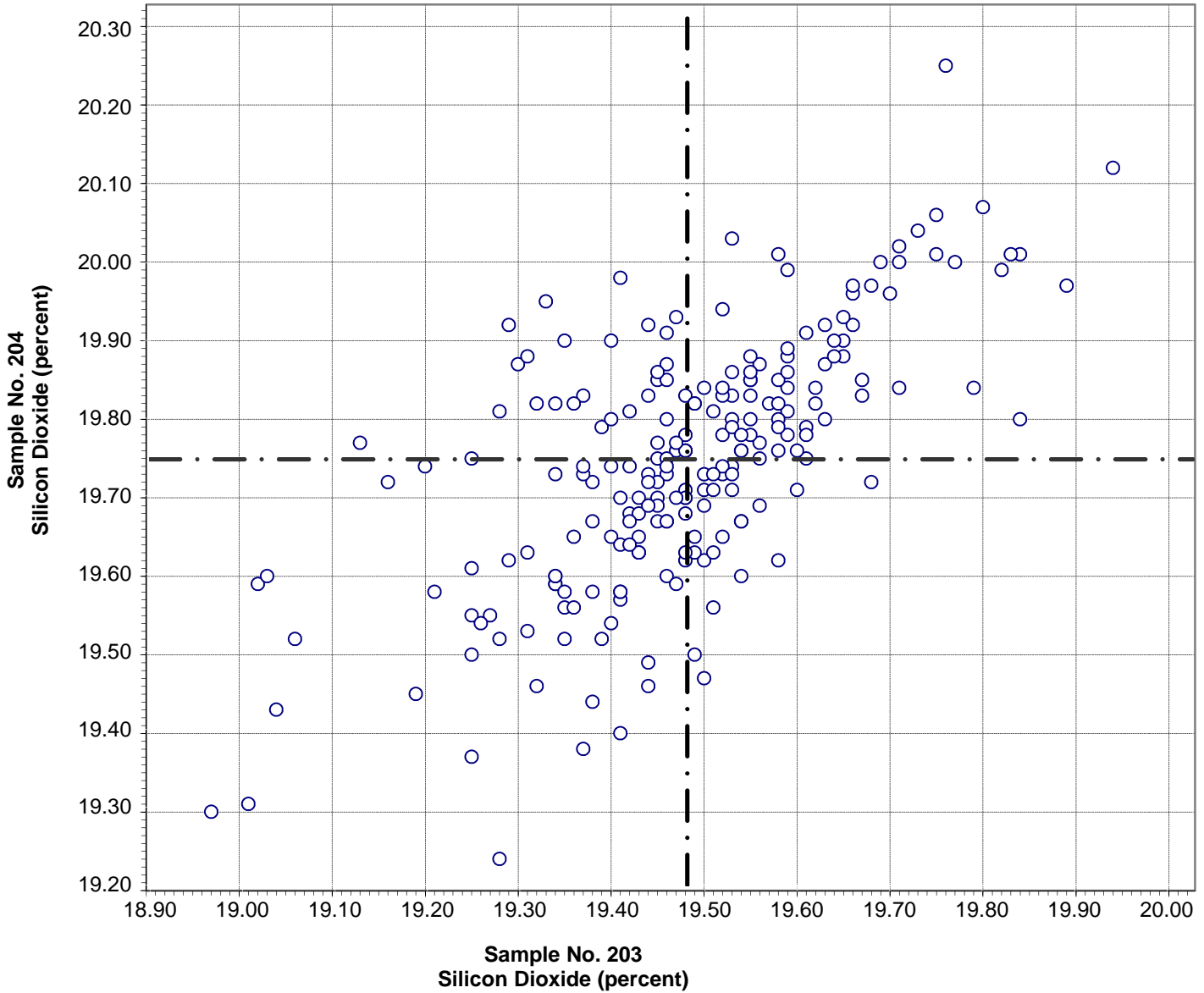
SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Chromium Oxide (percent)							
	101	0.012	0.010	87	0.010	0.007	65
	*82	0.009	0.002	19	0.009	0.002	17
* Labs Eliminated - 34, 36, 66, 105, 116, 157, 415, 438, 493, 1079, 1466, 2462, 2491, 2522, 3057, 3238, 3279, 3368, 4099							
Tricalcium Silicate (percent)							
	200	54.5	3.7	6.8	56.8	4.1	7.2
	*197	54.6	3.3	6.1	56.8	3.9	6.8
* Labs Eliminated - 206, 1942, 4206							
Dicalcium Silicate (percent)							
	200	14.3	3.1	21.9	13.0	3.1	24.1
	*196	14.3	2.8	19.4	13.0	2.9	22.0
* Labs Eliminated - 137, 206, 1942, 4206							
Tricalcium Aluminate (percent)							
	200	6.6	0.4	5.8	5.1	0.5	8.8
	*195	6.6	0.2	3.6	5.1	0.2	4.8
* Labs Eliminated - 134, 494, 2477, 3238, 4137							
Tetracalcium Aluminoferrite (percent)							
	200	11.6	0.3	2.6	10.5	0.7	6.6
	*195	11.6	0.2	2.0	10.4	0.2	2.2
* Labs Eliminated - 134, 438, 494, 2477, 3238							

**CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 203 and No. 204**



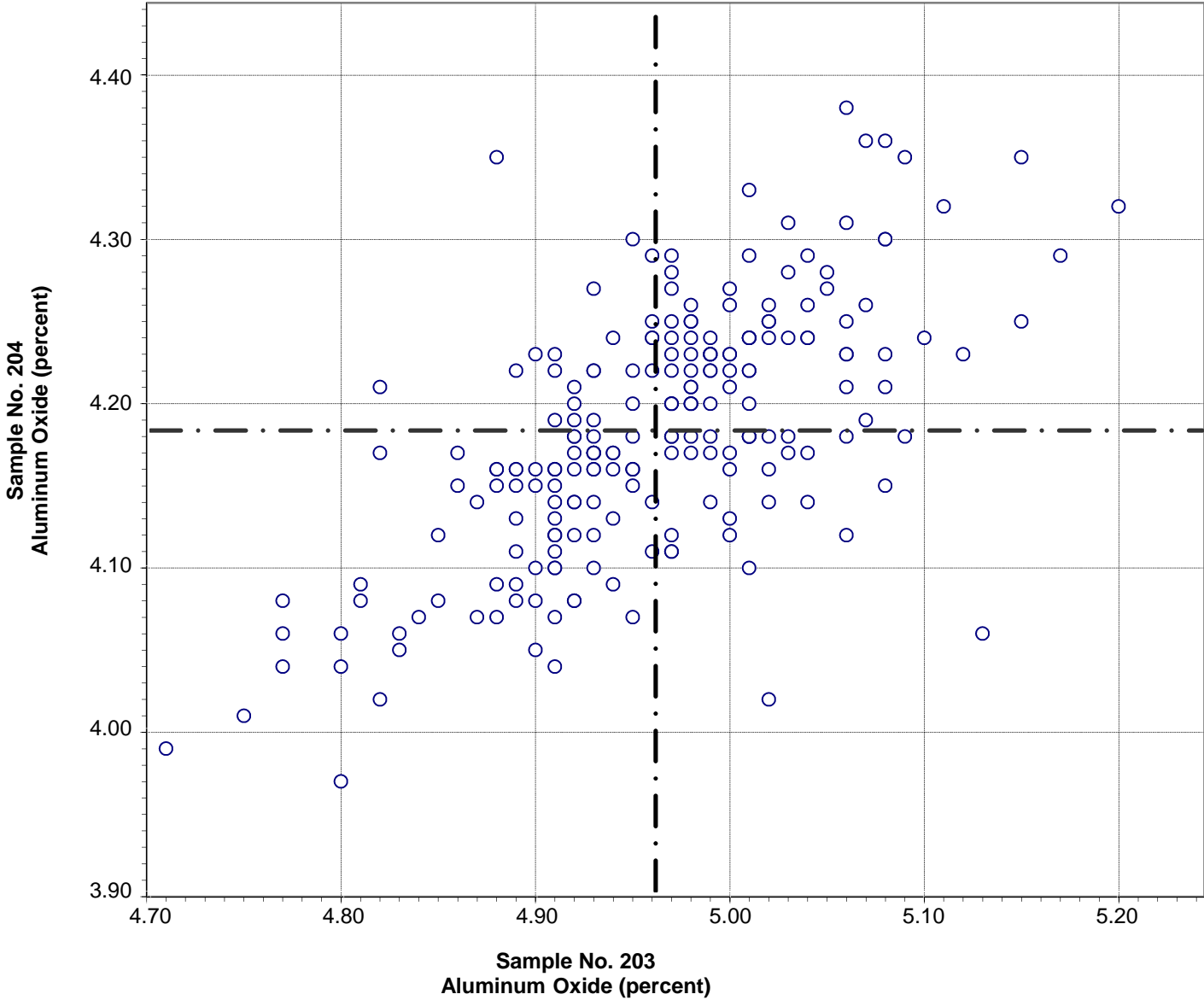
Test No. 10 Silicon Dioxide 220 Points

Sample No. 203	Ave 19.48	S.D. 0.16	C.V. 0.82
Sample No. 204	Ave 19.75	S.D. 0.18	C.V. 0.91

Labs Eliminated: 48, 50, 95, 98, 284, 684, 1644, 4142

Labs off Diagram: 134, 2437, 2477, 3297

**CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

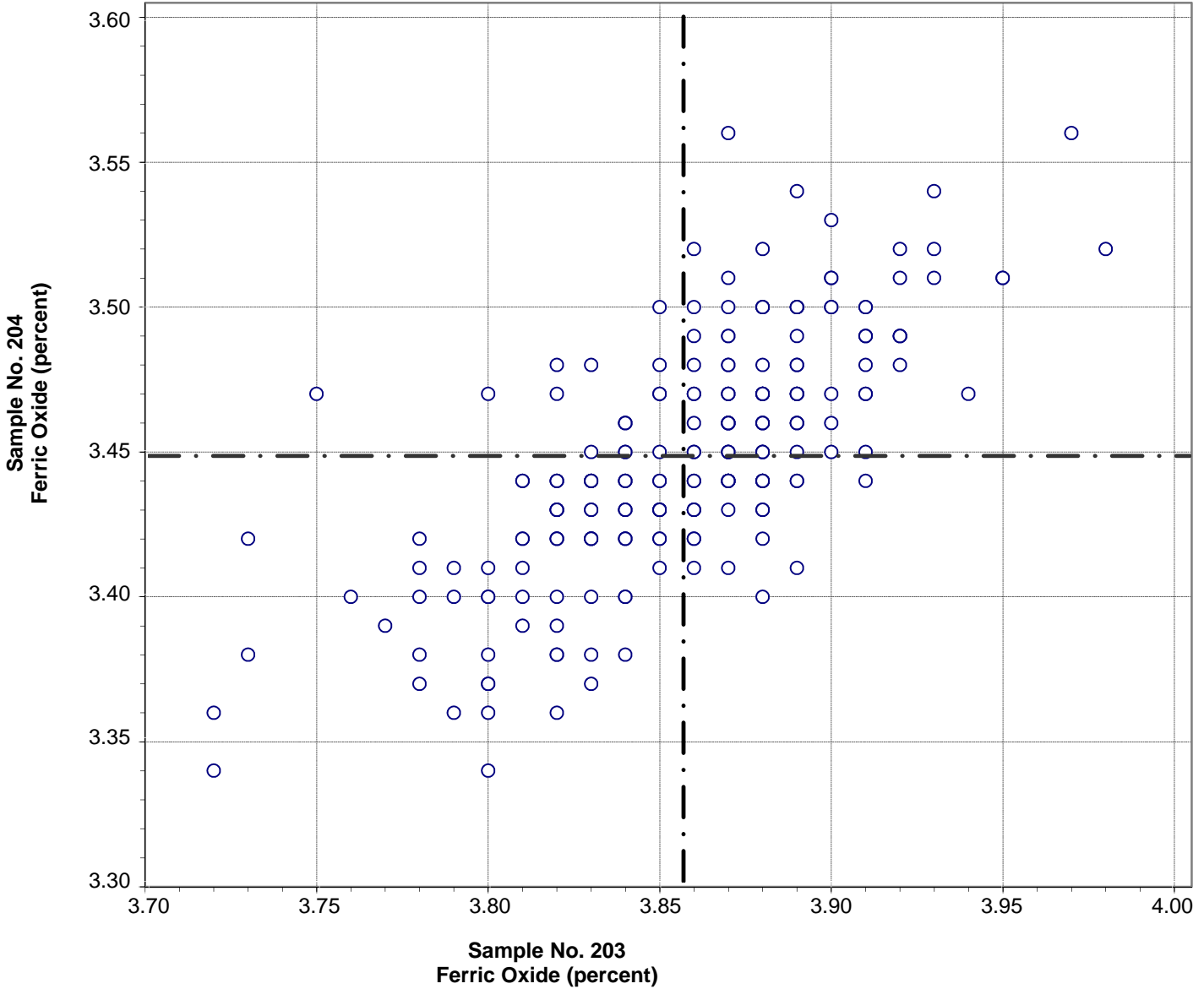


Test No. 21 Aluminum Oxide 218 Points

Sample No. 203	Ave 4.96	S.D. 0.08	C.V. 1.6
Sample No. 204	Ave 4.18	S.D. 0.08	C.V. 1.8

Labs Eliminated: 14, 42, 50, 134, 157, 698, 1956, 2477, 4099, 4137, 4206

**CCRL Proficiency Sample Program
 Ferric Oxide
 PORTLAND CEMENT Samples No. 203 and No. 204**

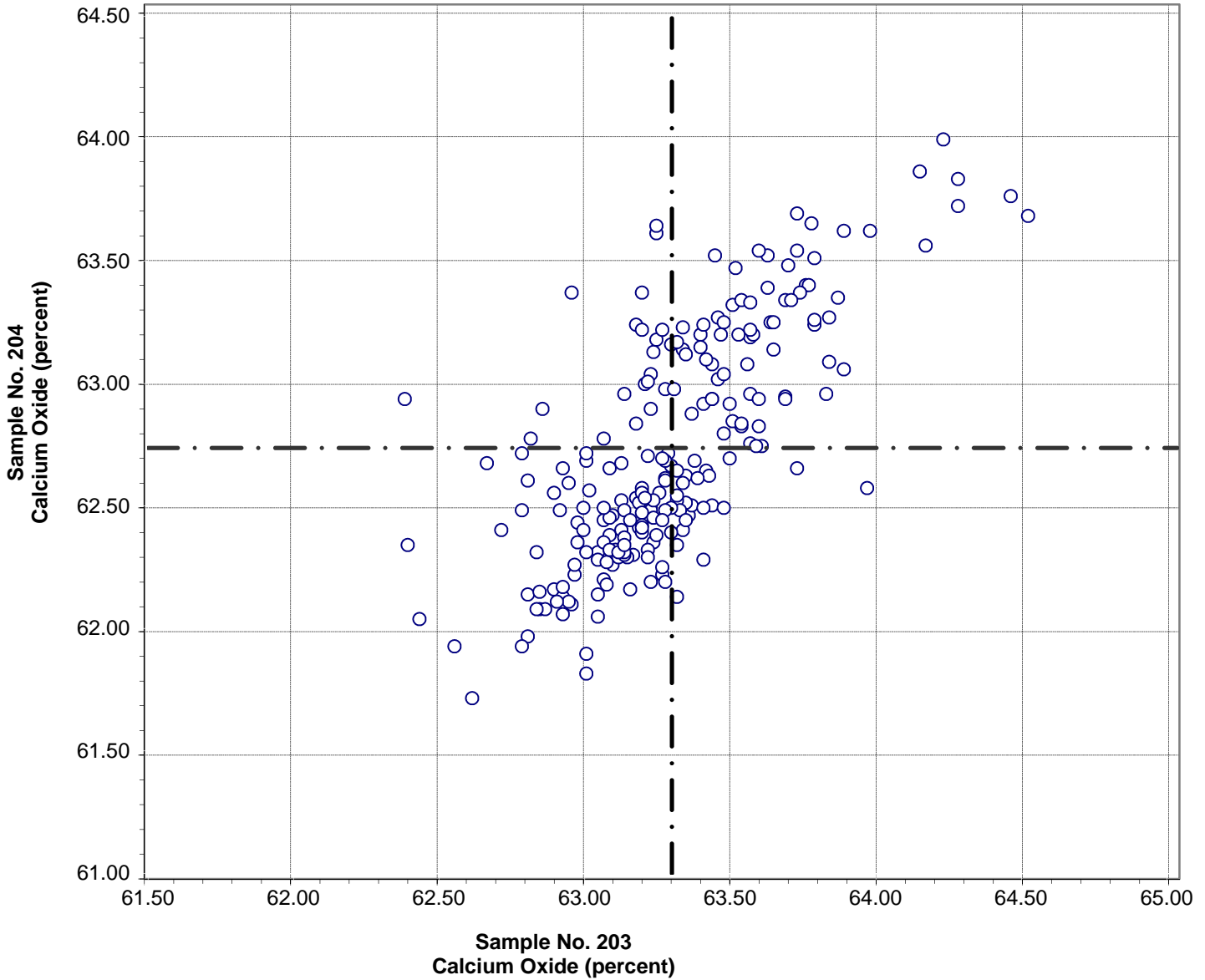


Test No. 30 Ferric Oxide 216 Points

Sample No. 203	Ave 3.86	S.D. 0.04	C.V. 1.1
Sample No. 204	Ave 3.45	S.D. 0.04	C.V. 1.2

Labs Eliminated: 22, 126, 134, 162, 206, 416, 2477, 2491, 4051, 4080, 4099, 4150, 4206

**CCRL Proficiency Sample Program
Calcium Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

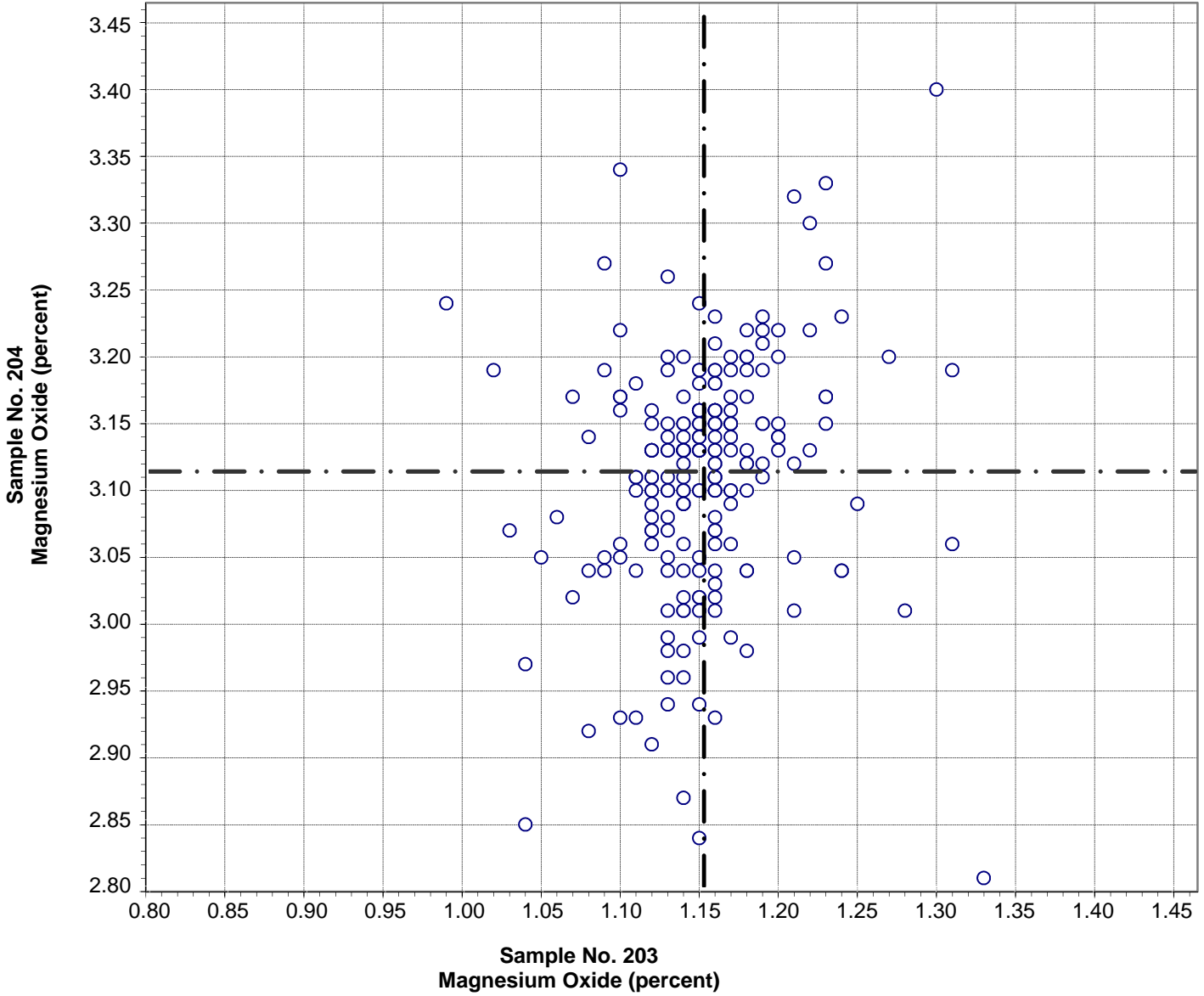


Test No. 40 Calcium Oxide 226 Points

Sample No. 203	Ave 63.30	S.D. 0.34	C.V. 0.54
Sample No. 204	Ave 62.74	S.D. 0.47	C.V. 0.75

Labs Eliminated: 98, 284, 4206

**CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

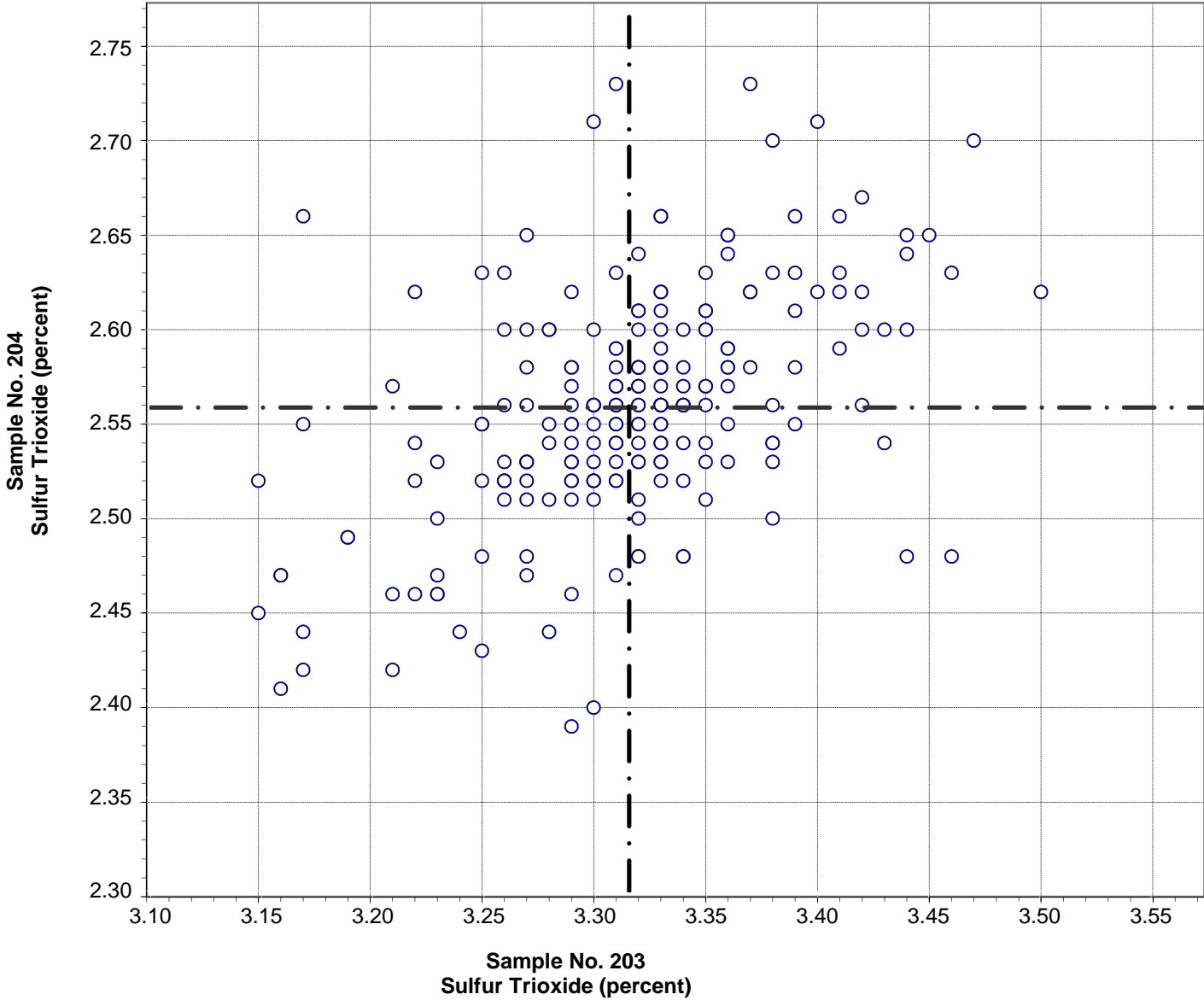


Test No. 50 Magnesium Oxide 219 Points

Sample No. 203	Ave 1.15	S.D. 0.05	C.V. 4.0
Sample No. 204	Ave 3.11	S.D. 0.09	C.V. 2.8

Labs Eliminated: 14, 84, 134, 206, 222, 493, 779, 2463, 2477, 4039, 4099

**CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 203 and No. 204**

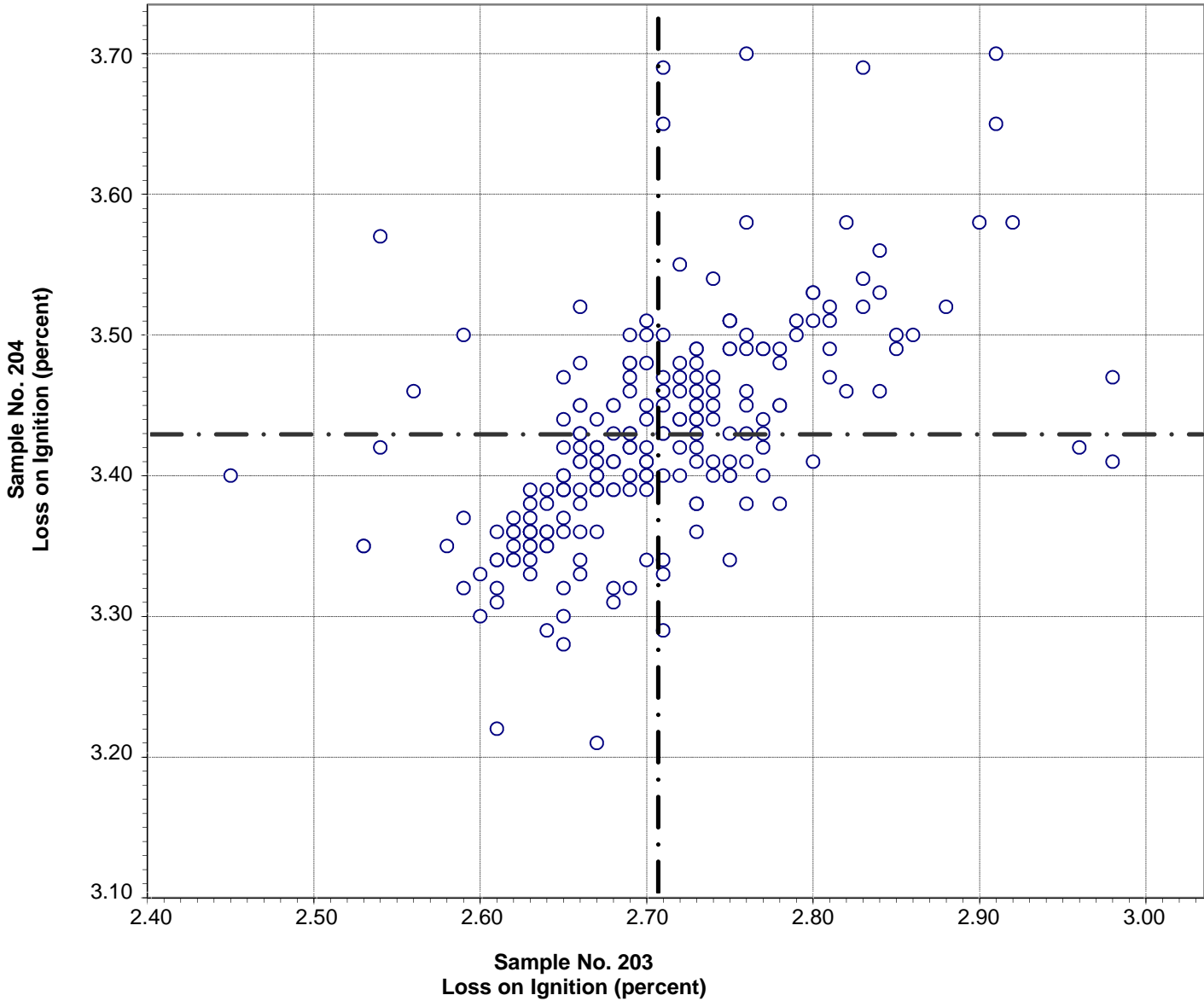


Test No. 60 Sulfur Trioxide 219 Points

Sample No. 203	Ave 3.32	S.D. 0.06	C.V. 1.9
Sample No. 204	Ave 2.56	S.D. 0.06	C.V. 2.4

Labs Eliminated: 93, 134, 146, 159, 169, 203, 246, 694, 883, 2360, 2463, 3279, 3297, 4142

**CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 203 and No. 204**

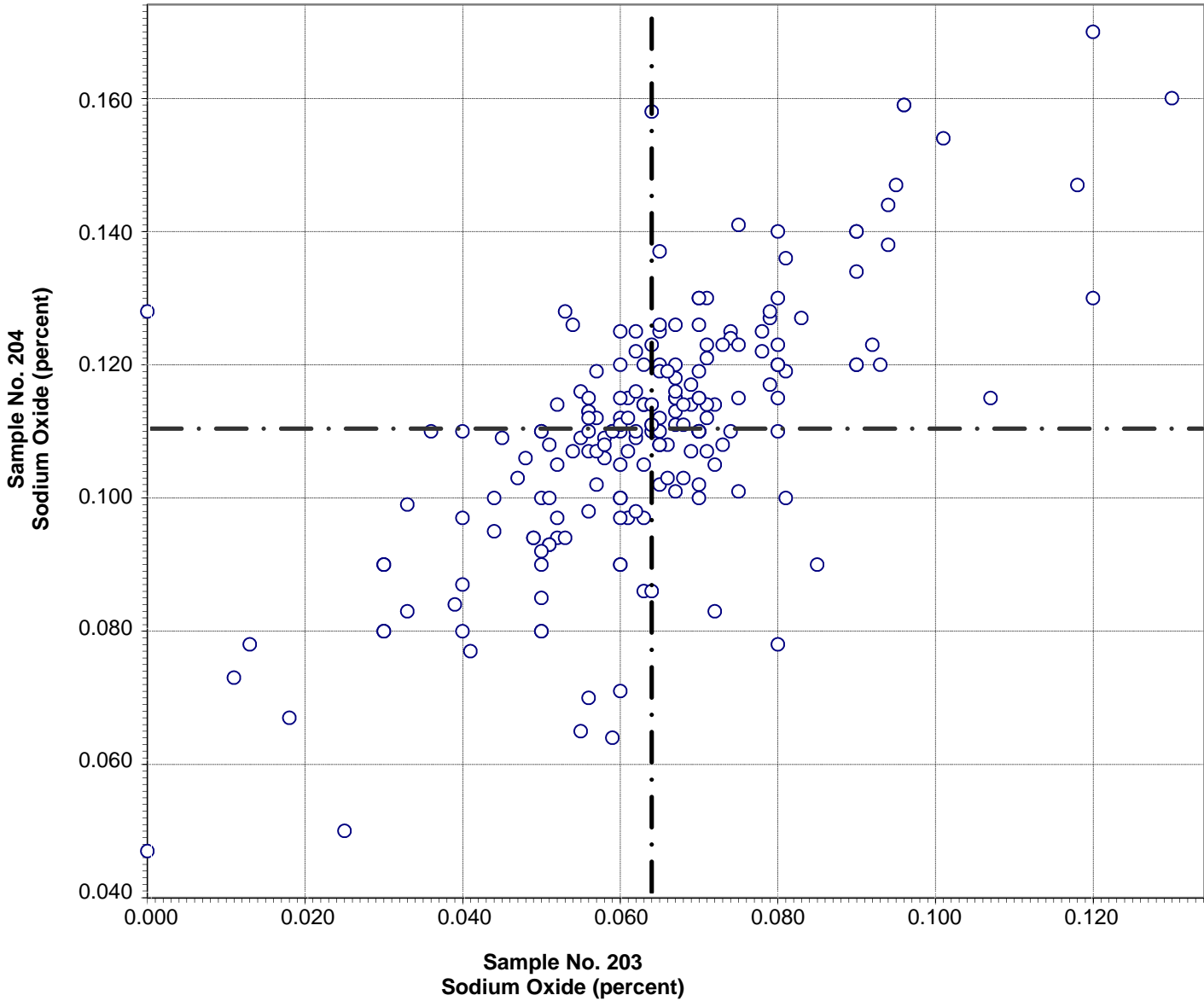


Test No. 70 Loss on Ignition 221 Points

Sample No. 203	Ave 2.71	S.D. 0.08	C.V. 2.9
Sample No. 204	Ave 3.43	S.D. 0.08	C.V. 2.3

Labs Eliminated: 4, 47, 95, 131, 137, 159, 493, 1054, 1644, 1799, 1942, 1956, 3368, 4080, 4099

**CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**



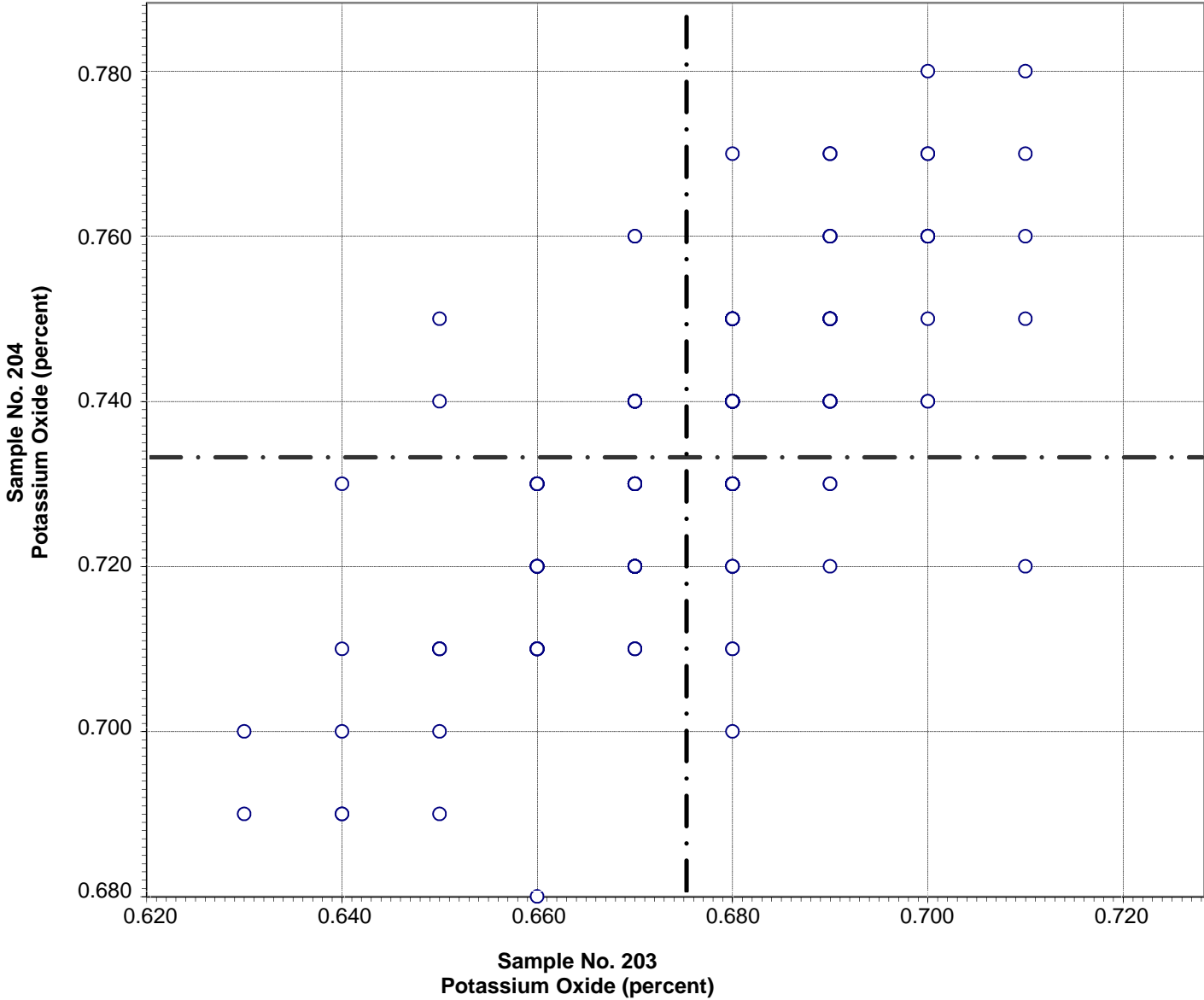
Test No. 90 Sodium Oxide 204 Points

Sample No. 203	Ave 0.064	S.D. 0.020	C.V. 32
Sample No. 204	Ave 0.110	S.D. 0.021	C.V. 19

Labs Eliminated: 86, 94, 99, 134, 221, 284, 494, 1054, 1644, 2352, 2463, 3368, 4099

Labs off Diagram: 41, 416, 3607

**CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

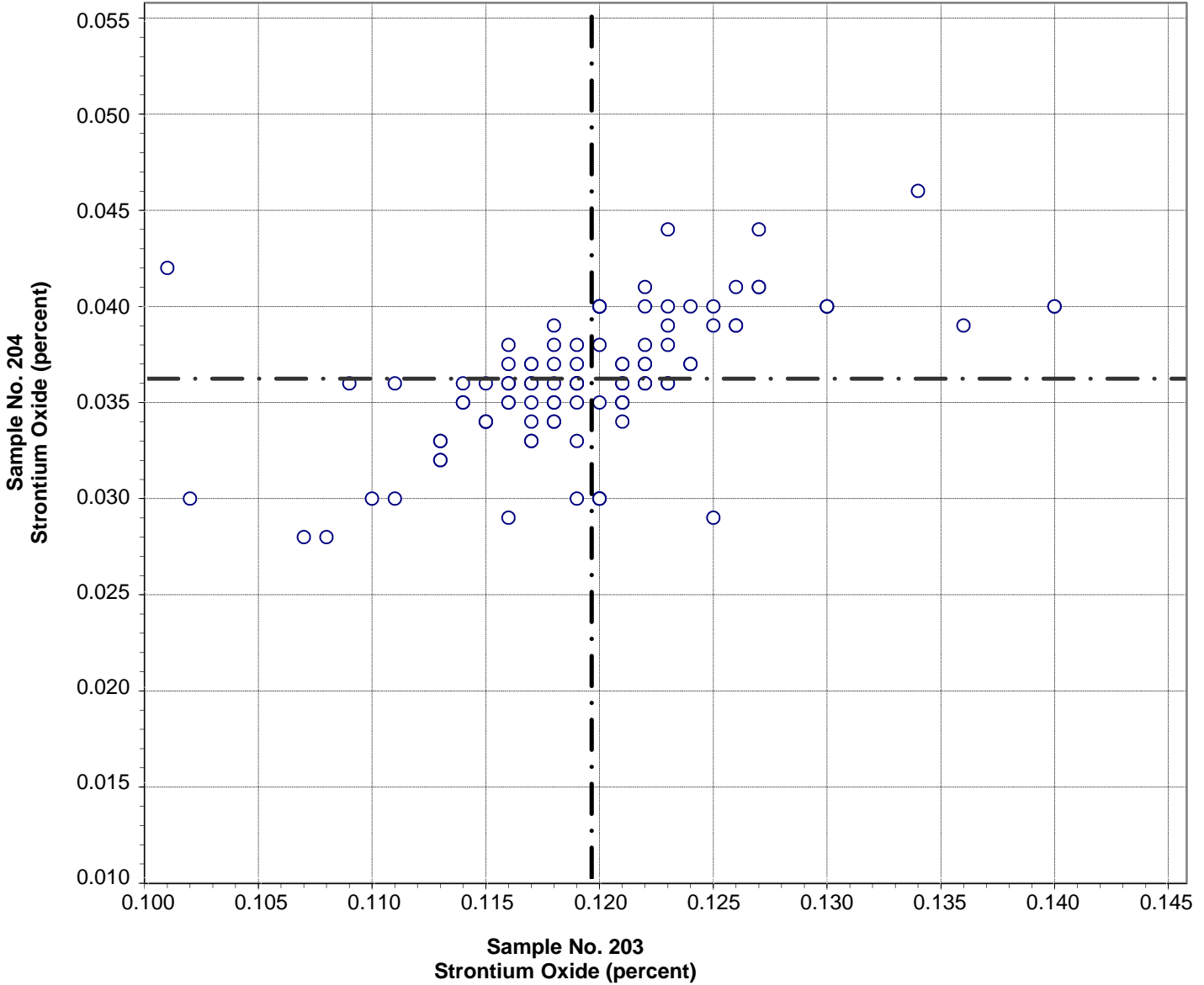


Test No. 100 Potassium Oxide 212 Points

Sample No. 203	Ave 0.675	S.D. 0.015	C.V. 2.2
Sample No. 204	Ave 0.733	S.D. 0.018	C.V. 2.4

Labs Eliminated: 47, 95, 125, 134, 246, 694, 1956, 2308, 2412, 4080, 4099, 4137, 4206

**CCRL Proficiency Sample Program
Strontium Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

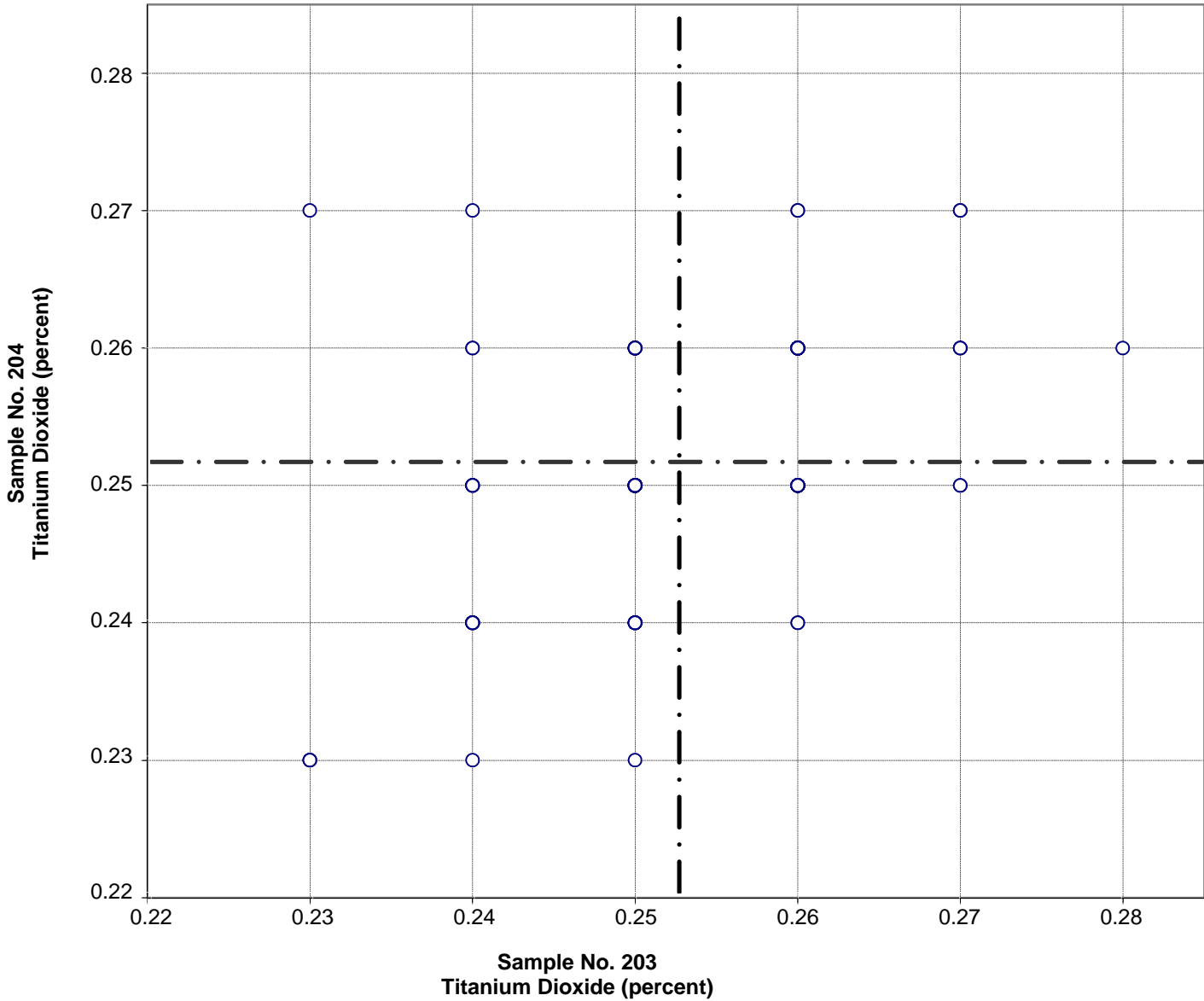


Test No. 92 Strontium Oxide 103 Points

Sample No. 203	Ave 0.120	S.D. 0.006	C.V. 5
Sample No. 204	Ave 0.036	S.D. 0.004	C.V. 10

Labs Eliminated: 7, 34, 134, 493, 1657, 2293, 2491, 4099, 4137

**CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 203 and No. 204**

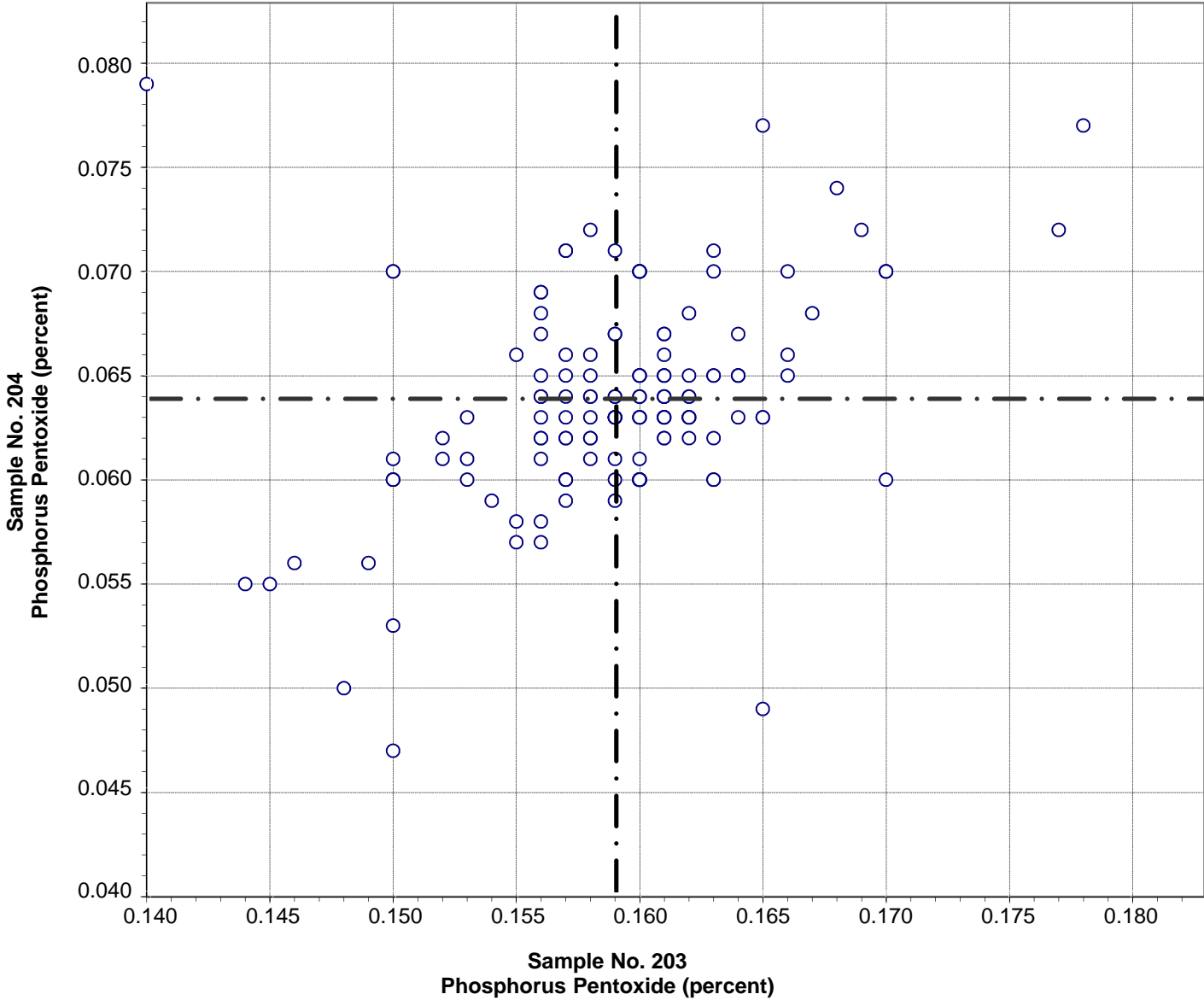


Test No. 103 Titanium Dioxide 173 Points

Sample No. 203	Ave 0.25	S.D. 0.008	C.V. 3.3
Sample No. 204	Ave 0.25	S.D. 0.008	C.V. 3.2

Labs Eliminated: 175, 246, 493, 1054, 1644, 3707, 4099, 4131, 4137

**CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 203 and No. 204**



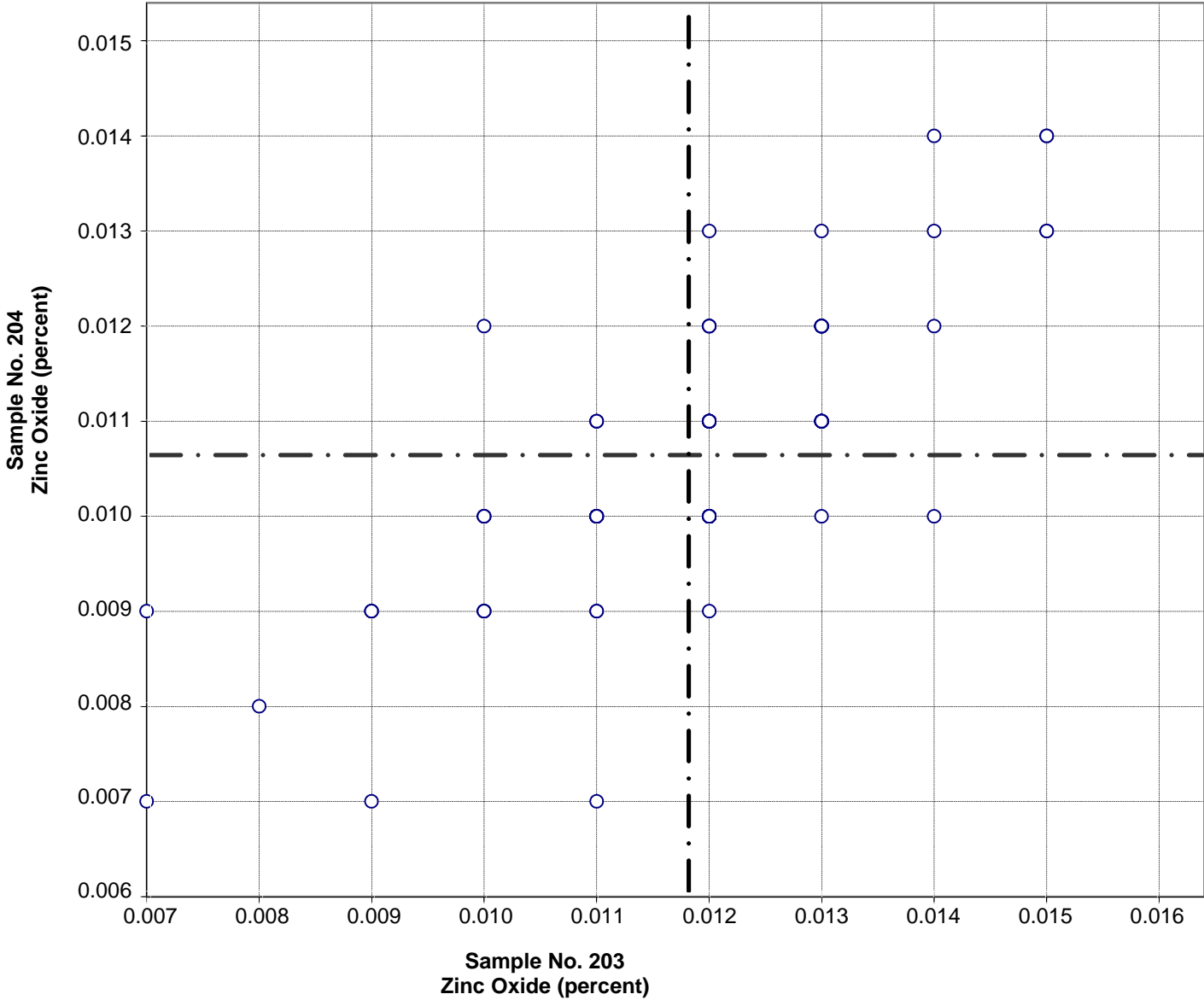
Test No. 102 Phosphorus Pentoxide 154 Points

Sample No. 203	Ave 0.159	S.D. 0.006	C.V. 3.5
Sample No. 204	Ave 0.064	S.D. 0.005	C.V. 7.9

Labs Eliminated: 8, 47, 48, 78, 90, 134, 247, 407, 493, 494, 1799, 2463, 2477, 2483, 2490, 2491, 2522, 4093, 4099, 4115, 4131

Labs off Diagram: 60, 413

**CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

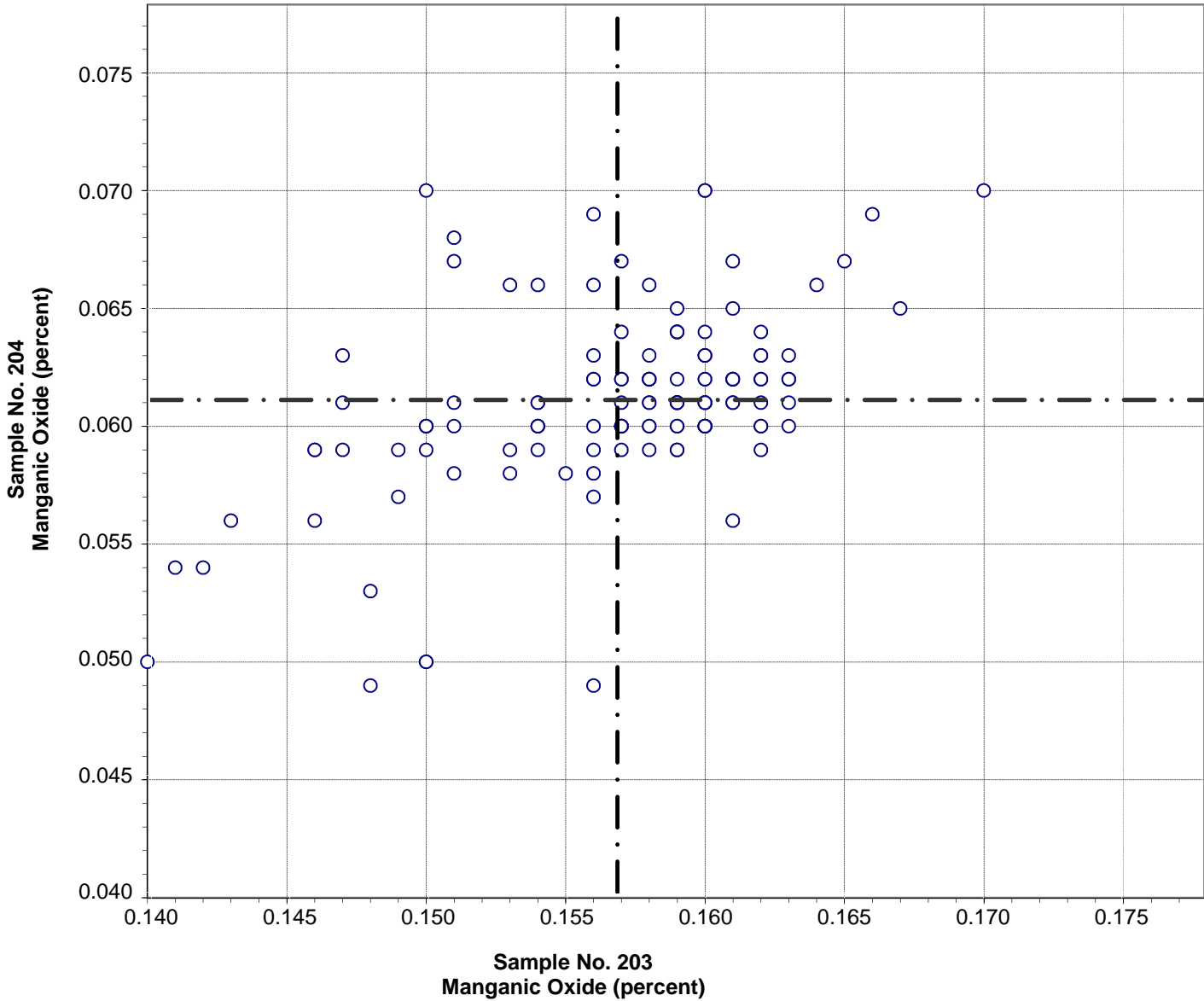


Test No. 99 Zinc Oxide 100 Points

Sample No. 203	Ave 0.012	S.D. 0.002	C.V. 12.7
Sample No. 204	Ave 0.011	S.D. 0.001	C.V. 12.7

Labs Eliminated: 19, 101, 440, 493, 2462, 2477, 2483, 2491, 2522, 4099

**CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

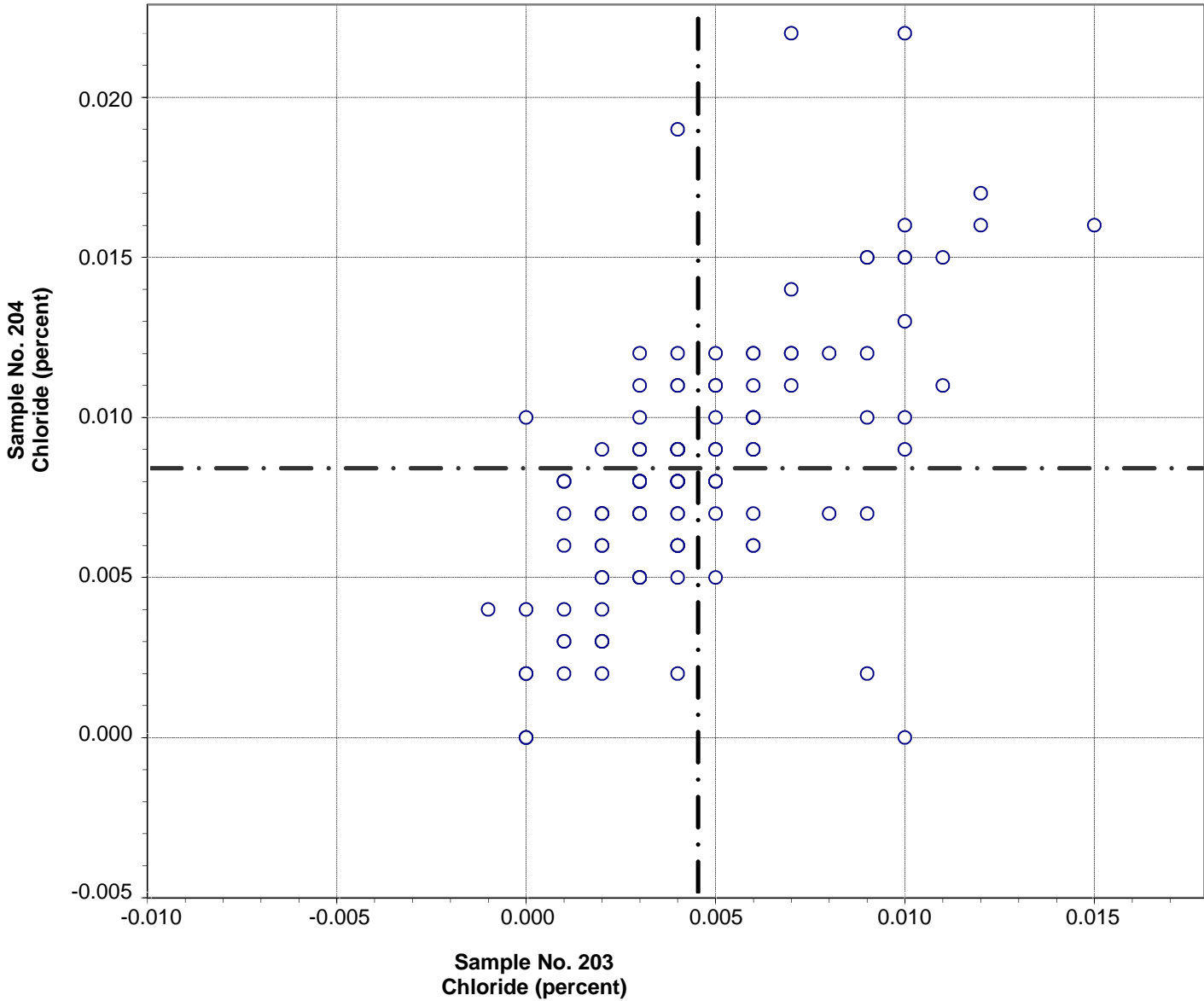


Test No. 101 Manganic Oxide 131 Points

Sample No. 203	Ave 0.157	S.D. 0.005	C.V. 3.5
Sample No. 204	Ave 0.061	S.D. 0.004	C.V. 6.4

Labs Eliminated: 47, 84, 134, 137, 203, 284, 354, 493, 768, 2293, 2463, 2466, 2477, 2484, 2491, 3238, 3297, 3707, 4099, 4131

**CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 203 and No. 204**

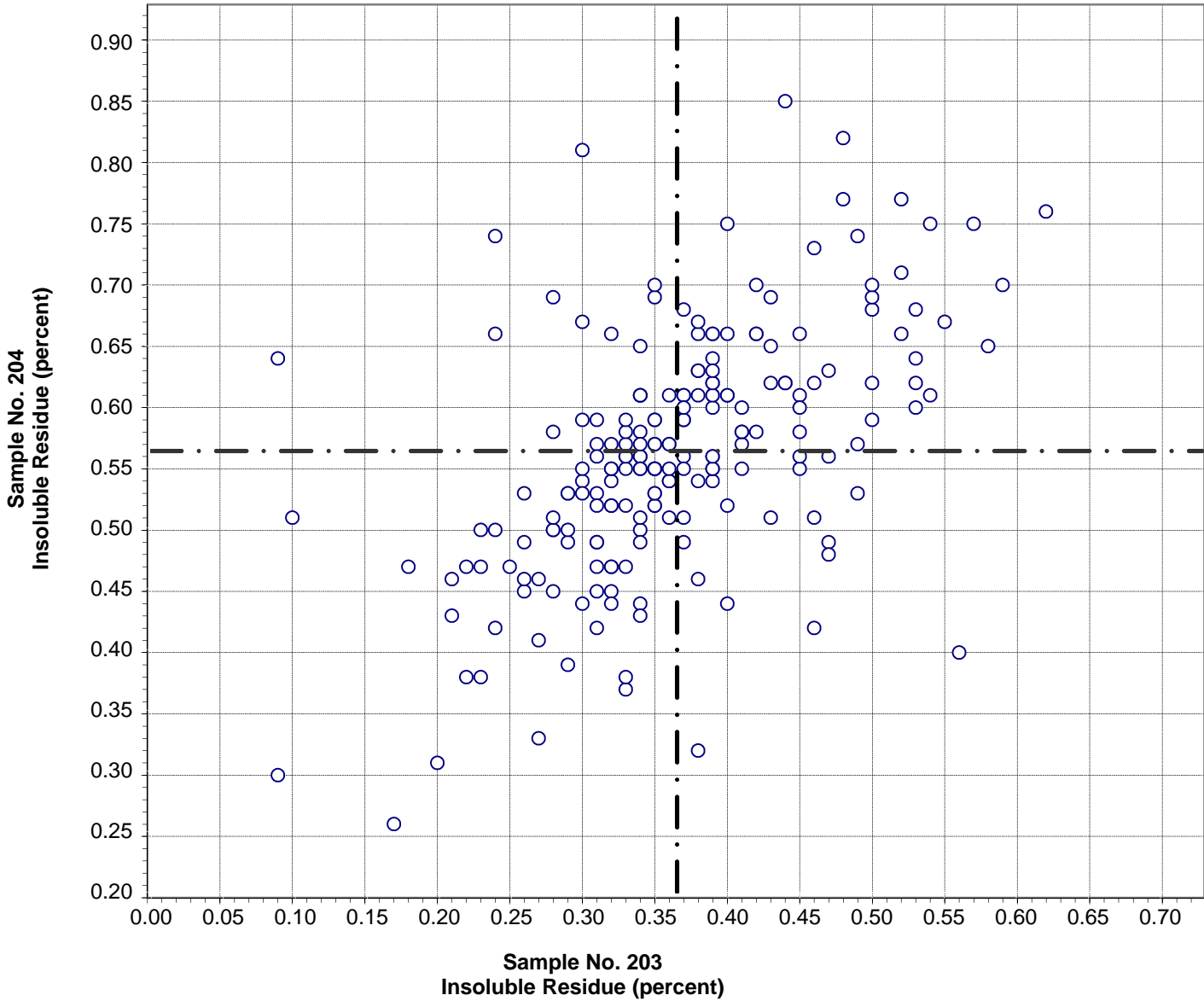


Test No. 104 Chloride 130 Points

Sample No. 203	Ave 0.005	S.D. 0.003	C.V. 67
Sample No. 204	Ave 0.008	S.D. 0.004	C.V. 49

Labs Eliminated: 60, 219, 692, 1644, 1942, 2491, 3057, 3607

**CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 203 and No. 204**

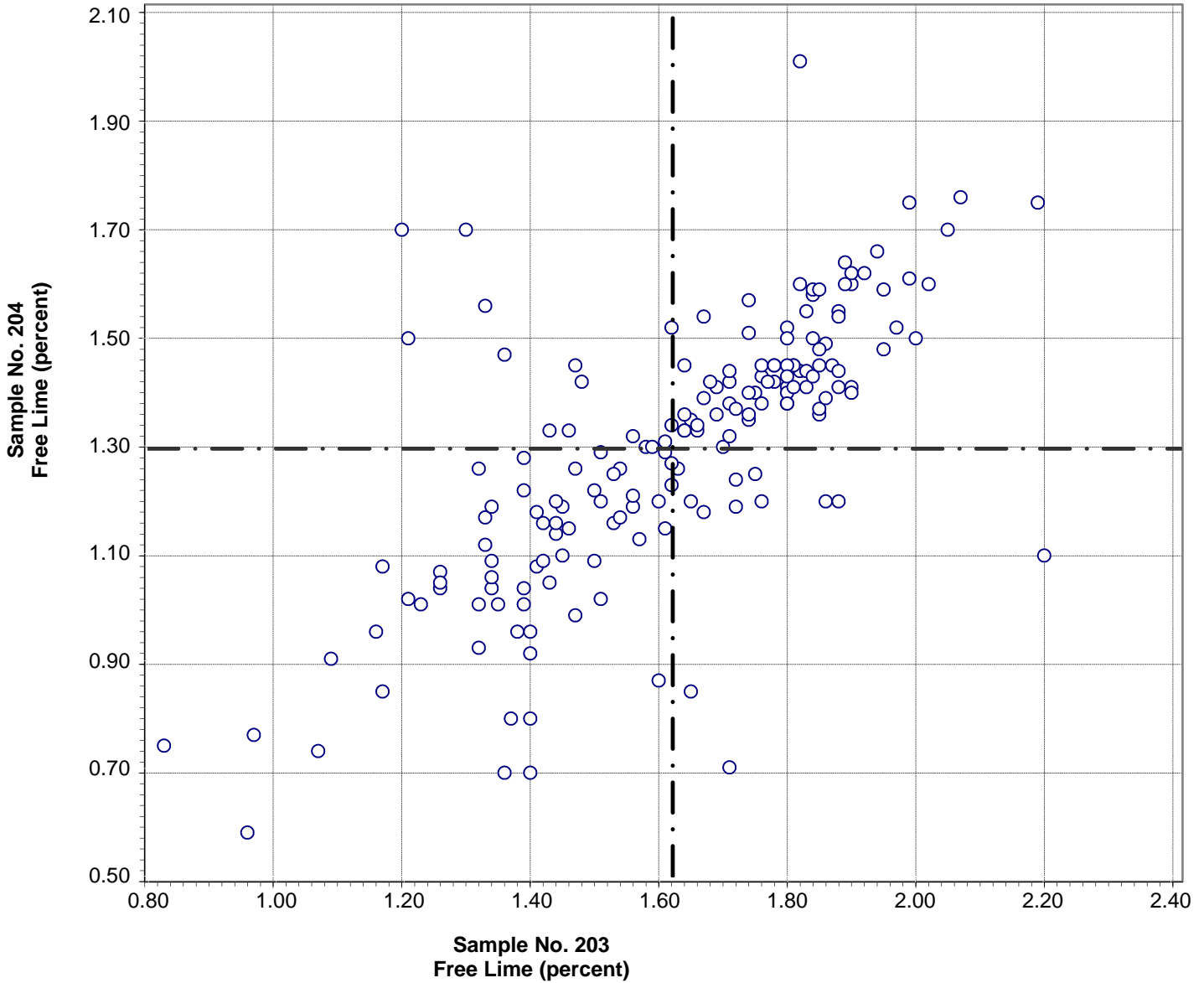


Test No. 80 Insoluble Residue 204 Points

Sample No. 203	Ave 0.36	S.D. 0.09	C.V. 25
Sample No. 204	Ave 0.56	S.D. 0.10	C.V. 18

Labs Eliminated: 8, 24, 26, 36, 159, 206, 209, 246, 493, 768, 2465, 3249, 3368, 3658, 4155, 4200

**CCRL Proficiency Sample Program
Free Lime
PORTLAND CEMENT Samples No. 203 and No. 204**

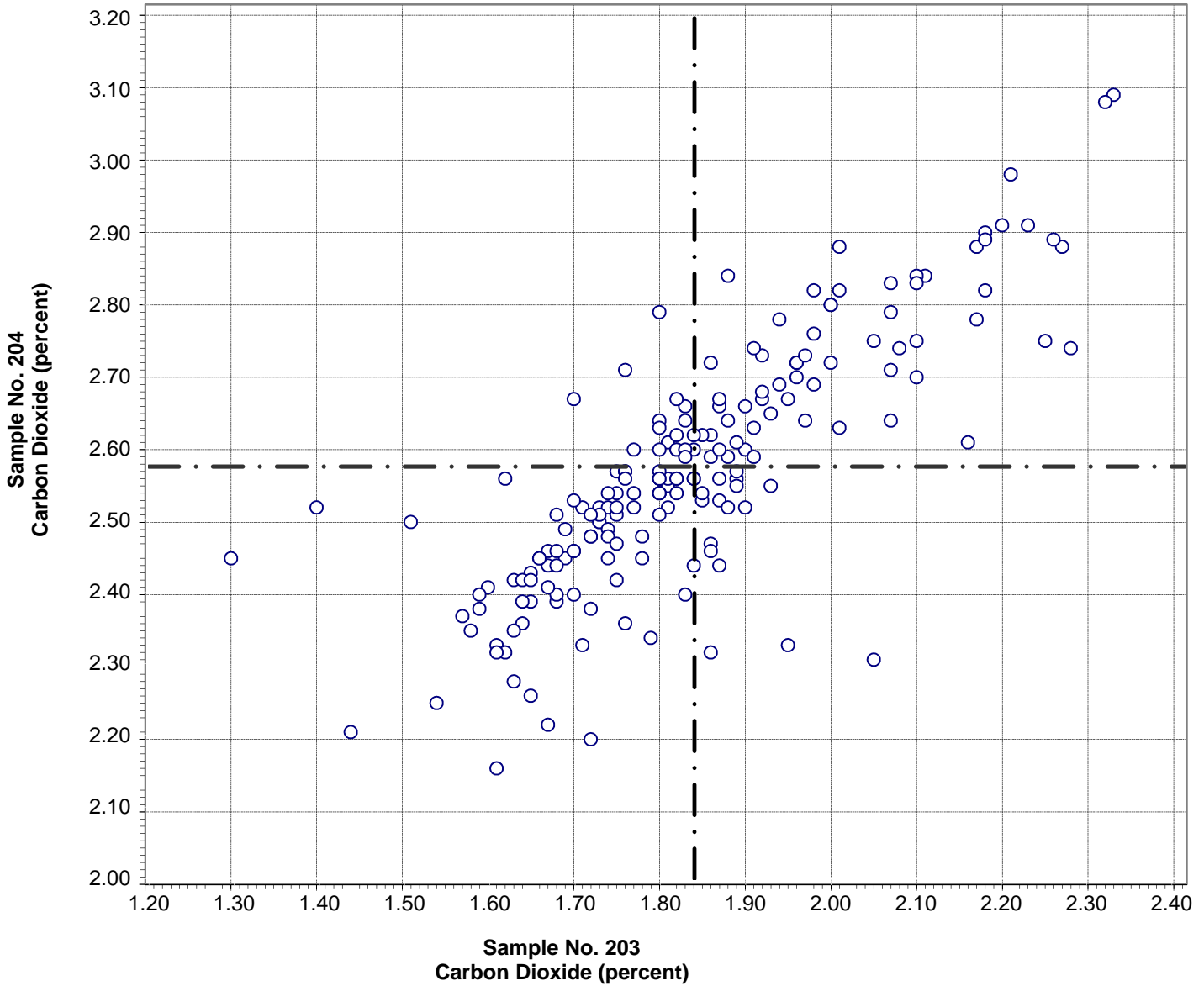


Test No. 41 Free Lime 174 Points

Sample No. 203	Ave 1.62	S.D. 0.25	C.V. 15
Sample No. 204	Ave 1.29	S.D. 0.25	C.V. 19

Labs Eliminated: 126, 415, 450, 768, 881, 3297, 4206

**CCRL Proficiency Sample Program
Carbon Dioxide
PORTLAND CEMENT Samples No. 203 and No. 204**



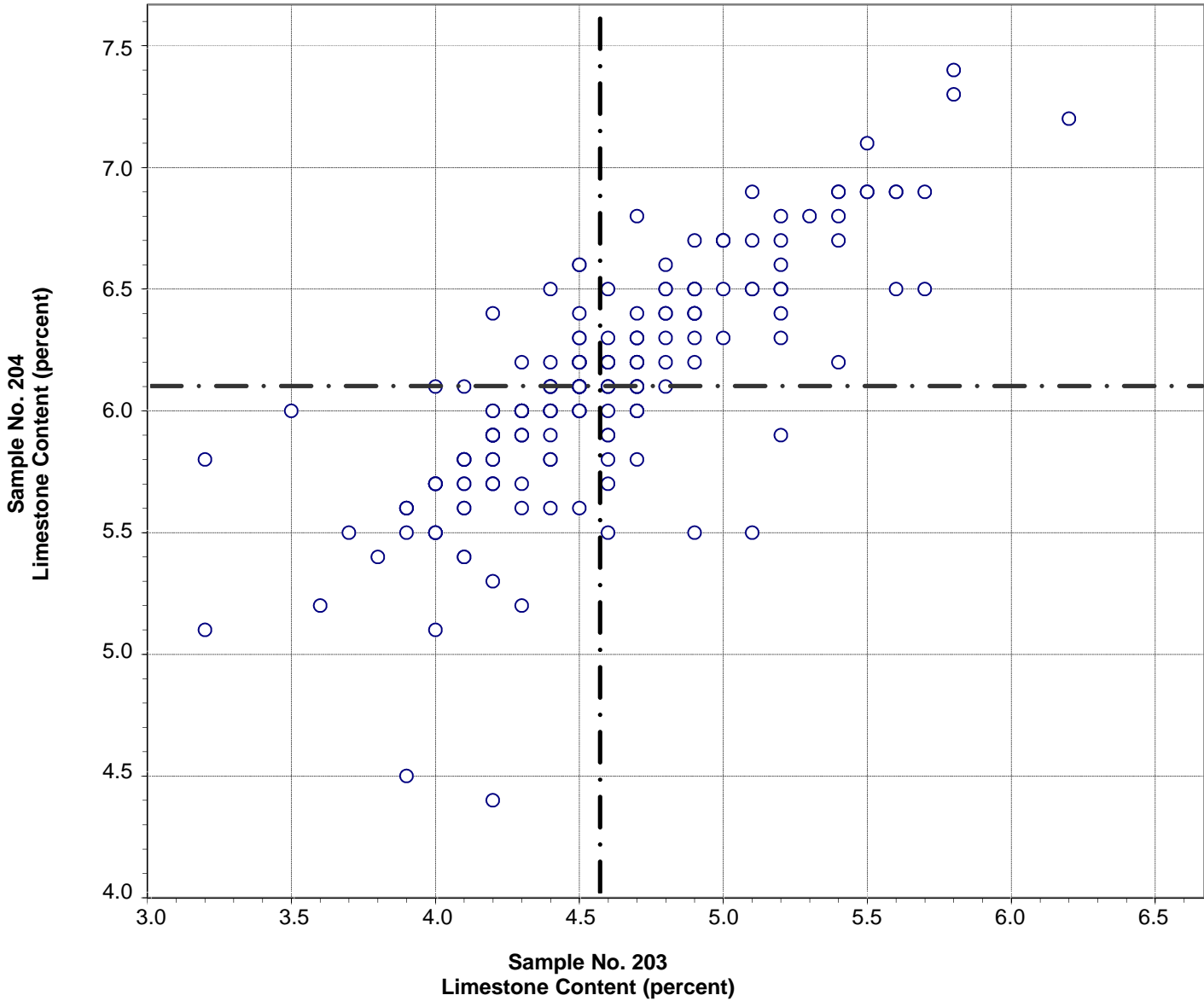
Test No. 97 Carbon Dioxide 189 Points

Sample No. 203	Ave 1.84	S.D. 0.18	C.V. 10.0
Sample No. 204	Ave 2.57	S.D. 0.17	C.V. 6.7

Labs Eliminated: 129, 137, 142, 169, 206, 415, 416, 457, 1054, 2490, 3607, 4051, 4093, 4150, 4155, 4206

Labs off Diagram: 247

**CCRL Proficiency Sample Program
Limestone Content
PORTLAND CEMENT Samples No. 203 and No. 204**



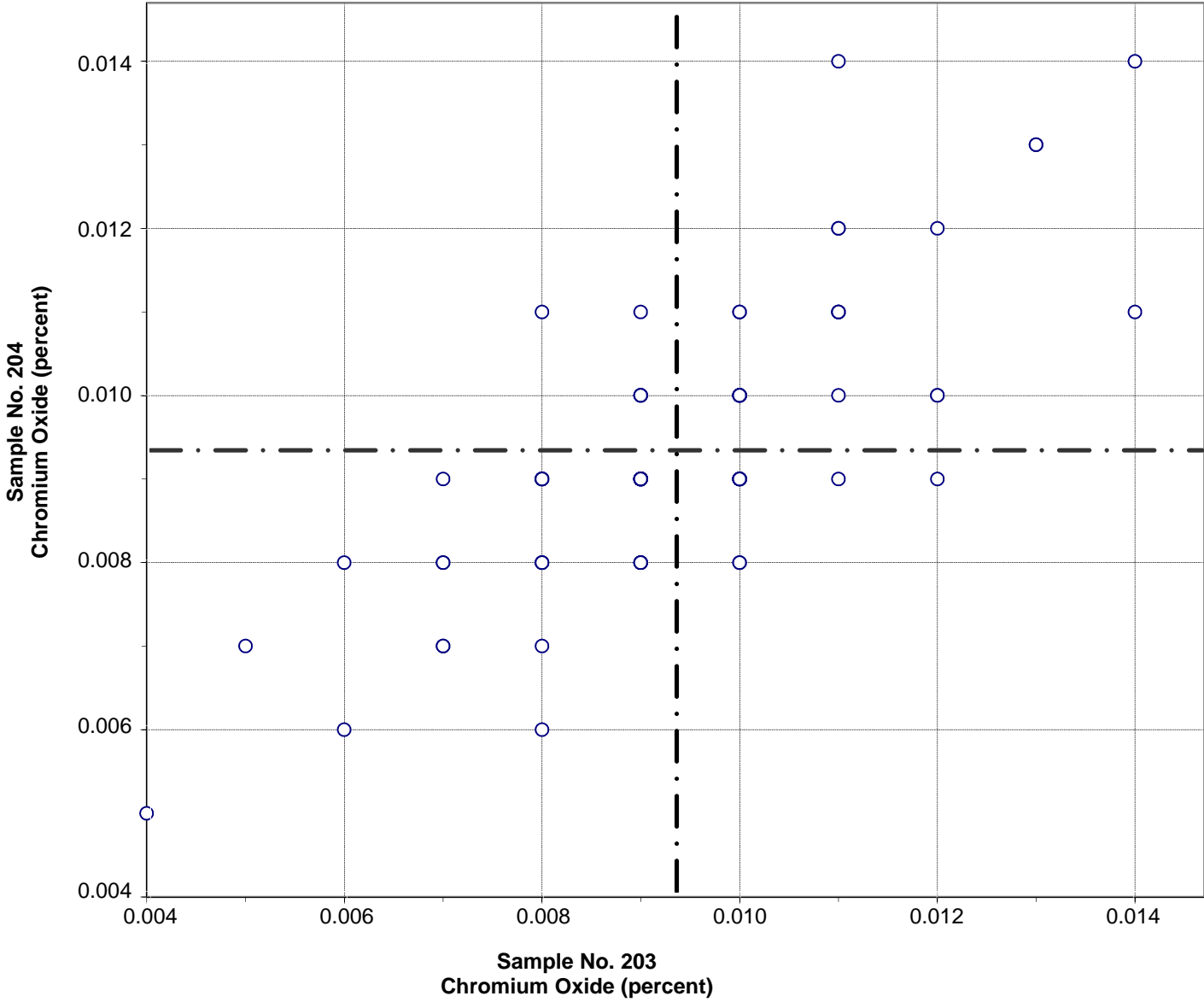
Test No. 98 Limestone Content 187 Points

Sample No. 203	Ave 4.6	S.D. 0.5	C.V. 11.0
Sample No. 204	Ave 6.1	S.D. 0.5	C.V. 7.7

Labs Eliminated: 129, 137, 142, 169, 206, 219, 415, 457, 886, 1435, 4051, 4093, 4150, 4155

Labs off Diagram: 4206

**CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 203 and No. 204**

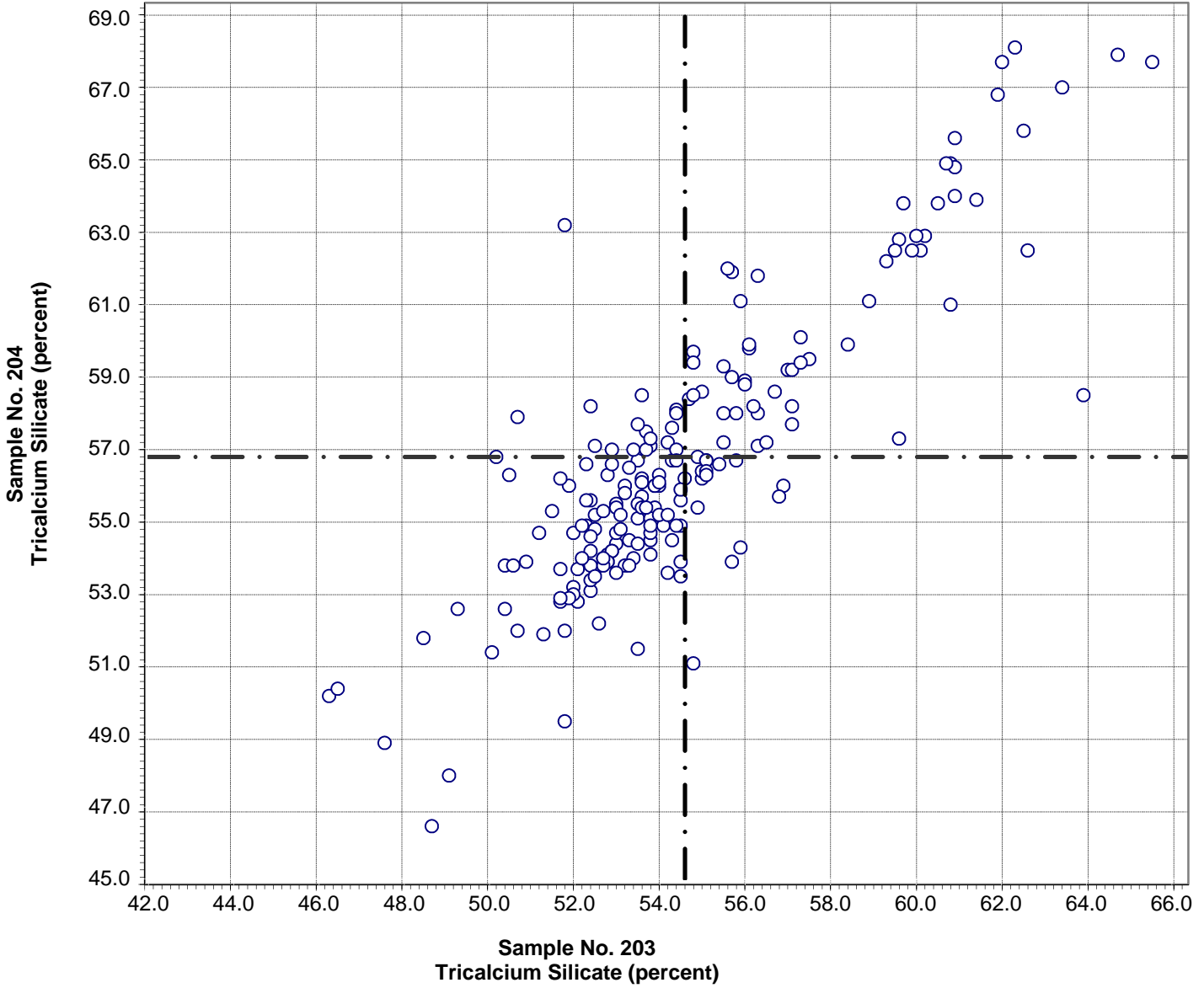


Test No. 105 Chromium Oxide 82 Points

Sample No. 203	Ave 0.009	S.D. 0.002	C.V. 19
Sample No. 204	Ave 0.009	S.D. 0.002	C.V. 17

Labs Eliminated: 34, 36, 66, 105, 116, 157, 415, 438, 493, 1079, 1466, 2462, 2491, 2522, 3057, 3238, 3279, 3368, 4099

**CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 203 and No. 204**

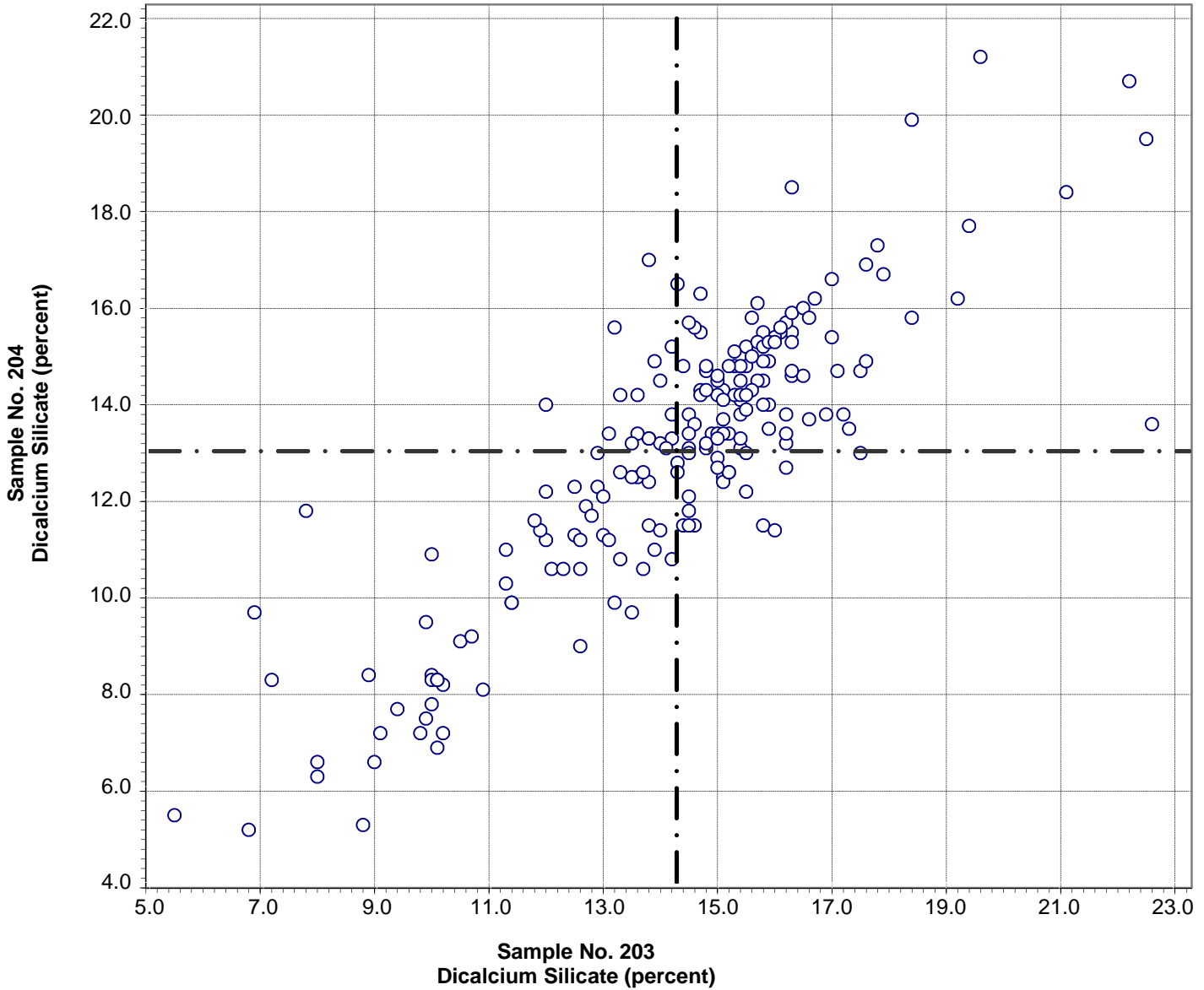


Test No. 106 Tricalcium Silicate 197 Points

Sample No. 203	Ave 54.6	S.D. 3.3	C.V. 6.1
Sample No. 204	Ave 56.8	S.D. 3.9	C.V. 6.8

Labs Eliminated: 206, 1942, 4206

**CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 203 and No. 204**

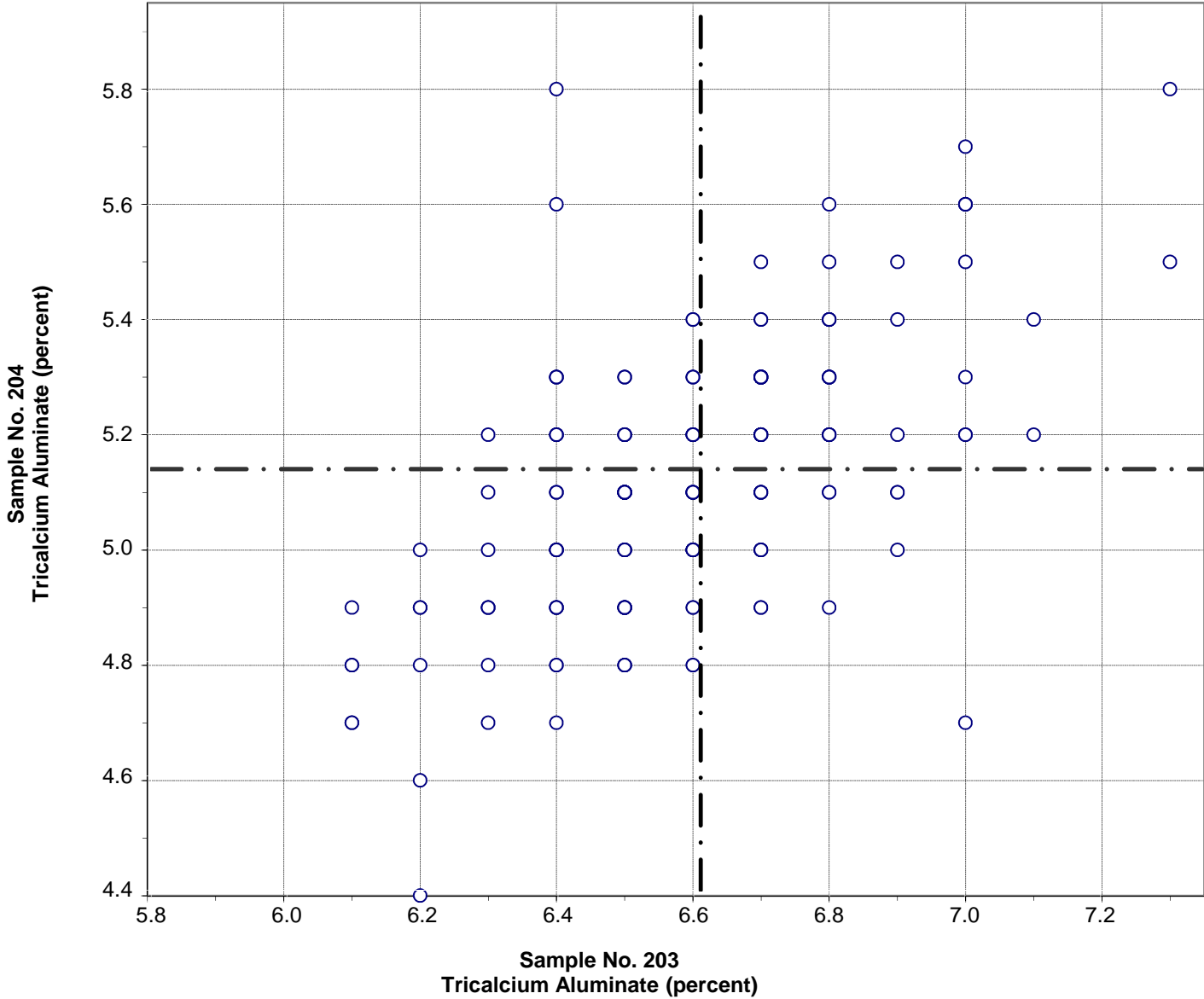


Test No. 107 Dicalcium Silicate 196 Points

Sample No. 203	Ave 14.3	S.D. 2.8	C.V. 19.4
Sample No. 204	Ave 13.0	S.D. 2.9	C.V. 22.0

Labs Eliminated: 137, 206, 1942, 4206

**CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 203 and No. 204**



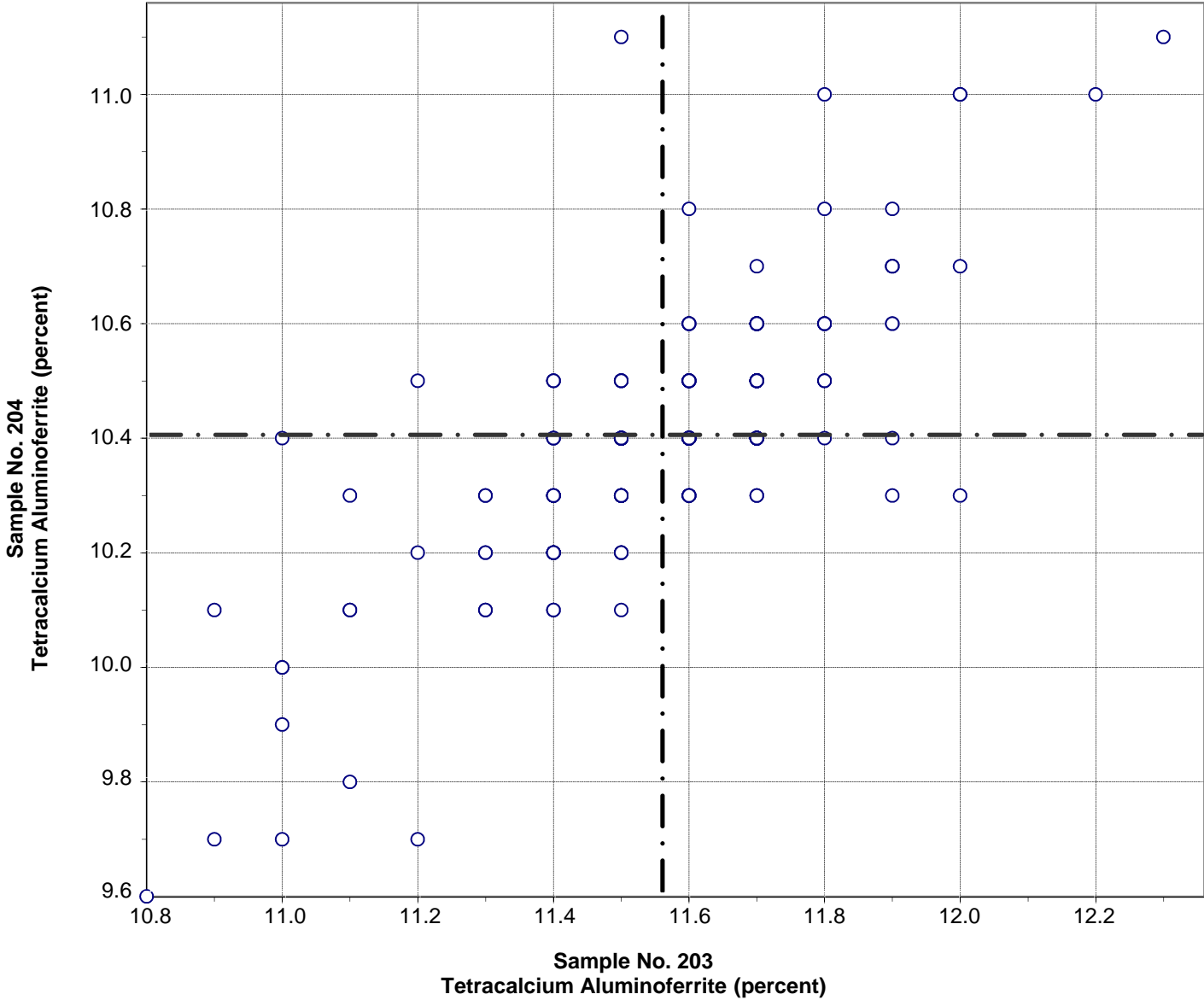
Test No. 108 Tricalcium Aluminate 191 Points

Sample No. 203	Ave 6.6	S.D. 0.2	C.V. 3.6
Sample No. 204	Ave 5.1	S.D. 0.2	C.V. 4.8

Labs Eliminated: 134, 494, 2477, 3238, 4137

Labs off Diagram: 42, 206, 1956, 4206

**CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 203 and No. 204**



Test No. 109 Tetracalcium Aluminoferrite 193 Points

Sample No. 203	Ave 11.6	S.D. 0.2	C.V. 2.0
Sample No. 204	Ave 10.4	S.D. 0.2	C.V. 2.2

Labs Eliminated: 134, 438, 494, 2477, 3238

Labs off Diagram: 60, 4051

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Physical Results
 March 15, 2017

SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
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Normal Consistency - % Water (percent)

256	26.3	2.90	11.00	26.6	2.84	10.70
*249	26.4	0.45	1.70	26.7	0.46	1.70

* Labs Eliminated - 497, 557, 2477, 3850, 4080, 4137, 4200

Vicat Time of Set - Initial (minutes)

252	127	13	10	138	13	10
*247	126	12	9	138	12	8

* Labs Eliminated - 1715, 2462, 2477, 4142, 4206

Vicat Time of Set - Final (minutes)

244	222	32	14	242	31	13
*237	219	27	12	240	28	12

* Labs Eliminated - 8, 74, 132, 165, 1466, 3801, 4206

Gillmore Time of Set - Initial (minutes)

144	161	23	14	175	23	13
*141	160	22	14	173	20	11

* Labs Eliminated - 18, 408, 493

Gillmore Time of Set - Final (minutes)

144	254	37	15	276	35	13
*143	254	36	14	275	33	12

* Labs Eliminated - 18

False Set - Paste Method (percent)

191	81	8.0	9.9	79	9.0	11.4
*189	81	8.0	9.9	79	8.4	10.6

* Labs Eliminated - 565, 1079

Autoclave Expansion (percent)

237	-0.01	0.033	180	0.03	0.041	154
*225	-0.01	0.018	107	0.02	0.018	75

* Labs Eliminated - 24, 32, 431, 493, 502, 515, 698, 2477, 2484, 4093, 4137, 4200

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Physical Results
 March 15, 2017

SUMMARY OF RESULTS

Test (unit)	Sample No.203				Sample No. 204		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Air Content % (percent)							
	236	8.3	1.3	15	9.3	1.3	14
	*232	8.4	1.1	13	9.3	1.1	12
* Labs Eliminated - 3297, 3801, 4051, 4200							
Air Content - % Water (percent)							
	230	68.7	9.4	13.7	67.7	9.3	13.8
	*216	69.9	2.3	3.3	68.9	2.5	3.7
* Labs Eliminated - 51, 60, 66, 101, 129, 692, 694, 1644, 3662, 3801, 4039, 4093, 4200, 4206							
Air Content - Flow (percent)							
	232	86	3.5	4.1	89	3.4	3.8
No Labs Eliminated for This Test							
Compressive Strength - 3 day (psi)							
	259	3527	257	7.3	3687	241	6.5
	*253	3537	232	6.5	3699	220	6.0
* Labs Eliminated - 39, 42, 360, 474, 1222, 3801							
Compressive Strength - 7 day (psi)							
	259	4378	286	6.5	4357	270	6.2
	*255	4385	265	6.0	4364	255	5.9
* Labs Eliminated - 9, 474, 1222, 3801							
Compressive Strength - 28 day (psi)							
	244	5835	413	7.1	5381	364	6.8
	*241	5846	390	6.7	5383	349	6.5
* Labs Eliminated - 360, 515, 958							
Compressive Strength - Flow (percent)							
	226	107	10	9.1	113	10	8.9
	*222	108	9	8.1	114	9	8.1
* Labs Eliminated - 840, 2481, 3801, 4206							

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Physical Results
 March 15, 2017

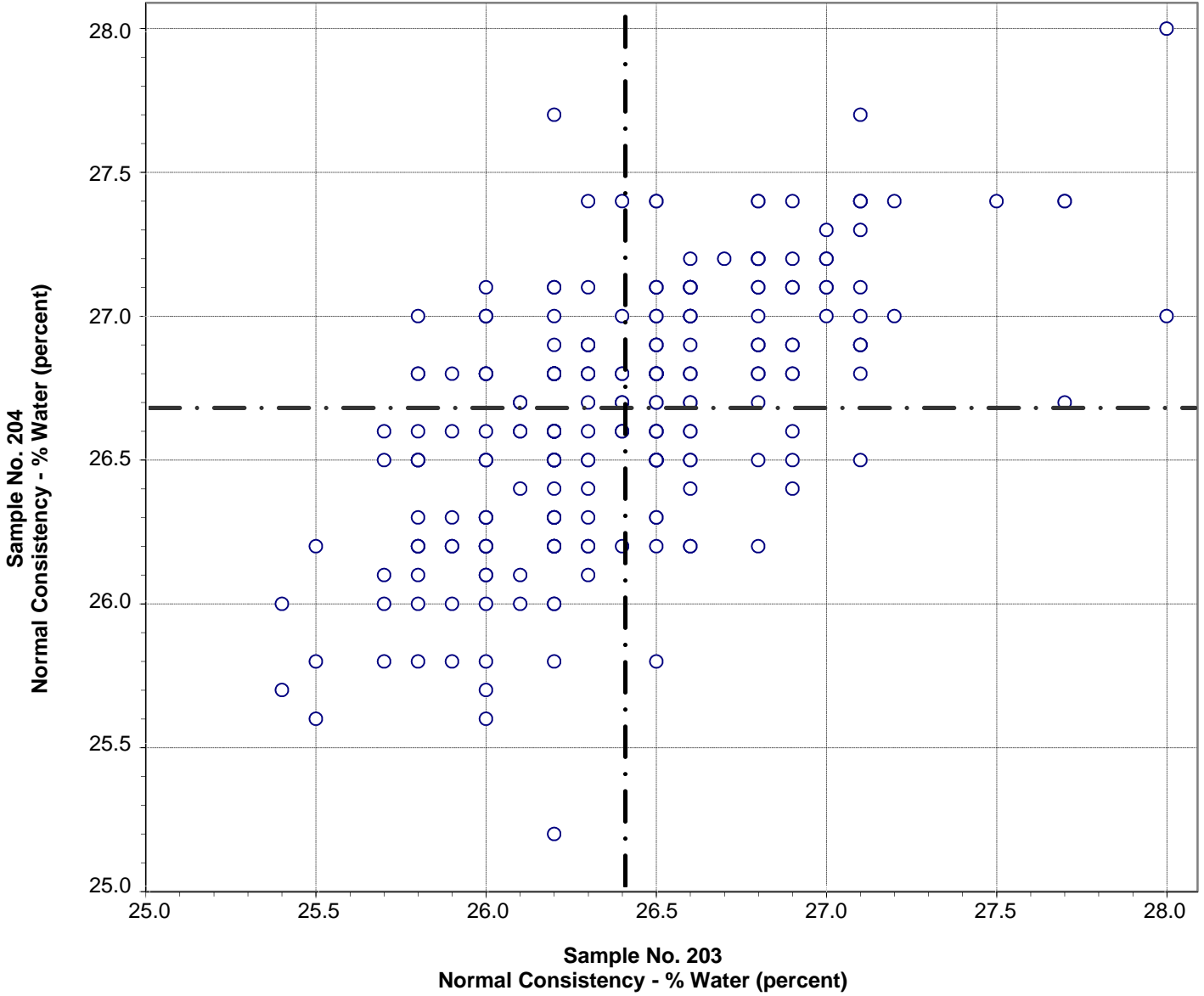
SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Fineness - Air Permeability (m²/kg)							
	250	395	17	4.2	450	18	4.1
	*239	396	10	2.6	450	13	3.0
* Labs Eliminated - 4, 7, 24, 51, 52, 116, 252, 3606, 3819, 4200, 4206							
Fineness - 45µm Sieve (percent)							
	233	95.12	4.04	4.25	97.06	0.46	0.48
	*224	95.39	0.67	0.70	97.09	0.39	0.40
* Labs Eliminated - 18, 39, 132, 143, 219, 768, 2254, 2293, 3057							
C1038 Mortar Bar Expansion (percent)							
	165	0.004	0.006	162	0.006	0.008	126
	*155	0.003	0.003	97	0.005	0.004	68
* Labs Eliminated - 14, 26, 116, 121, 176, 203, 222, 1435, 4115, 4206							

CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 203 and No. 204



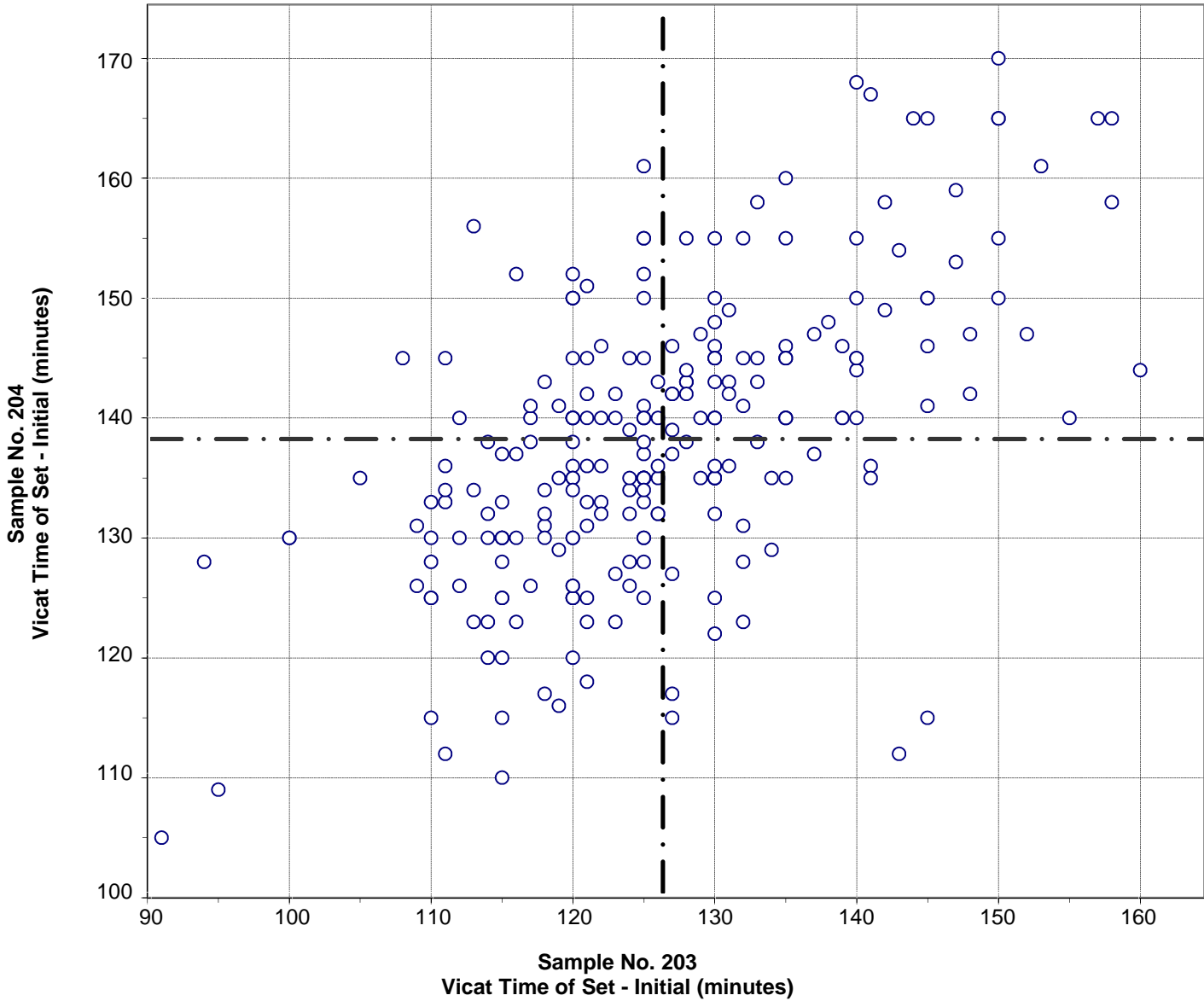
Test No. 110 Normal Consistency - % Water 247 Points

Sample No. 203	Ave 26.4	S.D. 0.45	C.V. 1.70
Sample No. 204	Ave 26.7	S.D. 0.46	C.V. 1.70

Labs Eliminated: 497, 557, 2477, 3850, 4080, 4137, 4200

Labs off Diagram: 25, 640

**CCRL Proficiency Sample Program
 Vicat Time of Set - Initial
 PORTLAND CEMENT Samples No. 203 and No. 204**

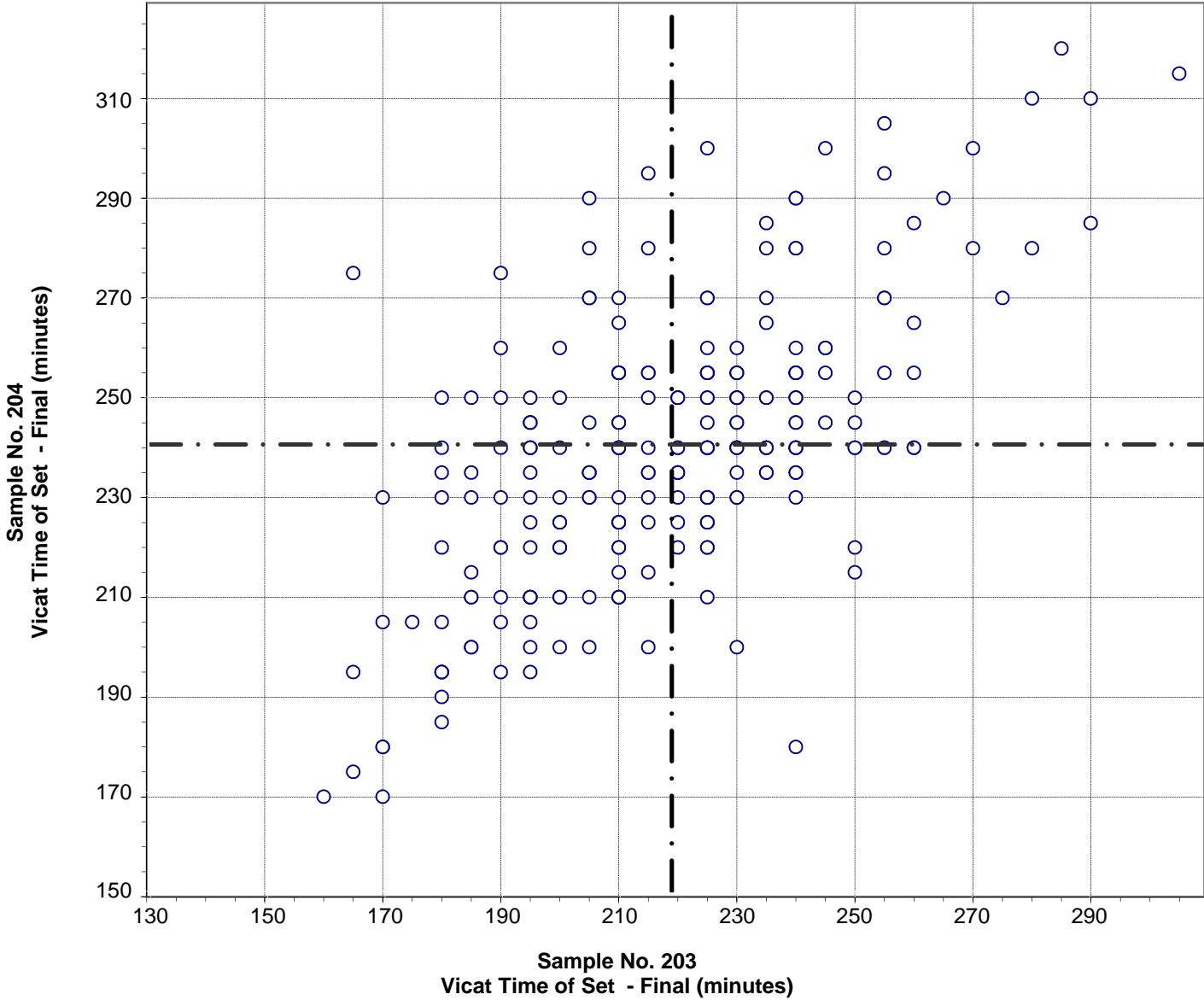


Test No. 120 Vicat Time of Set - Initial 247 Points

Sample No. 203	Ave 126	S.D. 12	C.V. 9
Sample No. 204	Ave 138	S.D. 12	C.V. 8

Labs Eliminated: 1715, 2462, 2477, 4142, 4206

**CCRL Proficiency Sample Program
 Vicat Time of Set - Final
 PORTLAND CEMENT Samples No. 203 and No. 204**



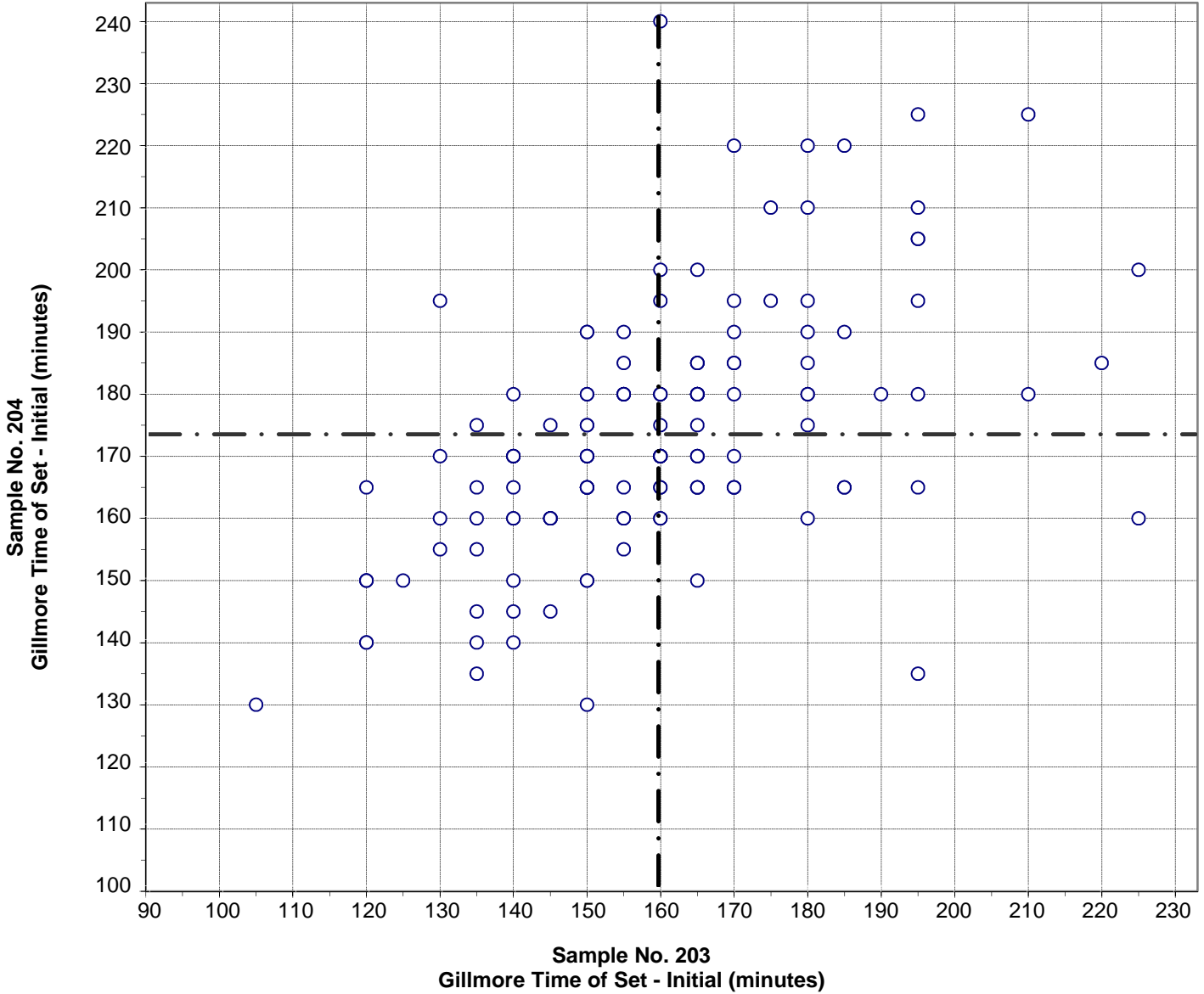
Test No. 121 Vicat Time of Set - Final 236 Points

Sample No. 203	Ave 219	S.D. 27	C.V. 12
Sample No. 204	Ave 240	S.D. 28	C.V. 12

Labs Eliminated: 8, 74, 132, 165, 1466, 3801, 4206

Labs off Diagram: 34

**CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 203 and No. 204**

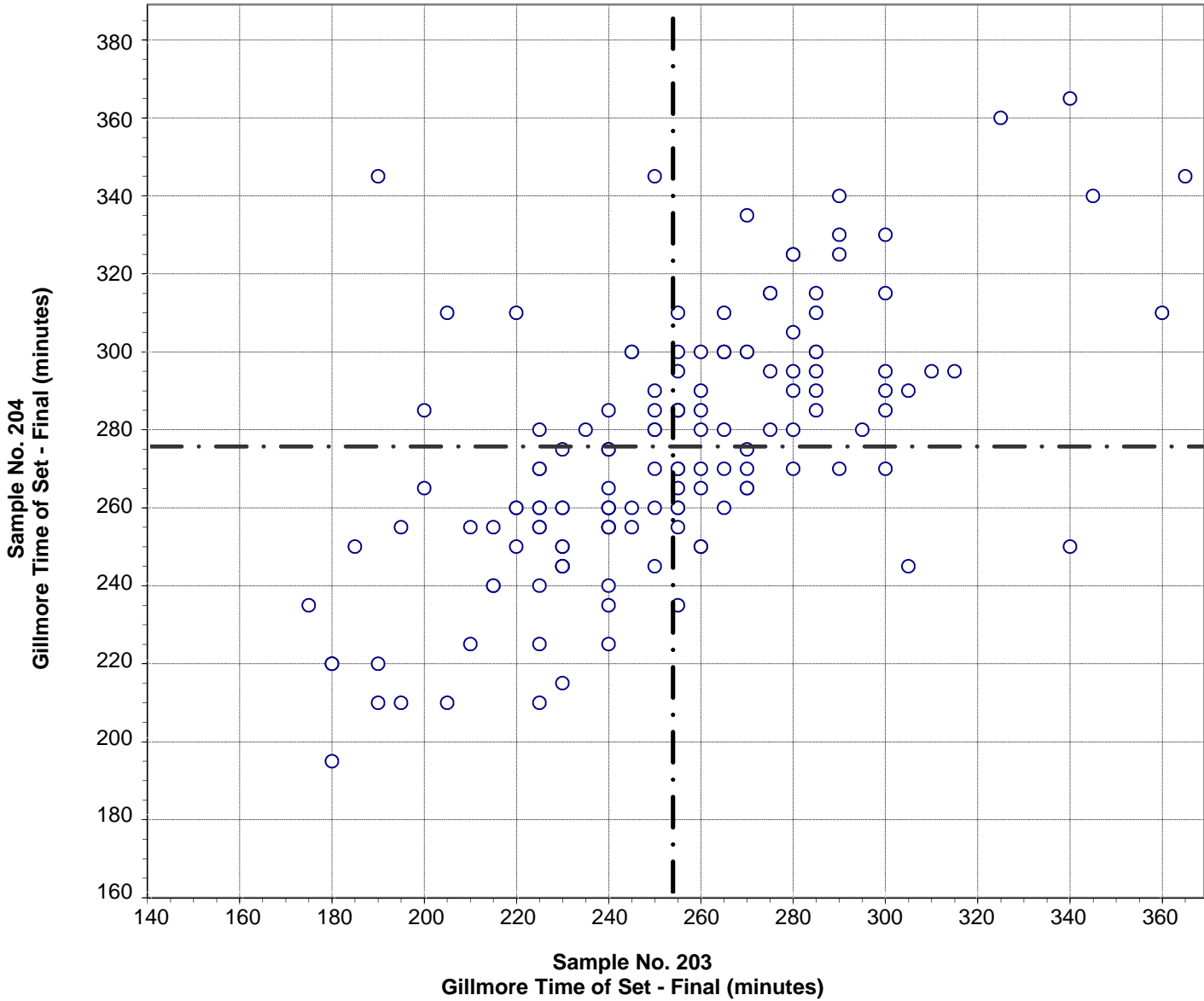


Test No. 130 Gillmore Time of Set - Initial 141 Points

Sample No. 203	Ave 160	S.D. 22	C.V. 14
Sample No. 204	Ave 173	S.D. 20	C.V. 11

Labs Eliminated: 18, 408, 493

**CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 203 and No. 204**

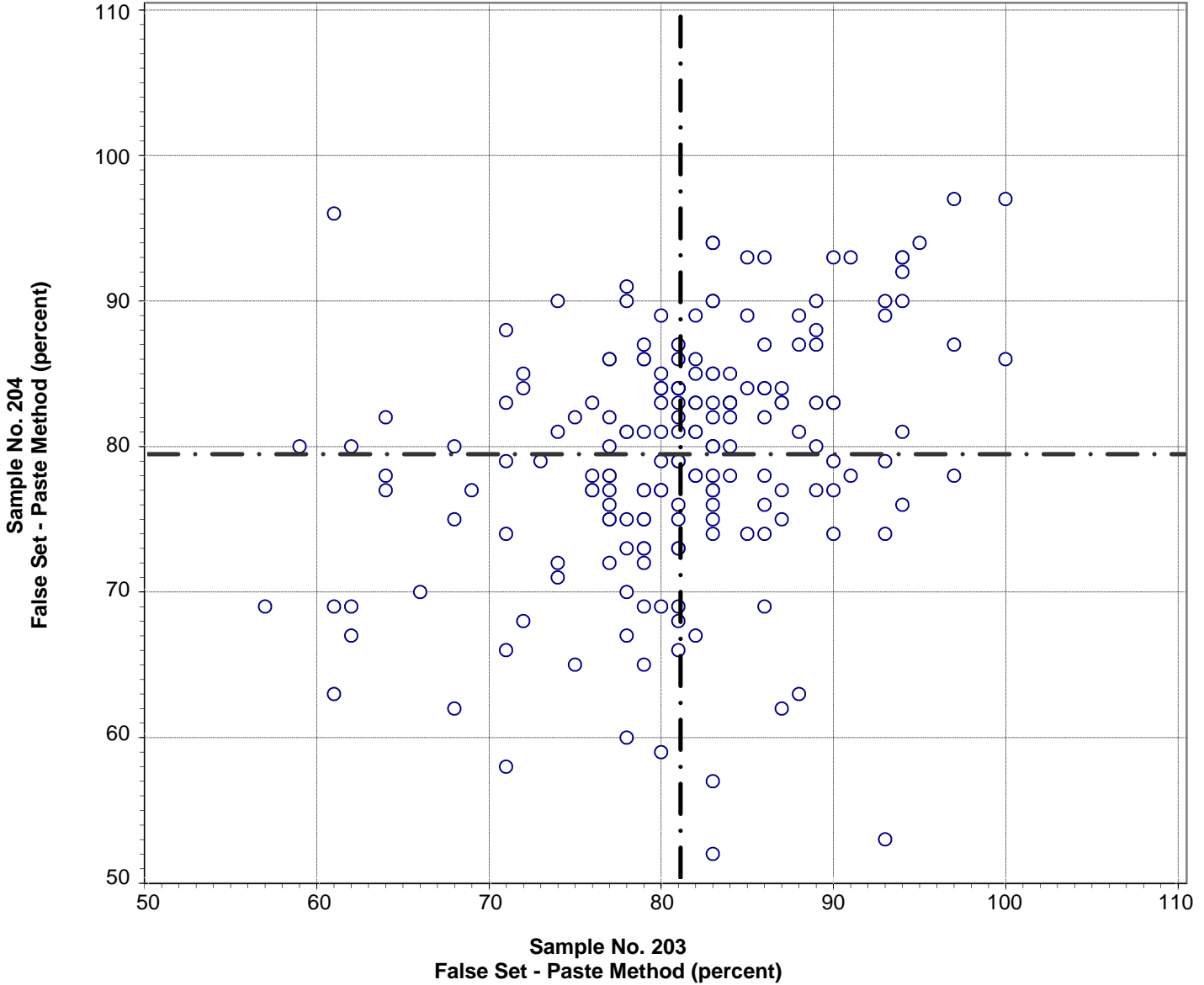


Test No. 140 Gillmore Time of Set - Final 143 Points

Sample No. 203	Ave 254	S.D. 36	C.V. 14
Sample No. 204	Ave 275	S.D. 33	C.V. 12

Labs Eliminated: 18

**CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 203 and No. 204**

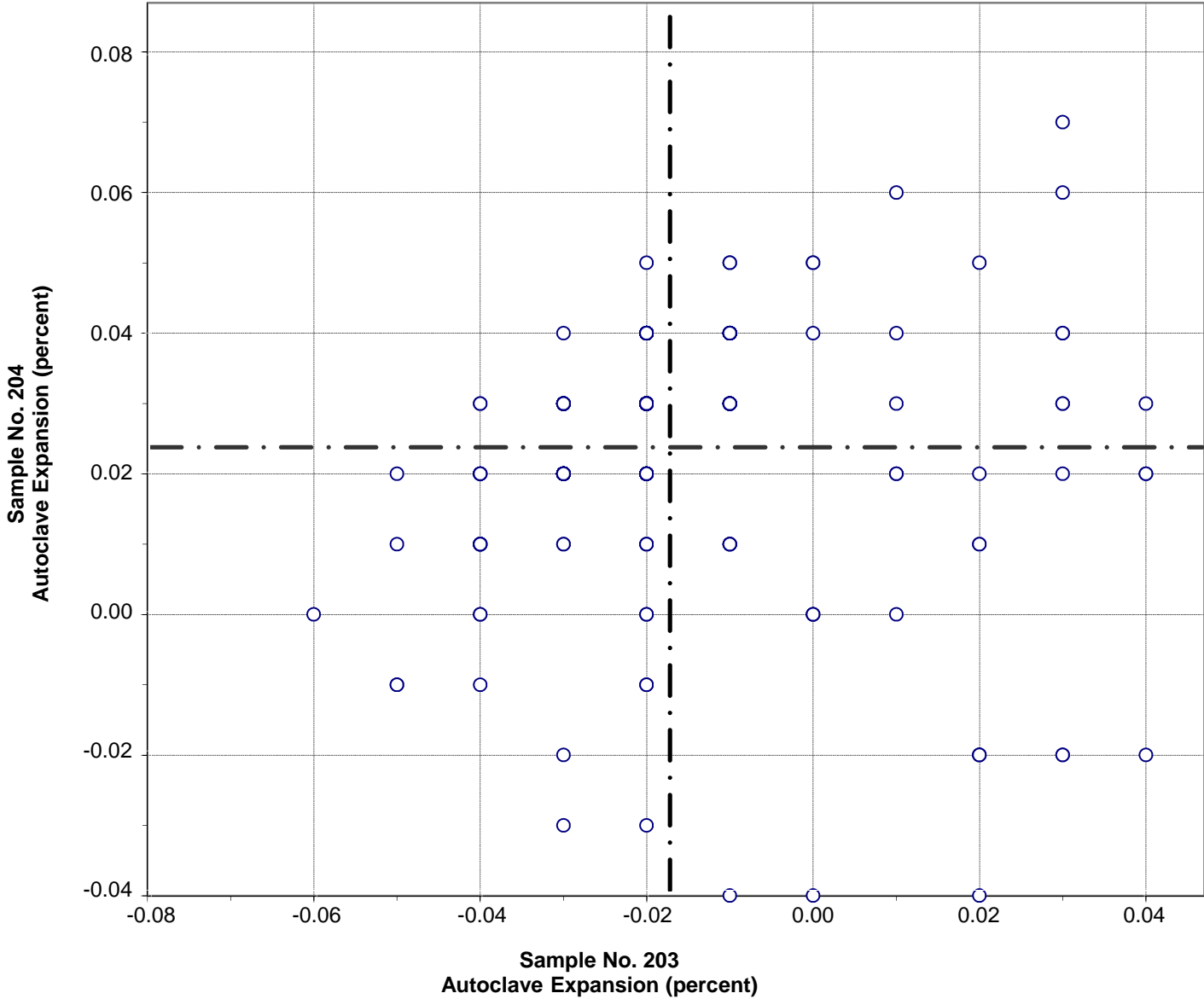


Test No. 150 False Set - Paste Method 189 Points

Sample No. 203	Ave 81	S.D. 8.0	C.V. 9.9
Sample No. 204	Ave 79	S.D. 8.4	C.V. 10.6

Labs Eliminated: 565, 1079

**CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 203 and No. 204**

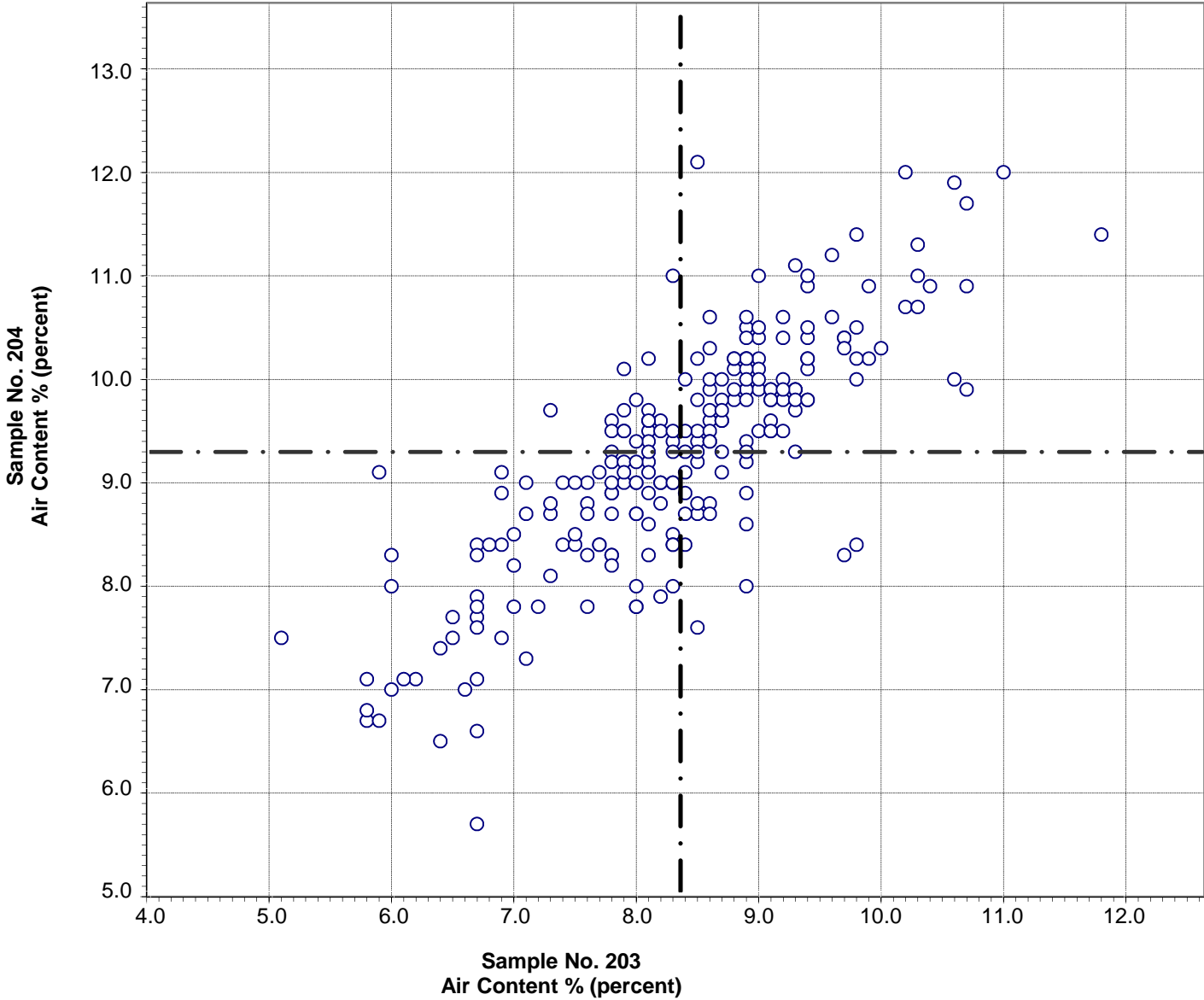


Test No. 160 Autoclave Expansion 225 Points

Sample No. 203	Ave -0.01	S.D. 0.018	C.V. 107
Sample No. 204	Ave 0.02	S.D. 0.018	C.V. 75

Labs Eliminated: 24, 32, 431, 493, 502, 515, 698, 2477, 2484, 4093, 4137, 4200

CCRL Proficiency Sample Program
Air Content %
PORTLAND CEMENT Samples No. 203 and No. 204

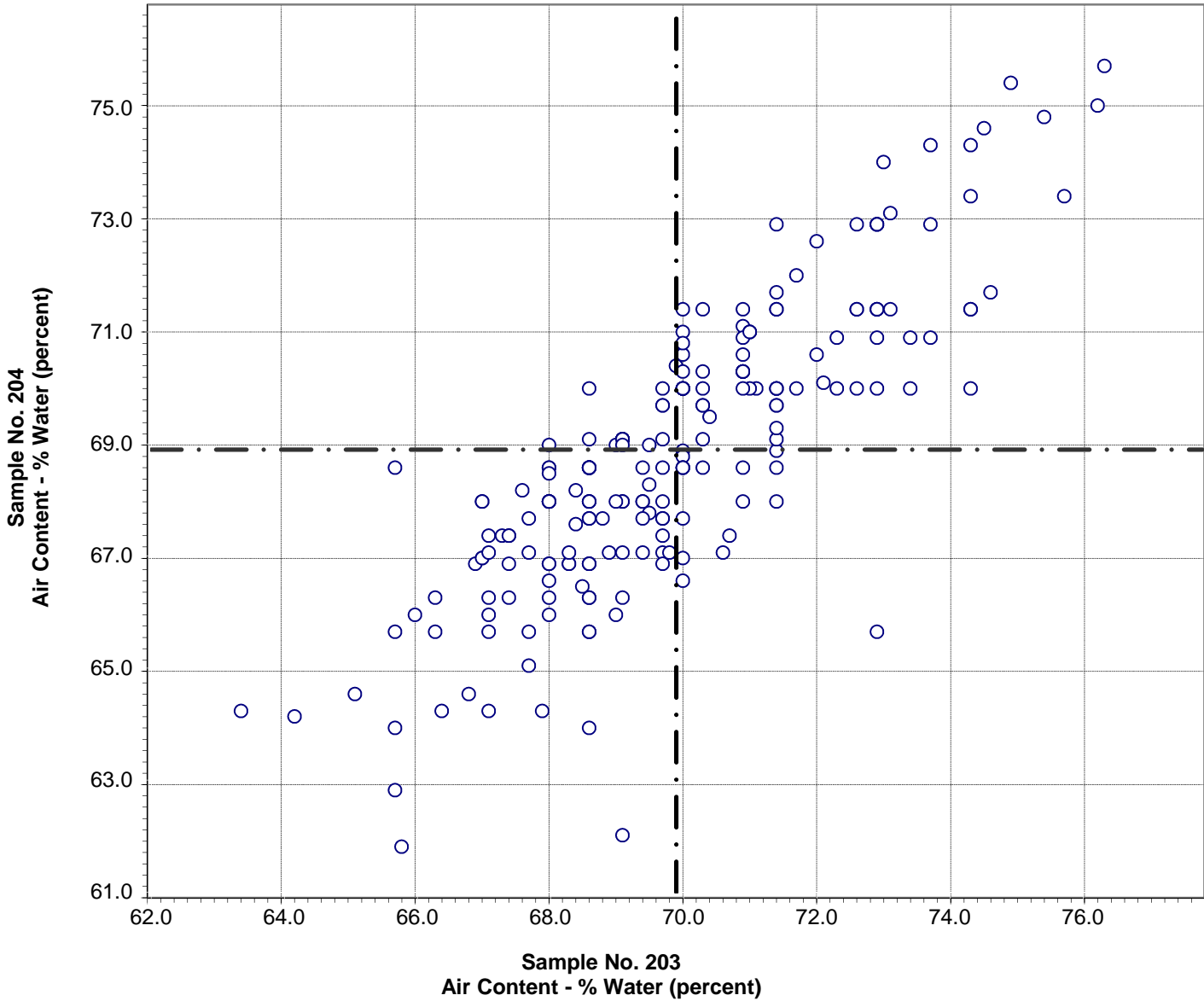


Test No. 170 Air Content % 232 Points

Sample No. 203	Ave 8.4	S.D. 1.1	C.V. 13
Sample No. 204	Ave 9.3	S.D. 1.1	C.V. 12

Labs Eliminated: 3297, 3801, 4051, 4200

CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 203 and No. 204



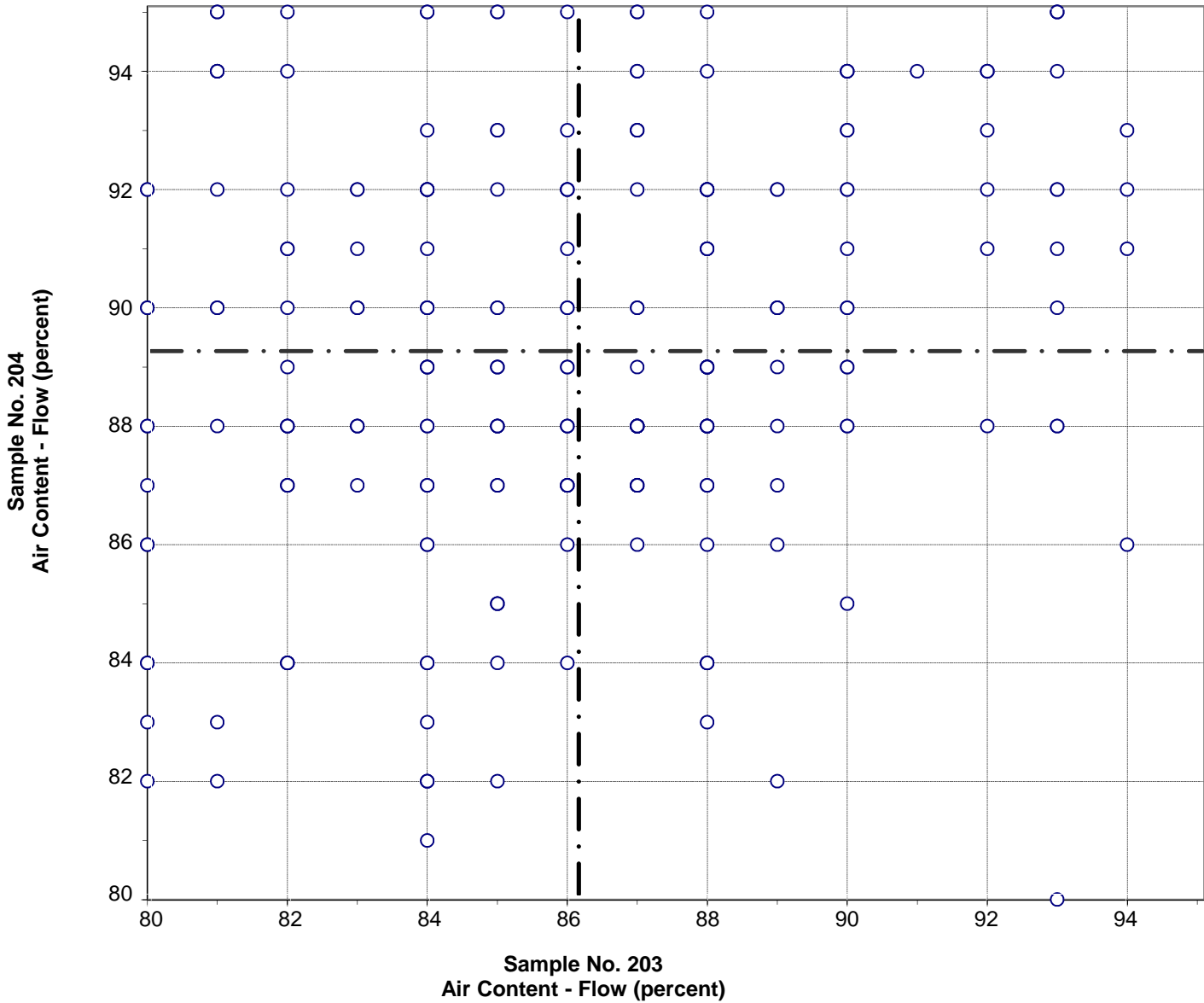
Test No. 180 Air Content - % Water 215 Points

Sample No. 203	Ave 69.9	S.D. 2.3	C.V. 3.3
Sample No. 204	Ave 68.9	S.D. 2.5	C.V. 3.7

Labs Eliminated: 51, 60, 66, 101, 129, 692, 694, 1644, 3662, 3801, 4039, 4093, 4200, 4206

Labs off Diagram: 2296

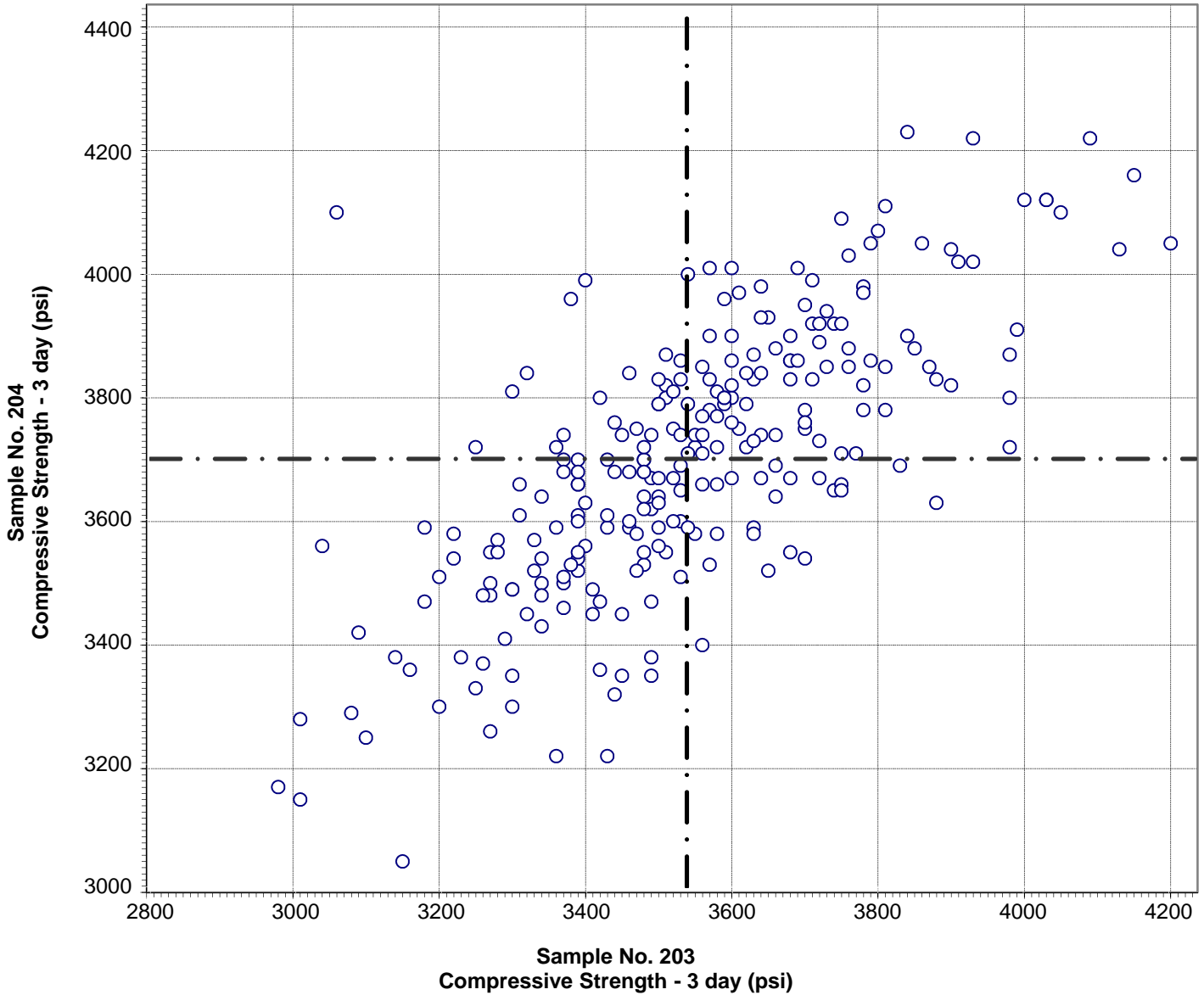
**CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 203 and No. 204**



Test No. 190 Air Content - Flow 232 Points

Sample No. 203	Ave 86	S.D. 3.5	C.V. 4.1
Sample No. 204	Ave 89	S.D. 3.4	C.V. 3.8

**CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 203 and No. 204**



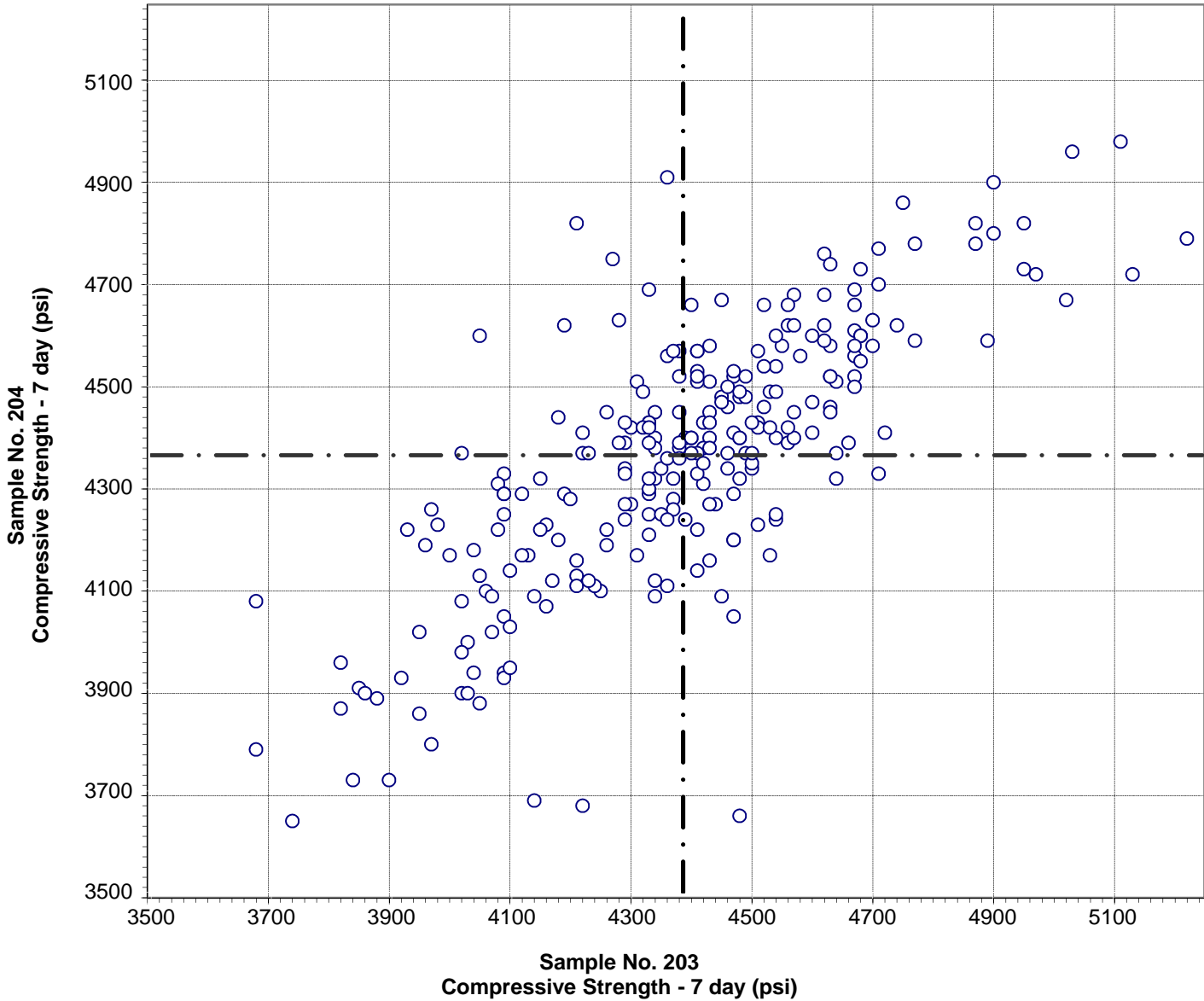
Test No. 200 Compressive Strength - 3 day 251 Points

Sample No. 203	Ave 3537	S.D. 232	C.V. 6.5
Sample No. 204	Ave 3699	S.D. 220	C.V. 6.0

Labs Eliminated: 39, 42, 360, 474, 1222, 3801

Labs off Diagram: 9, 49

**CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 203 and No. 204**

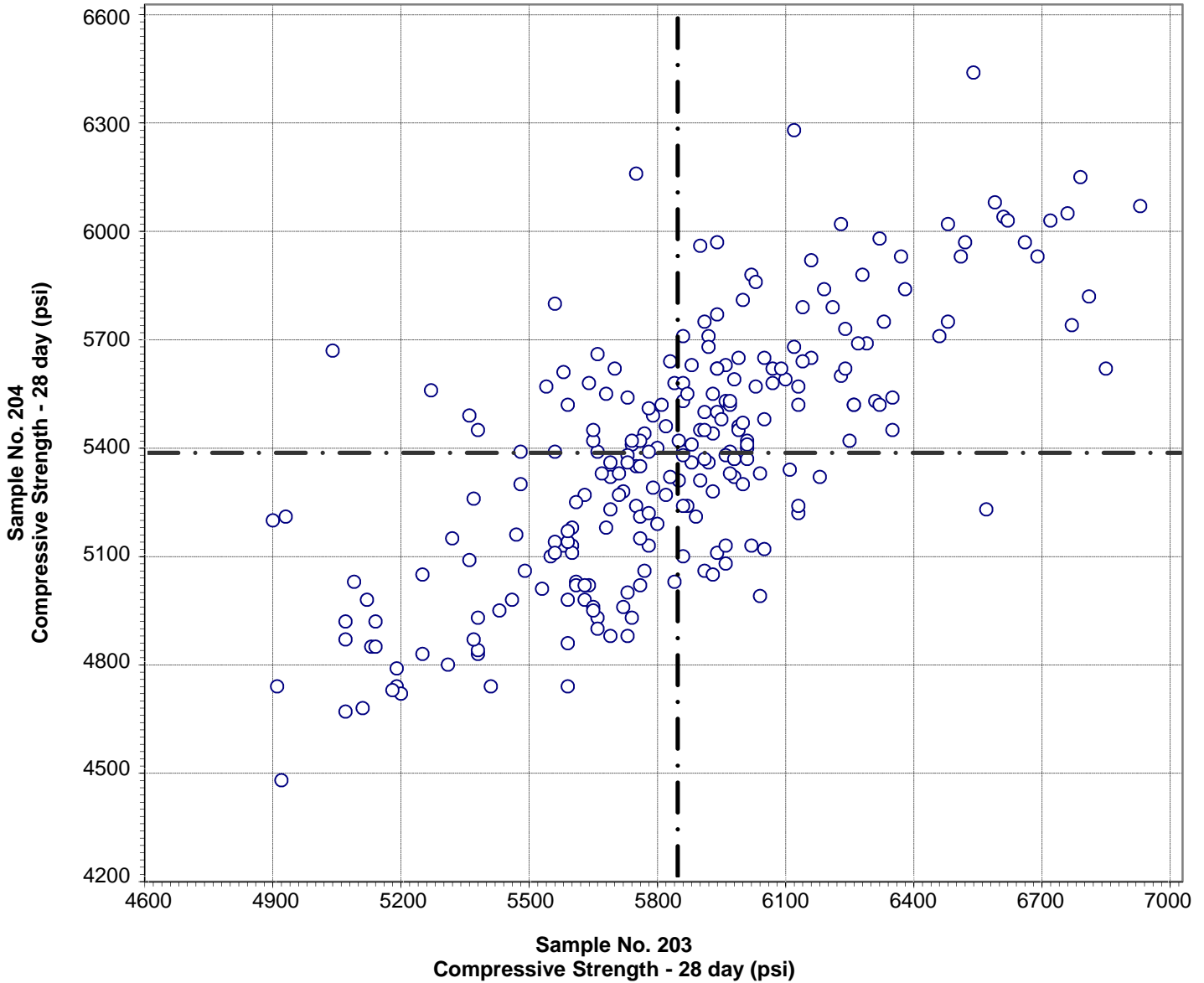


Test No. 210 Compressive Strength - 7 day 255 Points

Sample No. 203	Ave 4385	S.D. 265	C.V. 6.0
Sample No. 204	Ave 4364	S.D. 255	C.V. 5.9

Labs Eliminated: 9, 474, 1222, 3801

**CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 203 and No. 204**

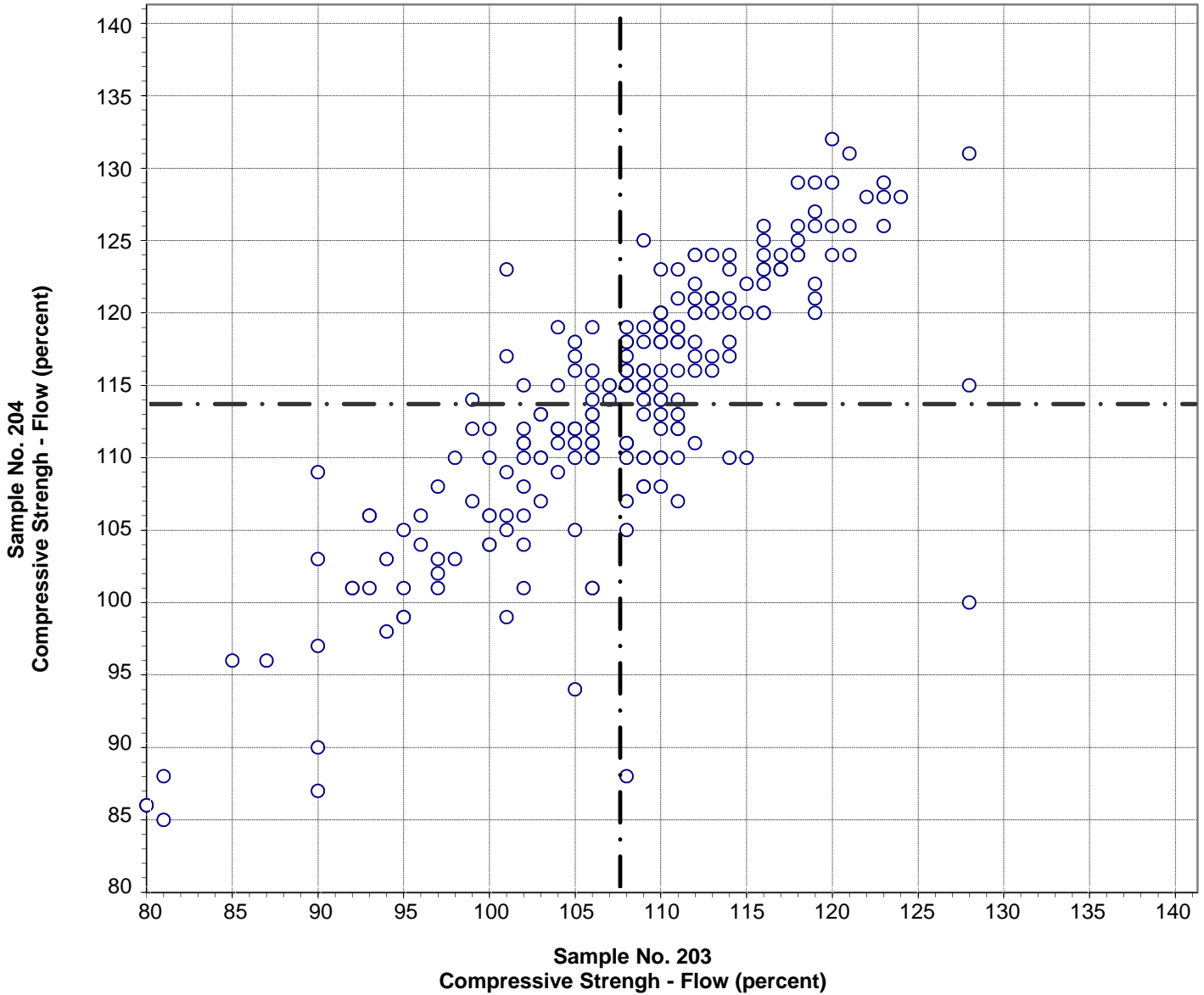


Test No. 211 Compressive Strength - 28 day 241 Points

Sample No. 203	Ave 5846	S.D. 390	C.V. 6.7
Sample No. 204	Ave 5383	S.D. 349	C.V. 6.5

Labs Eliminated: 360, 515, 958

**CCRL Proficiency Sample Program
Compressive Strength - Flow
PORTLAND CEMENT Samples No. 203 and No. 204**

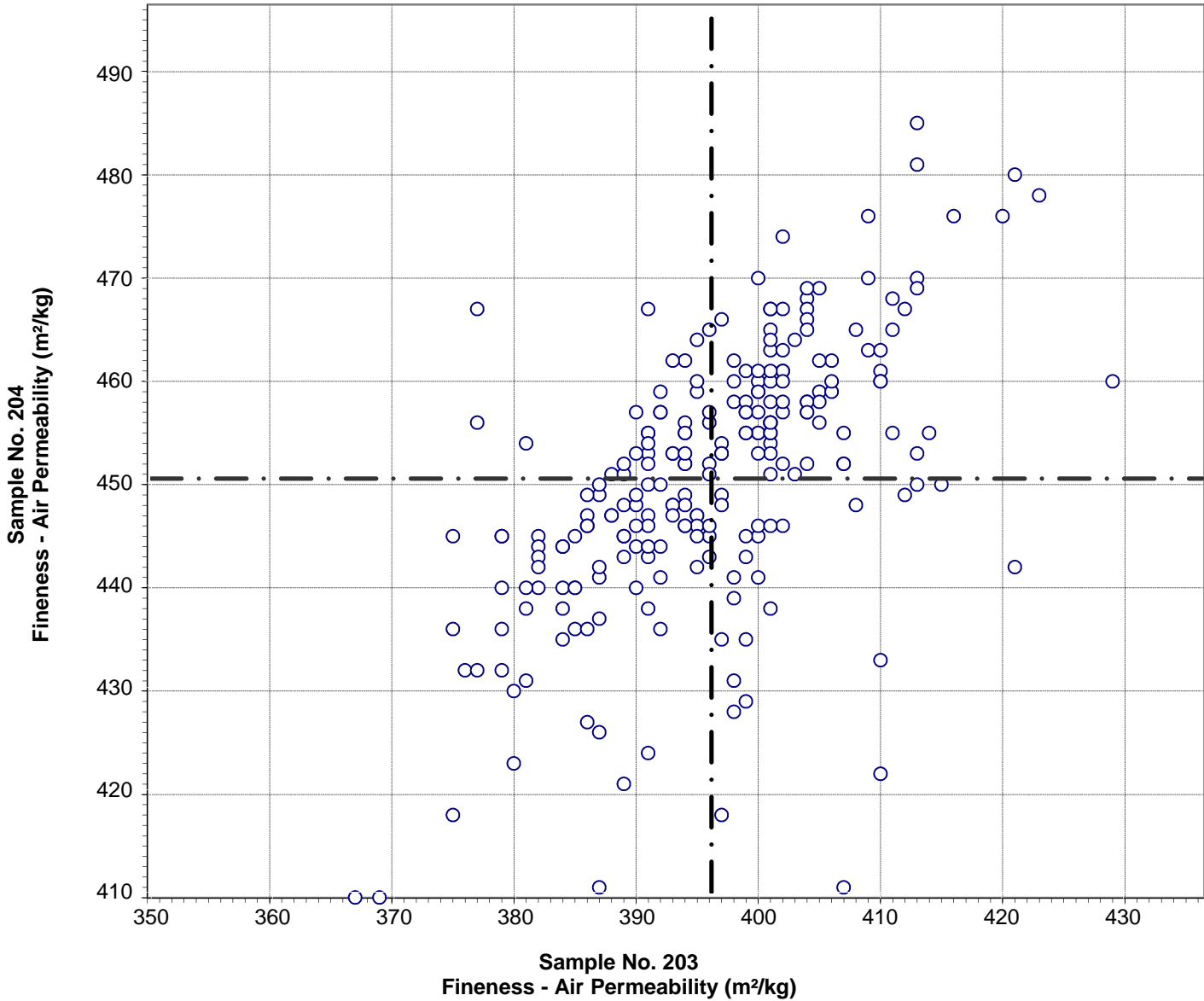


Test No. 230 Compressive Strength - Flow 222 Points

Sample No. 203	Ave 108	S.D. 9	C.V. 8.1
Sample No. 204	Ave 114	S.D. 9	C.V. 8.1

Labs Eliminated: 840, 2481, 3801, 4206

**CCRL Proficiency Sample Program
Fineness - Air Permeability
PORTLAND CEMENT Samples No. 203 and No. 204**



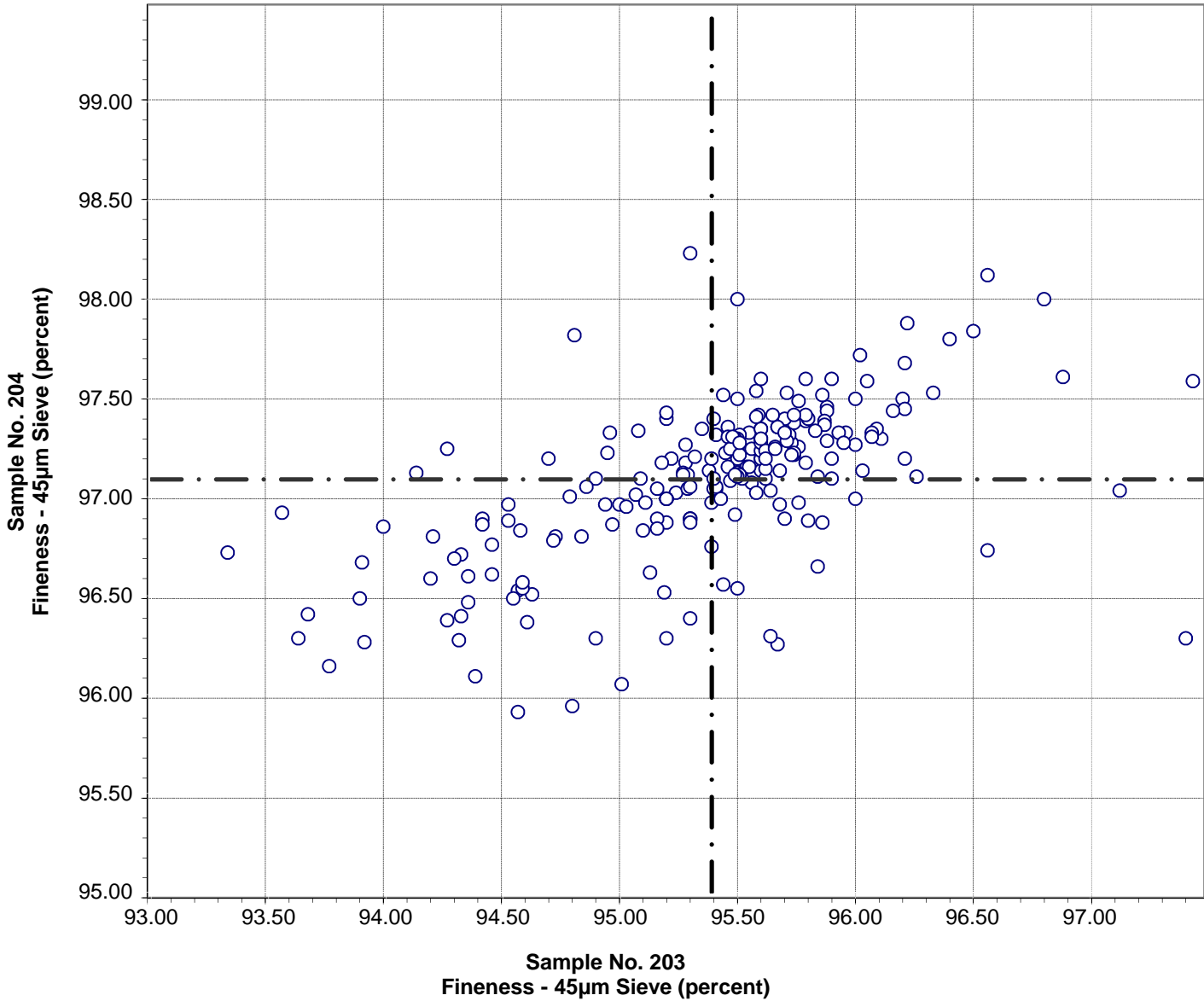
Test No. 270 Fineness - Air Permeability 237 Points

Sample No. 203	Ave 396	S.D. 10	C.V. 2.6
Sample No. 204	Ave 450	S.D. 13	C.V. 3.0

Labs Eliminated: 4, 7, 24, 51, 52, 116, 252, 3606, 3819, 4200, 4206

Labs off Diagram: 146, 4150

**CCRL Proficiency Sample Program
Fineness - 45 μ m Sieve
PORTLAND CEMENT Samples No. 203 and No. 204**



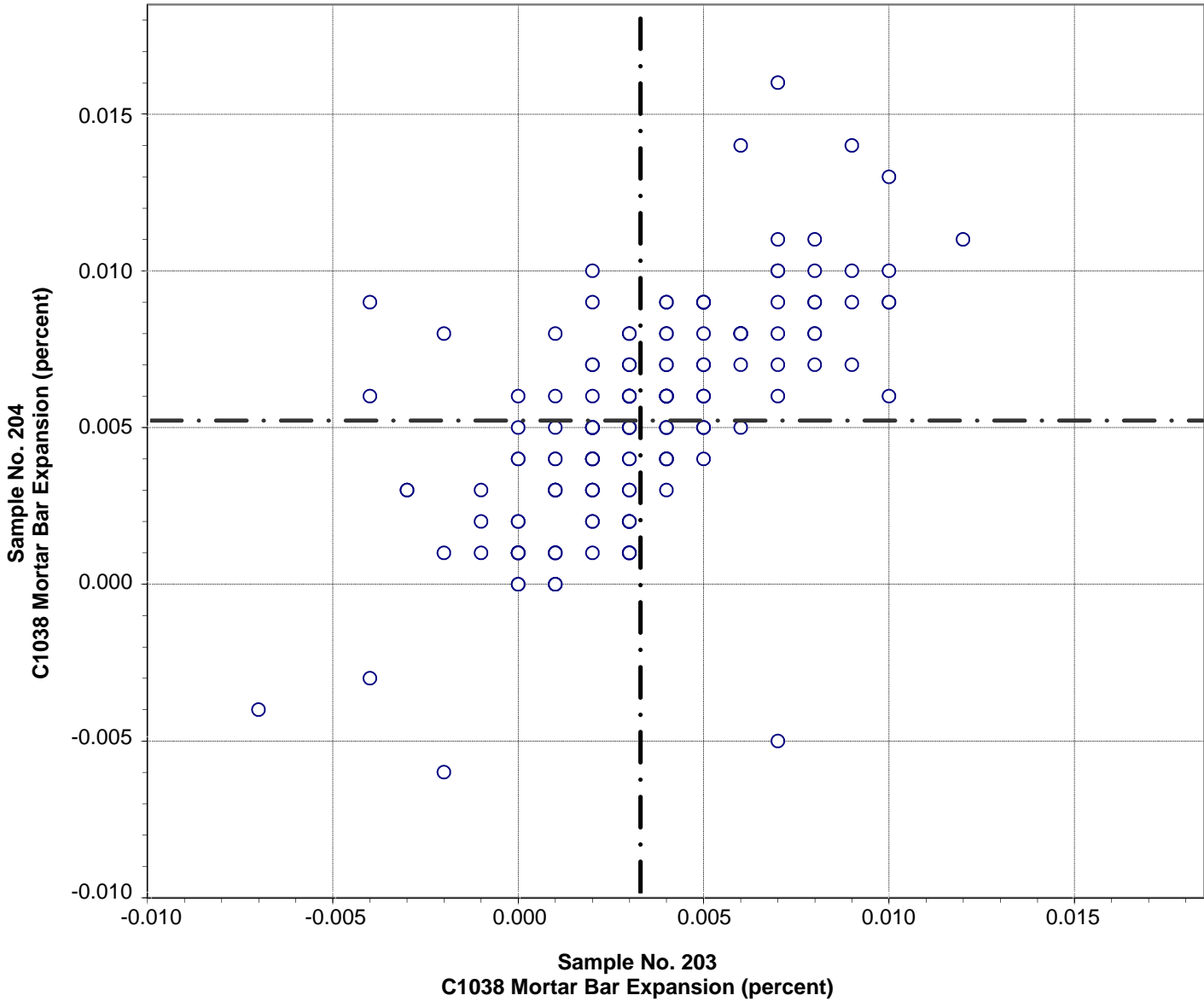
Test No. 281 Fineness - 45 μ m Sieve 223 Points

Sample No. 203	Ave 95.39	S.D. 0.67	C.V. 0.70
Sample No. 204	Ave 97.09	S.D. 0.39	C.V. 0.40

Labs Eliminated: 18, 39, 132, 143, 219, 768, 2254, 2293, 3057

Labs off Diagram: 3607

**CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 203 and No. 204**



Test No. 400 C1038 Mortar Bar Expansion 155 Points

Sample No. 203	Ave 0.003	S.D. 0.003	C.V. 97
Sample No. 204	Ave 0.005	S.D. 0.004	C.V. 68

Labs Eliminated: 14, 26, 116, 121, 176, 203, 222, 1435, 4115, 4206

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 203 and No. 204

Final Report – Heat of Hydration Results
 March 15, 2017

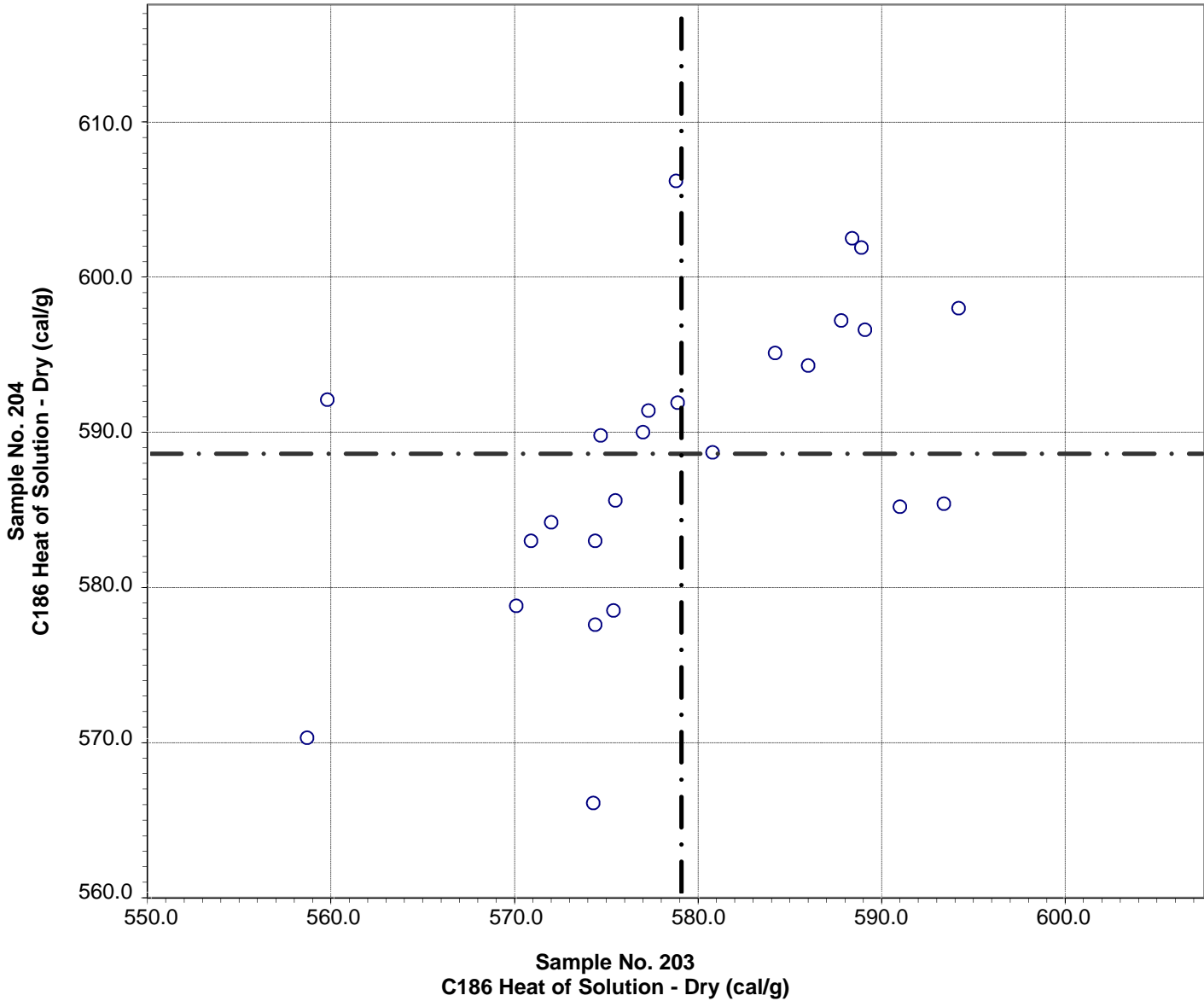
SUMMARY OF RESULTS

Sample No.203

Sample No. 204

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
C186 Heat of Solution - Dry (cal/g)							
	27	577.0	13.3	2.3	581.0	31.0	5.3
	*25	579.0	9.4	1.6	589.0	9.8	1.7
* Labs Eliminated - 2254, 4135							
C186 Heat of Solution - 7 day (cal/g)							
	26	503.0	11.3	2.2	508.1	10.8	2.1
	*25	504.5	8.5	1.7	509.5	8.3	1.6
* Labs Eliminated - 4135							
C186 Heat of Solution 28 day (cal/g)							
	21	494.6	8.6	1.7	501.0	9.4	1.9
No Labs Eliminated for This Test							
C186 Heat of Hydration - 7 day (cal/g)							
	30	73.8	10.0	13.5	78.9	8.0	10.1
No Labs Eliminated for This Test							
C186 Heat of Hydration - 28 day (cal/g)							
	25	84.7	9.4	11.2	89.2	9.0	10.1
	*24	85.9	7.3	8.5	89.9	8.5	9.5
* Labs Eliminated - 3057							
C1702 Heat of Hydration - 3 day (J/g)							
	15	265	64	24.1	285	64	22.5
	*13	285	12	4.2	310	12	3.9
* Labs Eliminated - 116, 3605							
C1702 Heat of Hydration - 7 day (J/g)							
	14	300	76	25.4	318	76	23.9
	*13	318	40	12.5	335	41	12.2
* Labs Eliminated - 3605							

**CCRL Proficiency Sample Program
C186 Heat of Solution - Dry
PORTLAND CEMENT Samples No. 203 and No. 204**

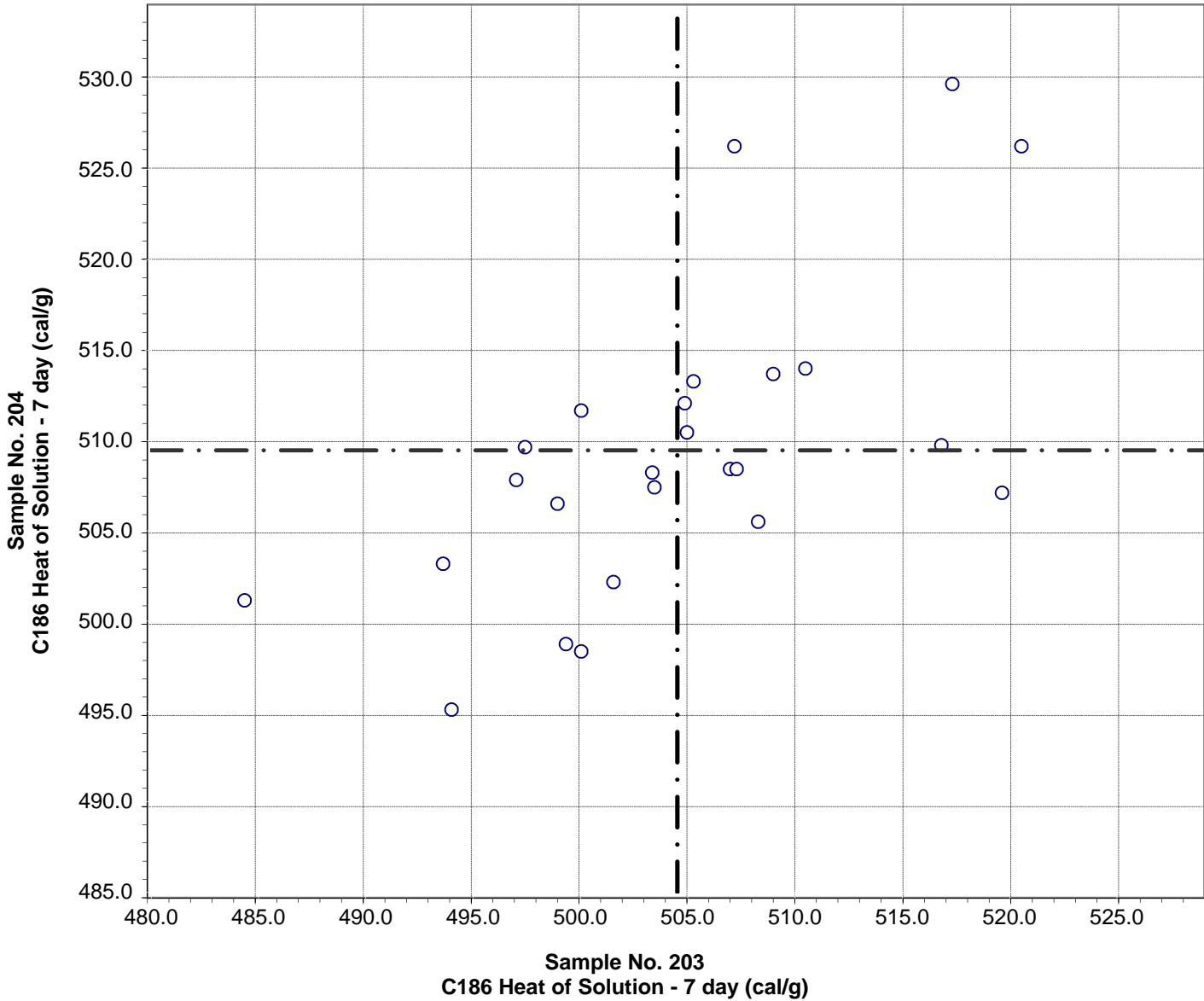


Test No. 291 C186 Heat of Solution - Dry 25 Points

Sample No. 203	Ave 579.0	S.D. 9.4	C.V. 1.6
Sample No. 204	Ave 589.0	S.D. 9.8	C.V. 1.7

Labs Eliminated: 2254, 4135

**CCRL Proficiency Sample Program
C186 Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 203 and No. 204**

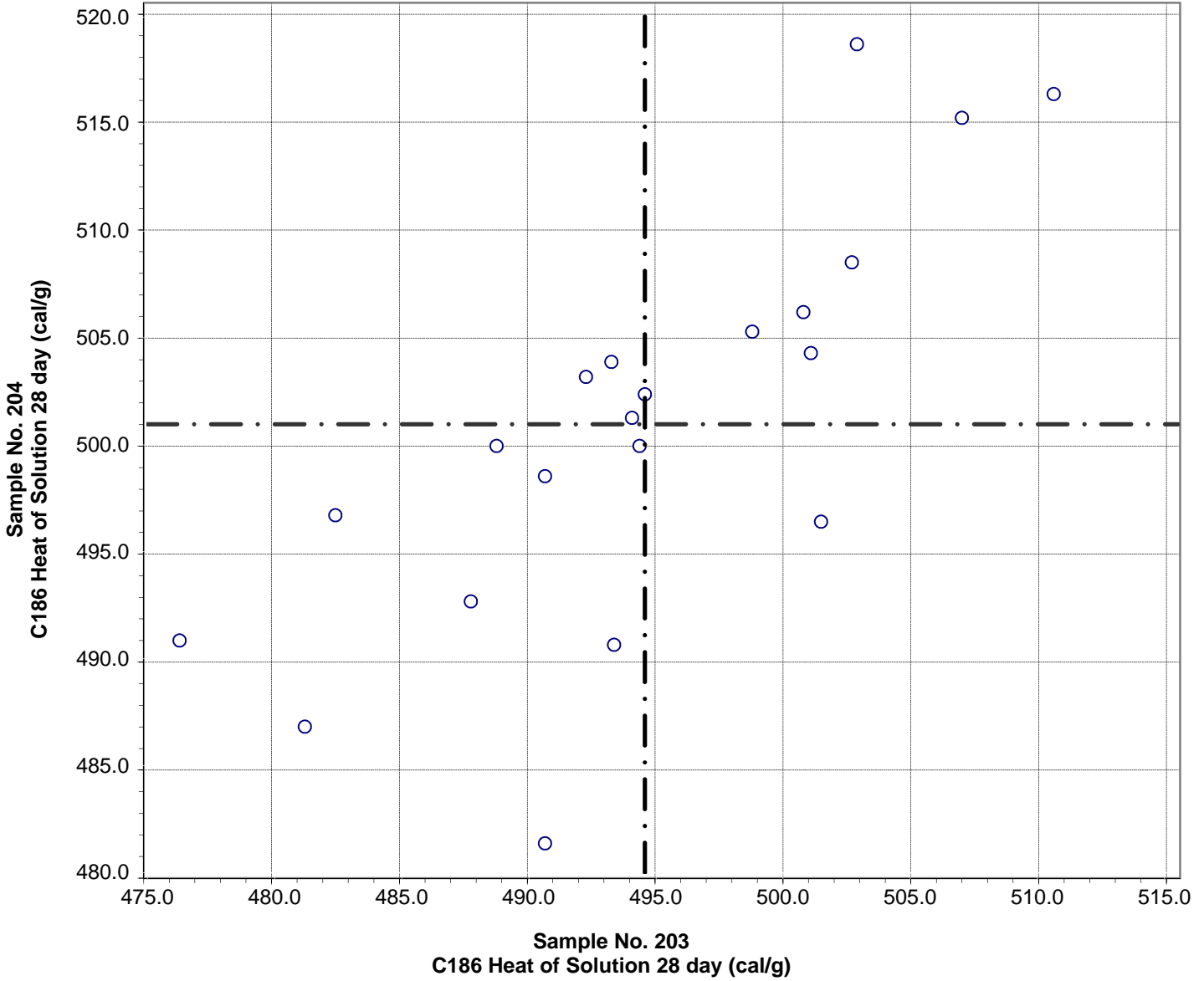


Test No. 292 C186 Heat of Solution - 7 day 25 Points

Sample No. 203	Ave 504.5	S.D. 8.5	C.V. 1.7
Sample No. 204	Ave 509.5	S.D. 8.3	C.V. 1.6

Labs Eliminated: 4135

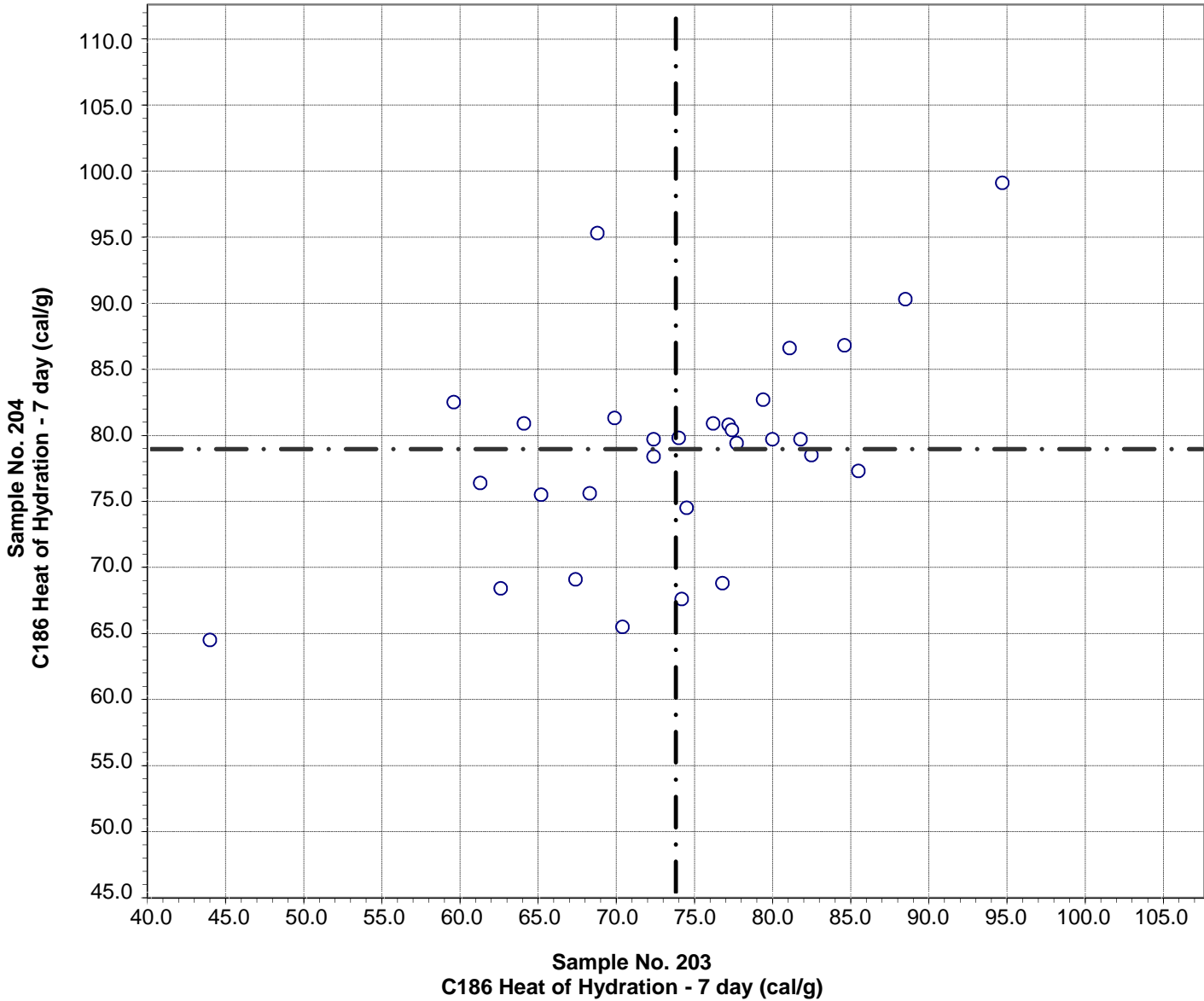
**CCRL Proficiency Sample Program
C186 Heat of Solution 28 day
PORTLAND CEMENT Samples No. 203 and No. 204**



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

Sample No. 203	Ave 494.6	S.D. 8.6	C.V. 1.7
Sample No. 204	Ave 501.0	S.D. 9.4	C.V. 1.9

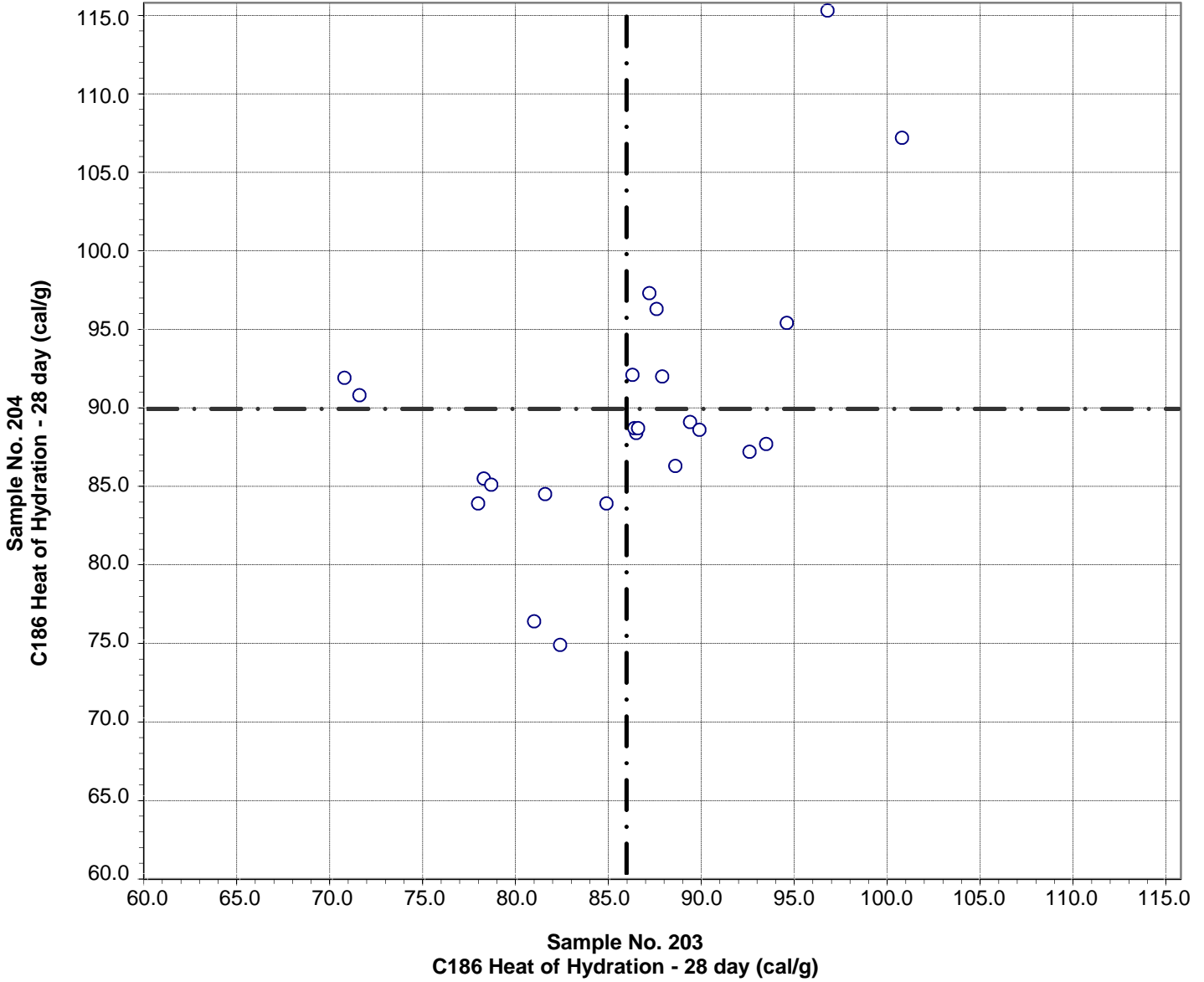
**CCRL Proficiency Sample Program
C186 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 203 and No. 204**



Test No. 290 C186 Heat of Hydration - 7 day 30 Points

Sample No. 203	Ave 73.8	S.D. 10.0	C.V. 13.5
Sample No. 204	Ave 78.9	S.D. 8.0	C.V. 10.1

**CCRL Proficiency Sample Program
C186 Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 203 and No. 204**

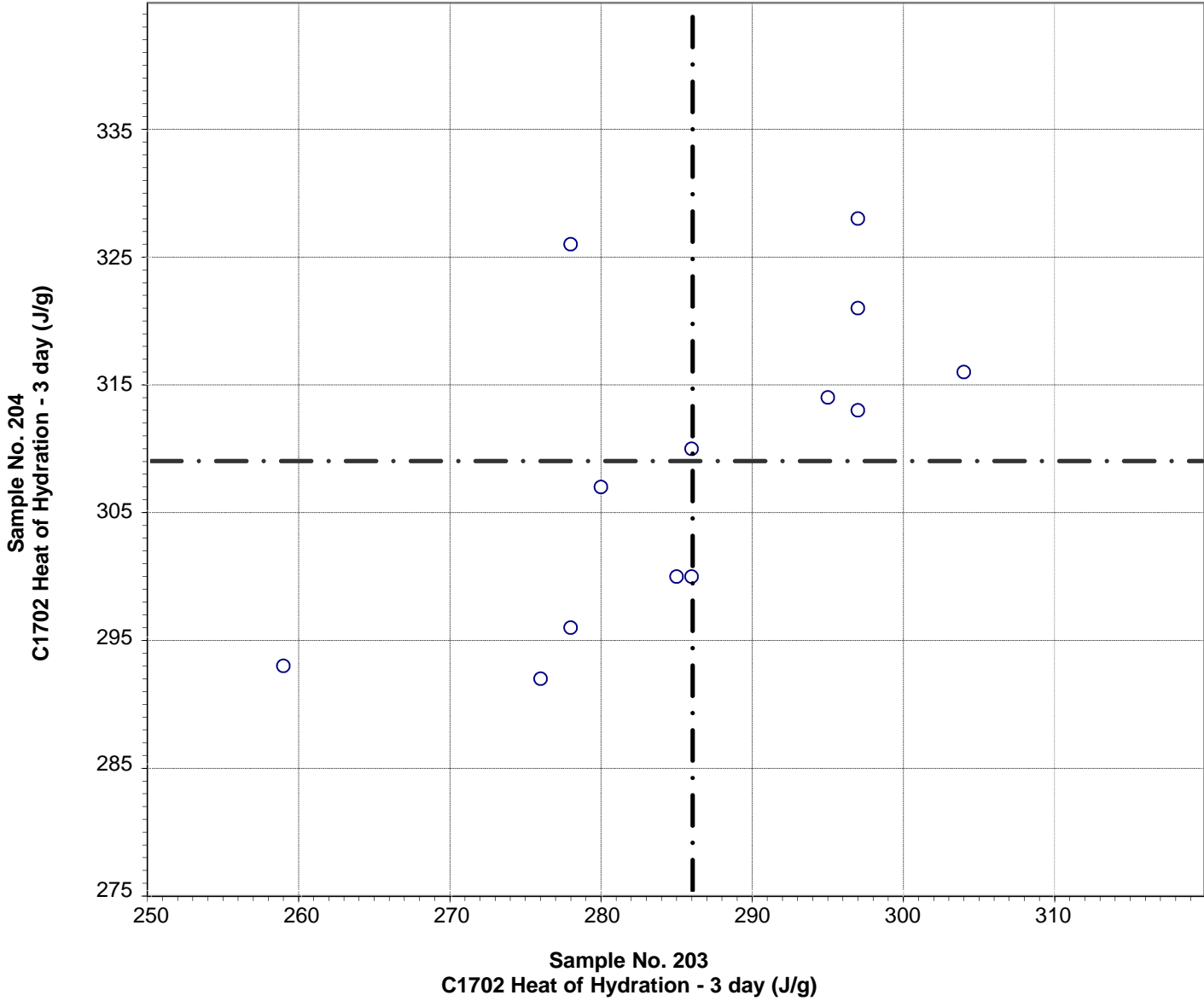


Test No. 300 C186 Heat of Hydration - 28 day 24 Points

Sample No. 203	Ave 85.9	S.D. 7.3	C.V. 8.5
Sample No. 204	Ave 89.9	S.D. 8.5	C.V. 9.5

Labs Eliminated: 3057

**CCRL Proficiency Sample Program
C1702 Heat of Hydration - 3 day
PORTLAND CEMENT Samples No. 203 and No. 204**

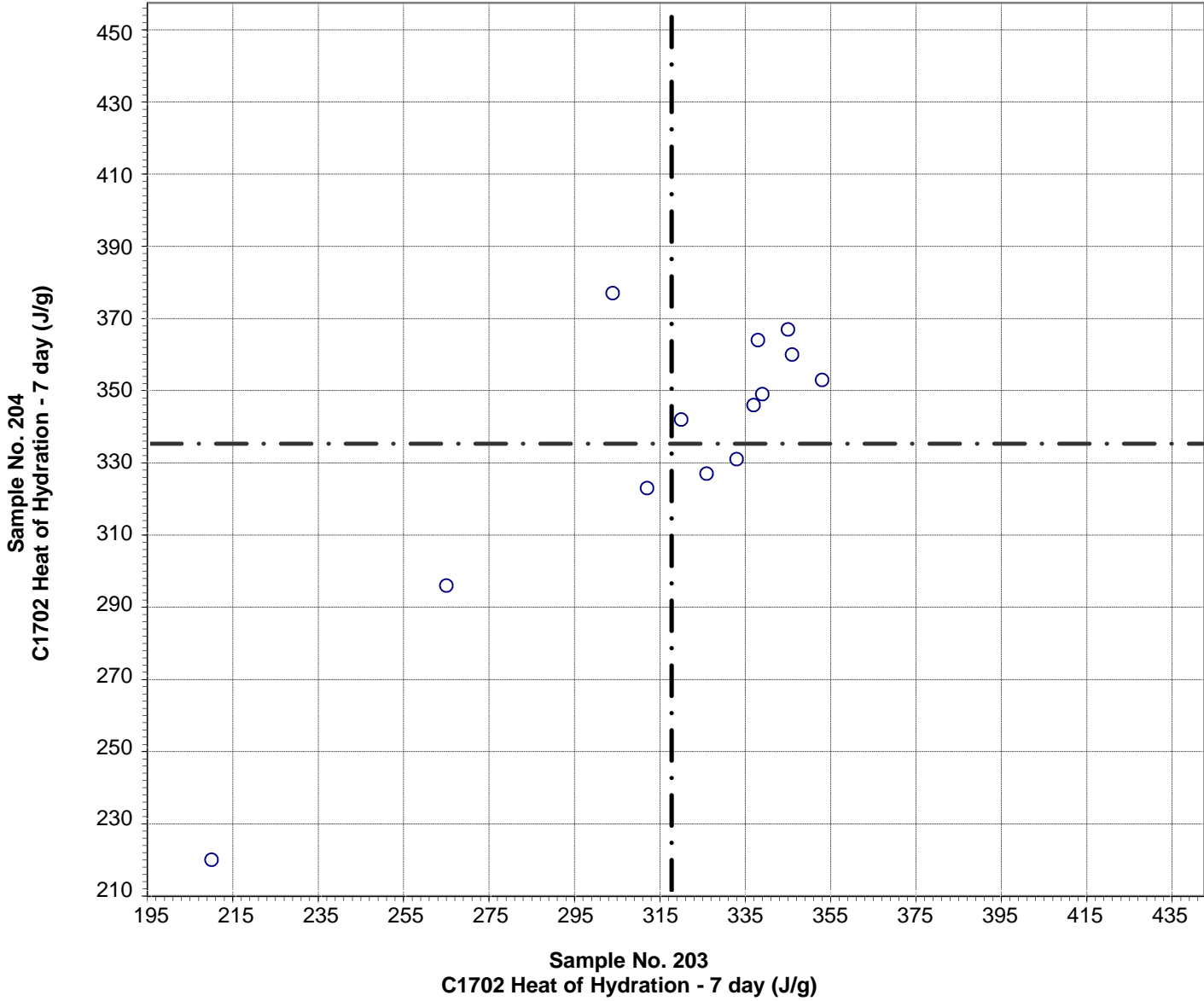


Test No. 500 C1702 Heat of Hydration - 3 day 13 Points

Sample No. 203	Ave 285	S.D. 12	C.V. 4.2
Sample No. 204	Ave 310	S.D. 12	C.V. 3.9

Labs Eliminated: 116, 3605

**CCRL Proficiency Sample Program
C1702 Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 203 and No. 204**



Test No. 510 C1702 Heat of Hydration - 7 day 13 Points

Sample No. 203	Ave 318	S.D. 40	C.V. 12.5
Sample No. 204	Ave 335	S.D. 41	C.V. 12.2

Labs Eliminated: 3605