

# **CEMENT AND CONCRETE REFERENCE LABORATORY**

## **PROFICIENCY SAMPLE PROGRAM**

### **Final Report**

### **Portland Cement Proficiency Samples**

### **Number 201 and Number 202**



**CCRL**  
Cement and Concrete  
Reference Laboratory

August 2016

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

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August 31, 2016

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

**SUBJECT: Final Report on Portland Cement Proficiency Samples No. 201 and No. 202**

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in June 2016. Portland Cement Samples No. 201 was an ASTM C150 meeting the specifications of Type I. Portland Cement No. 202 was an ASTM C150 meeting the specifications of Type I and Type II, and contained limestone addition and an organic processing 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.

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

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

It is presently anticipated that the next Portland Cement Proficiency Samples will be distributed in January 2017.

Sincerely,

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

**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. 201 and No. 202**

This letter, and the material included with it, constitutes the final report, and summary of results for the current pair of Portland Cement Proficiency Samples, which were distributed in June 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.

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

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

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

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

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

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

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

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

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

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

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

### **Summary of Results**

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

### **Scatter Diagrams**

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

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

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Primary Chemical Analysis  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Silicon Dioxide (percent)</b>							
	227	20.94	0.50	2.40	20.47	0.28	1.35
	*222	20.90	0.27	1.27	20.46	0.23	1.12
	* Labs Eliminated - 15, 50, 206, 494, 4155						
<b>Aluminum Oxide (percent)</b>							
	224	5.56	0.20	3.5	4.82	0.19	3.9
	*212	5.57	0.13	2.4	4.80	0.08	1.7
	* Labs Eliminated - 14, 19, 20, 27, 95, 494, 1644, 2352, 3606, 4042, 4099, 4137						
<b>Ferric Oxide (percent)</b>							
	225	1.99	0.14	7.0	3.12	0.18	5.9
	*205	1.97	0.03	1.7	3.14	0.04	1.3
	* Labs Eliminated - 15, 19, 95, 126, 162, 206, 407, 494, 1644, 2293, 3661, 3662, 3779, 3819, 4042, 4080, 4099, 4115, 4131, 4137						
<b>Calcium Oxide (percent)</b>							
	226	63.55	0.43	0.68	63.63	0.47	0.73
	*217	63.56	0.37	0.58	63.63	0.37	0.58
	* Labs Eliminated - 19, 48, 98, 175, 1956, 3819, 4042, 4115, 4137						
<b>Magnesium Oxide (percent)</b>							
	226	1.12	0.10	8.7	0.90	0.16	17.8
	*212	1.12	0.05	4.7	0.88	0.05	5.6
	* Labs Eliminated - 1, 14, 19, 35, 42, 47, 169, 494, 691, 1644, 1676, 1956, 4080, 4099						
<b>Sulfur Trioxide (percent)</b>							
	228	3.84	0.50	13.1	3.40	0.43	12.5
	*218	3.81	0.11	3.0	3.37	0.09	2.8
	* Labs Eliminated - 19, 42, 43, 95, 219, 494, 1644, 2934, 3819, 4093						

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Primary Chemical Analysis  
 August 31, 2016

SUMMARY OF RESULTS

Sample No.201

Sample No. 202

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Loss on Ignition (percent)</b>							
	230	1.94	0.15	7.5	2.44	0.17	7.1
	*216	1.95	0.08	4.2	2.45	0.09	3.8
* Labs Eliminated - 24, 46, 176, 222, 284, 407, 493, 768, 2360, 2412, 3368, 4042, 4099, 4150							
<b>Sodium Oxide (percent)</b>							
	219	0.099	0.038	38	0.063	0.033	51
	*202	0.095	0.020	21	0.058	0.022	39
* Labs Eliminated - 15, 19, 35, 175, 284, 494, 1079, 1251, 1644, 2360, 2463, 2484, 3368, 4042, 4093, 4099, 4137							
<b>Potassium Oxide (percent)</b>							
	222	0.517	0.043	8.3	0.734	0.044	6.0
	*205	0.516	0.015	2.9	0.742	0.018	2.5
* Labs Eliminated - 19, 27, 95, 246, 408, 494, 687, 1644, 1956, 2293, 2308, 2463, 2466, 4042, 4099, 4137, 4138							
<b>Strontium Oxide (percent)</b>							
	107	0.080	0.012	14	0.040	0.009	23
	*99	0.082	0.004	5	0.039	0.004	9
* Labs Eliminated - 4, 19, 95, 494, 1657, 1916, 4099, 4137							
<b>Titanium Dioxide (percent)</b>							
	180	0.24	0.027	11.1	0.24	0.047	19.6
	*168	0.24	0.008	3.1	0.24	0.007	2.8
* Labs Eliminated - 20, 95, 162, 246, 252, 494, 1054, 1644, 4042, 4131, 4137, 4150							
<b>Phosphorus Pentoxide (percent)</b>							
	174	0.254	0.025	9.7	0.287	0.034	11.8
	*157	0.255	0.007	2.9	0.287	0.009	3.1
* Labs Eliminated - 19, 48, 129, 139, 219, 413, 494, 1799, 1942, 2352, 2463, 2466, 2491, 3279, 4093, 4099, 4131							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Primary Chemical Analysis  
 August 31, 2016

SUMMARY OF RESULTS

Sample No.201

Sample No. 202

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Zinc Oxide (percent)</b>							
	104	0.027	0.032	115.5	0.005	0.019	359.3
	*93	0.027	0.002	5.7	0.006	0.002	30.2
* Labs Eliminated - 15, 19, 23, 95, 493, 502, 1916, 2463, 2477, 4099, 4138							
<b>Manganic Oxide (percent)</b>							
	152	0.030	0.012	38.9	0.094	0.012	12.6
	*139	0.029	0.004	13.7	0.096	0.005	5.2
* Labs Eliminated - 19, 203, 205, 354, 413, 457, 491, 494, 692, 2491, 3297, 3707, 4131							
<b>Chloride (percent)</b>							
	134	0.005	0.006	120	0.006	0.006	86
	*125	0.004	0.004	104	0.005	0.003	61
* Labs Eliminated - 15, 219, 611, 694, 2293, 2491, 3662, 4080, 4093							
<b>Insoluble Residue (percent)</b>							
	213	0.69	0.16	22	0.19	0.11	61
	*198	0.70	0.11	16	0.17	0.08	45
* Labs Eliminated - 3, 36, 98, 162, 206, 222, 246, 354, 768, 932, 1079, 1942, 2466, 3297, 4051							
<b>Free Lime (percent)</b>							
	176	0.84	0.25	30	1.24	0.31	25
	*166	0.83	0.17	21	1.24	0.23	19
* Labs Eliminated - 84, 132, 206, 493, 494, 497, 1956, 3238, 3752, 4155							
<b>Carbon Dioxide (percent)</b>							
	189				1.44	0.27	18.5
	*179				1.44	0.17	12.1
* Labs Eliminated - 46, 131, 176, 309, 415, 3238, 3661, 4115, 4135, 4138							
<b>Limestone Content (percent)</b>							
	188				3.5	0.7	19.3
	*174				3.3	0.3	7.9
* Labs Eliminated - 49, 93, 121, 131, 134, 175, 309, 415, 883, 1644, 3661, 4115, 4135, 4138							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Primary Chemical Analysis  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Chromium Oxide (percent)</b>							
	97	0.010	0.009	89	0.012	0.009	76
	*90	0.008	0.003	39	0.010	0.004	36

\* Labs Eliminated - 15, 66, 151, 415, 493, 2463, 4131



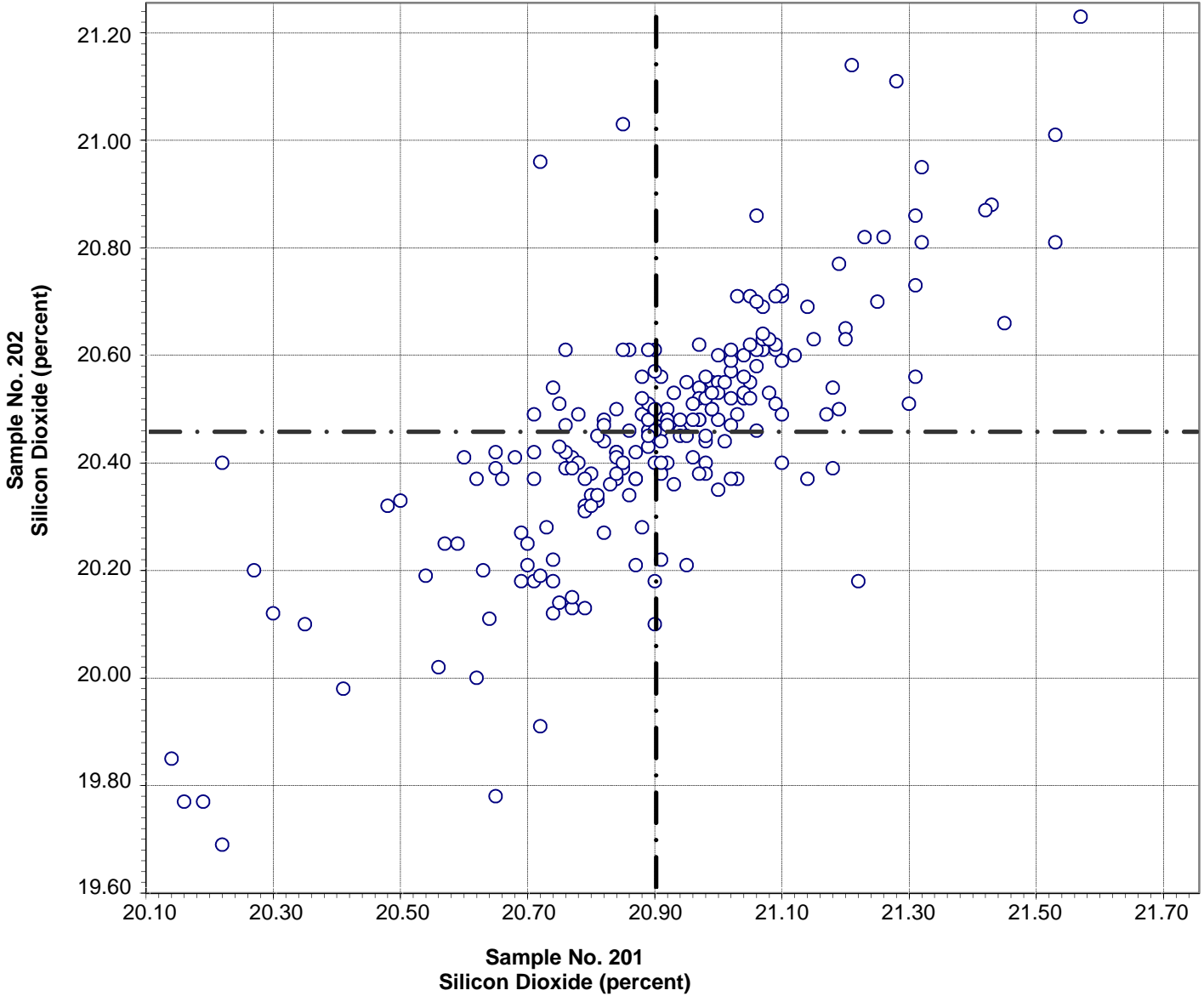
**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Primary Chemical Analysis  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Tricalcium Silicate (percent)</b>							
	193	49.1	4.4	9.0	57.3	4.2	7.3
	*187	49.1	3.8	7.8	57.4	3.7	6.5
	* Labs Eliminated - 38, 42, 407, 551, 2352, 4155						
<b>Dicalcium Silicate (percent)</b>							
	193	22.9	4.1	17.8	11.7	4.4	37.9
	*184	22.7	3.3	14.4	11.3	3.8	34.1
	* Labs Eliminated - 38, 42, 50, 130, 148, 494, 2352, 2477, 4155						
<b>Tricalcium Aluminate (percent)</b>							
	193	11.3	0.7	5.8	6.7	0.9	13.5
	*185	11.4	0.4	3.8	6.6	0.5	7.1
	* Labs Eliminated - 19, 95, 116, 494, 768, 1644, 3238, 3779						
<b>Tetracalcium Aluminoferrite (percent)</b>							
	193	6.0	0.6	10.0	9.3	0.7	7.3
	*170	6.0	0.1	1.8	9.4	0.2	1.6
	* Labs Eliminated - 15, 19, 38, 47, 64, 78, 95, 116, 126, 206, 209, 413, 494, 768, 1644, 2293, 3238, 3606, 3661, 3662, 3779, 4042, 4080						

**CCRL Proficiency Sample Program  
Silicon Dioxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



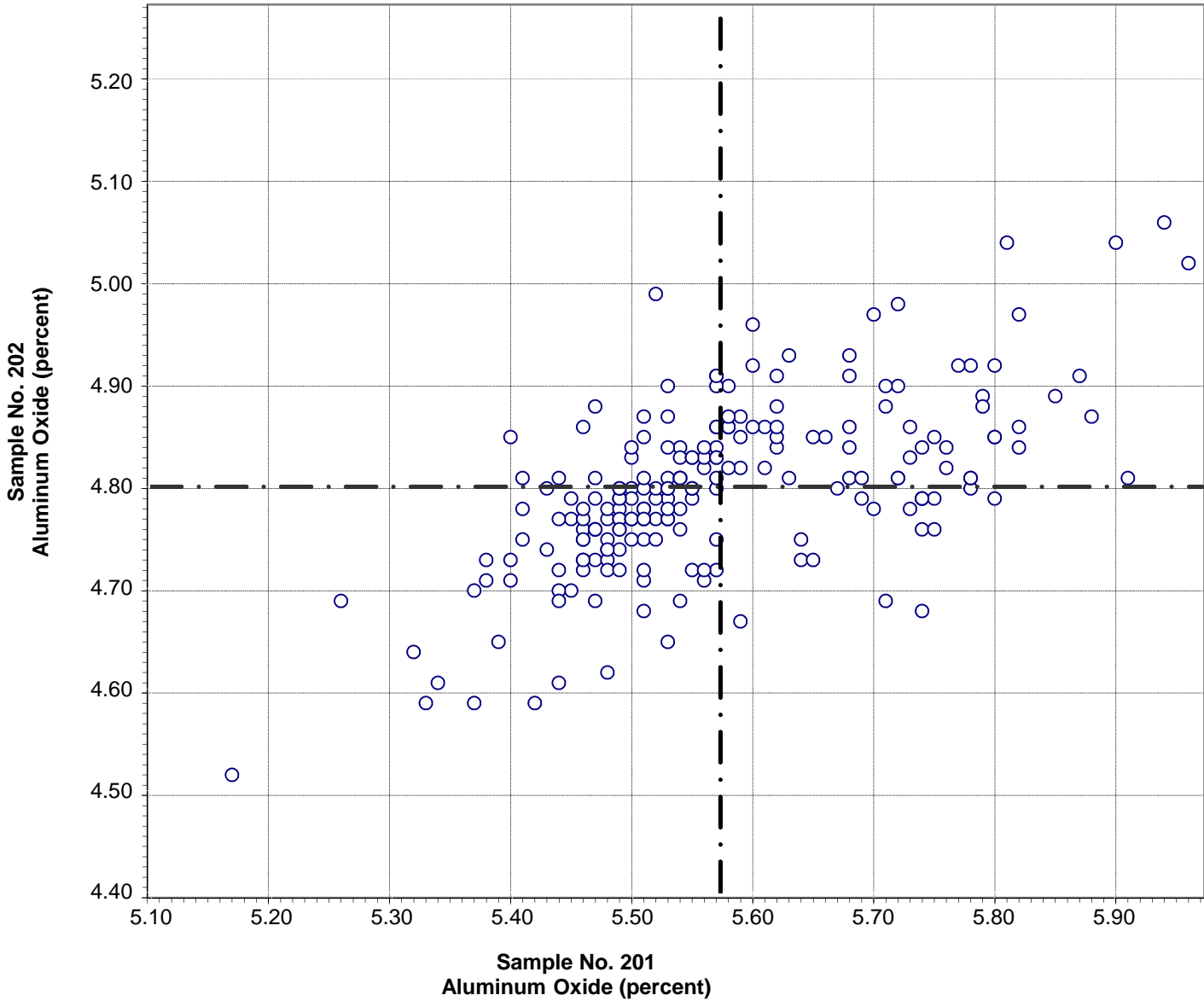
Test No. 10    Silicon Dioxide    218 Points

Sample No. 201	Ave 20.90	S.D. 0.27	C.V. 1.27
Sample No. 202	Ave 20.46	S.D. 0.23	C.V. 1.12

Labs Eliminated: 15, 50, 206, 494, 4155

Labs off Diagram: 14, 19, 38, 98

**CCRL Proficiency Sample Program  
Aluminum Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**

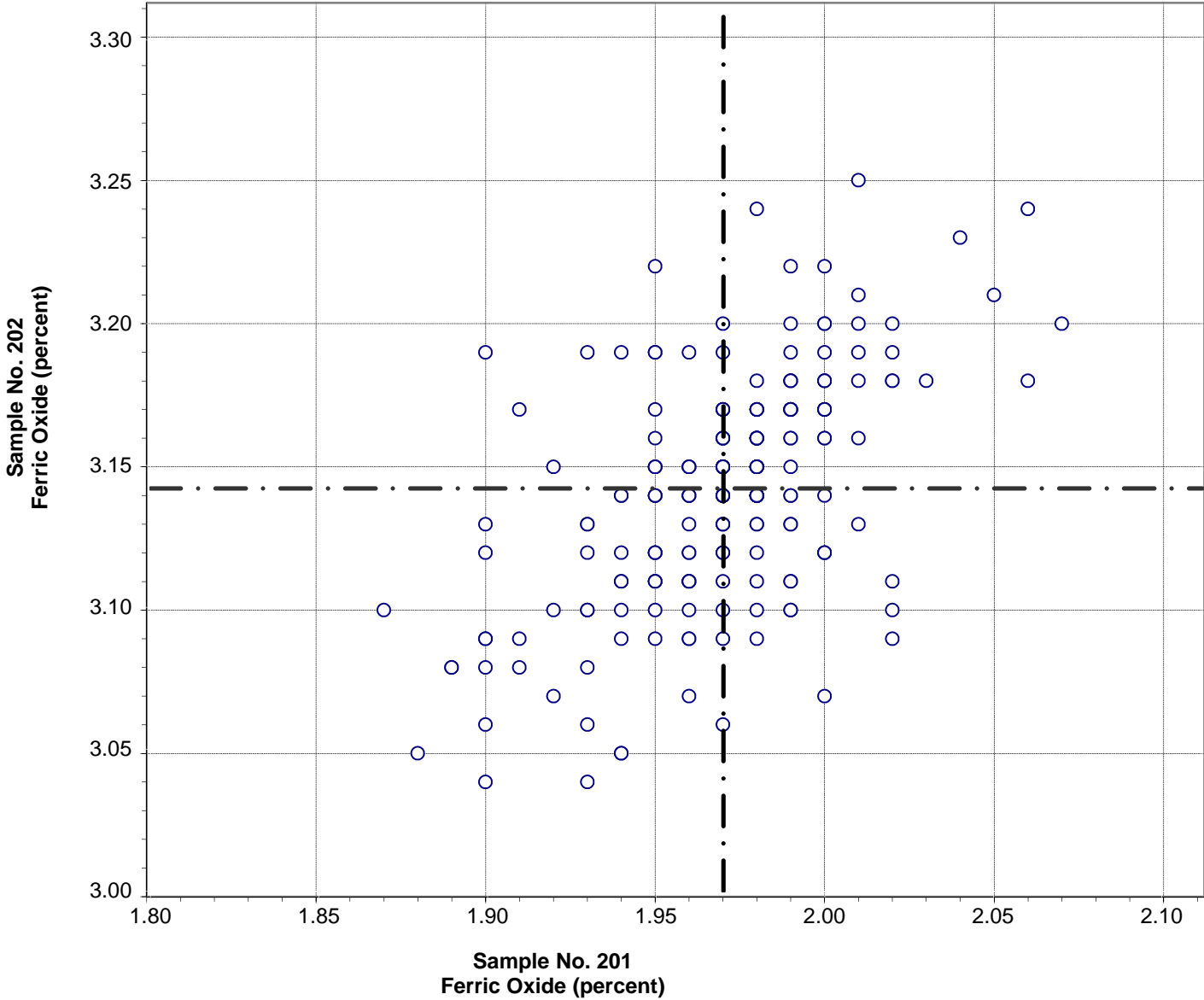


Test No. 21    Aluminum Oxide    212 Points

Sample No. 201	Ave 5.57	S.D. 0.13	C.V. 2.4
Sample No. 202	Ave 4.80	S.D. 0.08	C.V. 1.7

Labs Eliminated: 14, 19, 20, 27, 95, 494, 1644, 2352, 3606, 4042, 4099, 4137

**CCRL Proficiency Sample Program  
 Ferric Oxide  
 PORTLAND CEMENT Samples No. 201 and No. 202**

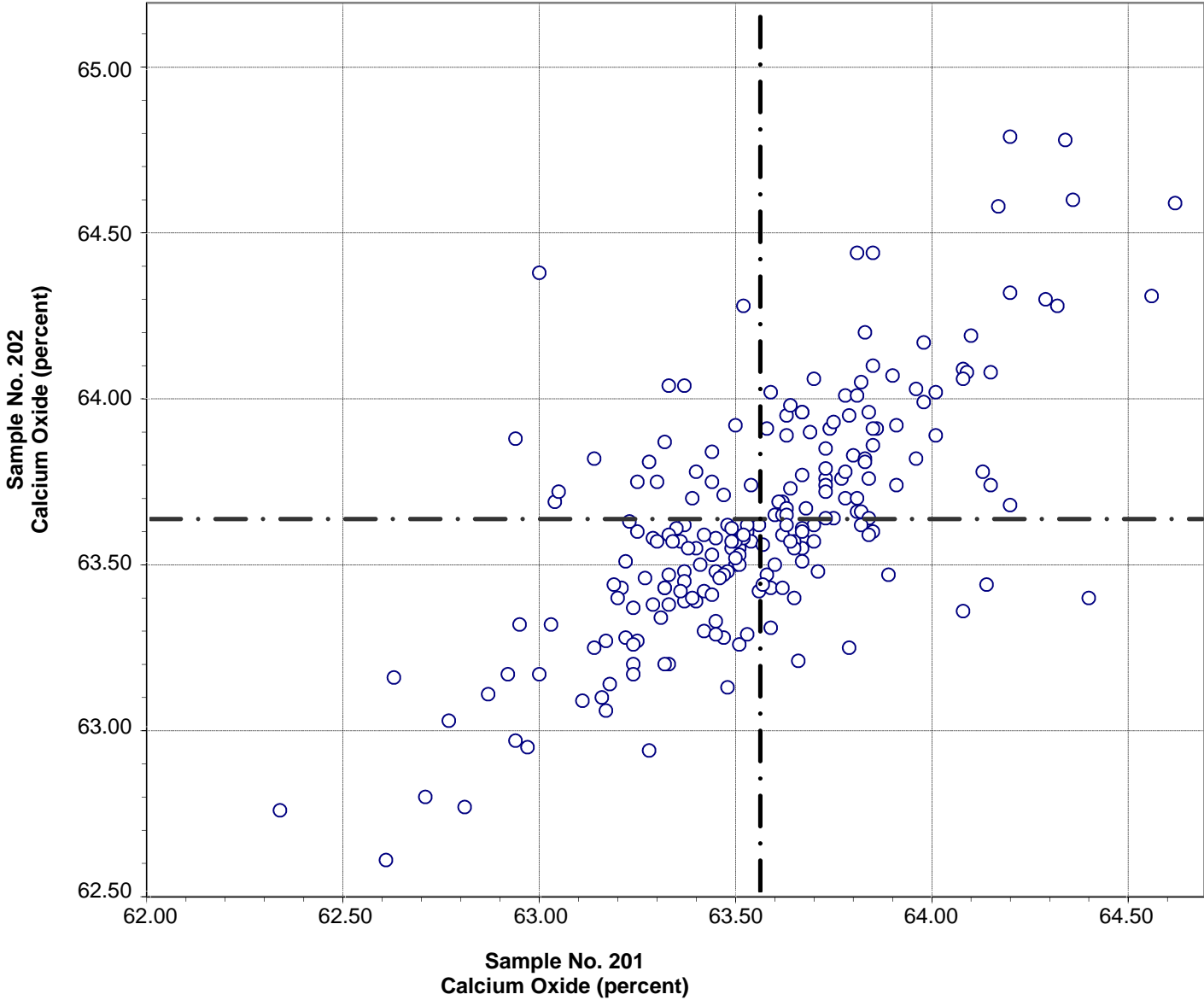


Test No. 30 Ferric Oxide 205 Points

Sample No. 201	Ave 1.97	S.D. 0.03	C.V. 1.7
Sample No. 202	Ave 3.14	S.D. 0.04	C.V. 1.3

Labs Eliminated: 15, 19, 95, 126, 162, 206, 407, 494, 1644, 2293, 3661, 3662, 3779, 3819, 4042, 4080, 4099, 4115, 4131, 4137

**CCRL Proficiency Sample Program  
Calcium Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



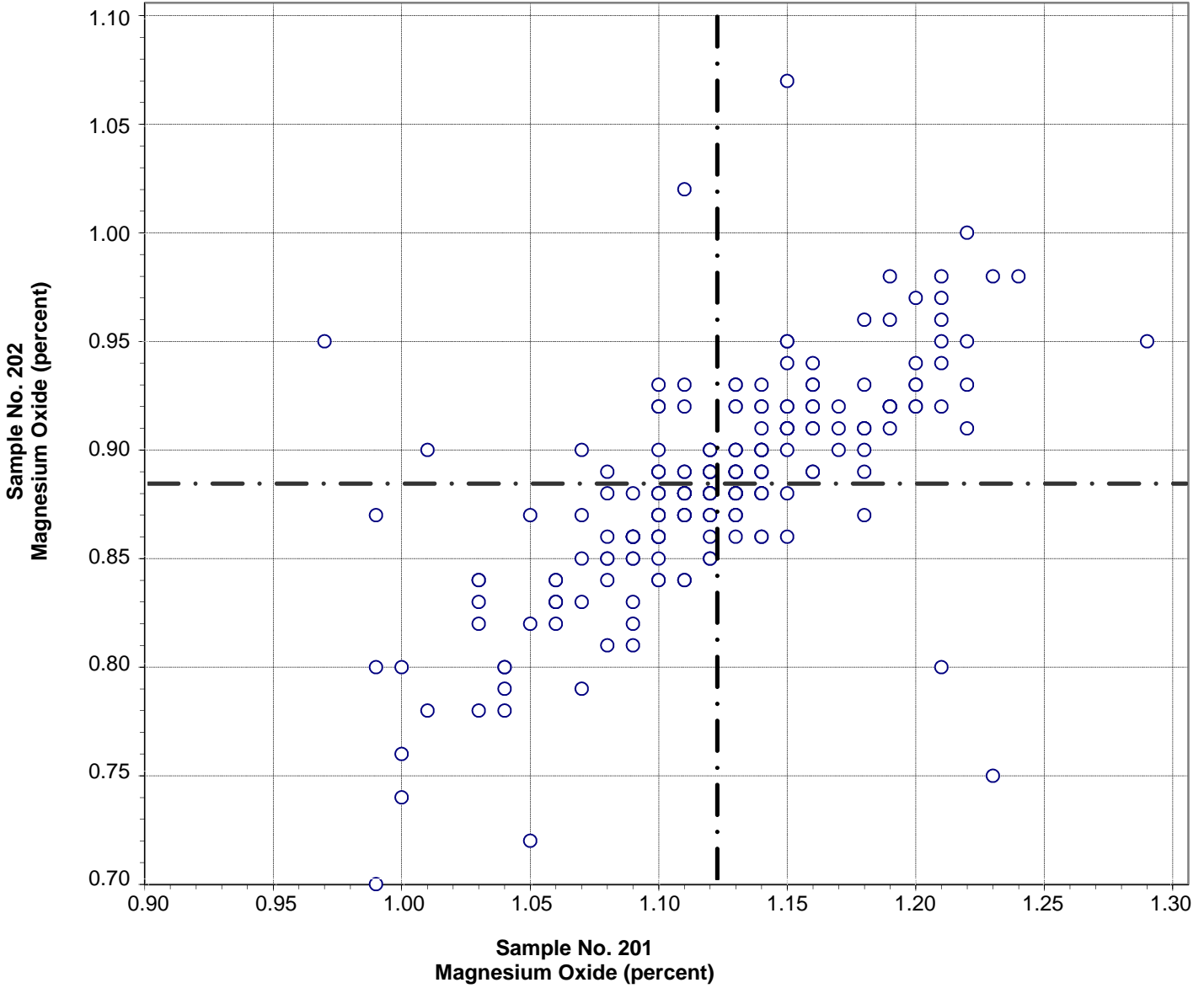
Test No. 40    Calcium Oxide    215 Points

Sample No. 201	Ave 63.56	S.D. 0.37	C.V. 0.58
Sample No. 202	Ave 63.63	S.D. 0.37	C.V. 0.58

Labs Eliminated: 19, 48, 98, 175, 1956, 3819, 4042, 4115, 4137

Labs off Diagram: 14, 219

**CCRL Proficiency Sample Program  
Magnesium Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**

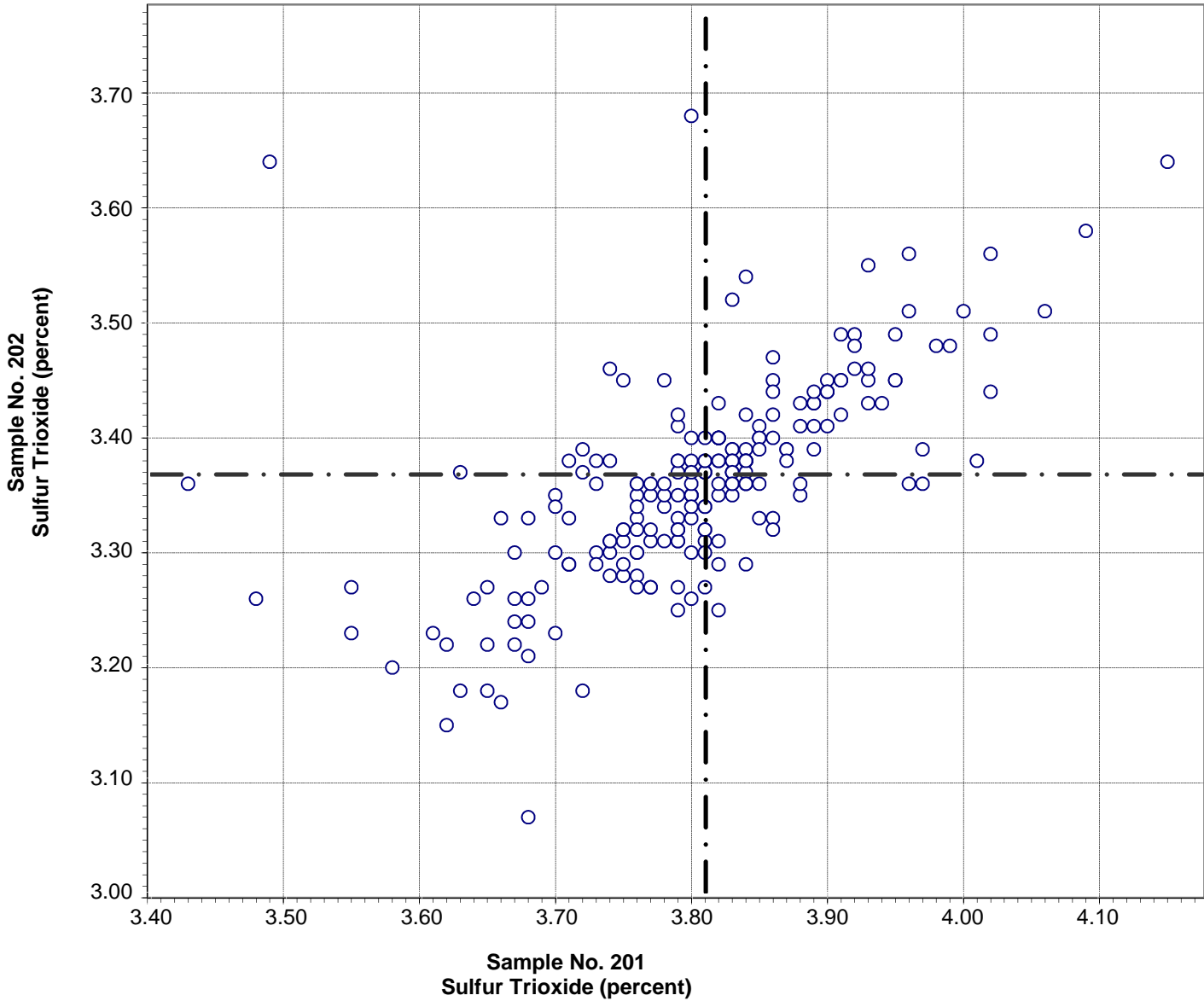


**Test No. 50    Magnesium Oxide    212 Points**

Sample No. 201	Ave 1.12	S.D. 0.05	C.V. 4.7
Sample No. 202	Ave 0.88	S.D. 0.05	C.V. 5.6

Labs Eliminated: 1, 14, 19, 35, 42, 47, 169, 494, 691, 1644, 1676, 1956, 4080, 4099

**CCRL Proficiency Sample Program  
Sulfur Trioxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



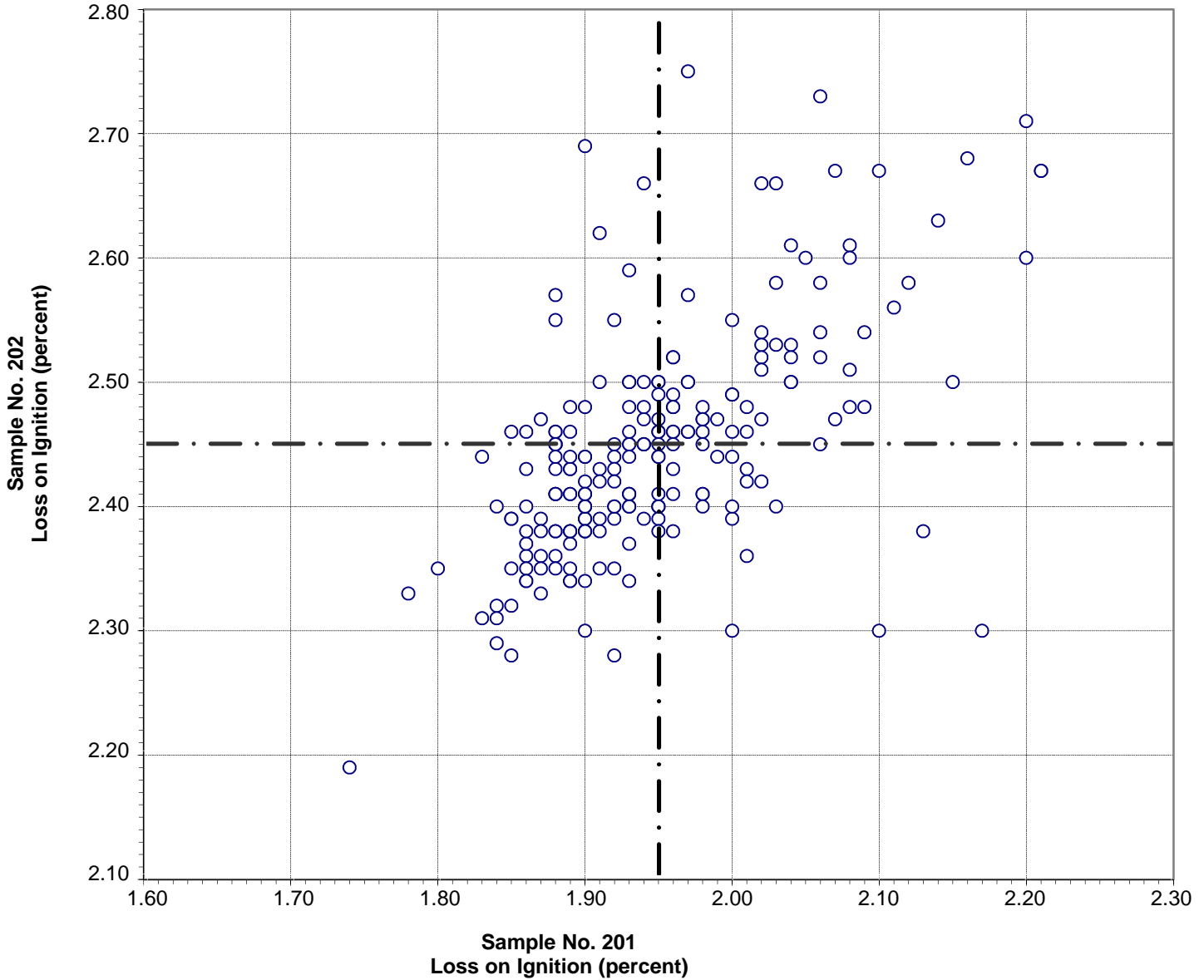
**Test No. 60 Sulfur Trioxide 215 Points**

Sample No. 201	Ave 3.81	S.D. 0.11	C.V. 3.0
Sample No. 202	Ave 3.37	S.D. 0.09	C.V. 2.8

Labs Eliminated: 19, 42, 43, 95, 219, 494, 1644, 2934, 3819, 4093

Labs off Diagram: 125, 221, 690

**CCRL Proficiency Sample Program  
Loss on Ignition  
PORTLAND CEMENT Samples No. 201 and No. 202**



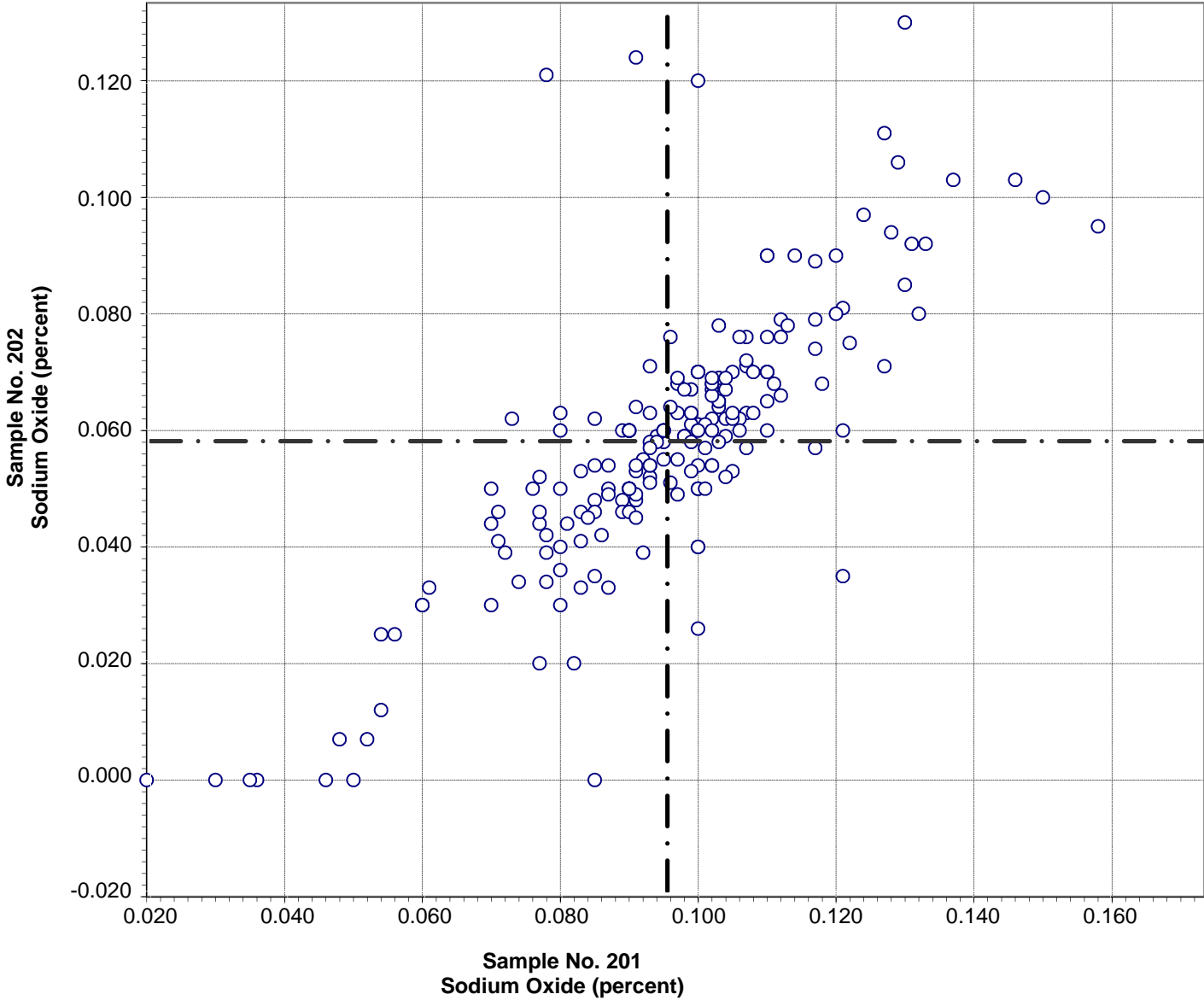
Test No. 70 Loss on Ignition 216 Points

Sample No. 201	Ave 1.95	S.D. 0.08	C.V. 4.2
Sample No. 202	Ave 2.45	S.D. 0.09	C.V. 3.8

Labs Eliminated: 24, 46, 176, 222, 284, 407, 493, 768, 2360, 2412, 3368, 4042, 4099, 4150



**CCRL Proficiency Sample Program  
Sodium Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**

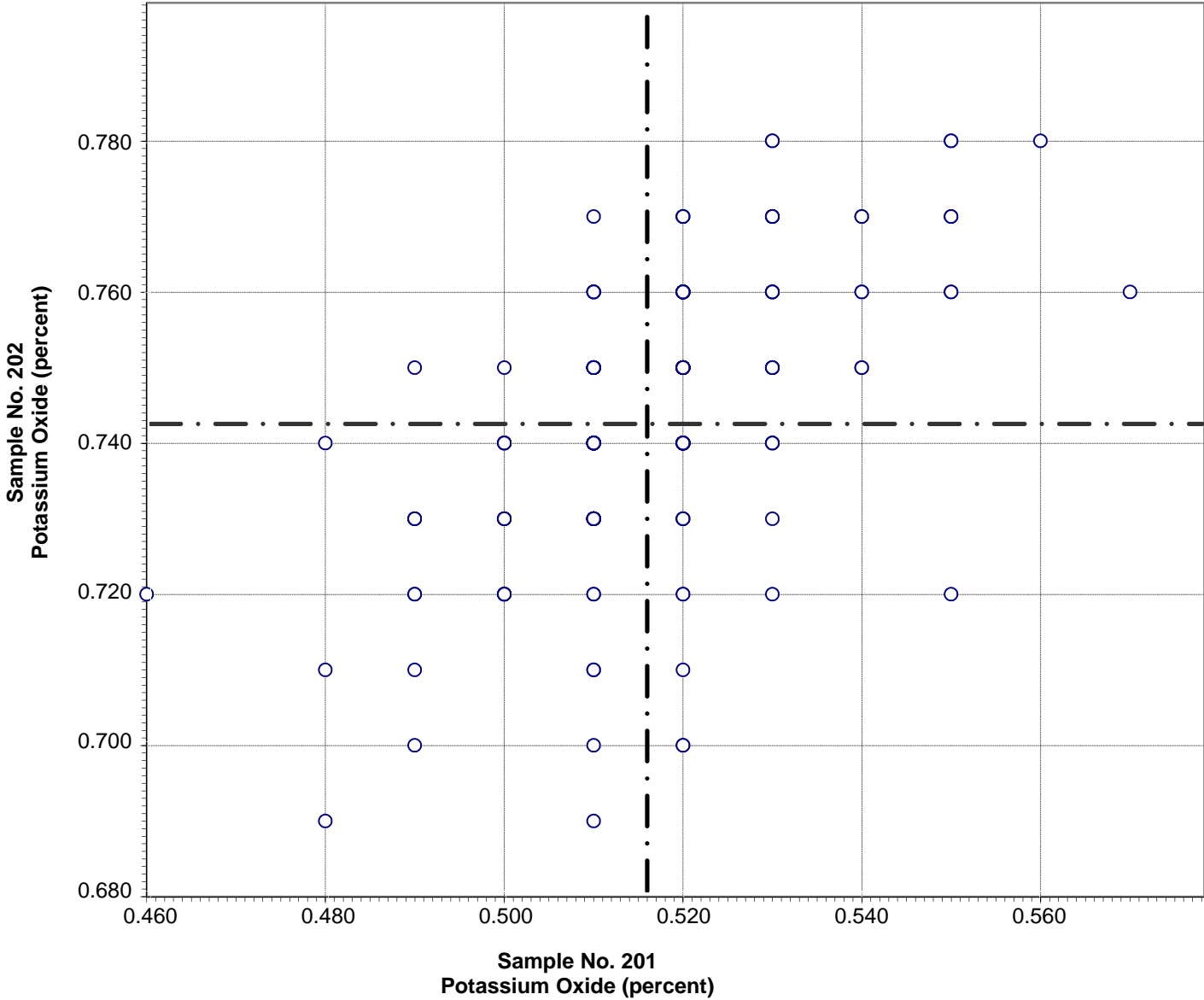


Test No. 90 Sodium Oxide 202 Points

Sample No. 201	Ave 0.095	S.D. 0.020	C.V. 21
Sample No. 202	Ave 0.058	S.D. 0.022	C.V. 39

Labs Eliminated: 15, 19, 35, 175, 284, 494, 1079, 1251, 1644, 2360, 2463, 2484, 3368, 4042, 4093, 4099, 4137

**CCRL Proficiency Sample Program  
Potassium Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



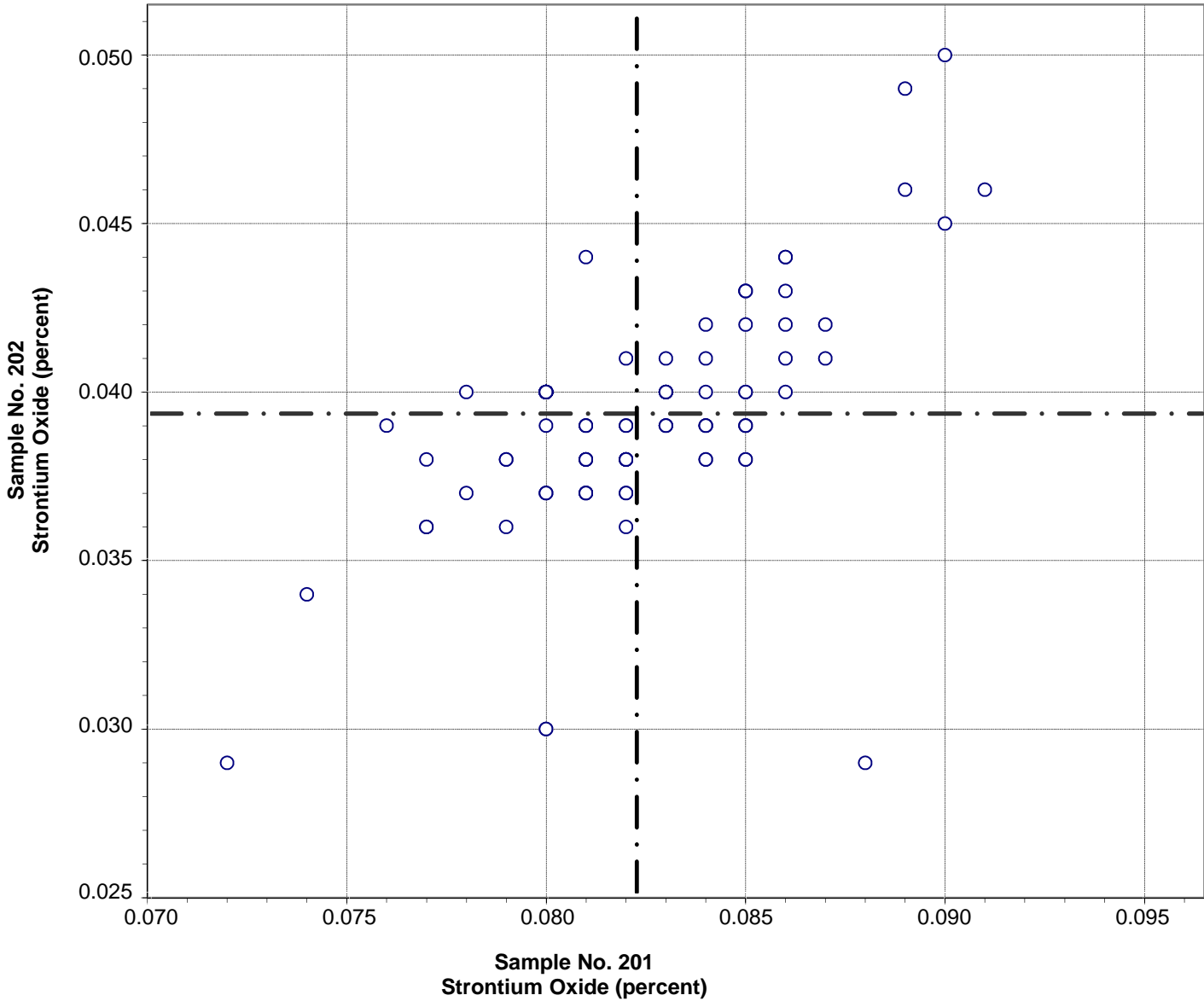
Test No. 100 Potassium Oxide 203 Points

Sample No. 201	Ave 0.516	S.D. 0.015	C.V. 2.9
Sample No. 202	Ave 0.742	S.D. 0.018	C.V. 2.5

Labs Eliminated: 19, 27, 95, 246, 408, 494, 687, 1644, 1956, 2293, 2308, 2463, 2466, 4042, 4099, 4137, 4138

Labs off Diagram: 1435, 4080

**CCRL Proficiency Sample Program  
Strontium Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



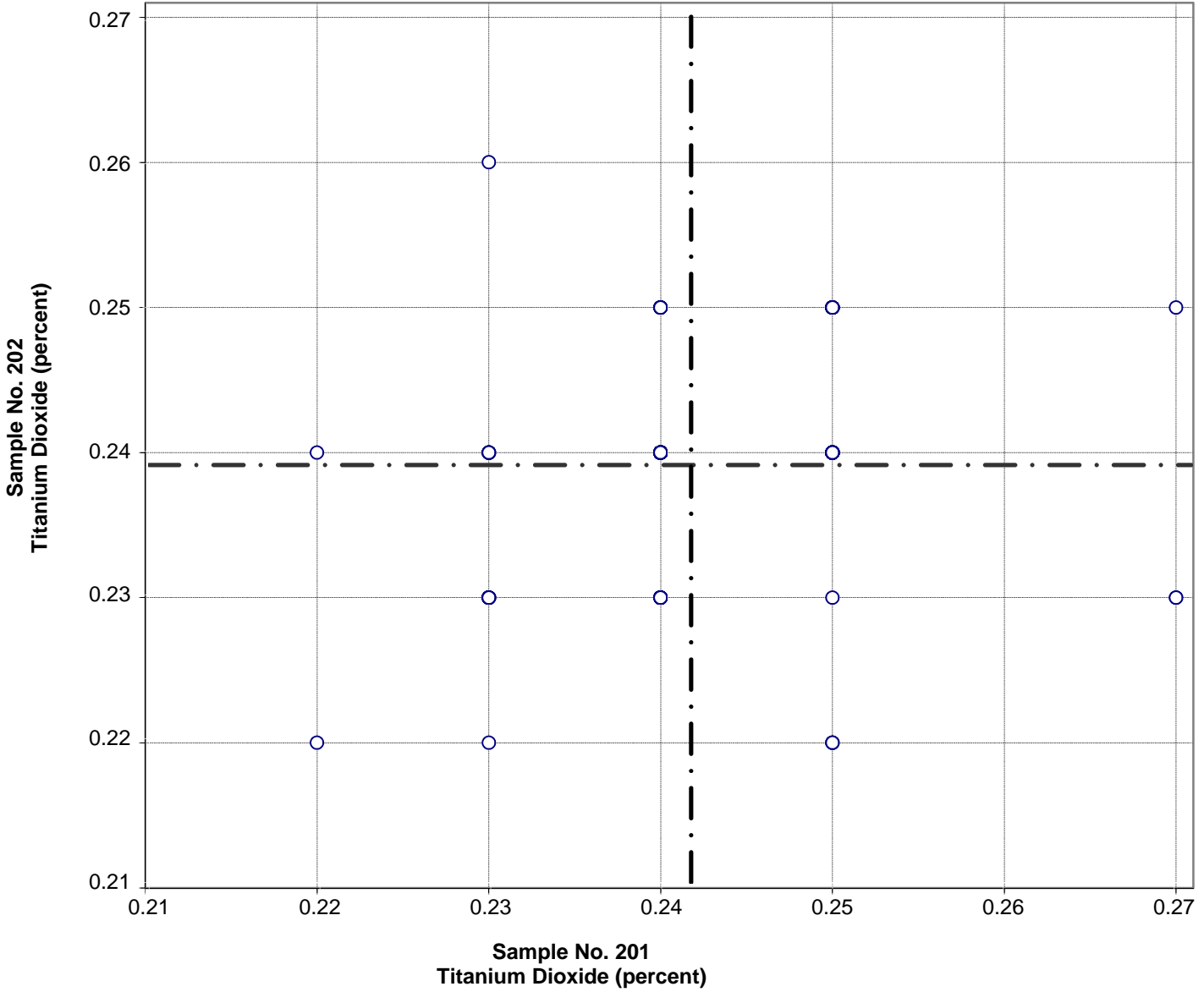
Test No. 92 Strontium Oxide 97 Points

Sample No. 201	Ave 0.082	S.D. 0.004	C.V. 5
Sample No. 202	Ave 0.039	S.D. 0.004	C.V. 9

Labs Eliminated: 4, 19, 95, 494, 1657, 1916, 4099, 4137

Labs off Diagram: 1956, 4138

**CCRL Proficiency Sample Program  
Titanium Dioxide  
PORTLAND CEMENT Samples No. 201 and No. 202**

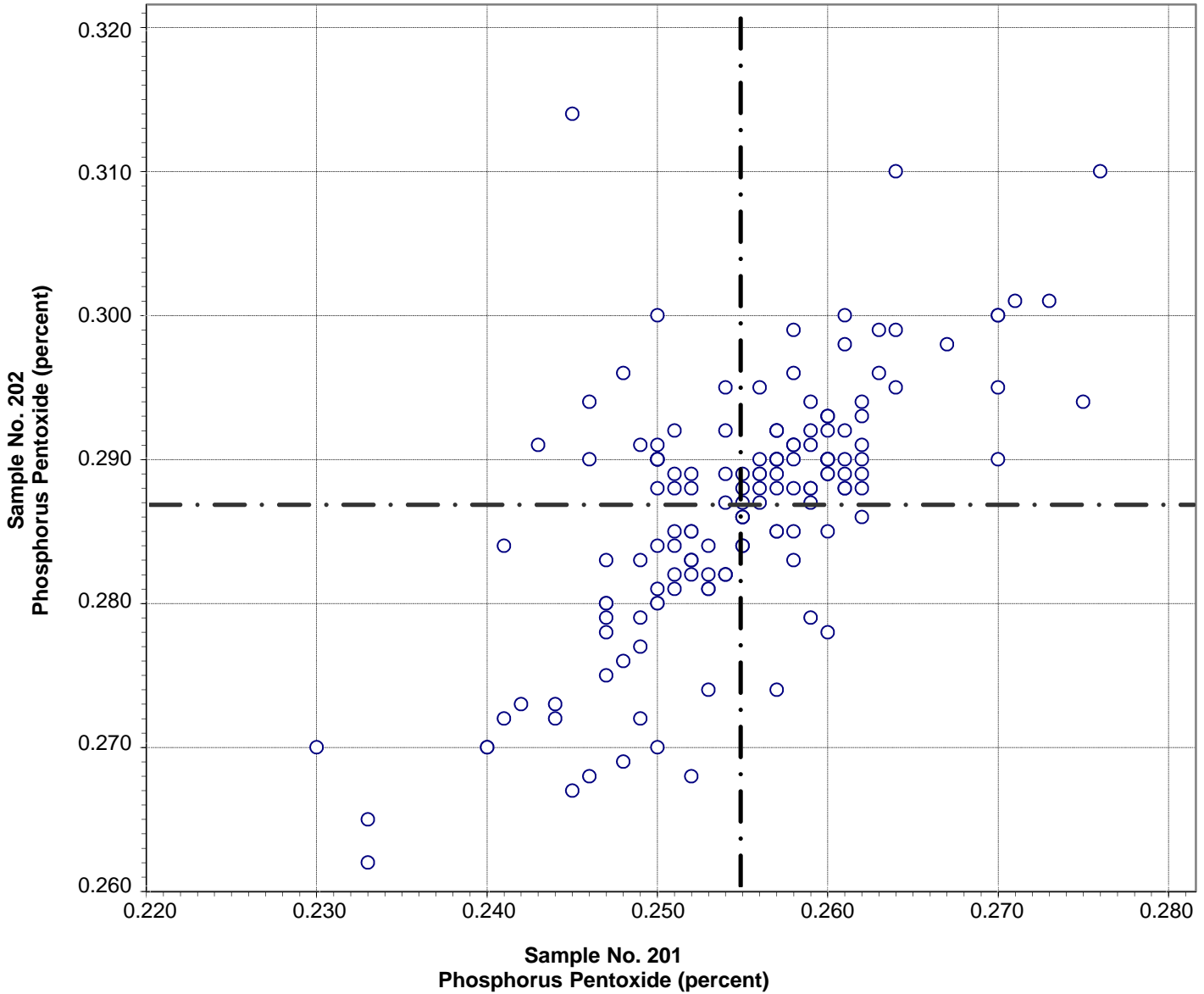


Test No. 103 Titanium Dioxide 168 Points

Sample No. 201	Ave 0.24	S.D. 0.008	C.V. 3.1
Sample No. 202	Ave 0.24	S.D. 0.007	C.V. 2.8

Labs Eliminated: 20, 95, 162, 246, 252, 494, 1054, 1644, 4042, 4131, 4137, 4150

**CCRL Proficiency Sample Program  
Phosphorus Pentoxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



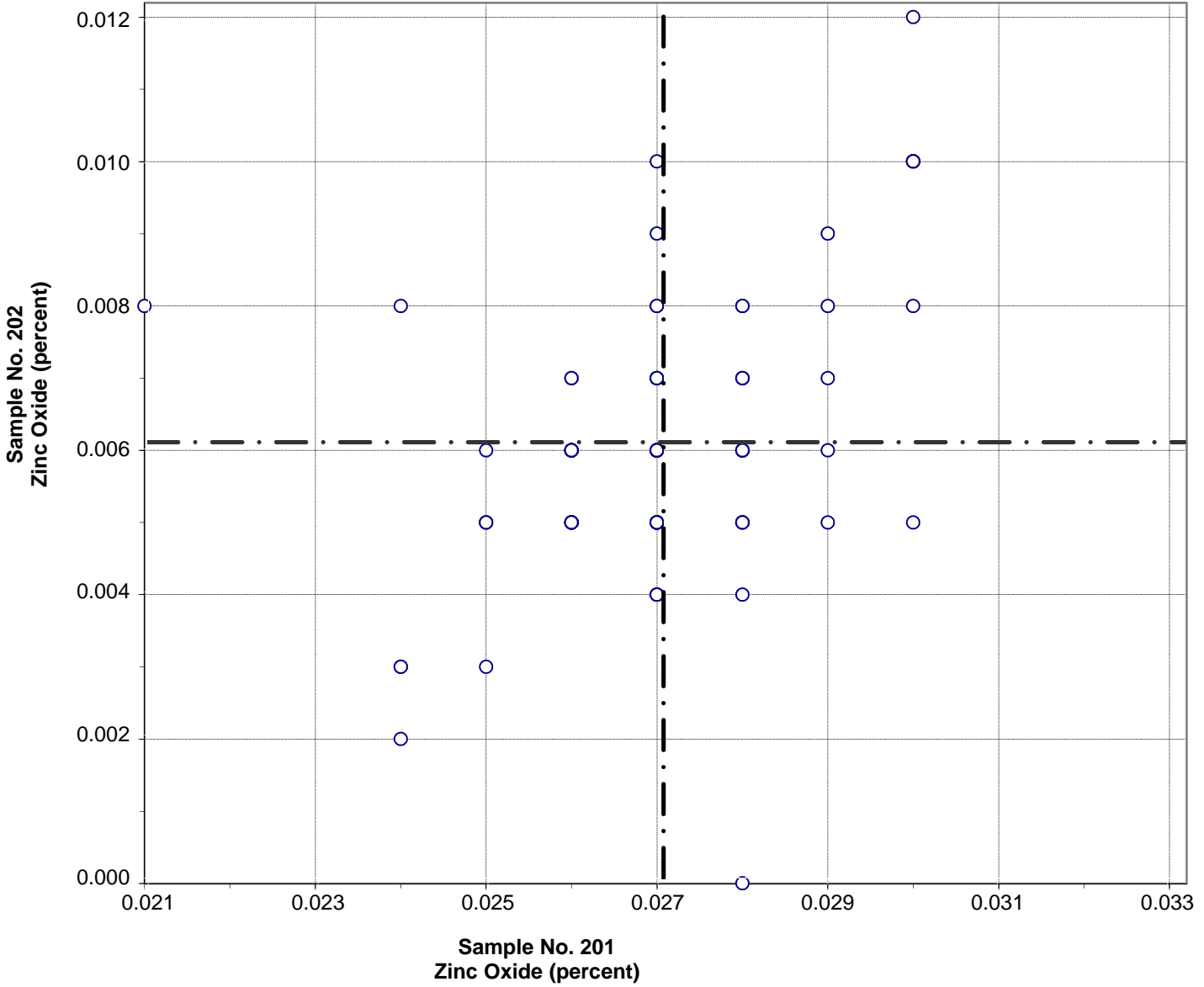
Test No. 102 Phosphorus Pentoxide 156 Points

Sample No. 201	Ave 0.255	S.D. 0.007	C.V. 2.9
Sample No. 202	Ave 0.287	S.D. 0.009	C.V. 3.1

Labs Eliminated: 19, 48, 129, 139, 219, 413, 494, 1799, 1942, 2352, 2463, 2466, 2491, 3279, 4093, 4099, 4131

Labs off Diagram: 2412

**CCRL Proficiency Sample Program  
Zinc Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**

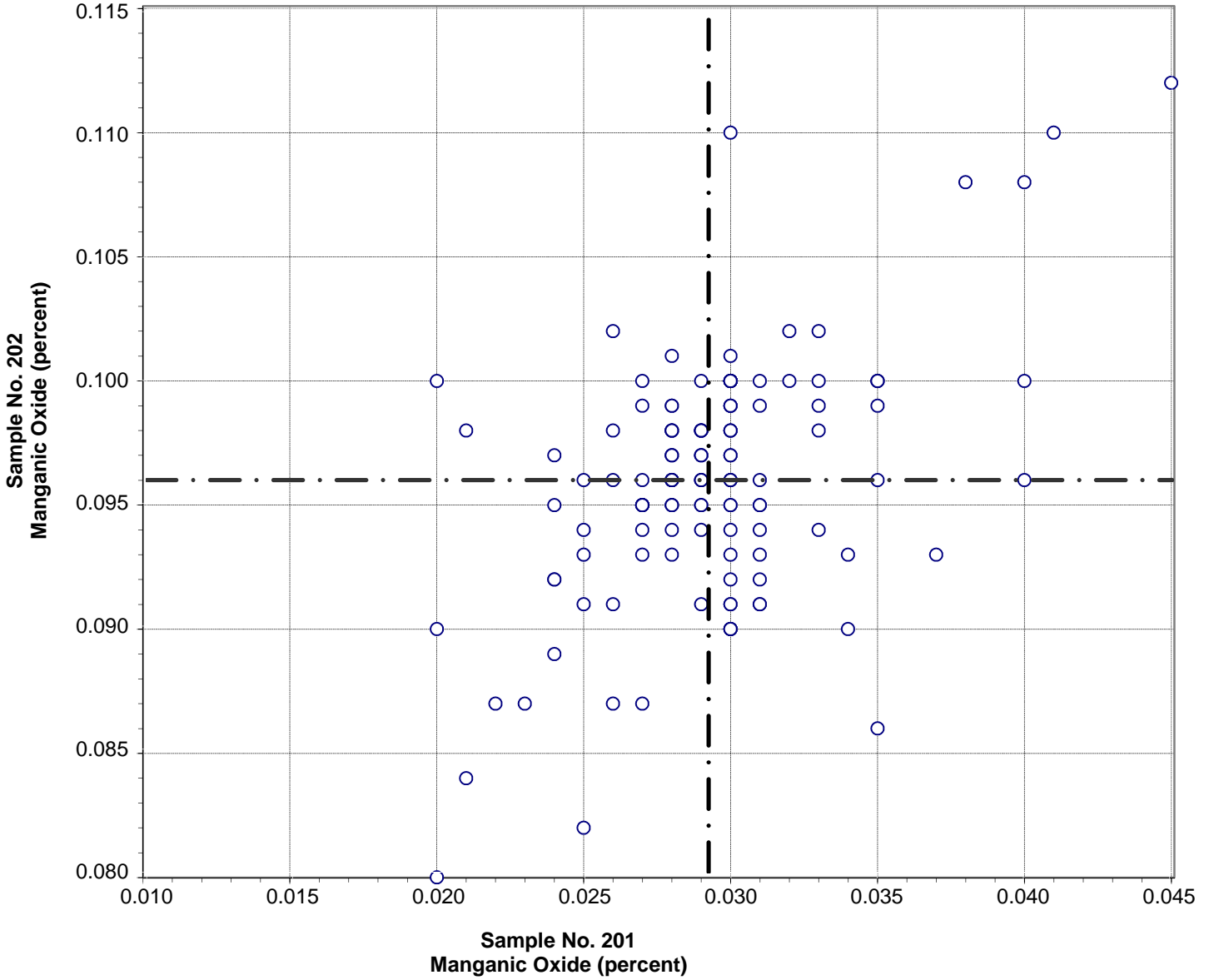


Test No. 99    Zinc Oxide    93 Points

Sample No. 201	Ave 0.027	S.D. 0.002	C.V. 5.7
Sample No. 202	Ave 0.006	S.D. 0.002	C.V. 30.2

Labs Eliminated: 15, 19, 23, 95, 493, 502, 1916, 2463, 2477, 4099, 4138

**CCRL Proficiency Sample Program  
Manganic Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**



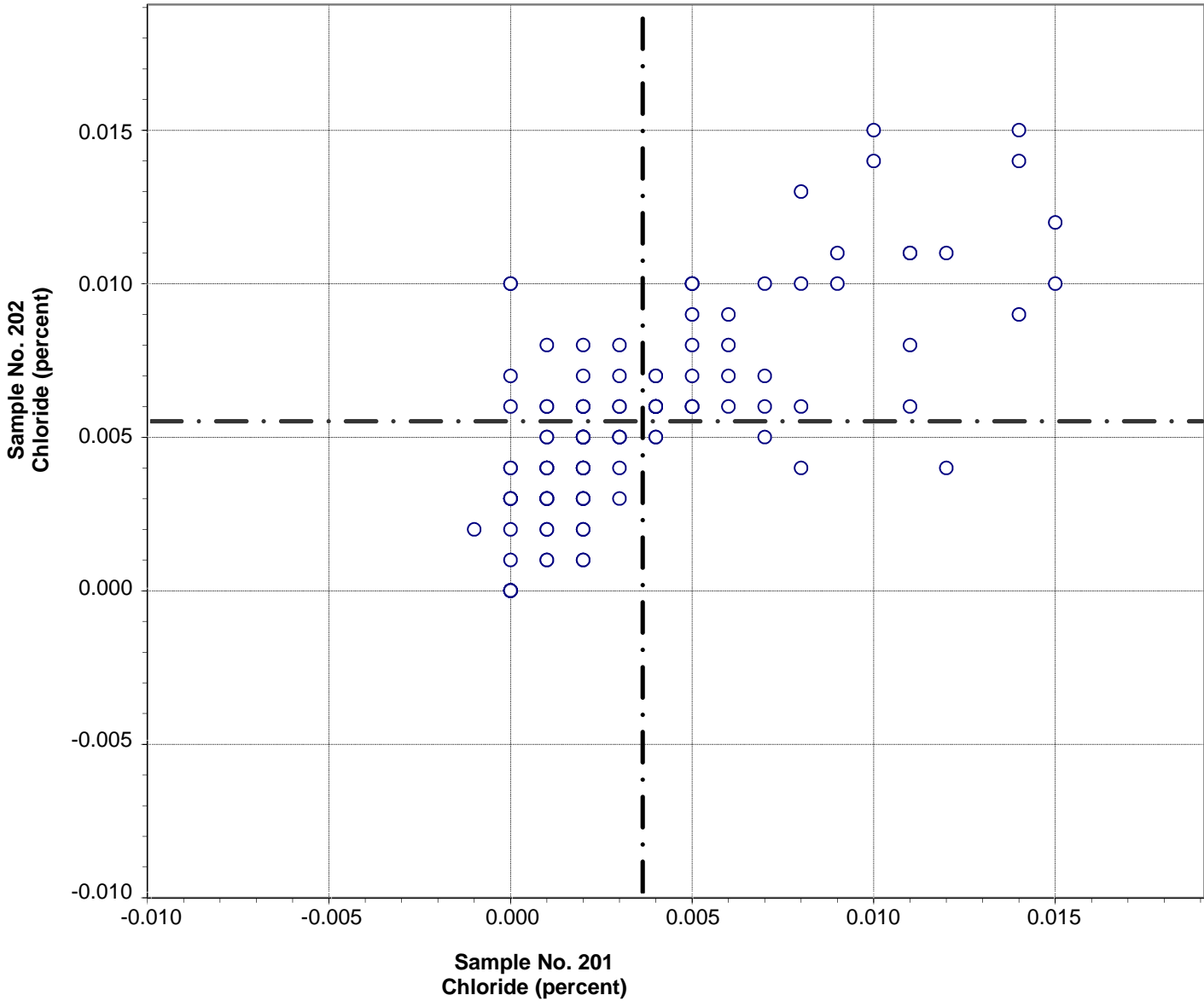
Test No. 101 Manganic Oxide 138 Points

Sample No. 201	Ave 0.029	S.D. 0.004	C.V. 13.7
Sample No. 202	Ave 0.096	S.D. 0.005	C.V. 5.2

Labs Eliminated: 19, 203, 205, 354, 413, 457, 491, 494, 692, 2491, 3297, 3707, 4131

Labs off Diagram: 4138

**CCRL Proficiency Sample Program  
Chloride  
PORTLAND CEMENT Samples No. 201 and No. 202**



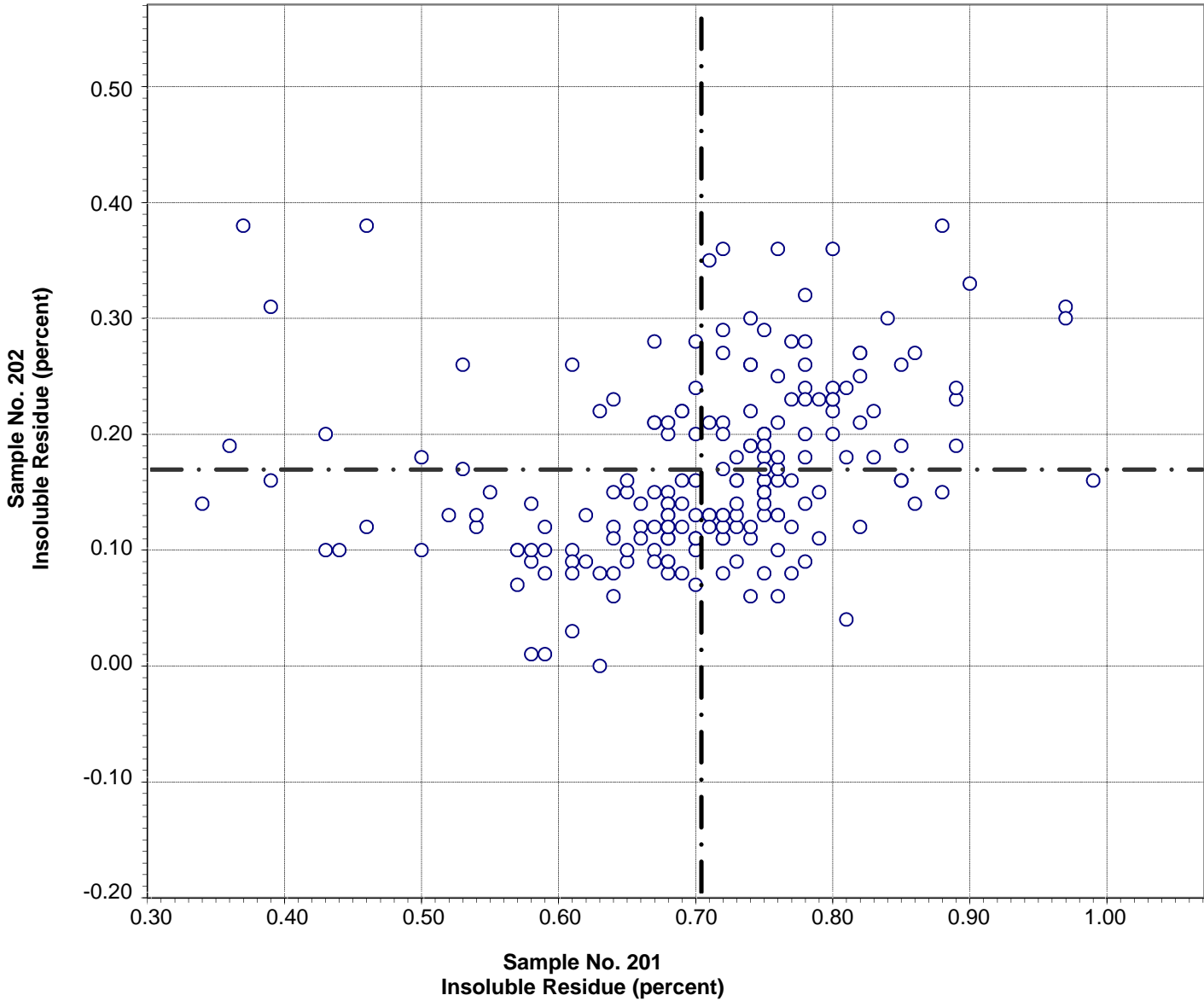
Test No. 104 Chloride 125 Points

Sample No. 201	Ave 0.004	S.D. 0.004	C.V. 104
Sample No. 202	Ave 0.005	S.D. 0.003	C.V. 61

Labs Eliminated: 15, 219, 611, 694, 2293, 2491, 3662, 4080, 4093



**CCRL Proficiency Sample Program  
Insoluble Residue  
PORTLAND CEMENT Samples No. 201 and No. 202**

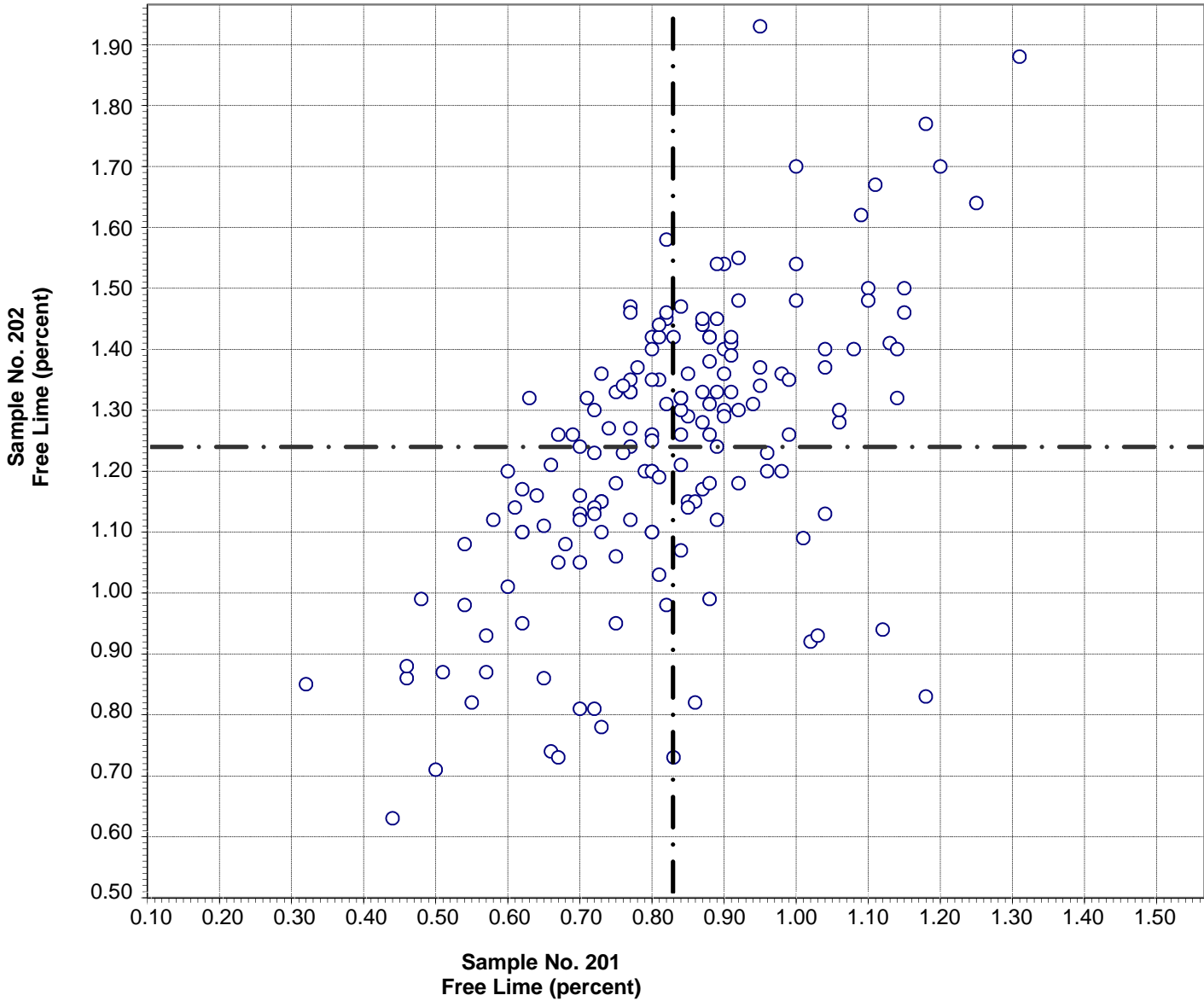


Test No. 80 Insoluble Residue 198 Points

Sample No. 201	Ave 0.70	S.D. 0.11	C.V. 16
Sample No. 202	Ave 0.17	S.D. 0.08	C.V. 45

Labs Eliminated: 3, 36, 98, 162, 206, 222, 246, 354, 768, 932, 1079, 1942, 2466, 3297, 4051

**CCRL Proficiency Sample Program  
Free Lime  
PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 41 Free Lime 166 Points

Sample No. 201	Ave 0.83	S.D. 0.17	C.V. 21
Sample No. 202	Ave 1.24	S.D. 0.23	C.V. 19

Labs Eliminated: 84, 132, 206, 493, 494, 497, 1956, 3238, 3752, 4155

**CCRL Proficiency Sample Program  
Carbon Dioxide  
PORTLAND CEMENT Samples No. 201 & No. 202**

No Diagram Printed for this Component

Sample No. 201 did not  
Contain Limestone Additions.

Test Results Were Analyzed for  
Sample No. 202 Only.

Test No. 97                      Carbon Dioxide                      179 labs

Sample No. 202    AVE 1.44    S.D. 0.17    C.V. 12.1

Labs Eliminated: 46, 131, 176, 309, 415, 3238, 3661, 4115, 4135, 4138

**CCRL Proficiency Sample Program  
Limestone Content  
PORTLAND CEMENT Samples No. 201 & No. 202**

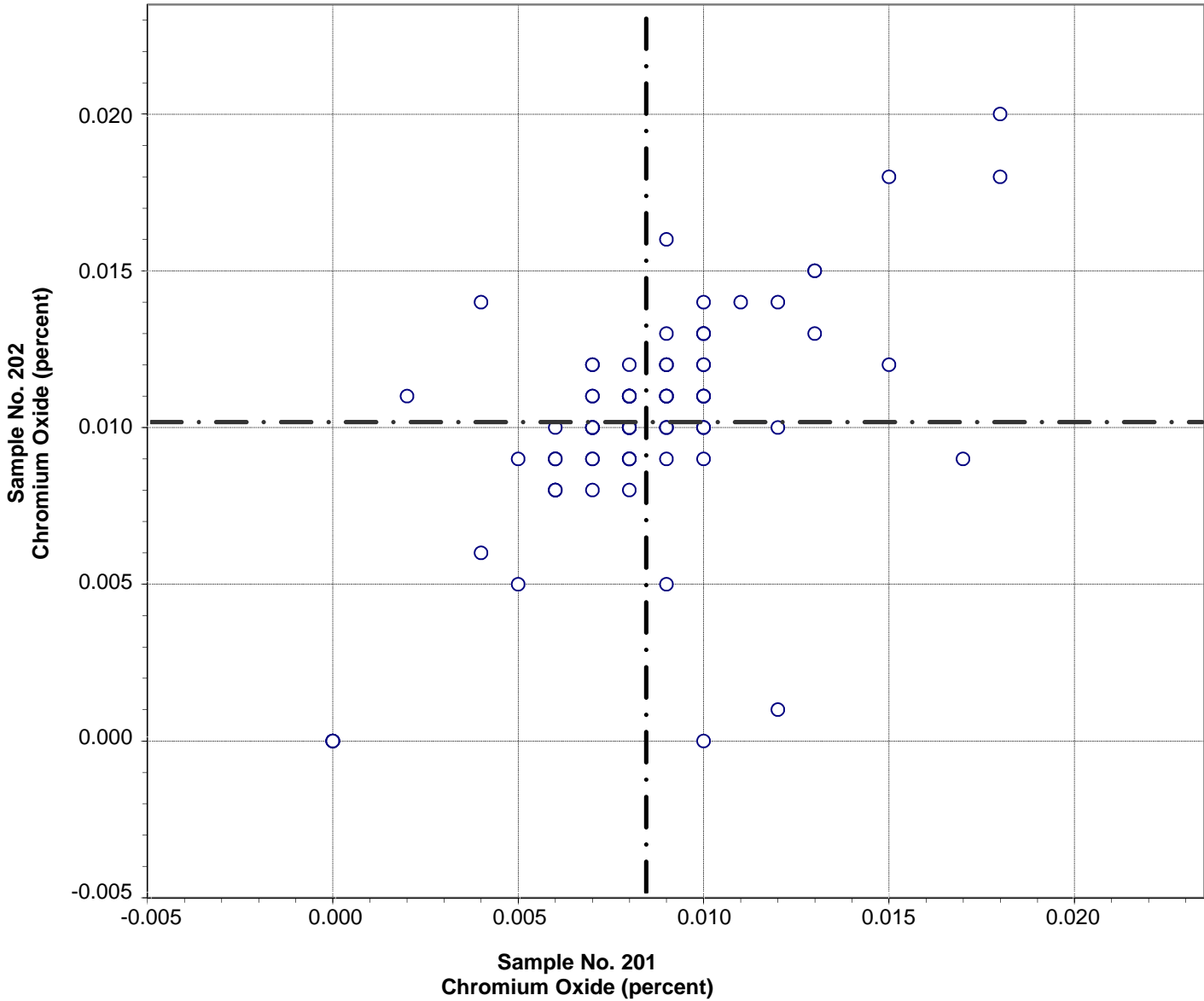
No Diagram Printed for this Component

Sample No. 201 did not  
Contain Limestone Additions.

Test Results Were Analyzed for  
Sample No. 202 Only.

Test No. 98	Limestone Content	174 labs
Sample No. 202	AVE 3.3    S.D. 0.3    C.V. 7.9	
Labs Eliminated:	46, 93, 121, 131, 134, 175, 309, 415, 883, 1644, 3661, 4115, 4135, 4138	

**CCRL Proficiency Sample Program  
Chromium Oxide  
PORTLAND CEMENT Samples No. 201 and No. 202**

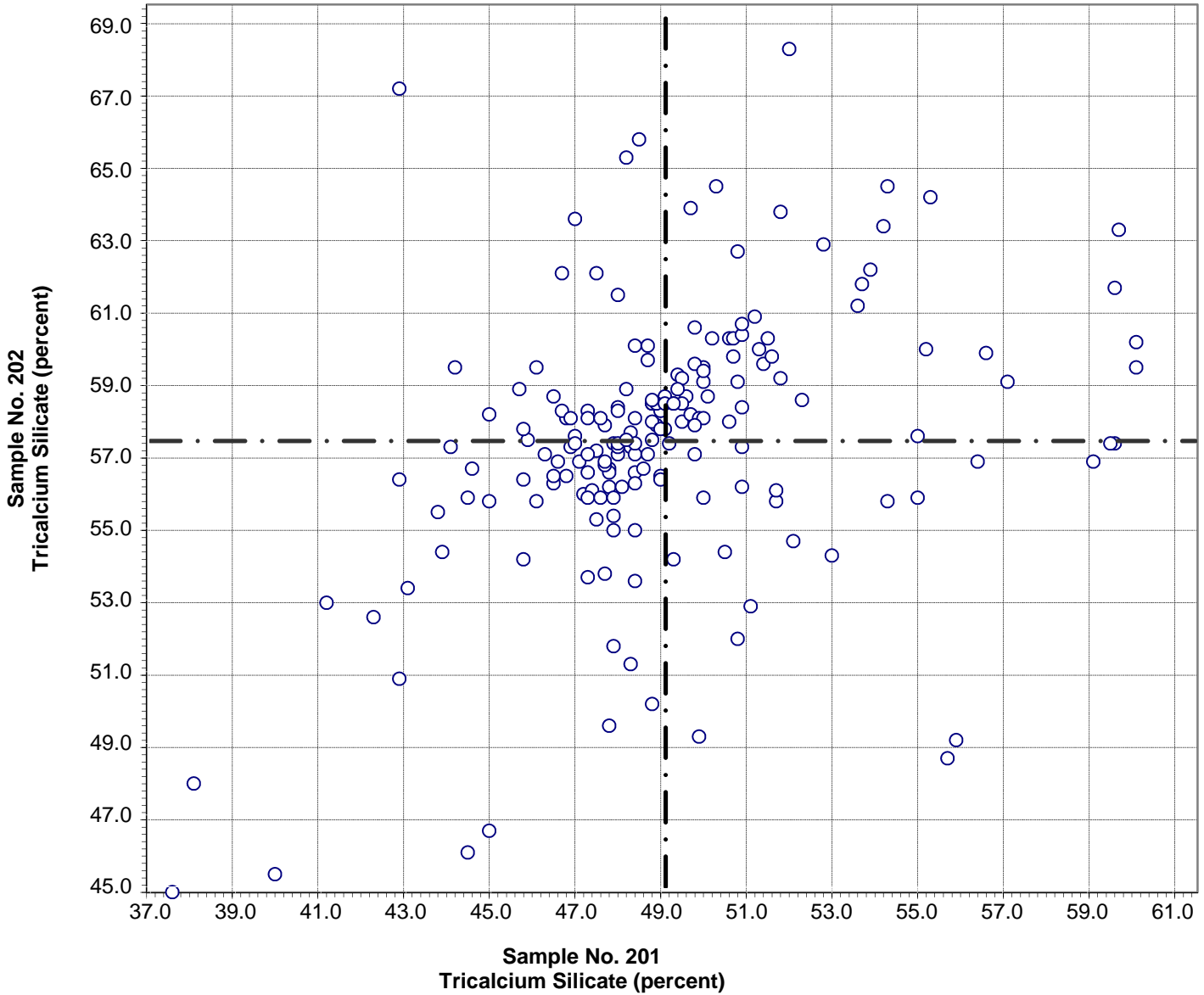


Test No. 105 Chromium Oxide 90 Points

Sample No. 201	Ave 0.008	S.D. 0.003	C.V. 39
Sample No. 202	Ave 0.010	S.D. 0.004	C.V. 36

Labs Eliminated: 15, 66, 151, 415, 493, 2463, 4131

**CCRL Proficiency Sample Program  
Tricalcium Silicate  
PORTLAND CEMENT Samples No. 201 and No. 202**



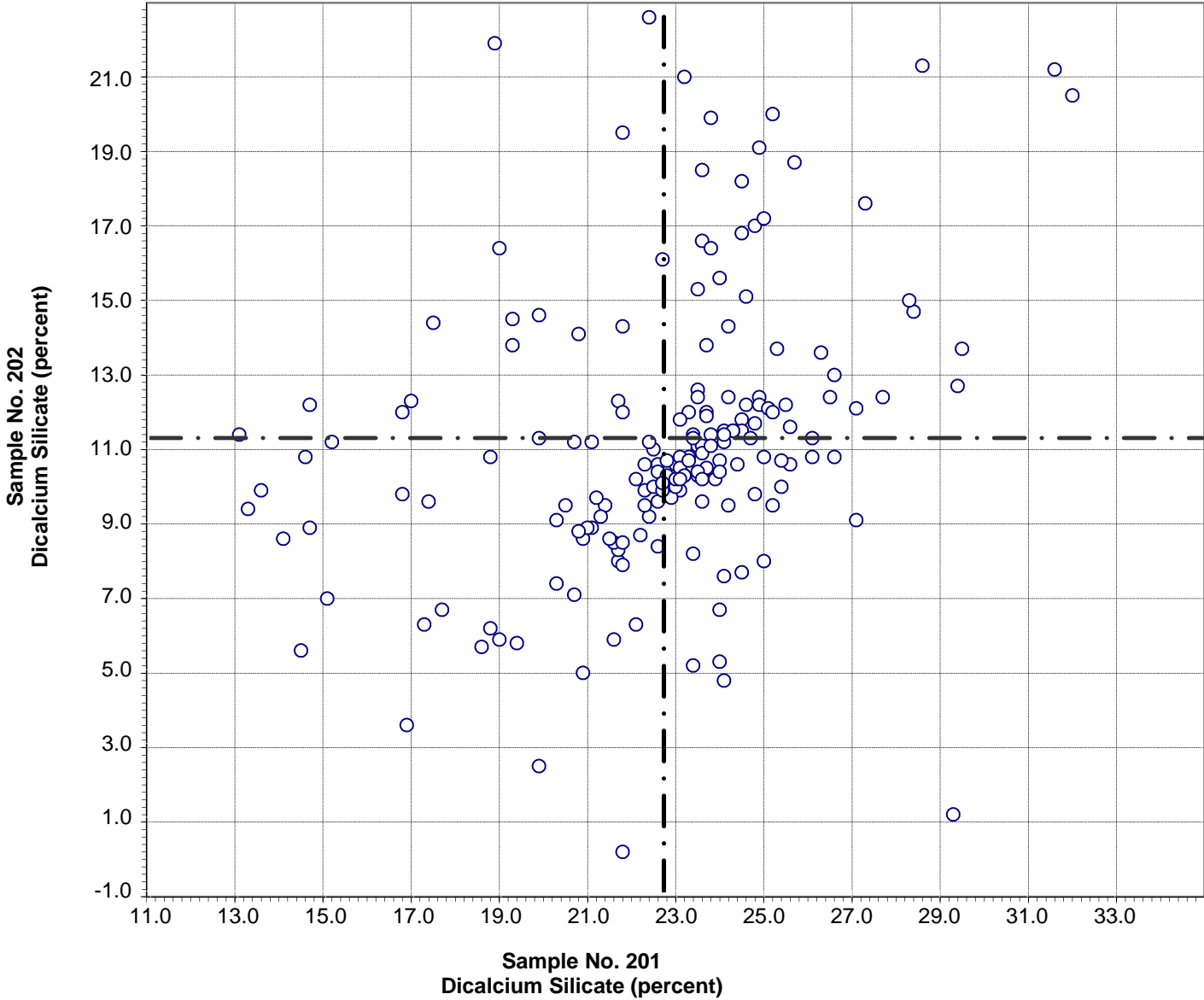
Test No. 106    Tricalcium Silicate    185 Points

Sample No. 201	Ave 49.1	S.D. 3.8	C.V. 7.8
Sample No. 202	Ave 57.4	S.D. 3.7	C.V. 6.5

Labs Eliminated: 38, 42, 407, 551, 2352, 4155

Labs off Diagram: 130, 1644

**CCRL Proficiency Sample Program  
Dicalcium Silicate  
PORTLAND CEMENT Samples No. 201 and No. 202**



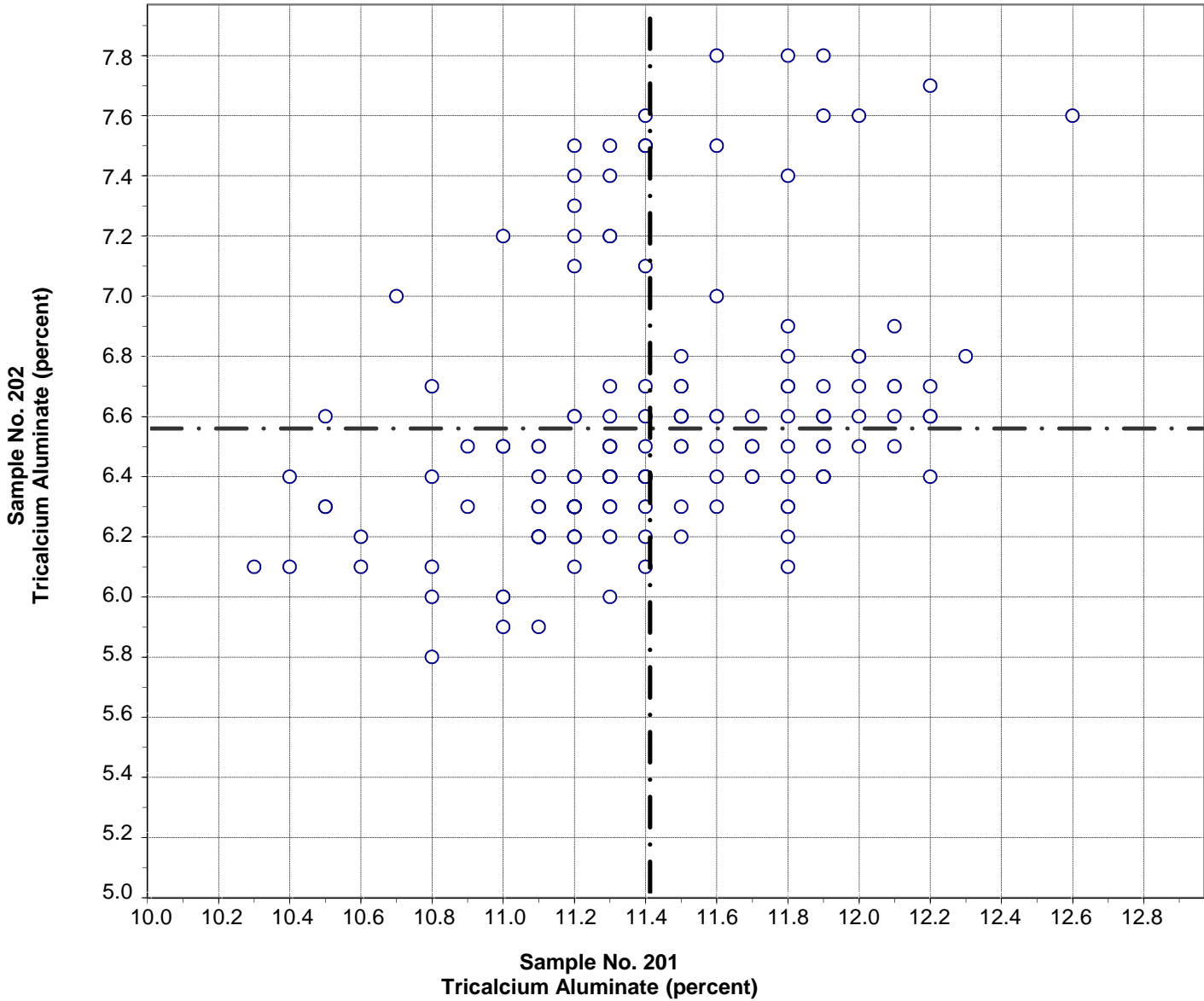
Test No. 107    Dicalcium Silicate    183 Points

Sample No. 201	Ave 22.7	S.D. 3.3	C.V. 14.4
Sample No. 202	Ave 11.3	S.D. 3.8	C.V. 34.1

Labs Eliminated: 38, 42, 50, 130, 148, 494, 2352, 2477, 4155

Labs off Diagram: 407

**CCRL Proficiency Sample Program  
Tricalcium Aluminate  
PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 108 Tricalcium Aluminate 181 Points

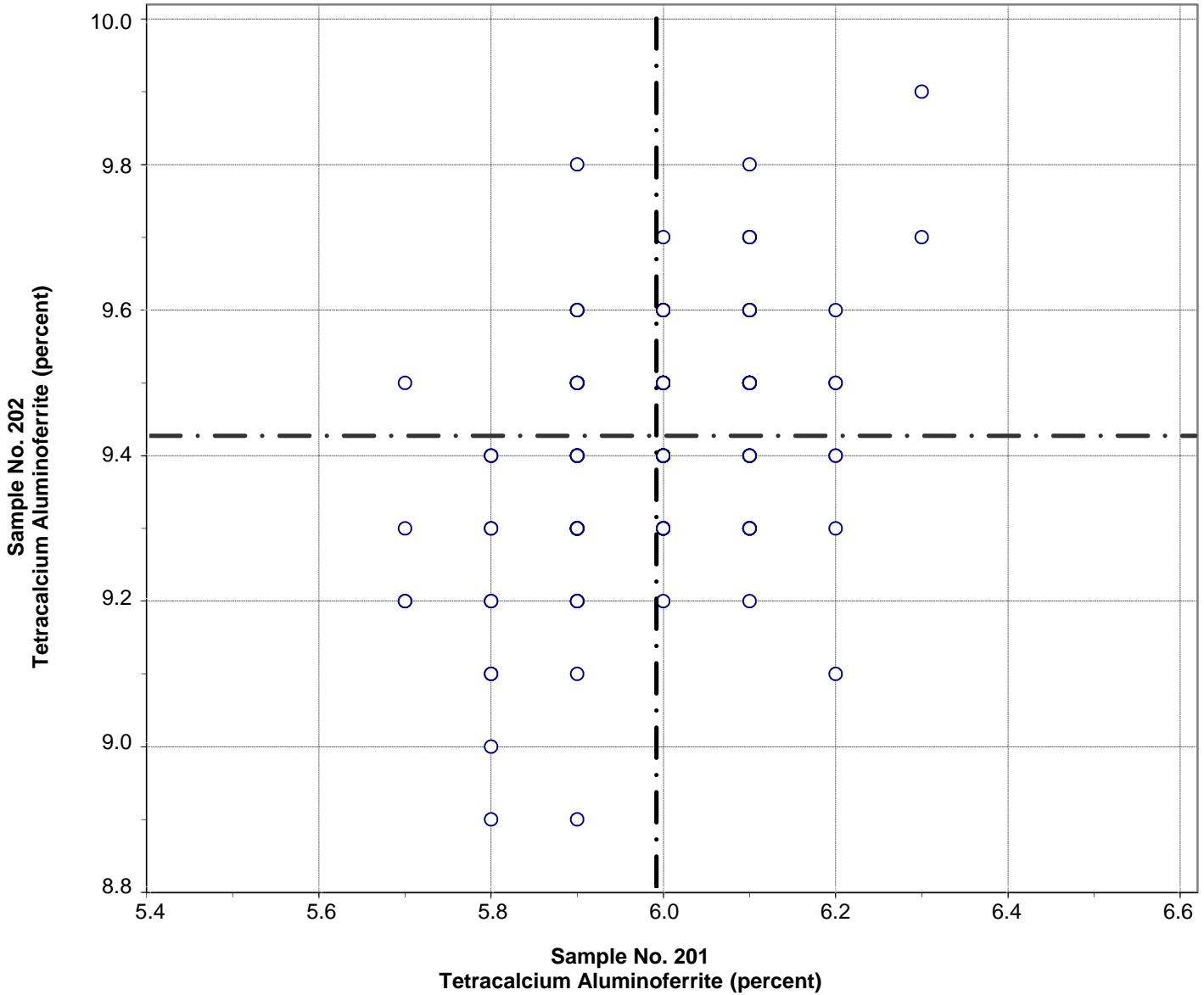
Sample No. 201 Ave 11.4 S.D. 0.4 C.V. 3.8  
 Sample No. 202 Ave 6.6 S.D. 0.5 C.V. 7.1

Labs Eliminated: 19, 95, 116, 494, 768, 1644, 3238, 3779

Labs off Diagram: 124, 413, 2352, 4042



**CCRL Proficiency Sample Program  
Tetracalcium Aluminoferrite  
PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 109 Tetracalcium Aluminoferrite 170 Points

Sample No. 201	Ave 6.0	S.D. 0.1	C.V. 1.8
Sample No. 202	Ave 9.4	S.D. 0.2	C.V. 1.6

Labs Eliminated: 15, 19, 38, 47, 64, 78, 95, 116, 126, 206, 209, 413, 494, 768, 1644, 2293, 3238, 3606, 3661, 3662, 3779, 4042, 4080

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Physical Results  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Normal Consistency - % Water (percent)</b>							
	242	26.8	0.67	2.50	26.6	0.71	2.70
	*236	26.8	0.49	1.80	26.6	0.56	2.10
	* Labs Eliminated - 22, 26, 2412, 3661, 4051, 4137						
<b>Vicat Time of Set - Initial (minutes)</b>							
	240	130	11	9	138	11	8
	No Labs Eliminated for This Test						
<b>Vicat Time of Set - Final (minutes)</b>							
	233	247	35	14	243	31	13
	*229	247	32	13	243	29	12
	* Labs Eliminated - 22, 24, 178, 309						
<b>Gillmore Time of Set - Initial (minutes)</b>							
	142	174	25	15	177	23	13
	*140	173	24	14	176	22	13
	* Labs Eliminated - 129, 205						
<b>Gillmore Time of Set - Final (minutes)</b>							
	142	288	37	13	280	37	13
	*141	287	36	13	280	37	13
	* Labs Eliminated - 167						
<b>False Set - Paste Method (percent)</b>							
	184	82	10.2	12.4	82	9.8	11.9
	*178	83	7.5	9.0	83	7.7	9.3
	* Labs Eliminated - 14, 26, 222, 360, 975, 1079						
<b>Autoclave Expansion (percent)</b>							
	230	0.02	0.043	204	-0.02	0.031	-120
	*219	0.02	0.018	96	-0.02	0.022	-84
	* Labs Eliminated - 22, 64, 93, 95, 134, 431, 551, 690, 2466, 3413, 4137						

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Physical Results  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Air Content % (percent)</b>							
	229	7.1	1.5	22	9.8	1.5	15
	*218	7.0	1.2	17	9.8	1.2	12
* Labs Eliminated - 34, 51, 143, 360, 2293, 2462, 3297, 3658, 4051, 4080, 4137							
<b>Air Content - % Water (percent)</b>							
	223	68.2	10.9	16.0	67.4	10.8	16.0
	*207	69.9	2.3	3.2	69.0	2.6	3.8
* Labs Eliminated - 26, 51, 101, 129, 167, 209, 360, 692, 1644, 2296, 2466, 2938, 3057, 3662, 4080, 4093							
<b>Air Content - Flow (percent)</b>							
	226	87	3.4	3.9	89	3.7	4.2
	*225	87	3.4	3.9	88	3.6	4.1
* Labs Eliminated - 360							
<b>Compressive Strength - 3 day (psi)</b>							
	251	3835	324	8.4	3724	304	8.2
	*247	3843	291	7.6	3734	274	7.3
* Labs Eliminated - 48, 360, 823, 4051							
<b>Compressive Strength - 7 day (psi)</b>							
	251	5001	403	8.1	4675	377	8.1
	*247	5012	353	7.0	4679	321	6.9
* Labs Eliminated - 48, 252, 360, 4051							
<b>Compressive Strength - 28 day (psi)</b>							
	233	6632	562	8.5	6021	473	7.9
	*229	6656	483	7.3	6039	408	6.8
* Labs Eliminated - 360, 3003, 3368, 4051							

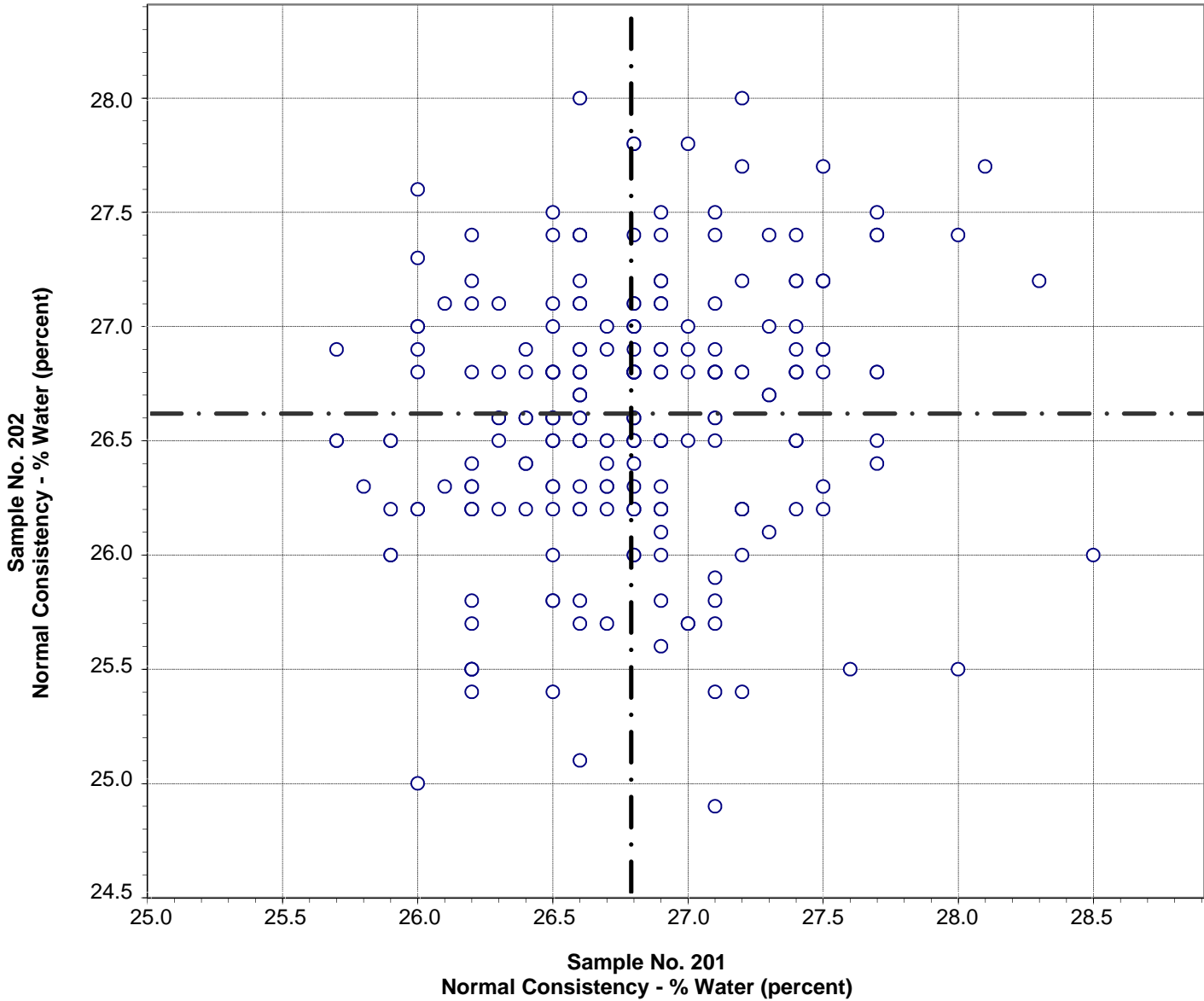
**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Physical Results  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Compressive Strength - Flow (percent)</b>							
	223	108	11	9.9	114	10	9.1
	*219	109	10	8.8	114	9	7.8
	* Labs Eliminated - 84, 129, 2483, 4093						
<b>Fineness - Air Permeability (m<sup>2</sup>/kg)</b>							
	243	385	17	4.4	372	15	4.1
	*231	387	10	2.6	373	9	2.5
	* Labs Eliminated - 4, 14, 34, 35, 51, 116, 143, 440, 768, 2462, 4042, 4150						
<b>Fineness - 45µm Sieve (percent)</b>							
	224	95.62	0.81	0.85	95.52	0.87	0.91
	*208	95.62	0.55	0.57	95.53	0.57	0.59
	* Labs Eliminated - 26, 35, 95, 116, 121, 132, 143, 360, 413, 823, 1726, 2477, 3606, 3658, 4093, 4131						
<b>C1038 Mortar Bar Expansion (percent)</b>							
	166	0.002	0.006	277	0.002	0.012	494
	*151	0.002	0.003	155	0.002	0.003	126
	* Labs Eliminated - 15, 66, 74, 121, 221, 408, 491, 497, 667, 690, 698, 1657, 1715, 2463, 2491						

**CCRL Proficiency Sample Program  
Normal Consistency - % Water  
PORTLAND CEMENT Samples No. 201 and No. 202**

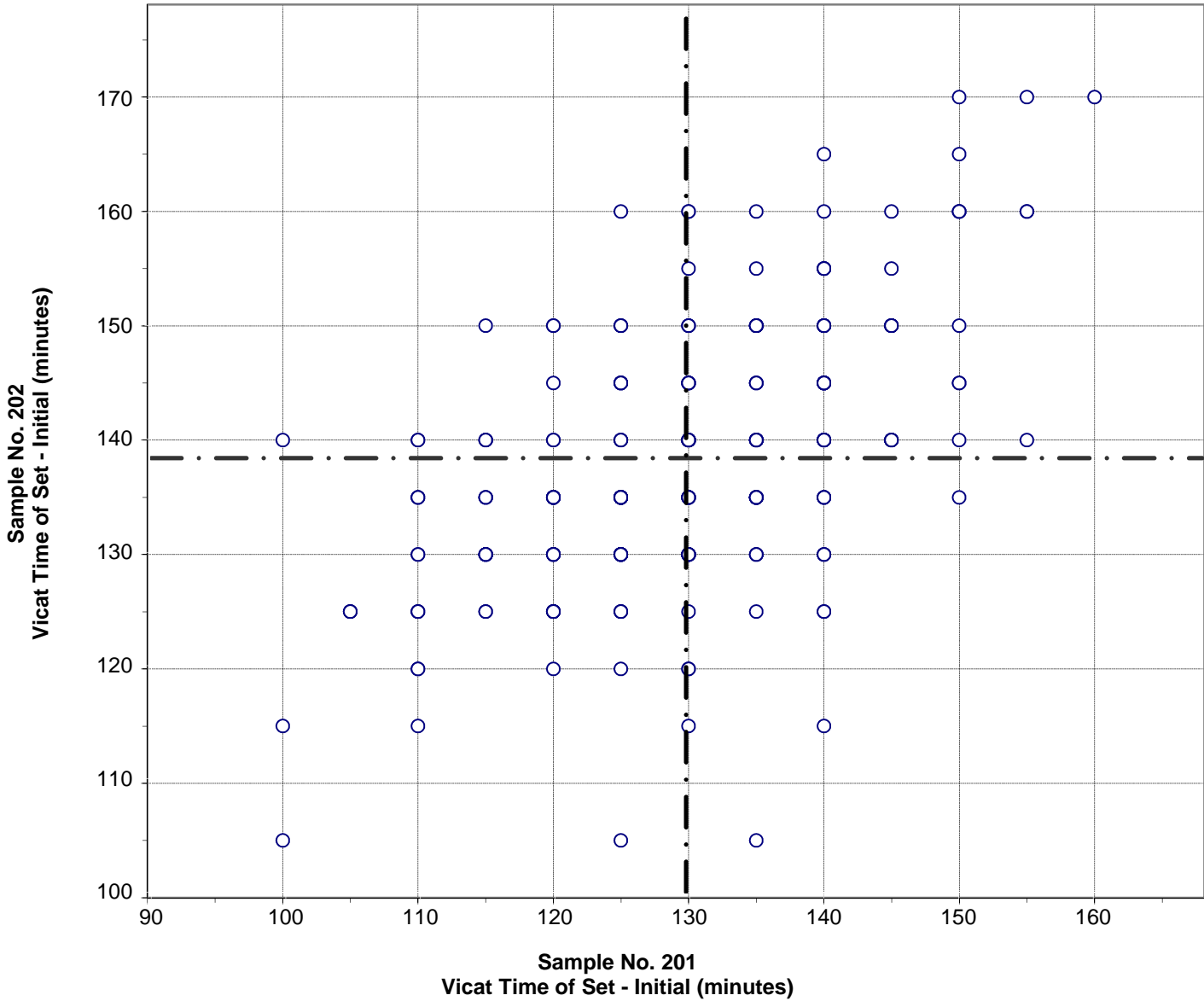


Test No. 110 Normal Consistency - % Water 236 Points

Sample No. 201	Ave 26.8	S.D. 0.49	C.V. 1.80
Sample No. 202	Ave 26.6	S.D. 0.56	C.V. 2.10

Labs Eliminated: 22, 26, 2412, 3661, 4051, 4137

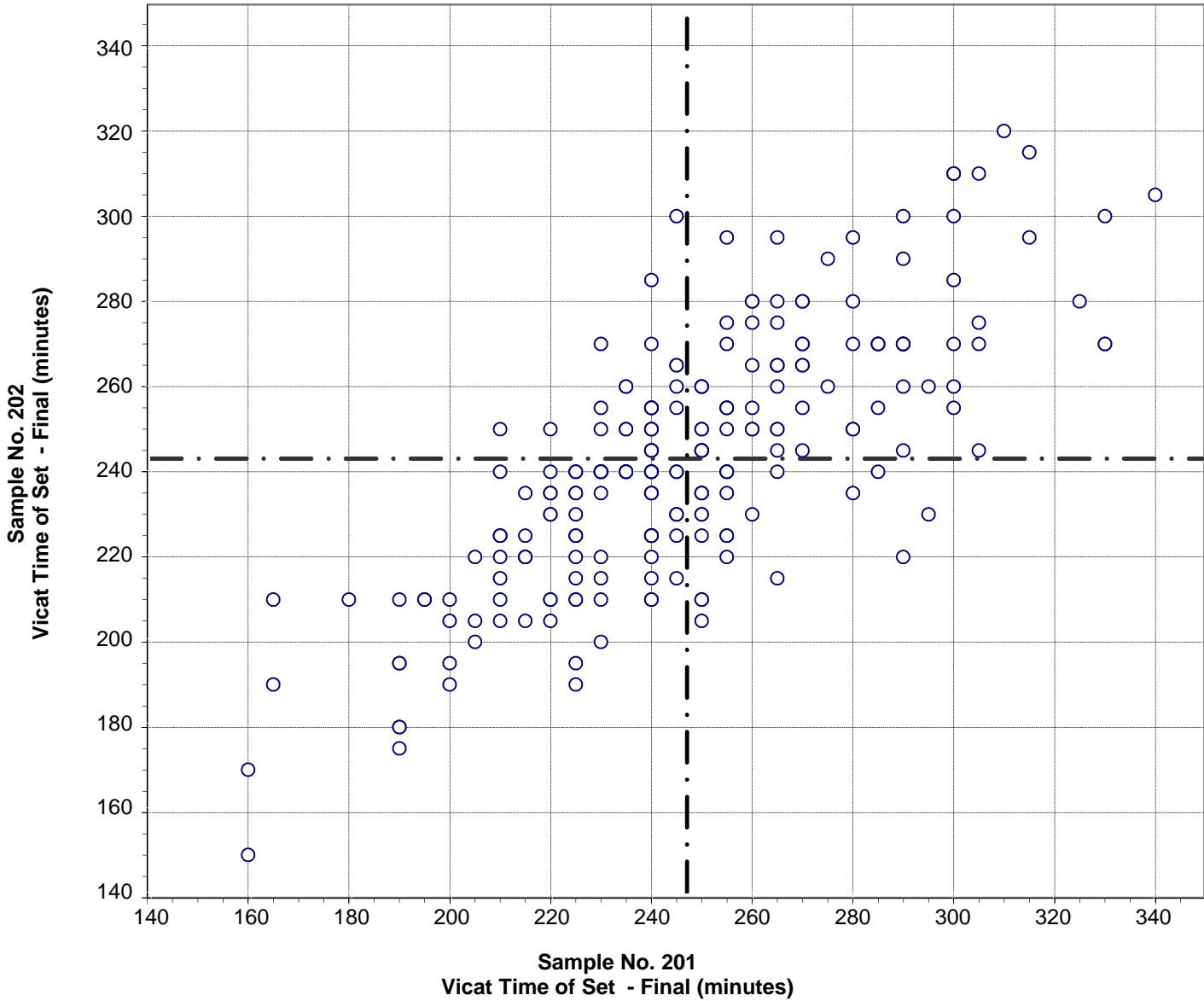
**CCRL Proficiency Sample Program**  
**Vicat Time of Set - Initial**  
**PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 120 Vicat Time of Set - Initial 240 Points

Sample No. 201	Ave 130	S.D. 11	C.V. 9
Sample No. 202	Ave 138	S.D. 11	C.V. 8

**CCRL Proficiency Sample Program  
Vicac Time of Set - Final  
PORTLAND CEMENT Samples No. 201 and No. 202**

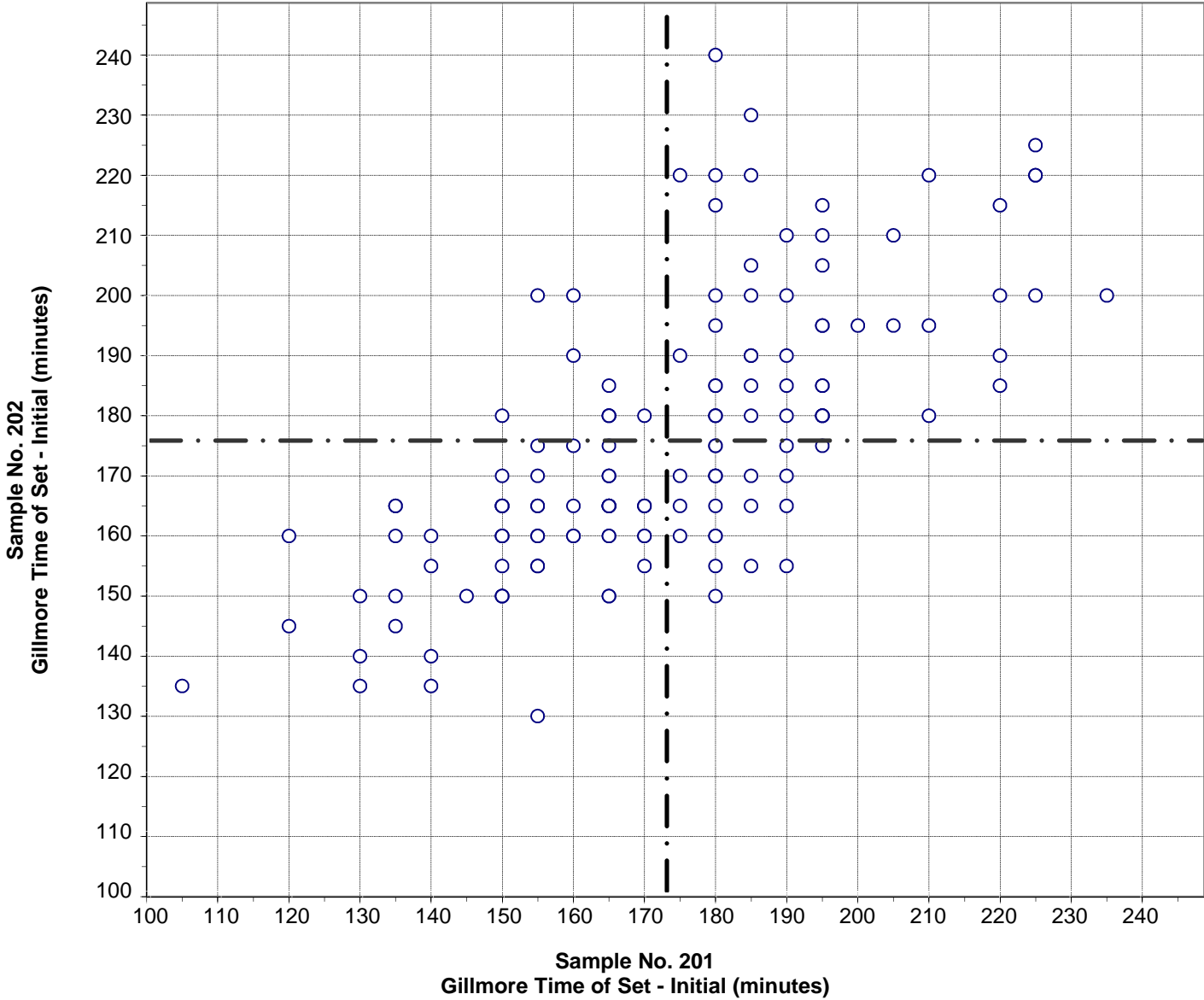


Test No. 121 Vicat Time of Set - Final 229 Points

Sample No. 201	Ave 247	S.D. 32	C.V. 13
Sample No. 202	Ave 243	S.D. 29	C.V. 12

Labs Eliminated: 22, 24, 178, 309

**CCRL Proficiency Sample Program  
Gillmore Time of Set - Initial  
PORTLAND CEMENT Samples No. 201 and No. 202**



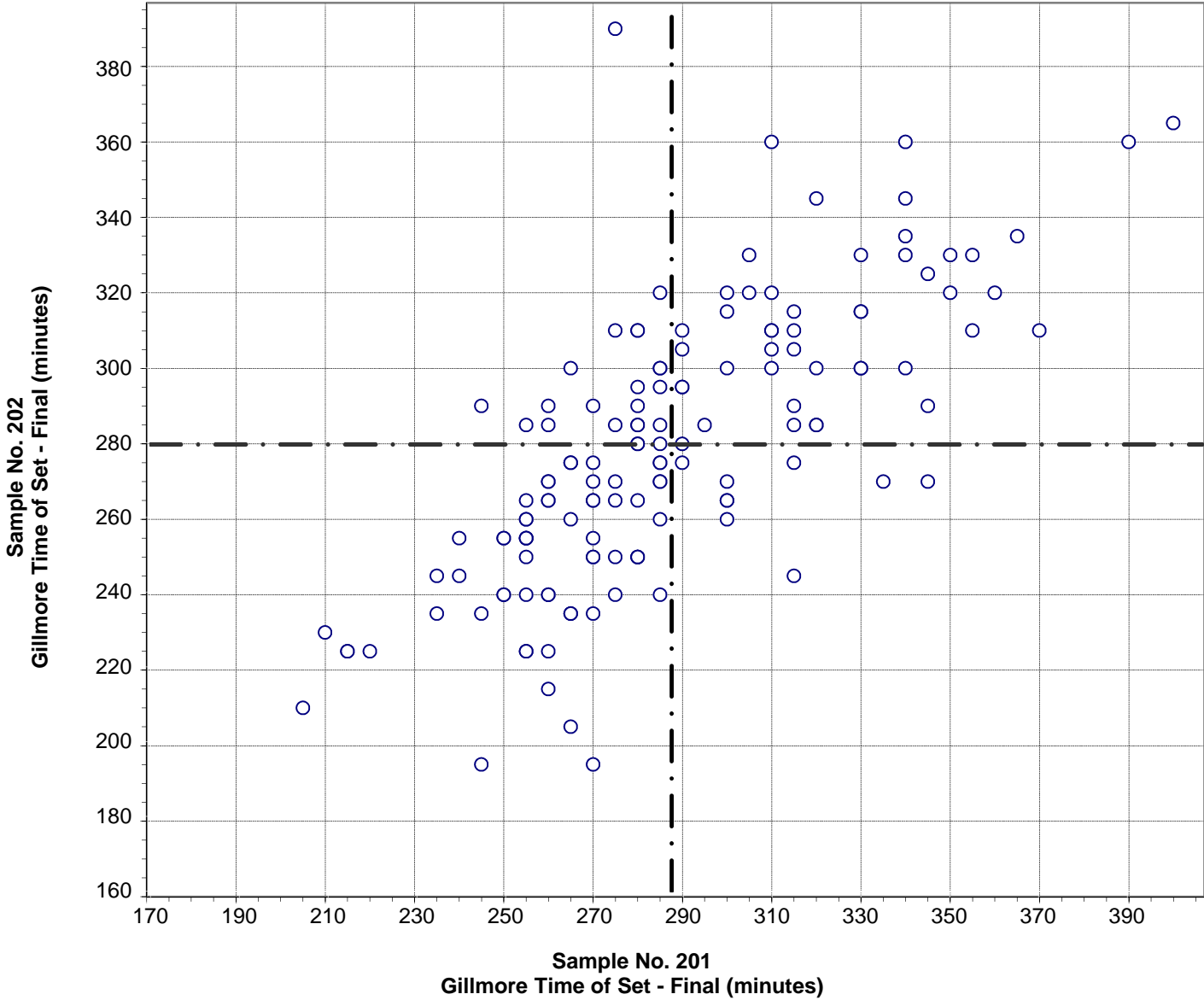
Test No. 130 Gillmore Time of Set - Initial 140 Points

Sample No. 201	Ave 173	S.D. 24	C.V. 14
Sample No. 202	Ave 176	S.D. 22	C.V. 13

Labs Eliminated: 129, 205



**CCRL Proficiency Sample Program  
Gillmore Time of Set - Final  
PORTLAND CEMENT Samples No. 201 and No. 202**

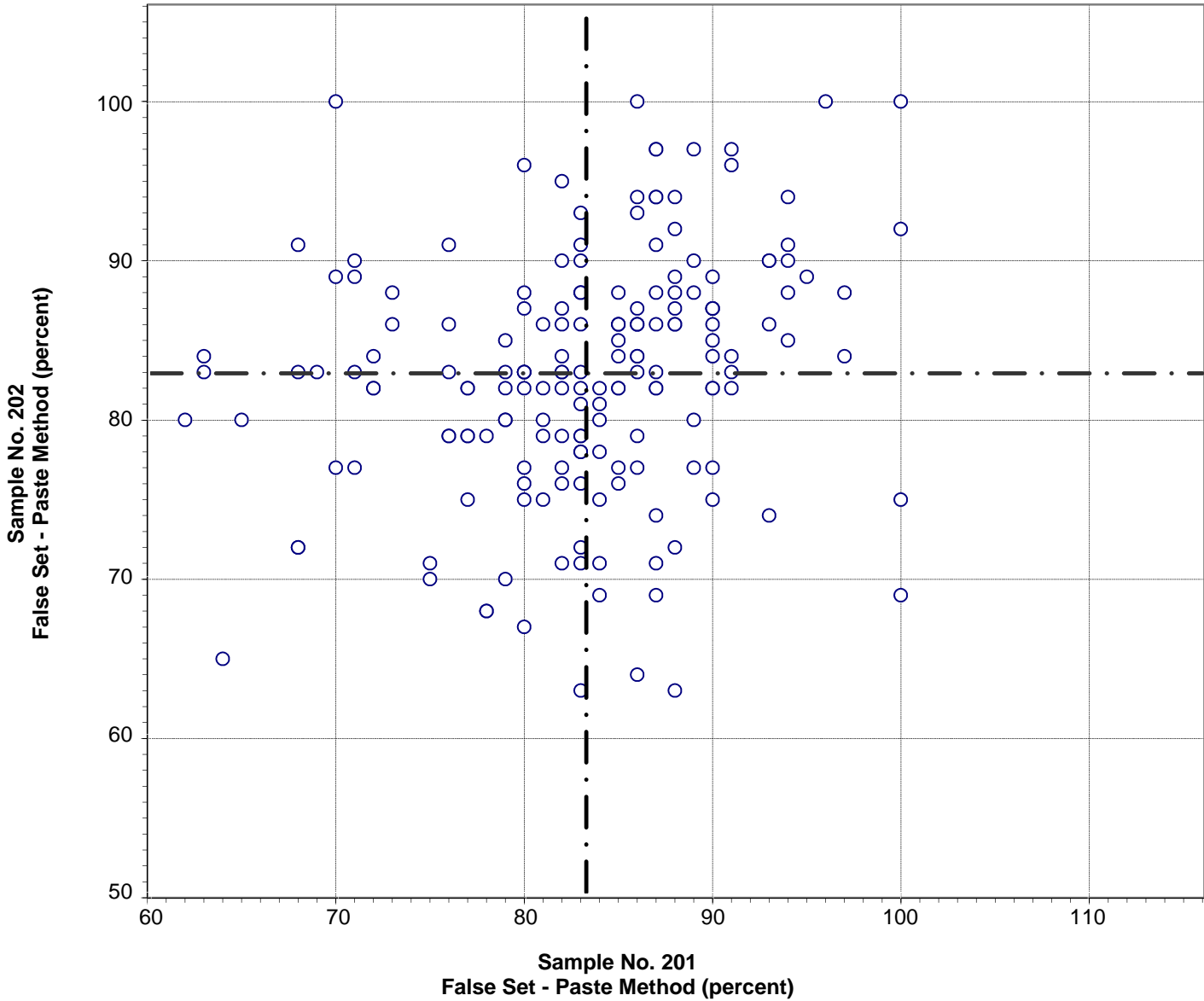


Test No. 140 Gillmore Time of Set - Final 141 Points

Sample No. 201	Ave 287	S.D. 36	C.V. 13
Sample No. 202	Ave 280	S.D. 37	C.V. 13

Labs Eliminated: 167

**CCRL Proficiency Sample Program  
False Set - Paste Method  
PORTLAND CEMENT Samples No. 201 and No. 202**

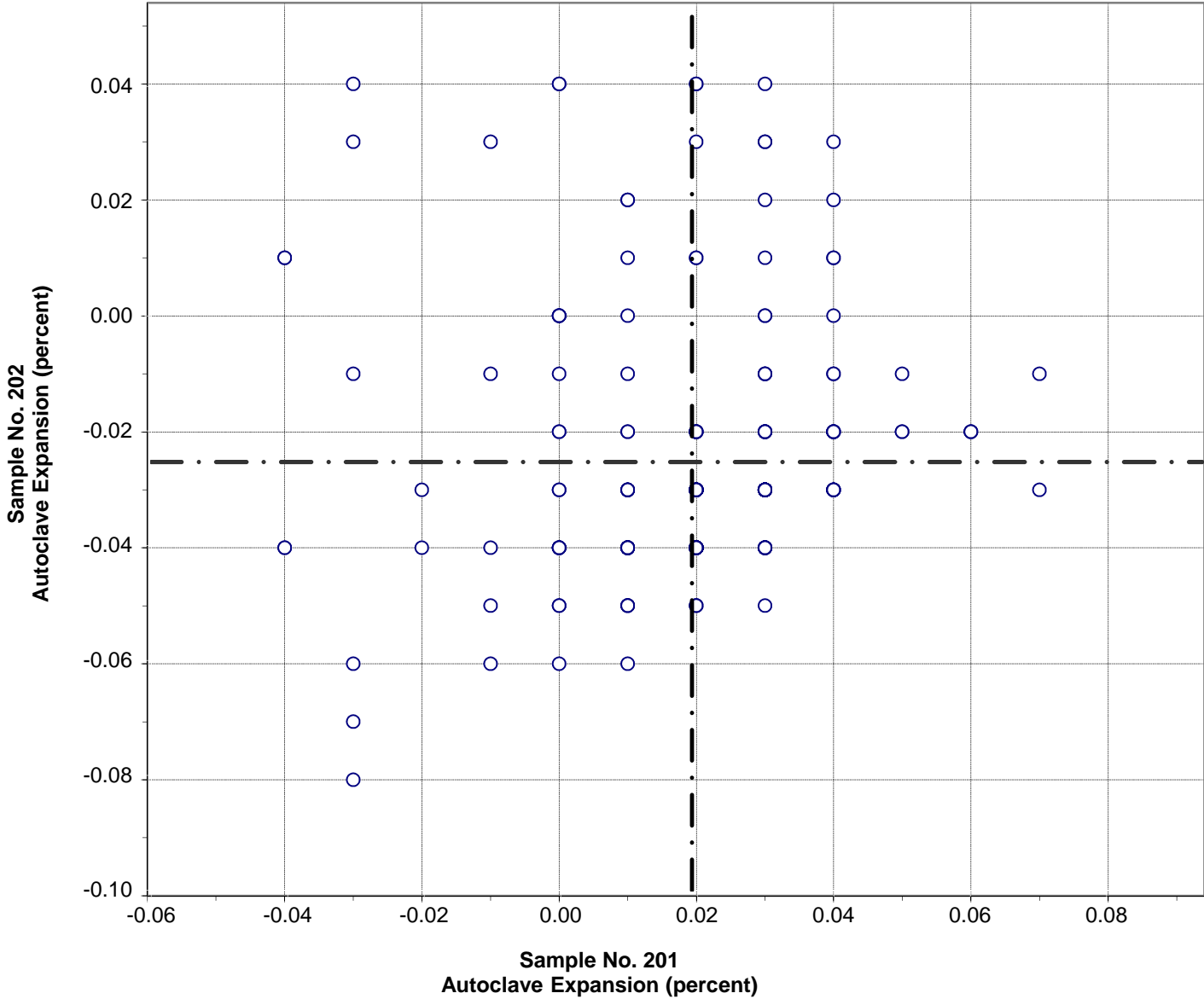


**Test No. 150 False Set - Paste Method 178 Points**

Sample No. 201	Ave 83	S.D. 7.5	C.V. 9.0
Sample No. 202	Ave 83	S.D. 7.7	C.V. 9.3

Labs Eliminated: 14, 26, 222, 360, 975, 1079

**CCRL Proficiency Sample Program  
Autoclave Expansion  
PORTLAND CEMENT Samples No. 201 and No. 202**

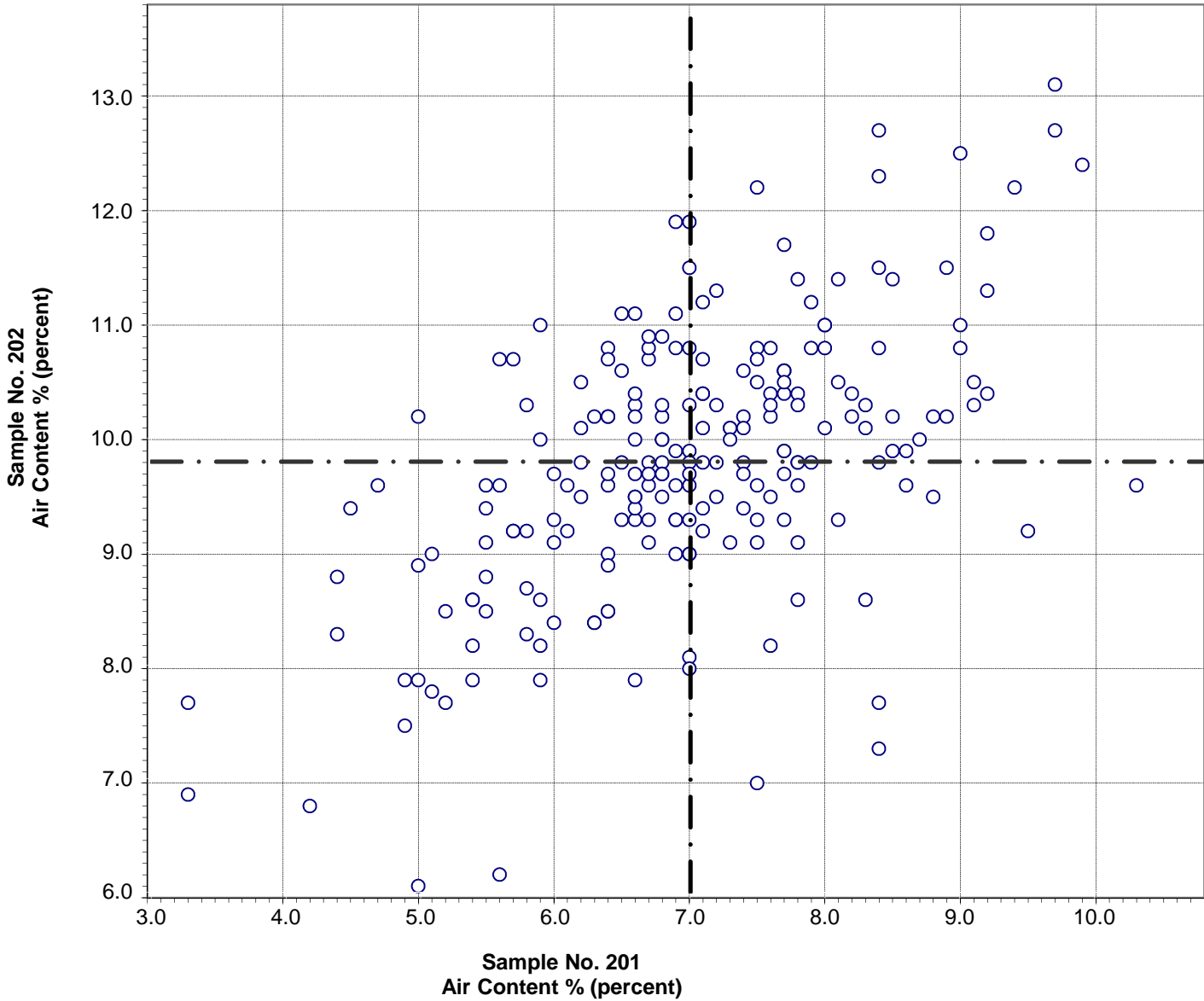


Test No. 160 Autoclave Expansion 219 Points

Sample No. 201	Ave 0.02	S.D. 0.018	C.V. 96
Sample No. 202	Ave -0.02	S.D. 0.022	C.V. -84

Labs Eliminated: 22, 64, 93, 95, 134, 431, 551, 690, 2466, 3413, 4137

**CCRL Proficiency Sample Program**  
**Air Content %**  
**PORTLAND CEMENT Samples No. 201 and No. 202**



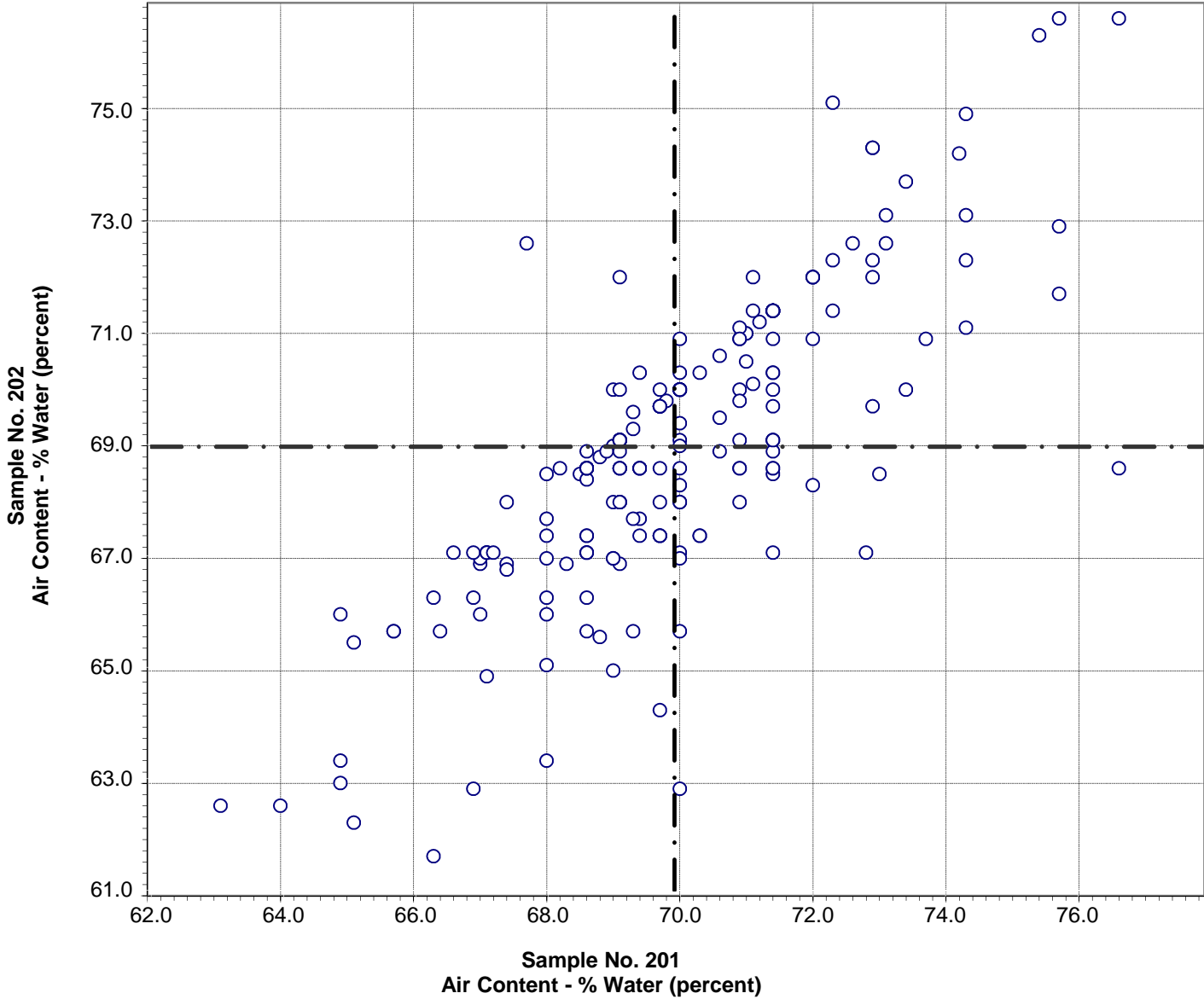
Test No. 170 Air Content % 217 Points

Sample No. 201	Ave 7.0	S.D. 1.2	C.V. 17
Sample No. 202	Ave 9.8	S.D. 1.2	C.V. 12

Labs Eliminated: 34, 51, 143, 360, 2293, 2462, 3297, 3658, 4051, 4080, 4137

Labs off Diagram: 19

**CCRL Proficiency Sample Program**  
**Air Content - % Water**  
**PORTLAND CEMENT Samples No. 201 and No. 202**

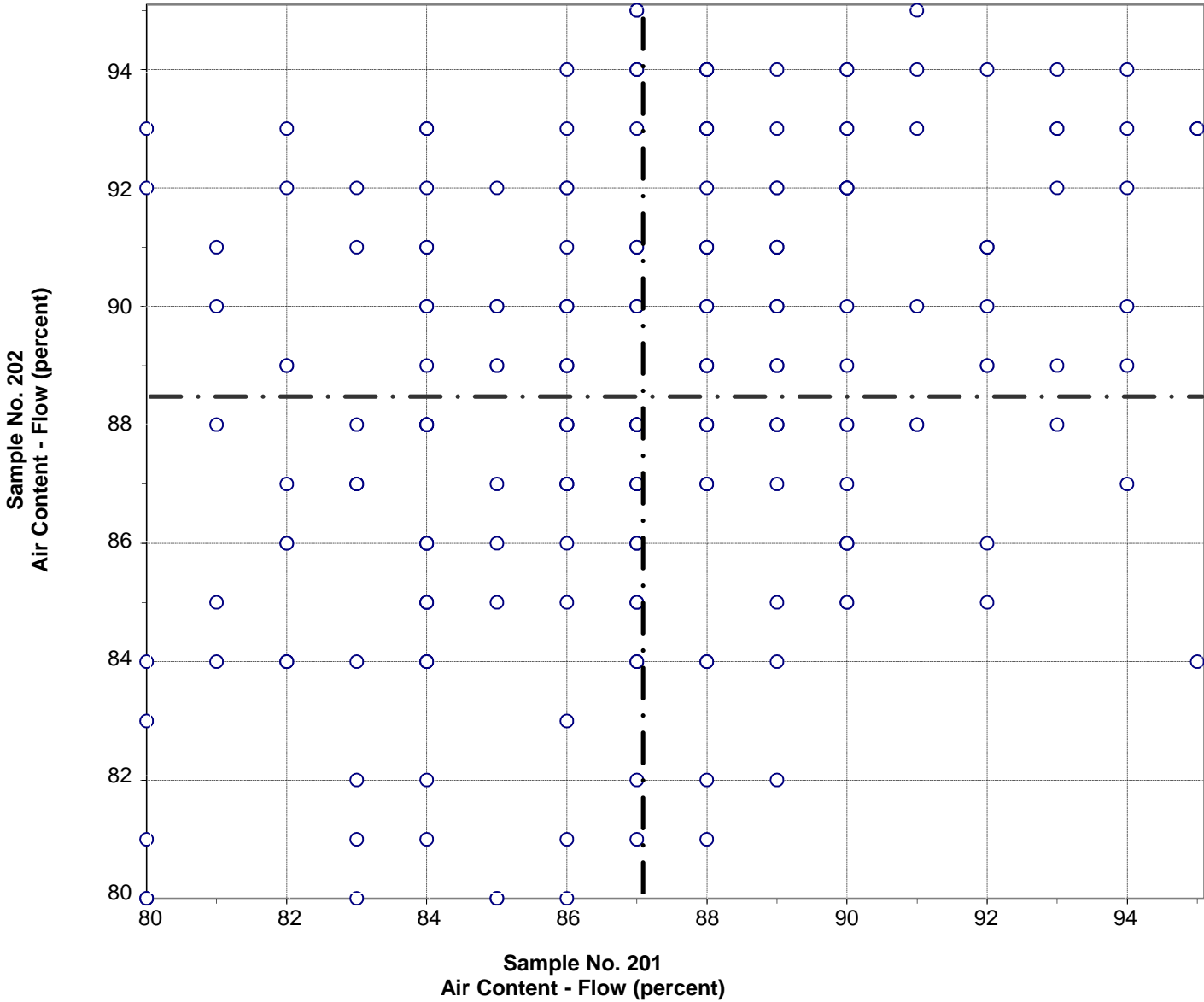


Test No. 180 Air Content - % Water 207 Points

Sample No. 201	Ave 69.9	S.D. 2.3	C.V. 3.2
Sample No. 202	Ave 69.0	S.D. 2.6	C.V. 3.8

Labs Eliminated: 26, 51, 101, 129, 167, 209, 360, 692, 1644, 2296, 2466, 2938, 3057, 3662, 4080, 4093

**CCRL Proficiency Sample Program**  
**Air Content - Flow**  
**PORTLAND CEMENT Samples No. 201 and No. 202**

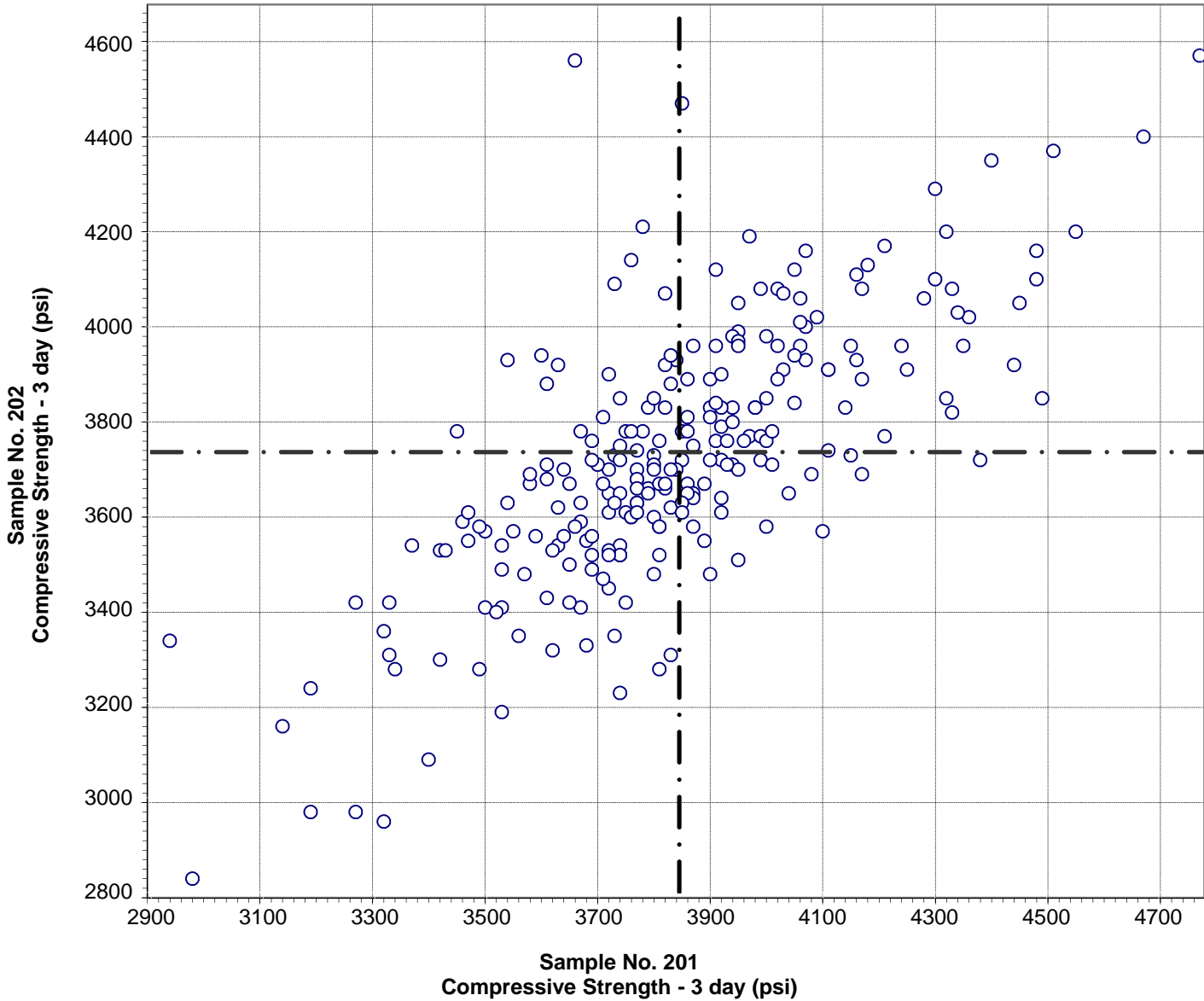


Test No. 190 Air Content - Flow 225 Points

Sample No. 201	Ave 87	S.D. 3.4	C.V. 3.9
Sample No. 202	Ave 88	S.D. 3.6	C.V. 4.1

Labs Eliminated: 360

**CCRL Proficiency Sample Program  
Compressive Strength - 3 day  
PORTLAND CEMENT Samples No. 201 and No. 202**



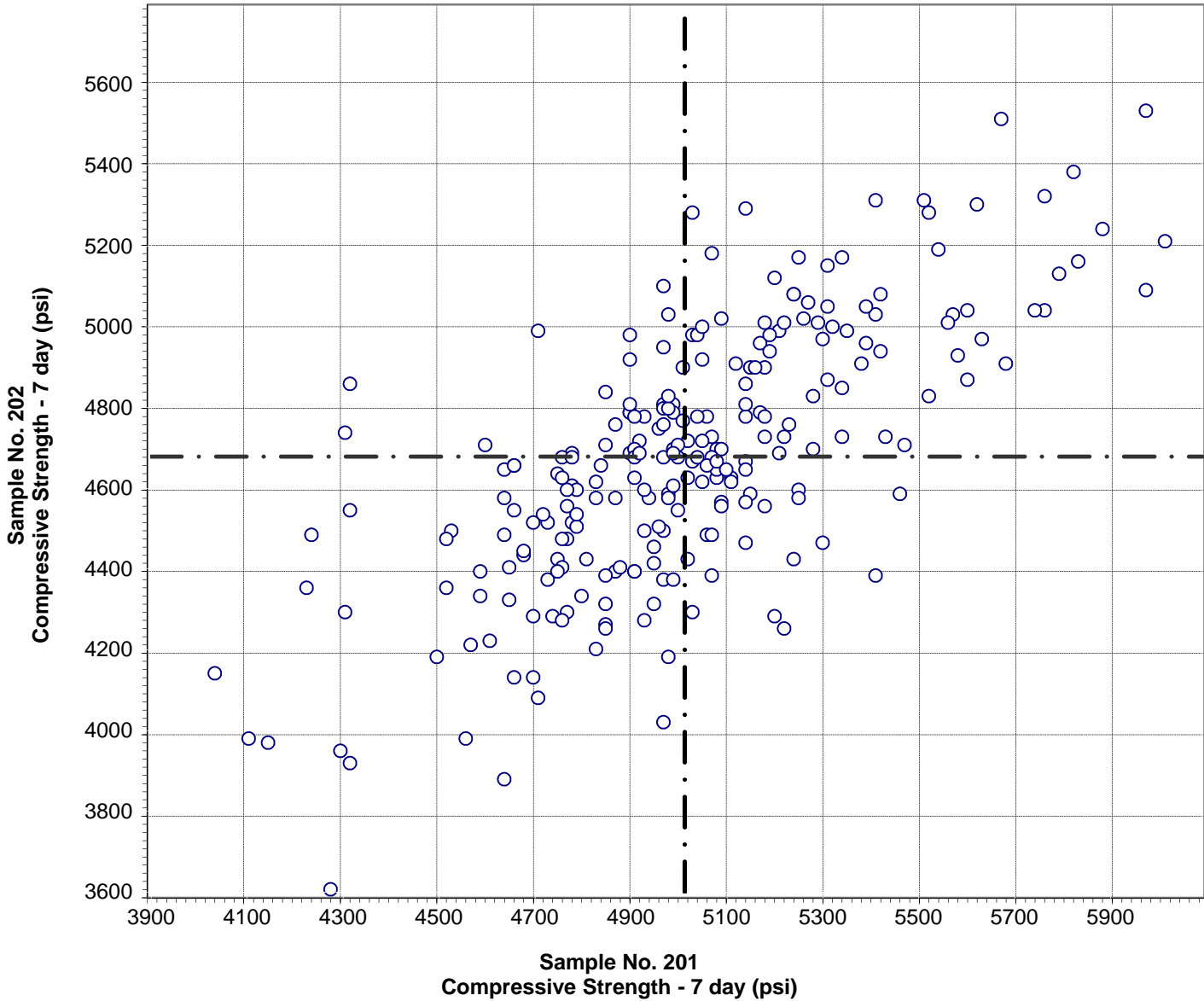
**Test No. 200    Compressive Strength - 3 day    246 Points**

Sample No. 201	Ave 3843	S.D. 291	C.V. 7.6
Sample No. 202	Ave 3734	S.D. 274	C.V. 7.3

Labs Eliminated: 48, 360, 823, 4051

Labs off Diagram: 3606

**CCRL Proficiency Sample Program  
Compressive Strength - 7 day  
PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 210    Compressive Strength - 7 day    245 Points

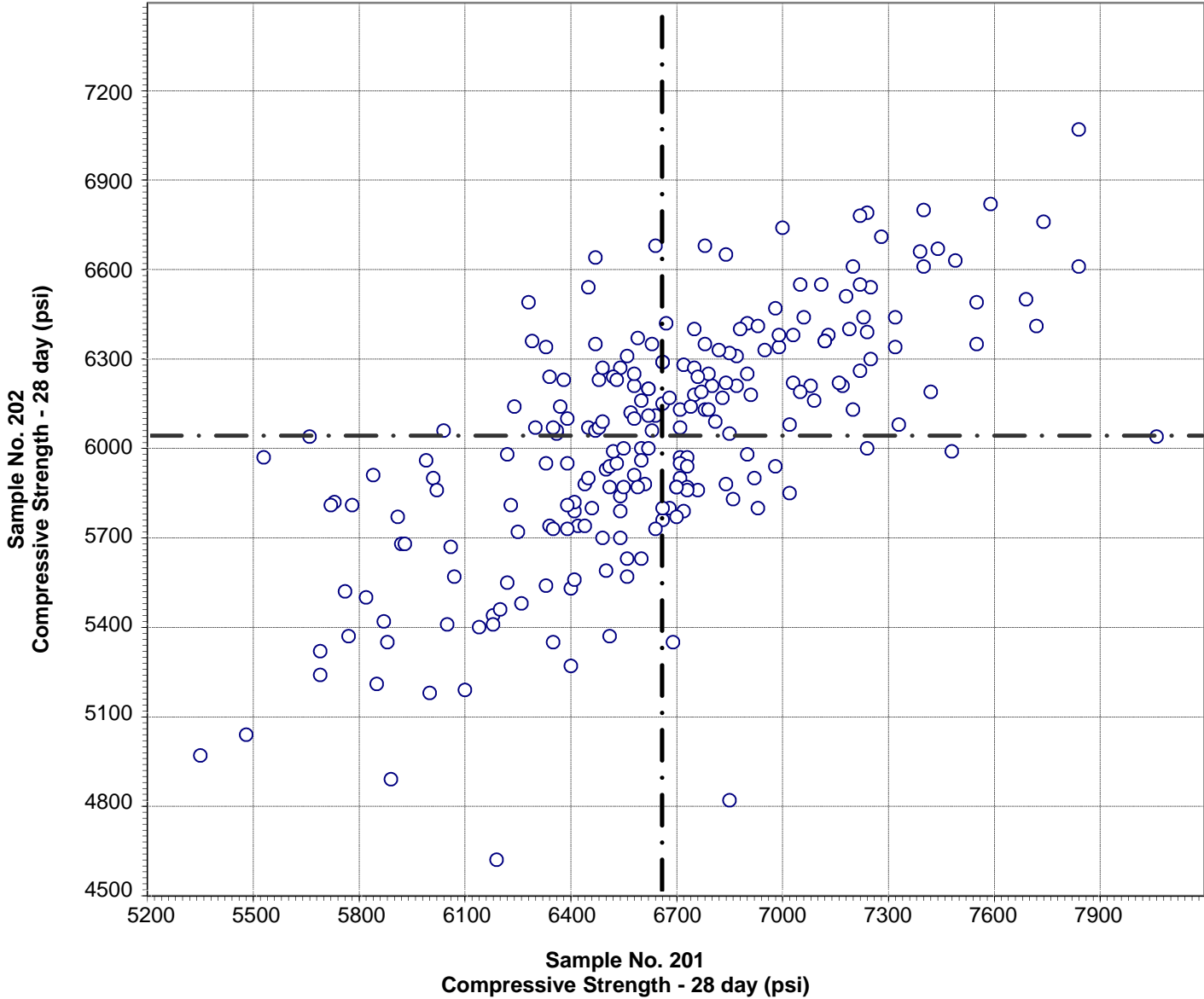
Sample No. 201	Ave 5012	S.D. 353	C.V. 7.0
Sample No. 202	Ave 4679	S.D. 321	C.V. 6.9

Labs Eliminated: 48, 252, 360, 4051

Labs off Diagram: 15, 169



**CCRL Proficiency Sample Program  
Compressive Strength - 28 day  
PORTLAND CEMENT Samples No. 201 and No. 202**



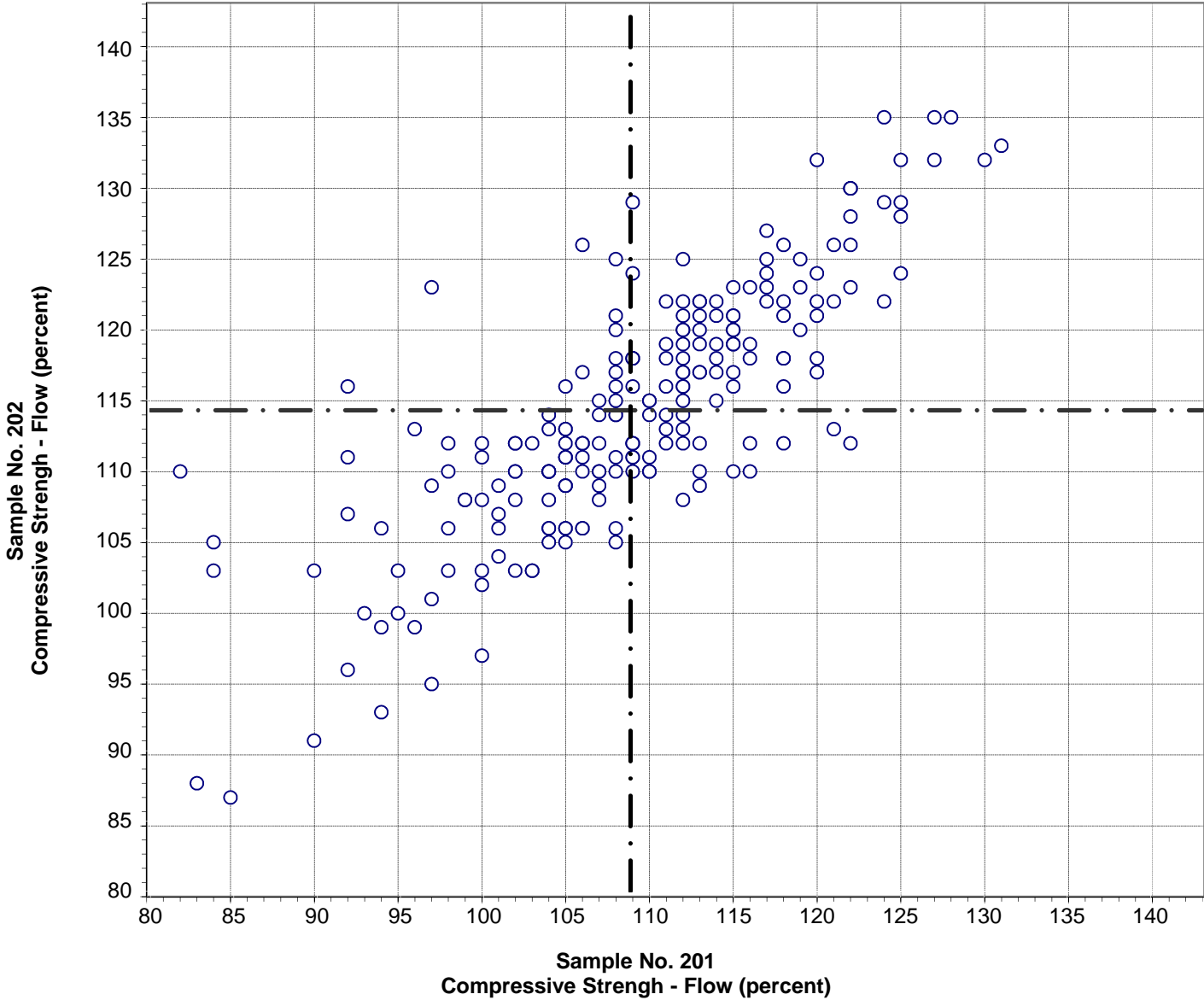
Test No. 211    Compressive Strength - 28 day    228 Points

Sample No. 201	Ave 6656	S.D. 483	C.V. 7.3
Sample No. 202	Ave 6039	S.D. 408	C.V. 6.8

Labs Eliminated: 360, 3003, 3368, 4051

Labs off Diagram: 4131

**CCRL Proficiency Sample Program  
Compressive Strength - Flow  
PORTLAND CEMENT Samples No. 201 and No. 202**



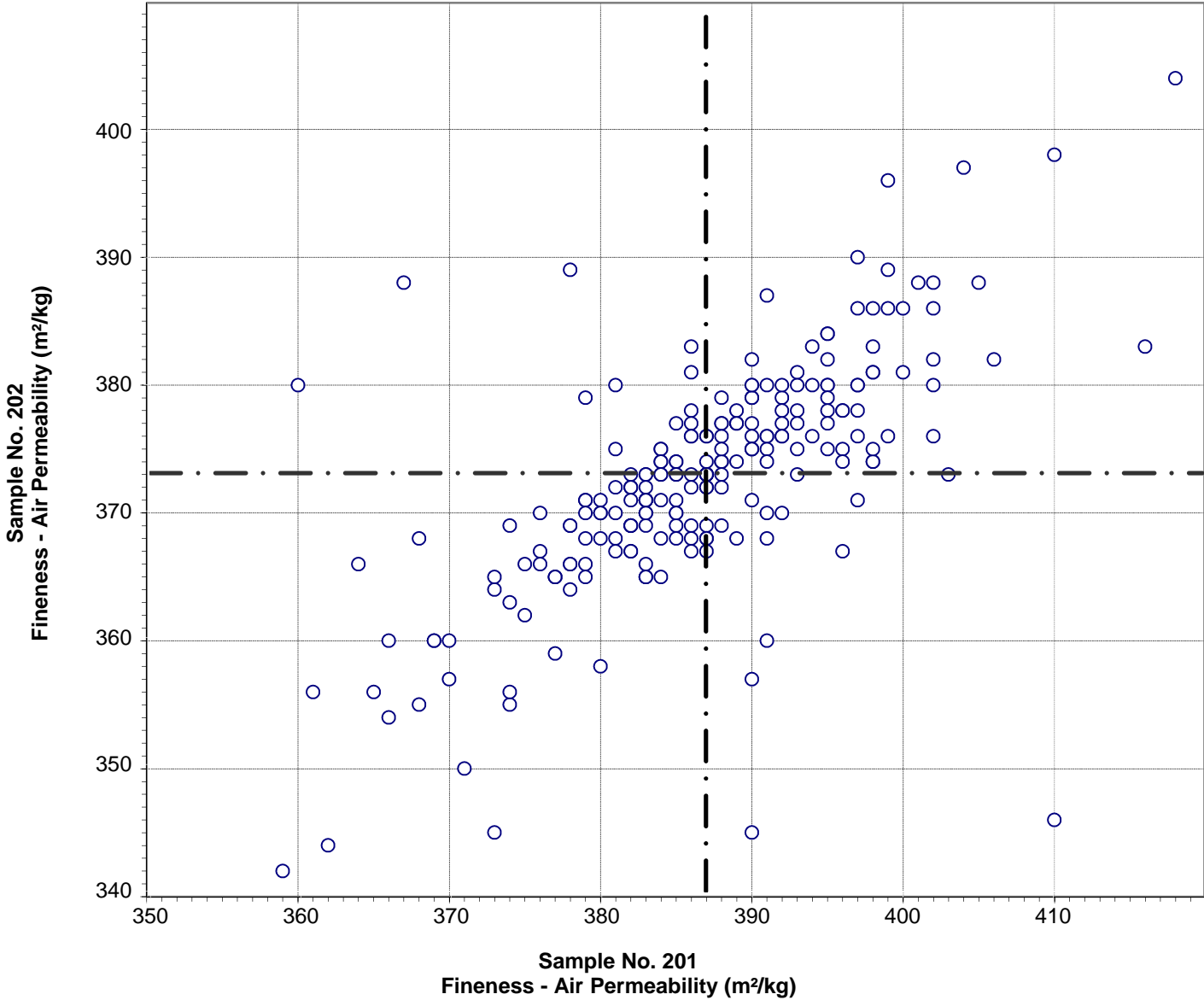
**Test No. 230 Compressive Strength - Flow 217 Points**

Sample No. 201	Ave 109	S.D. 10	C.V. 8.8
Sample No. 202	Ave 114	S.D. 9	C.V. 7.8

Labs Eliminated: 84, 129, 2483, 4093

Labs off Diagram: 95, 1466

**CCRL Proficiency Sample Program  
Fineness - Air Permeability  
PORTLAND CEMENT Samples No. 201 and No. 202**



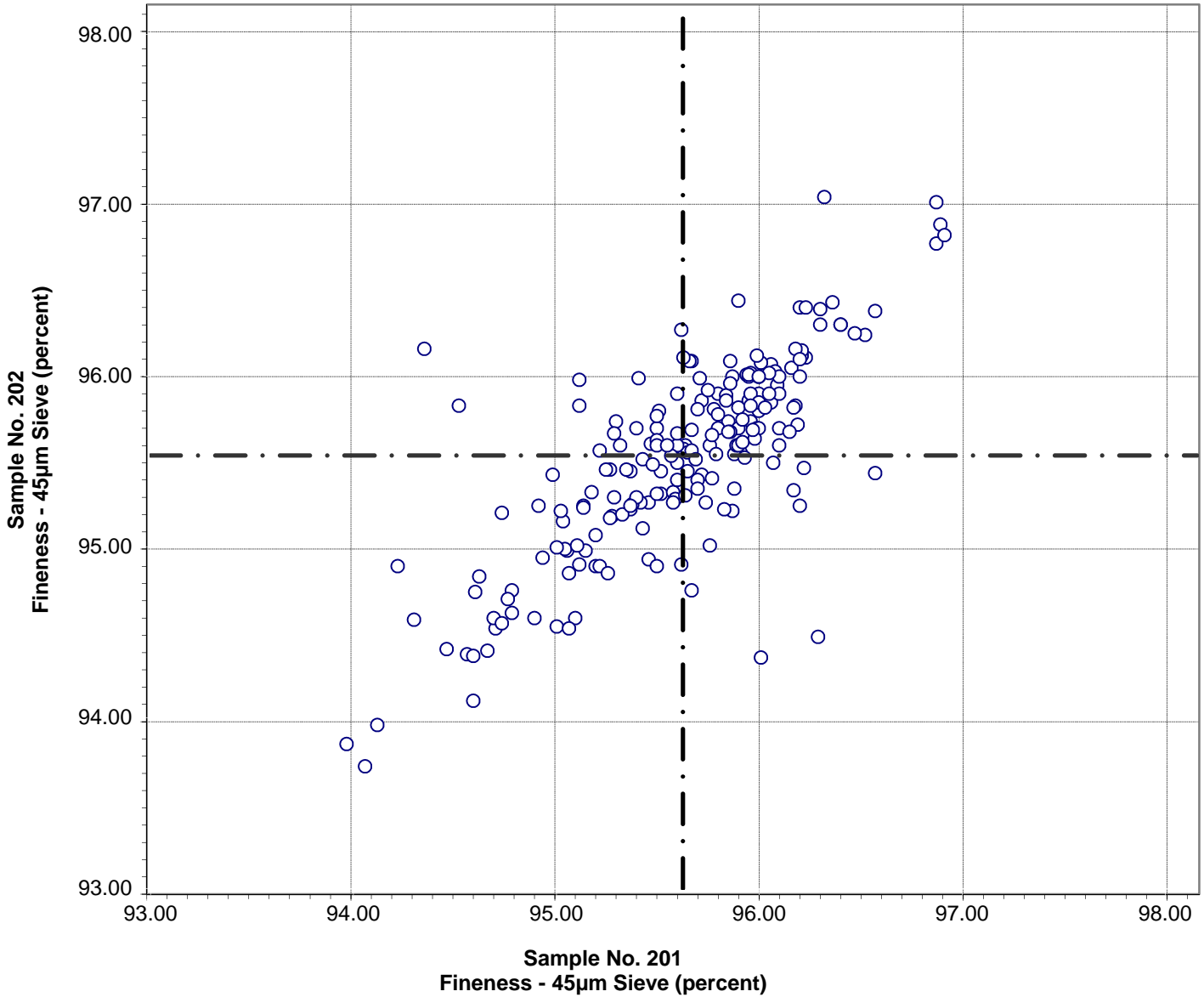
Test No. 270    Fineness - Air Permeability    229 Points

Sample No. 201	Ave 387	S.D. 10	C.V. 2.6
Sample No. 202	Ave 373	S.D. 9	C.V. 2.5

Labs Eliminated: 4, 14, 34, 35, 51, 116, 143, 440, 768, 2462, 4042, 4150

Labs off Diagram: 49, 1726

**CCRL Proficiency Sample Program  
Fineness - 45µm Sieve  
PORTLAND CEMENT Samples No. 201 and No. 202**

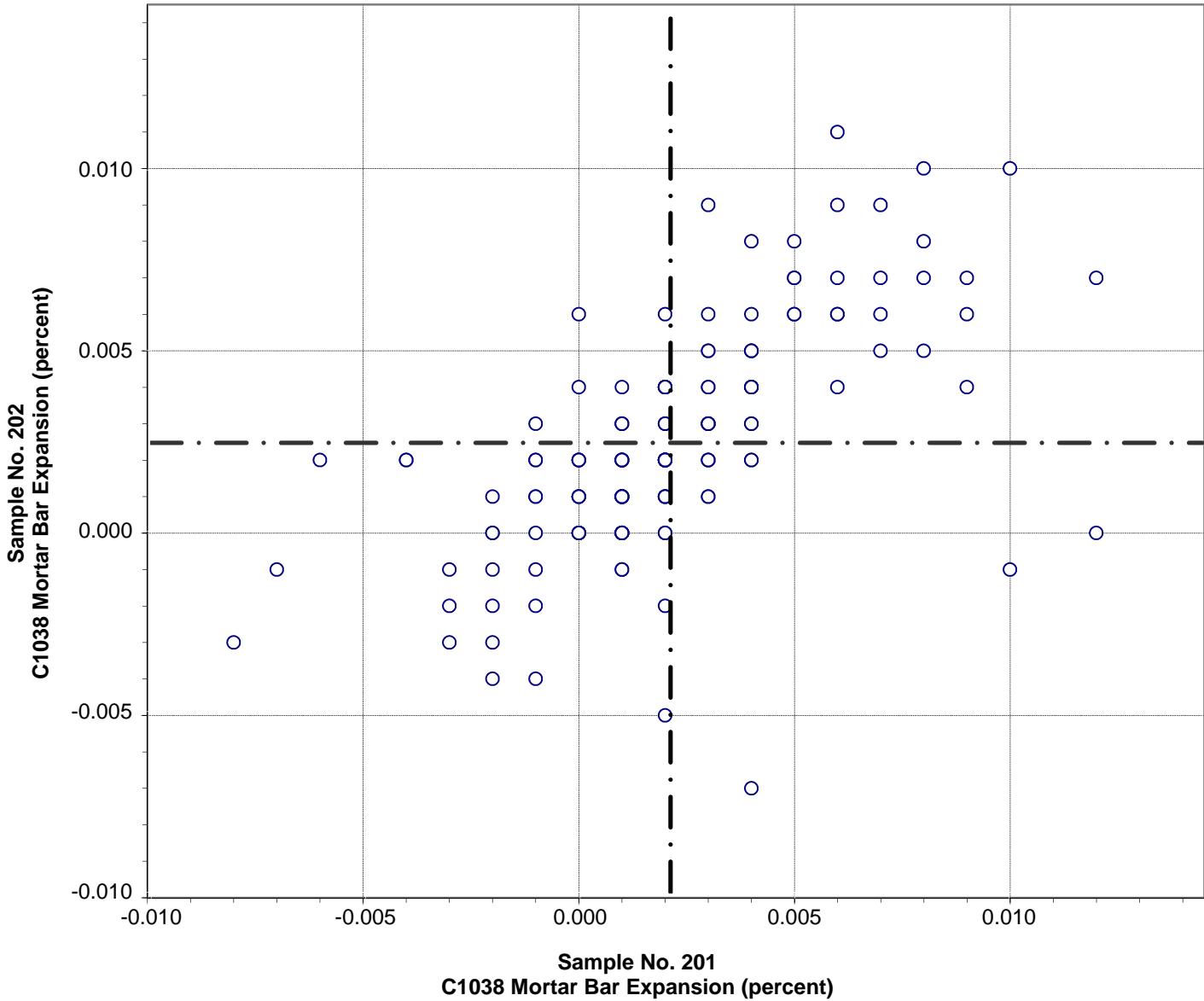


**Test No. 281    Fineness - 45µm Sieve    208 Points**

Sample No. 201	Ave 95.62	S.D. 0.55	C.V. 0.57
Sample No. 202	Ave 95.53	S.D. 0.57	C.V. 0.59

Labs Eliminated: 26, 35, 95, 116, 121, 132, 143, 360, 413, 823, 1726, 2477, 3606, 3658, 4093, 4131

**CCRL Proficiency Sample Program  
C1038 Mortar Bar Expansion  
PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 400 C1038 Mortar Bar Expansion 151 Points

Sample No. 201	Ave 0.002	S.D. 0.003	C.V. 155
Sample No. 202	Ave 0.002	S.D. 0.003	C.V. 126

Labs Eliminated: 15, 66, 74, 121, 221, 408, 491, 497, 667, 690, 698, 1657, 1715, 2463, 2491

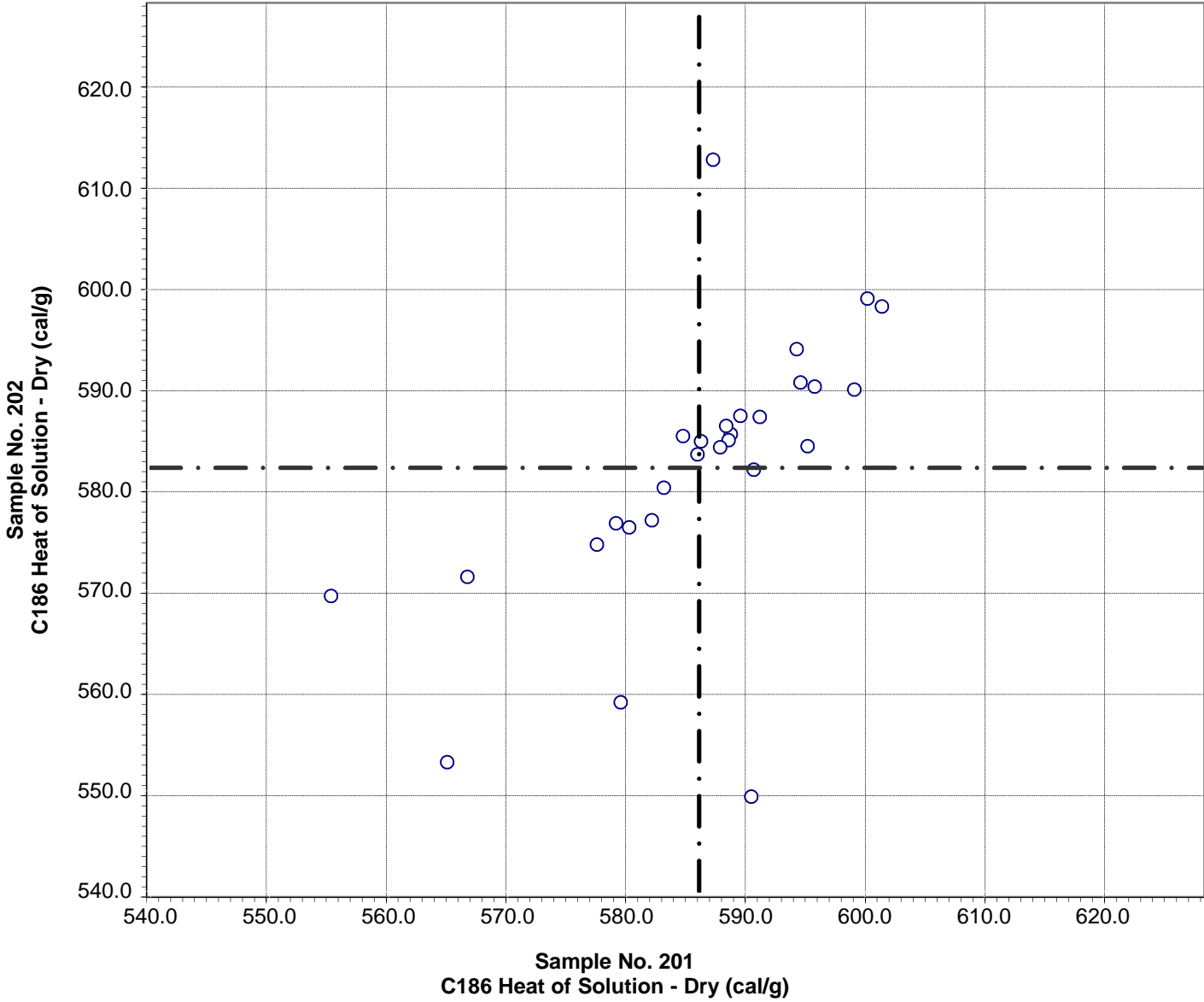
**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 201 and No. 202

Final Report – Heat of Hydration Results  
 August 31, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.201				Sample No. 202		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>C186 Heat of Solution - Dry (cal/g)</b>							
	29	587.0	12.7	2.2	583.0	13.1	2.3
	*28	586.0	10.5	1.8	582.0	13.3	2.3
* Labs Eliminated - 3606							
<b>C186 Heat of Solution - 7 day (cal/g)</b>							
	29	501.7	8.5	1.7	505.9	10.0	2.0
No Labs Eliminated for This Test							
<b>C186 Heat of Solution 28 day (cal/g)</b>							
	22	480.3	56.7	11.8	485.6	62.5	12.9
	*21	492.2	11.9	2.4	498.8	10.3	2.1
* Labs Eliminated - 1644							
<b>C186 Heat of Hydration - 7 day (cal/g)</b>							
	31	85.2	11.2	13.2	76.9	11.0	14.2
	*29	84.5	5.1	6.1	77.8	10.1	12.9
* Labs Eliminated - 975, 3606							
<b>C186 Heat of Hydration - 28 day (cal/g)</b>							
	24	95.8	7.8	8.2	86.7	12.1	14.0
	*23	94.8	6.2	6.6	84.8	7.7	9.0
* Labs Eliminated - 4150							
<b>C1702 Heat of Hydration - 3 day (J/g)</b>							
	11	300	80	26.9	265	71	26.7
	*9	330	16	4.8	295	14	4.9
* Labs Eliminated - 116, 3605							
<b>C1702 Heat of Hydration - 7 day (J/g)</b>							
	11	343	92	26.9	309	84	27.0
	*9	381	14	3.7	344	17	5.1
* Labs Eliminated - 116, 3605							

**CCRL Proficiency Sample Program  
C186 Heat of Solution - Dry  
PORTLAND CEMENT Samples No. 201 and No. 202**

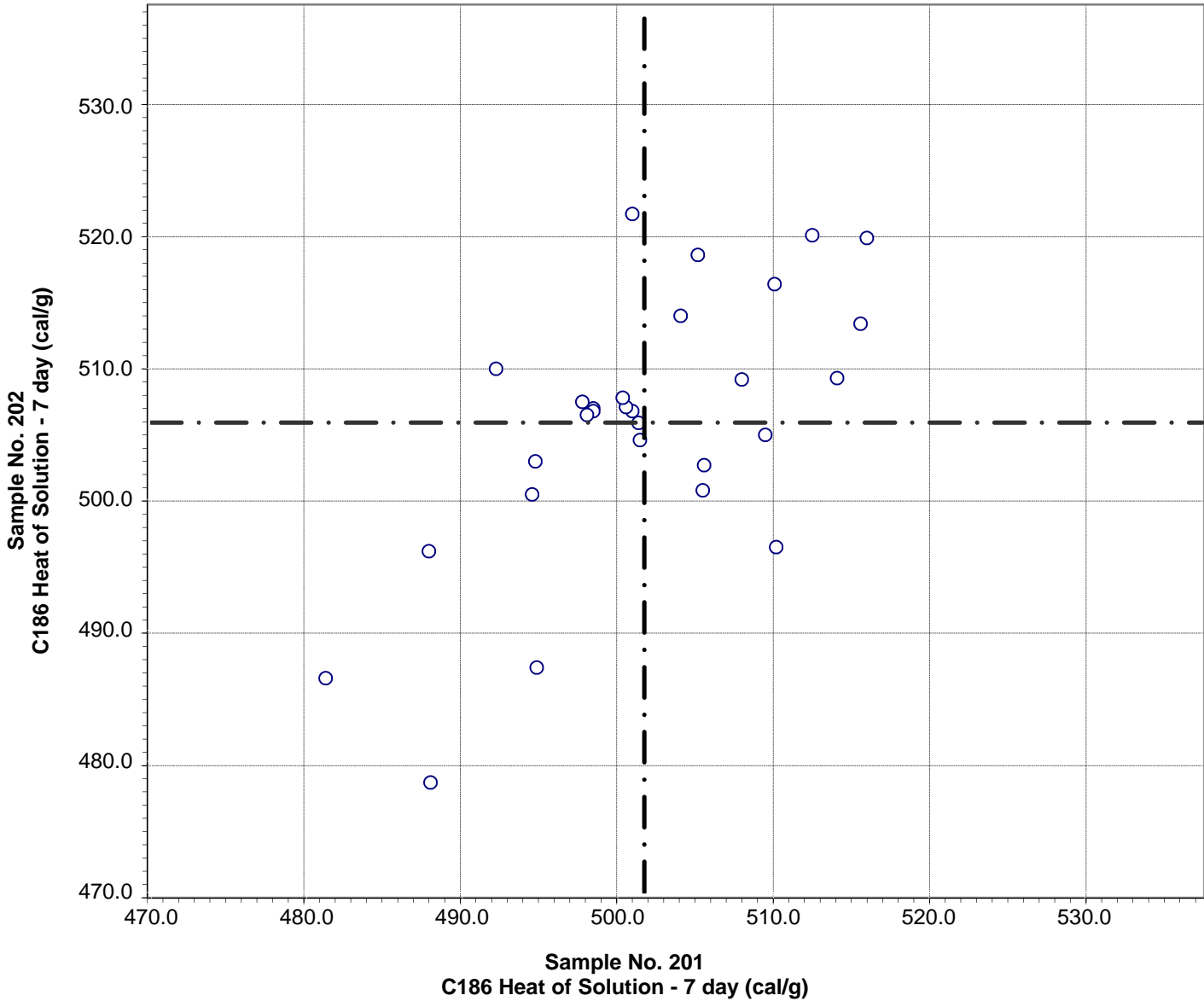


Test No. 291 C186 Heat of Solution - Dry 28 Points

Sample No. 201	Ave 586.0	S.D. 10.5	C.V. 1.8
Sample No. 202	Ave 582.0	S.D. 13.3	C.V. 2.3

Labs Eliminated: 3606

**CCRL Proficiency Sample Program  
C186 Heat of Solution - 7 day  
PORTLAND CEMENT Samples No. 201 and No. 202**

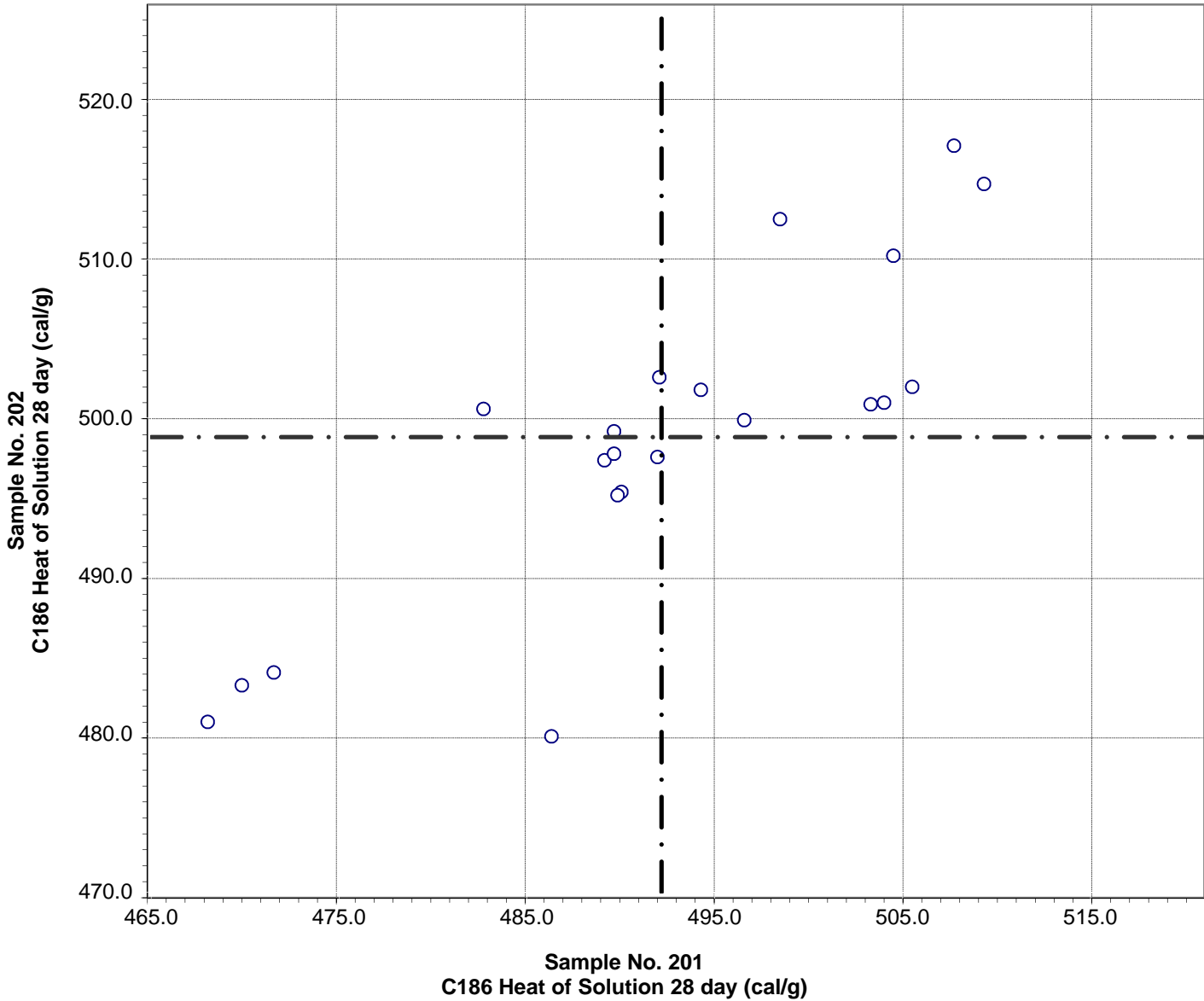


Test No. 292 C186 Heat of Solution - 7 day 29 Points

Sample No. 201	Ave 501.7	S.D. 8.5	C.V. 1.7
Sample No. 202	Ave 505.9	S.D. 10.0	C.V. 2.0



**CCRL Proficiency Sample Program  
C186 Heat of Solution 28 day  
PORTLAND CEMENT Samples No. 201 and No. 202**

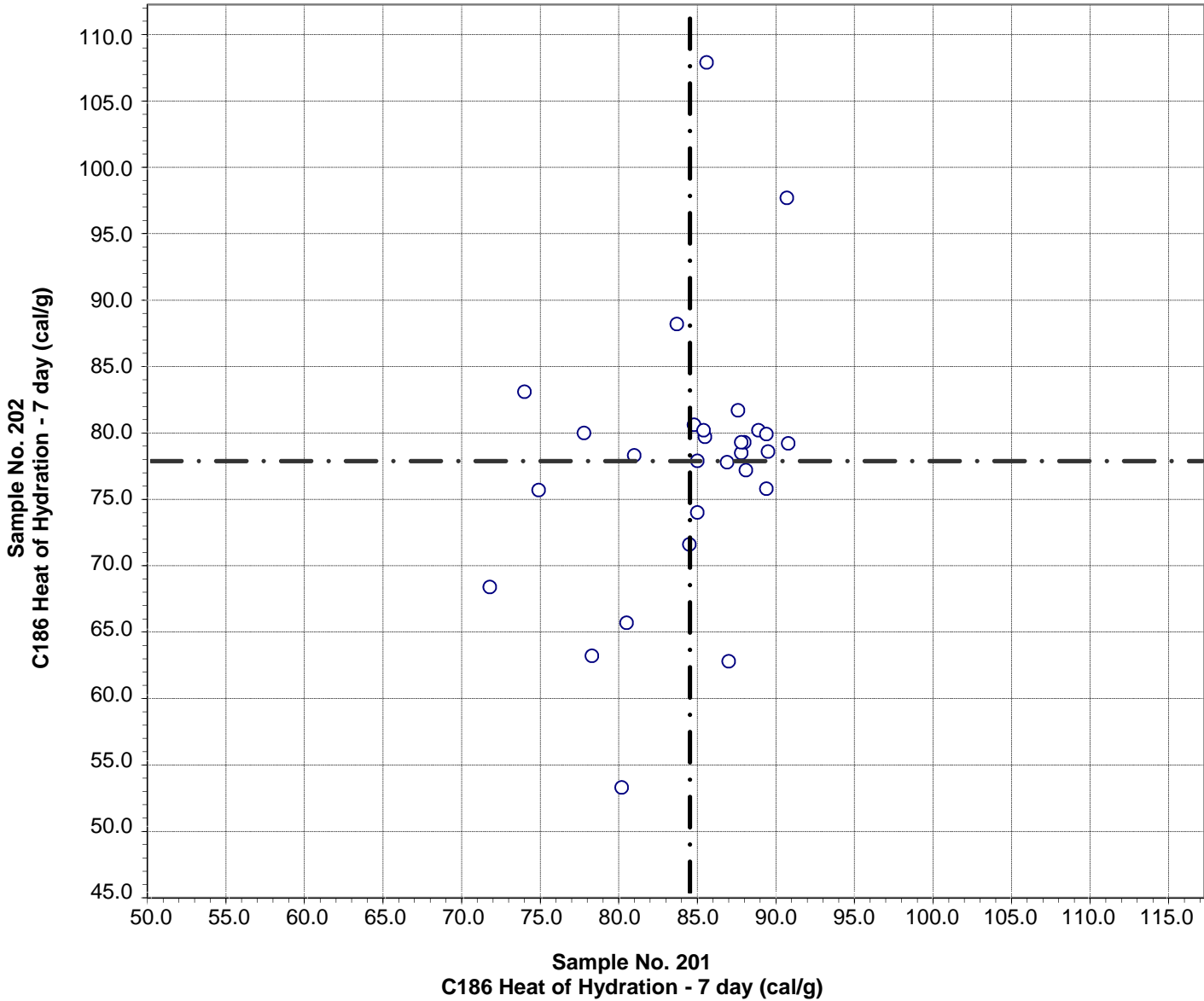


Test No. 301 C186 Heat of Solution 28 day 21 Points

Sample No. 201	Ave 492.2	S.D. 11.9	C.V. 2.4
Sample No. 202	Ave 498.8	S.D. 10.3	C.V. 2.1

Labs Eliminated: 1644

**CCRL Proficiency Sample Program  
C186 Heat of Hydration - 7 day  
PORTLAND CEMENT Samples No. 201 and No. 202**

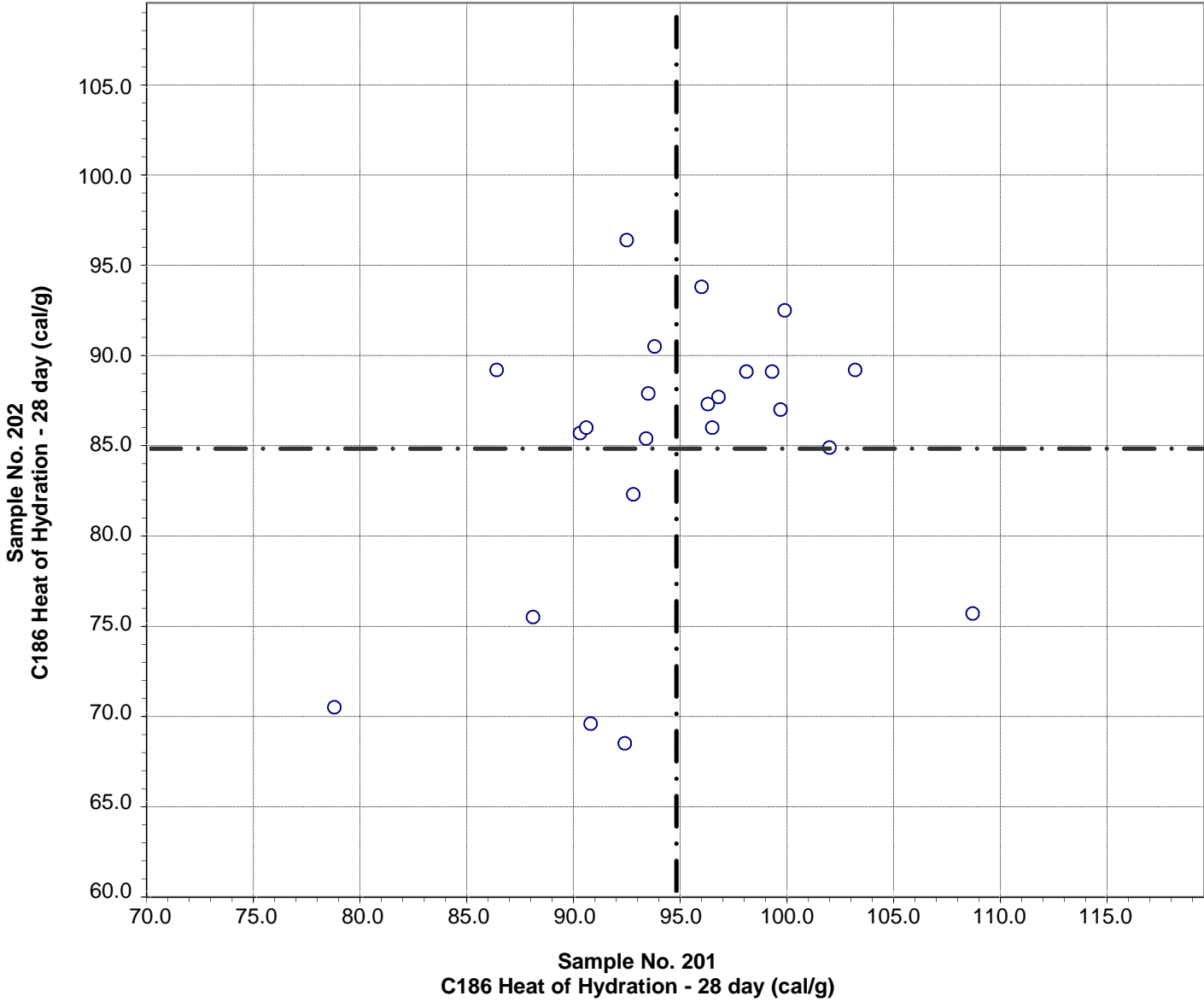


Test No. 290 C186 Heat of Hydration - 7 day 29 Points

Sample No. 201	Ave 84.5	S.D. 5.1	C.V. 6.1
Sample No. 202	Ave 77.8	S.D. 10.1	C.V. 12.9

Labs Eliminated: 975, 3606

**CCRL Proficiency Sample Program  
C186 Heat of Hydration - 28 day  
PORTLAND CEMENT Samples No. 201 and No. 202**

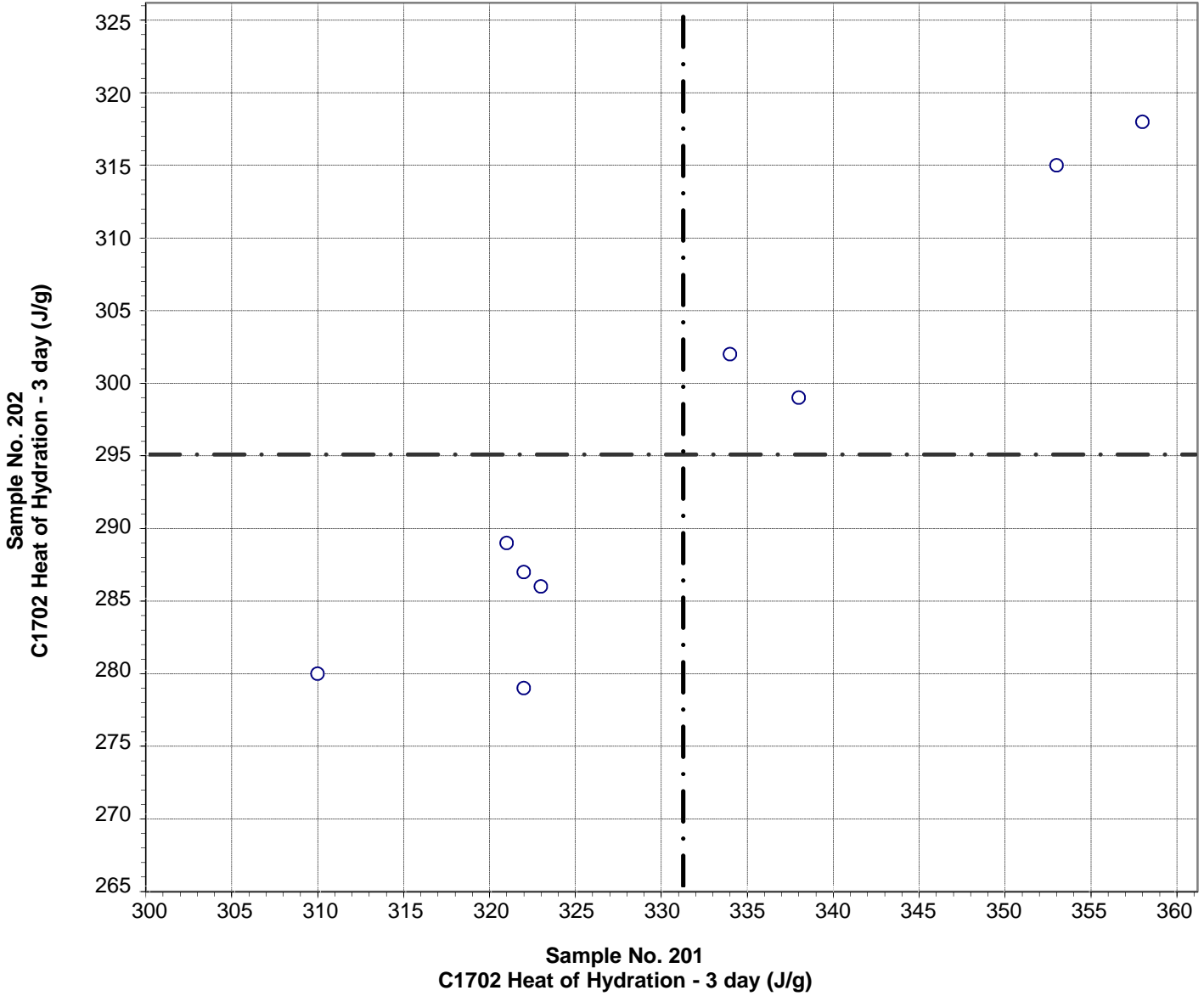


Test No. 300 C186 Heat of Hydration - 28 day 23 Points

Sample No. 201	Ave 94.8	S.D. 6.2	C.V. 6.6
Sample No. 202	Ave 84.8	S.D. 7.7	C.V. 9.0

Labs Eliminated: 4150

**CCRL Proficiency Sample Program  
C1702 Heat of Hydration - 3 day  
PORTLAND CEMENT Samples No. 201 and No. 202**

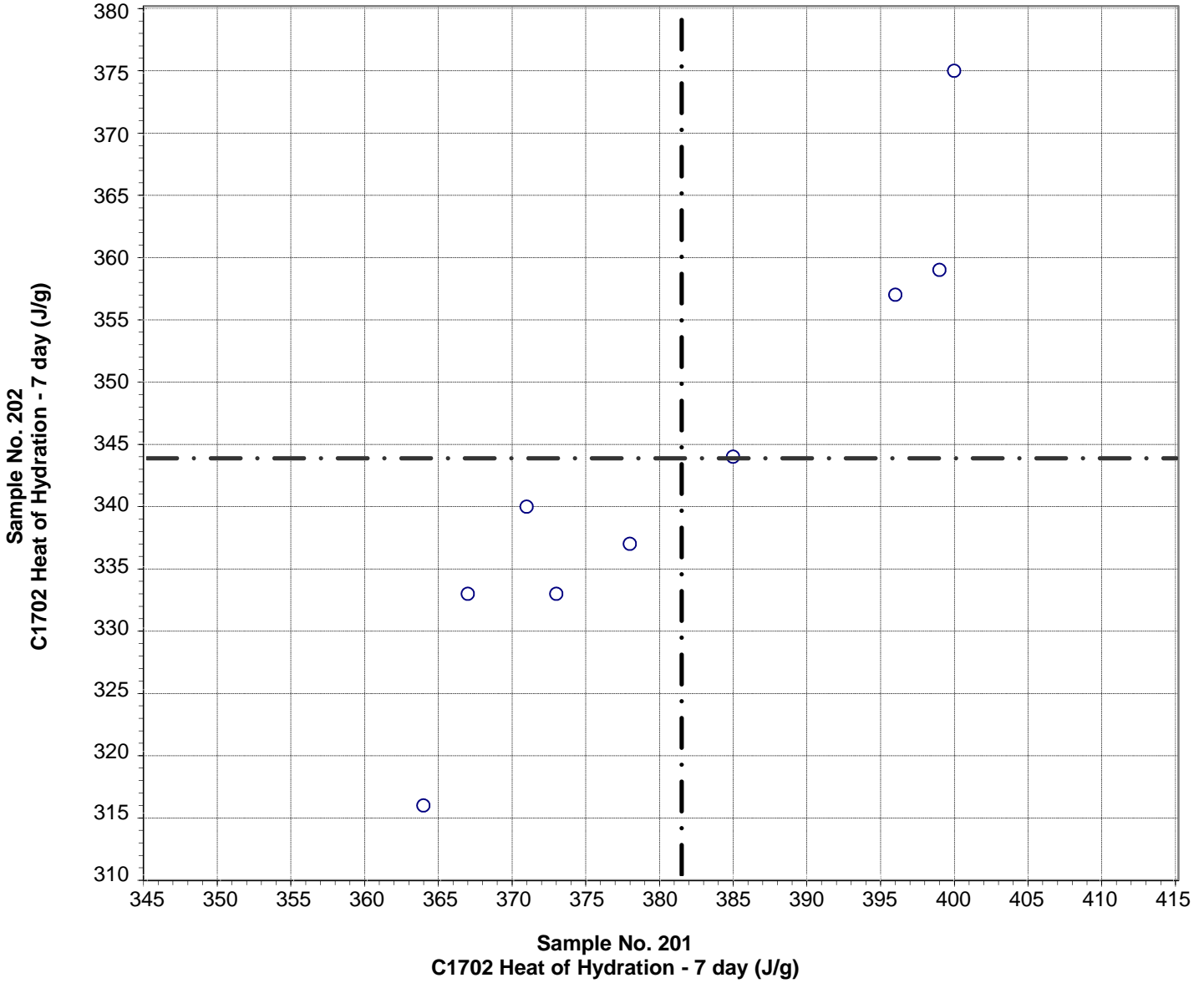


Test No. 500 C1702 Heat of Hydration - 3 day 9 Points

Sample No. 201	Ave 330	S.D. 16	C.V. 4.8
Sample No. 202	Ave 295	S.D. 14	C.V. 4.9

Labs Eliminated: 116, 3605

**CCRL Proficiency Sample Program  
C1702 Heat of Hydration - 7 day  
PORTLAND CEMENT Samples No. 201 and No. 202**



Test No. 510 C1702 Heat of Hydration - 7 day 9 Points

Sample No. 201	Ave 381	S.D. 14	C.V. 3.7
Sample No. 202	Ave 344	S.D. 17	C.V. 5.1

Labs Eliminated: 116, 3605