

**CEMENT AND CONCRETE REFERENCE LABORATORY**  
**PROFICIENCY SAMPLE PROGRAM**

**Final Report**  
**Portland Cement Proficiency Samples**  
**Number 189 and Number 190**

September 2013



**CCRL**  
Cement and Concrete  
Reference Laboratory

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

September 6, 2013

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

**SUBJECT: Final Report on Portland Cement Proficiency Samples No. 189 and No. 190**

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in June 2013. Portland Cement Samples No. 189 was an ASTM C150 meeting the specifications of Type I and Type II with limestone addition. Portland Cement No. 190 was an ASTM C150 meeting the specifications of Type I with 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.

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 2014.

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. 189 and No. 190**

This letter, and the material included with it, constitute the final report, and summary of results for the current pair of Portland Cement Proficiency Samples, which were distributed in June 2013. 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

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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.*

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

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

### **Summary of Results**

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

### **Scatter Diagrams**

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

Using the results received from each laboratory, a scatter diagram is generated for each test method by plotting the value for the odd numbered samples on the X, or horizontal axis, against the value for the even numbered samples on the Y, or vertical axis. To find your point, just plot as you would when plotting any scatter diagram. Vertical and horizontal dashed lines, which divide the diagrams into four sections or quadrants, place the average values for the odd and even numbered samples, respectively. The first line of print under the diagram includes the test number, as given on the data sheet, the test title, and the number of data points on the diagrams. The number of plotted points may not agree with the total number of data pairs included in the analysis because a few points may be off the diagram, and some points may represent several data pairs, which are identical. Laboratories whose points are off the diagram will have a rating of  $\pm 1$  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. 189 and No. 190

Final Report – Primary Chemical Results  
 September 6, 2013

SUMMARY OF RESULTS

Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Silicon Dioxide (percent)</b>							
	232	19.86	0.27	1.3	19.18	0.27	1.4
	*225	19.85	0.20	1.0	19.17	0.21	1.1
* Labs Eliminated - 4, 20, 35, 48, 93, 125, 416							
<b>Aluminum Oxide (percent)</b>							
	227	4.42	0.13	2.9	4.64	0.10	2.2
	*224	4.42	0.12	2.8	4.64	0.09	2.0
* Labs Eliminated - 35, 1715, 3752							
<b>Ferric Oxide (percent)</b>							
	229	3.09	0.05	1.8	2.96	0.05	1.8
	*222	3.09	0.04	1.4	2.96	0.05	1.5
* Labs Eliminated - 20, 51, 126, 221, 886, 1715, 2491							
<b>Calcium Oxide (percent)</b>							
	227	63.44	0.55	0.87	62.24	2.11	3.39
	*222	63.46	0.41	0.65	62.12	0.45	0.73
* Labs Eliminated - 35, 48, 93, 181, 840							
<b>Magnesium Oxide (percent)</b>							
	229	2.66	0.15	5.8	4.46	0.20	4.4
	*224	2.65	0.08	2.9	4.48	0.13	2.9
* Labs Eliminated - 181, 206, 1799, 3059, 3752							
<b>Sulfur Trioxide (percent)</b>							
	231	3.32	0.14	4.4	3.28	0.46	13.9
	*225	3.33	0.08	2.5	3.25	0.08	2.6
* Labs Eliminated - 38, 43, 51, 840, 3233, 3279							
<b>Loss on Ignition (percent)</b>							
	235	2.16	0.13	6.2	2.24	0.20	9.1
	*224	2.15	0.07	3.4	2.23	0.08	3.6
* Labs Eliminated - 24, 95, 162, 181, 244, 415, 431, 502, 691, 3413, 3443							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Primary Chemical Results  
 September 6, 2013

SUMMARY OF RESULTS

Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Sodium Oxide (percent)</b>							
	217	0.076	0.048	63	0.248	0.054	22
	*202	0.070	0.024	35	0.254	0.031	12
* Labs Eliminated - 125, 181, 221, 494, 667, 684, 840, 1251, 1940, 2360, 2490, 3235, 3279, 3695, 3807							
<b>Potassium Oxide (percent)</b>							
	224	0.618	0.068	11.0	0.824	0.082	9.9
	*202	0.615	0.014	2.3	0.835	0.020	2.4
* Labs Eliminated - 17, 40, 98, 110, 181, 438, 667, 768, 840, 1942, 1956, 2293, 2360, 2465, 2491, 3233, 3235, 3279, 3606, 3661, 3752, 3791							
<b>Titanium Dioxide (percent)</b>							
	186	0.25	0.018	7.0	0.24	0.014	5.8
	*181	0.25	0.010	3.8	0.24	0.009	3.7
* Labs Eliminated - 169, 494, 2437, 3233, 3807							
<b>Phosphorus Pentoxide (percent)</b>							
	181	0.105	0.019	18.4	0.099	0.019	19.6
	*167	0.106	0.006	5.7	0.098	0.007	6.8
* Labs Eliminated - 27, 48, 139, 169, 1799, 1942, 2412, 2462, 2490, 3059, 3233, 3235, 3662, 3695							
<b>Zinc Oxide (percent)</b>							
	92	0.008	0.015	184.9	0.009	0.016	186.3
	*84	0.007	0.002	28.7	0.006	0.002	30.9
* Labs Eliminated - 95, 151, 416, 768, 1466, 1942, 2484, 3662							
<b>Manganic Oxide (percent)</b>							
	147	0.158	0.020	12.8	0.103	0.360	351.2
	*138	0.159	0.008	5.0	0.073	0.005	7.0
* Labs Eliminated - 181, 416, 438, 932, 1466, 1942, 2305, 2491, 3807							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Primary Chemical Results  
 September 6, 2013

SUMMARY OF RESULTS

Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
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**Chloride (percent)**

125	0.012	0.020	172	0.006	0.008	140
*115	0.009	0.004	42	0.004	0.003	60

\* Labs Eliminated - 43, 75, 96, 105, 129, 491, 2293, 2296, 2412, 2491

**Insoluble Residue (percent)**

213	0.24	0.13	53	0.24	0.12	49
*194	0.21	0.07	35	0.21	0.07	33

\* Labs Eliminated - 51, 52, 56, 107, 206, 222, 246, 254, 413, 691, 1025, 1053, 1799, 2360, 2412, 2466, 2491, 3057, 3233

**Free Lime (percent)**

176	1.00	0.26	26	0.98	0.25	26
*172	1.00	0.22	22	0.98	0.21	22

\* Labs Eliminated - 244, 684, 3443, 3752

**Carbon Dioxide (percent)**

204	1.07	0.28	26	1.26	0.27	21
*194	1.07	0.19	18	1.26	0.19	15

\* Labs Eliminated - 131, 176, 219, 886, 1251, 1956, 2254, 2296, 2466, 3233

**Limestone Content (percent)**

200	2.6	0.7	26	3.0	0.6	21
*188	2.6	0.4	18	2.9	0.4	15

\* Labs Eliminated - 46, 131, 176, 219, 221, 252, 886, 1251, 1956, 2254, 2296, 2466

**Chromium Oxide (percent)**

90	0.024	0.007	29	0.009	0.004	42
*86	0.024	0.005	22	0.009	0.003	38

\* Labs Eliminated - 407, 1466, 2296, 3662

**Tricalcium Silicate (percent)**

199	60.6	2.9	4.8	57.6	4.0	6.9
*192	60.7	2.5	4.1	57.6	3.3	5.8

\* Labs Eliminated - 50, 93, 206, 289, 840, 3238, 3752

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Primary Chemical Results  
 September 6, 2013

SUMMARY OF RESULTS

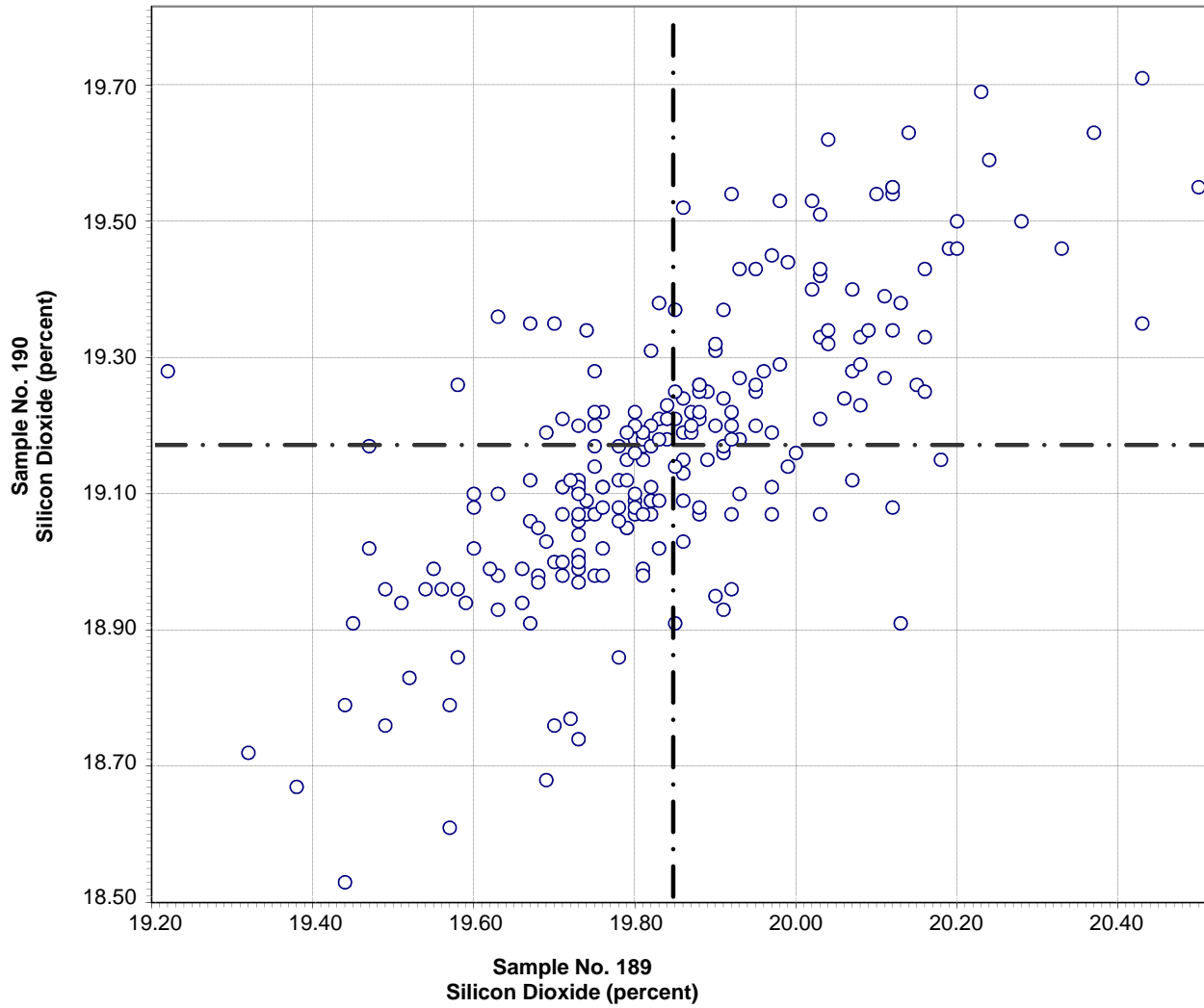
Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Dicalcium Silicate (percent)</b>							
	198	11.0	2.6	23	11.5	3.2	28
	*194	10.9	2.3	21	11.4	2.9	26
* Labs Eliminated - 50, 93, 206, 3752							
<b>Tricalcium Aluminate (percent)</b>							
	199	6.4	0.4	6.0	7.2	0.3	4.2
	*192	6.4	0.3	4.9	7.2	0.3	3.5
* Labs Eliminated - 35, 101, 181, 222, 1715, 2484, 3752							
<b>Tetracalcium Aluminoferrite (percent)</b>							
	198	9.4	0.9	9.3	9.0	1.0	10.9
	*196	9.3	0.2	2.1	9.0	0.2	1.9
* Labs Eliminated - 101, 1644							



**CCRL Proficiency Sample Program  
Silicon Dioxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 10 Silicon Dioxide 224 Points

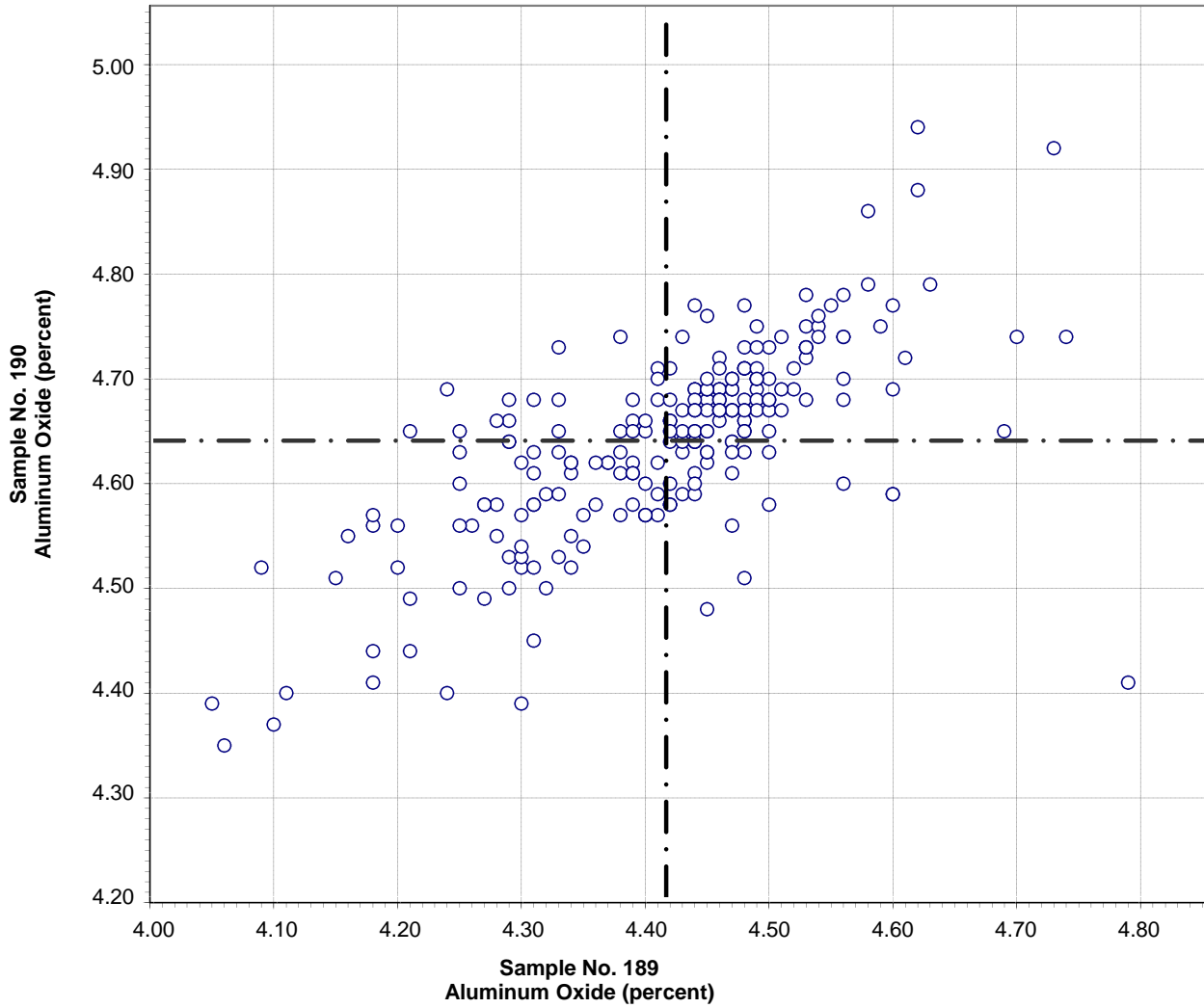
Sample No. 189 Ave 19.85 S.D. 0.20 C.V. 1.0

Sample No. 190 Ave 19.17 S.D. 0.21 C.V. 1.1

Labs Eliminated: 4, 20, 35, 48, 93, 125, 416

Labs off Diagram: 50

**CCRL Proficiency Sample Program  
Aluminum Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**

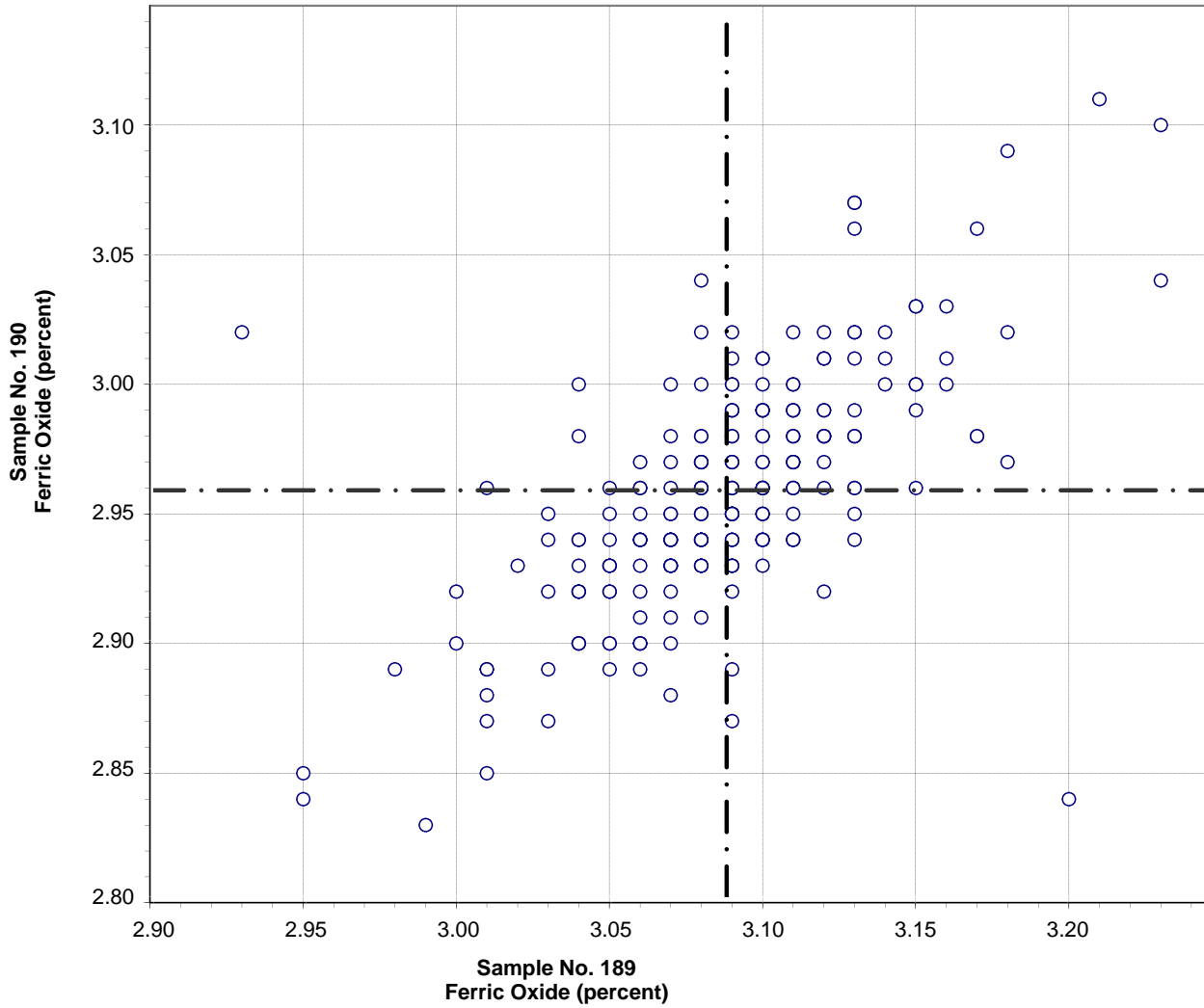


Test No. 21 Aluminum Oxide 224 Points

Sample No. 189	Ave 4.42	S.D. 0.12	C.V. 2.8
Sample No. 190	Ave 4.64	S.D. 0.09	C.V. 2.0

Labs Eliminated: 35, 1715, 3752

**CCRL Proficiency Sample Program  
Ferric Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



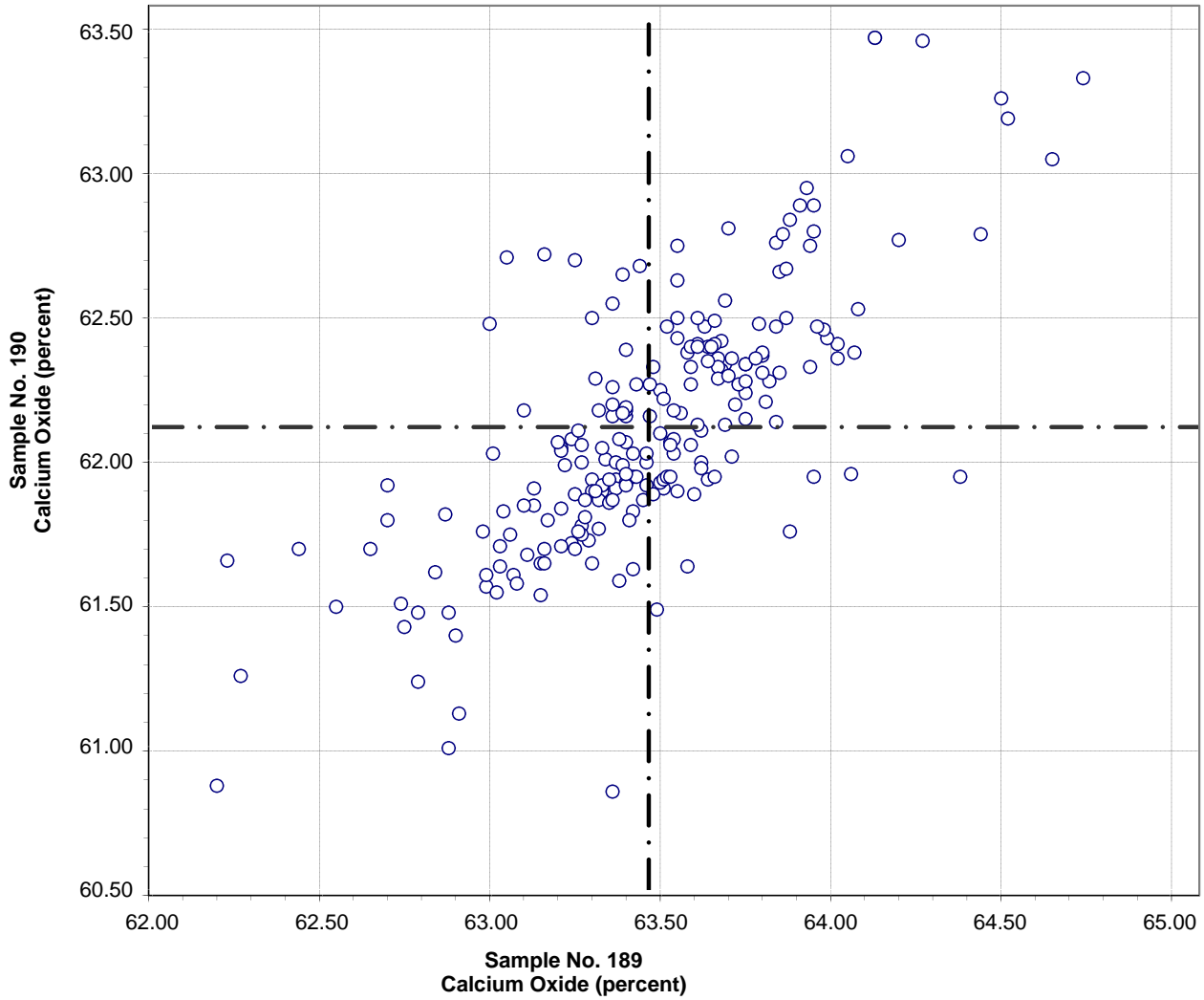
Test No. 30 Ferric Oxide 222 Points

Sample No. 189 Ave 3.09 S.D. 0.04 C.V. 1.4

Sample No. 190 Ave 2.96 S.D. 0.05 C.V. 1.5

Labs Eliminated: 20, 51, 126, 221, 886, 1715, 2491

**CCRL Proficiency Sample Program  
Calcium Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



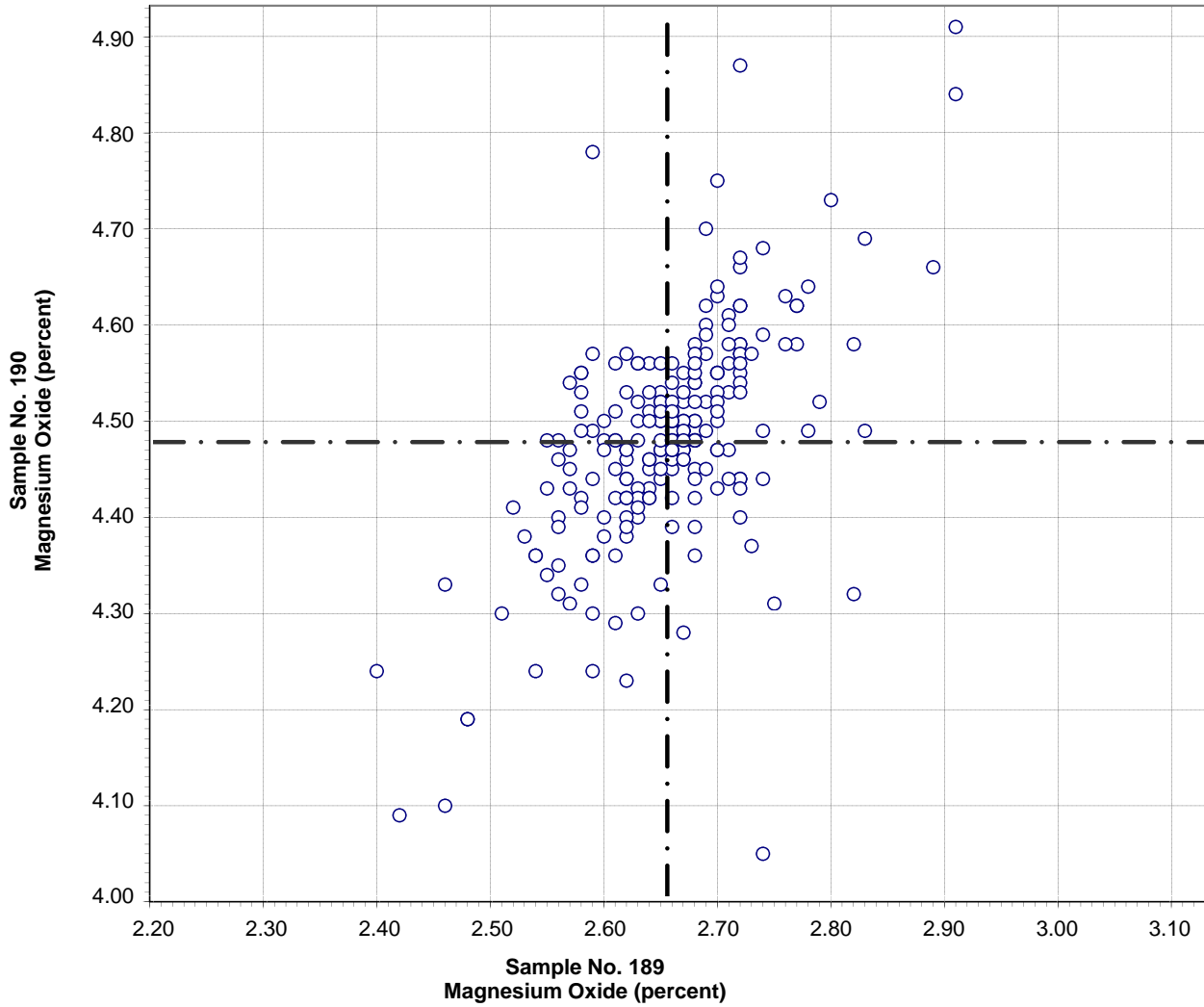
Test No. 40 Calcium Oxide 221 Points

Sample No. 189 Ave 63.46 S.D. 0.41 C.V. 0.65  
Sample No. 190 Ave 62.12 S.D. 0.45 C.V. 0.73

Labs Eliminated: 35, 48, 93, 181, 840

Labs off Diagram: 20

**CCRL Proficiency Sample Program  
Magnesium Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



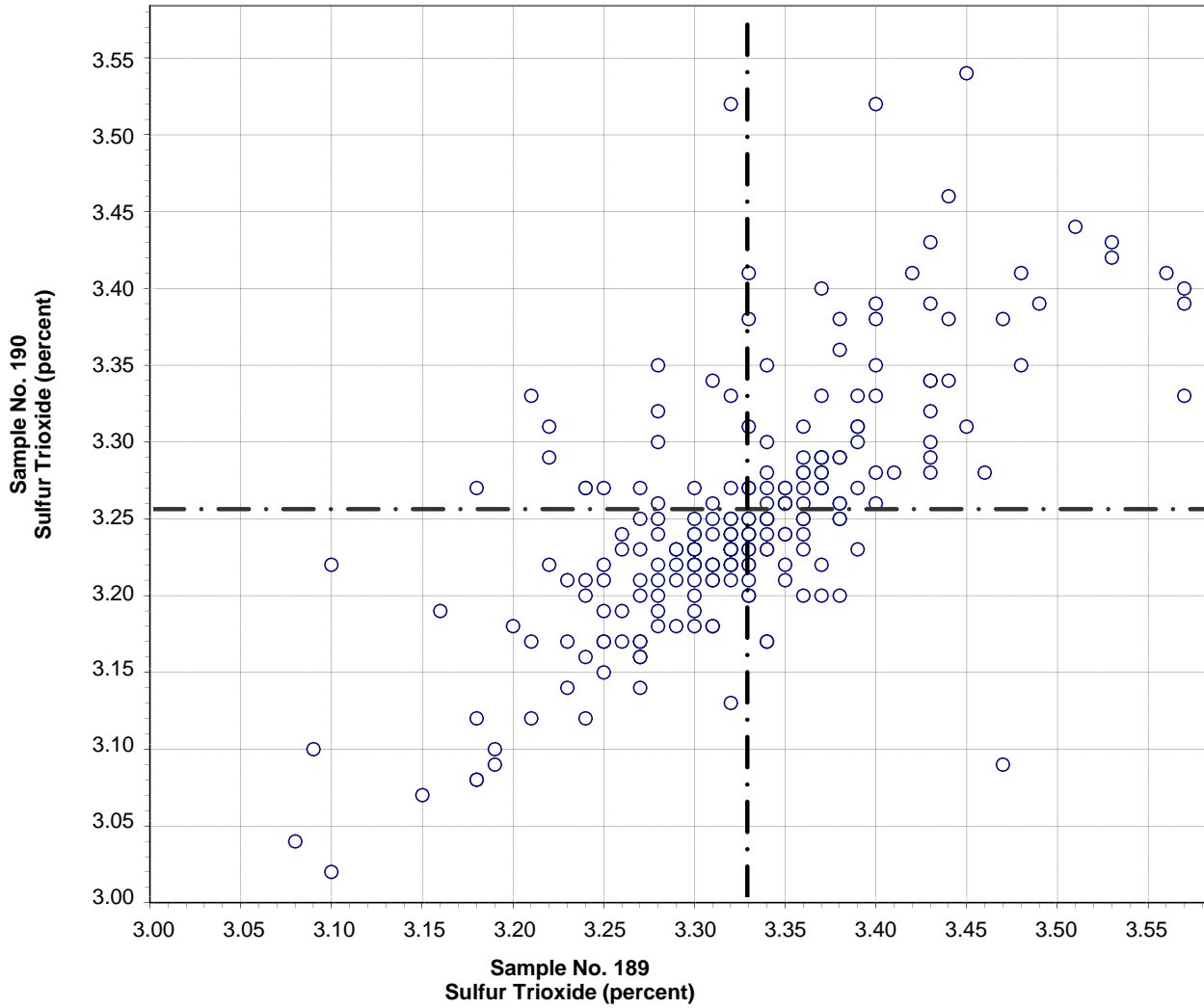
Test No. 50 Magnesium Oxide 222 Points

Sample No. 189 Ave 2.65 S.D. 0.08 C.V. 2.9  
Sample No. 190 Ave 4.48 S.D. 0.13 C.V. 2.9

Labs Eliminated: 181, 206, 1799, 3059, 3752

Labs off Diagram: 48, 1644

**CCRL Proficiency Sample Program**  
**Sulfur Trioxide**  
**PORTLAND CEMENT Samples No. 189 and No. 190**



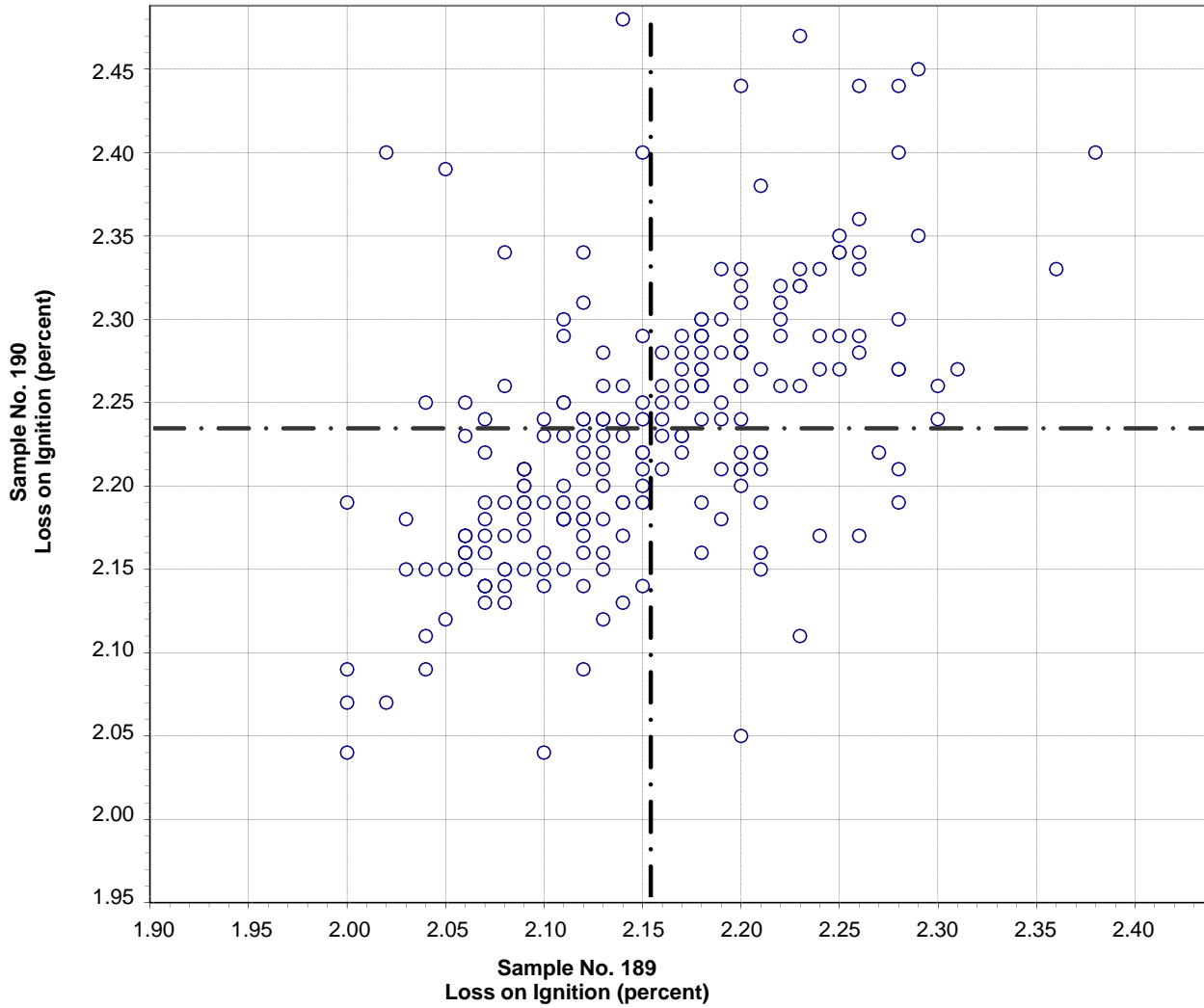
Test No. 60 Sulfur Trioxide 224 Points

Sample No. 189 Ave 3.33 S.D. 0.08 C.V. 2.5  
Sample No. 190 Ave 3.25 S.D. 0.08 C.V. 2.6

Labs Eliminated: 38, 43, 51, 840, 3233, 3279

Labs off Diagram: 159

**CCRL Proficiency Sample Program  
Loss on Ignition  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 70 Loss on Ignition 223 Points

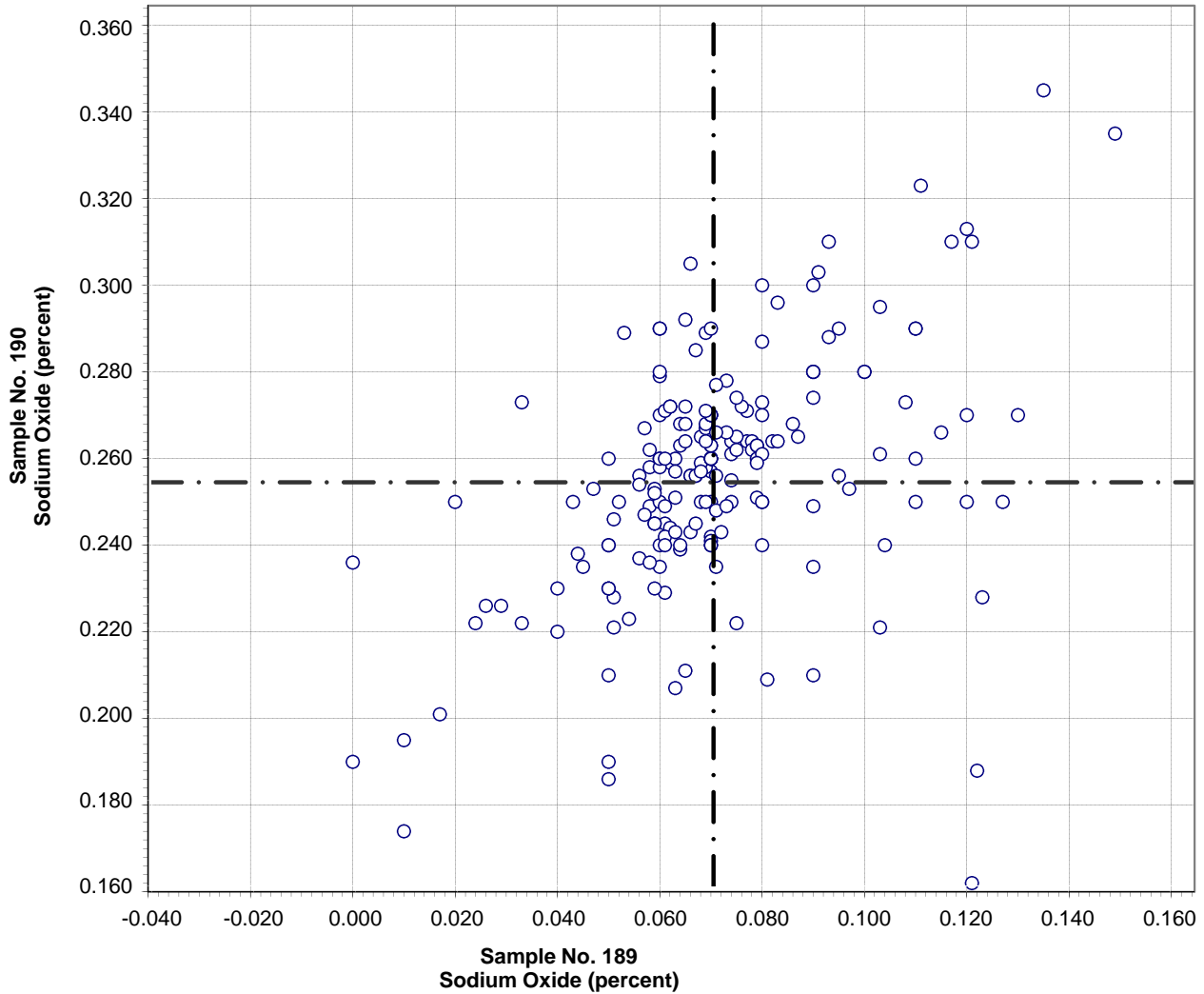
Sample No. 189 Ave 2.15 S.D. 0.07 C.V. 3.4

Sample No. 190 Ave 2.23 S.D. 0.08 C.V. 3.6

Labs Eliminated: 24, 95, 162, 181, 244, 415, 431, 502, 691, 3413, 3443

Labs off Diagram: 3127

**CCRL Proficiency Sample Program  
Sodium Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 90 Sodium Oxide 198 Points

Sample No. 189 Ave 0.070 S.D. 0.024 C.V. 35

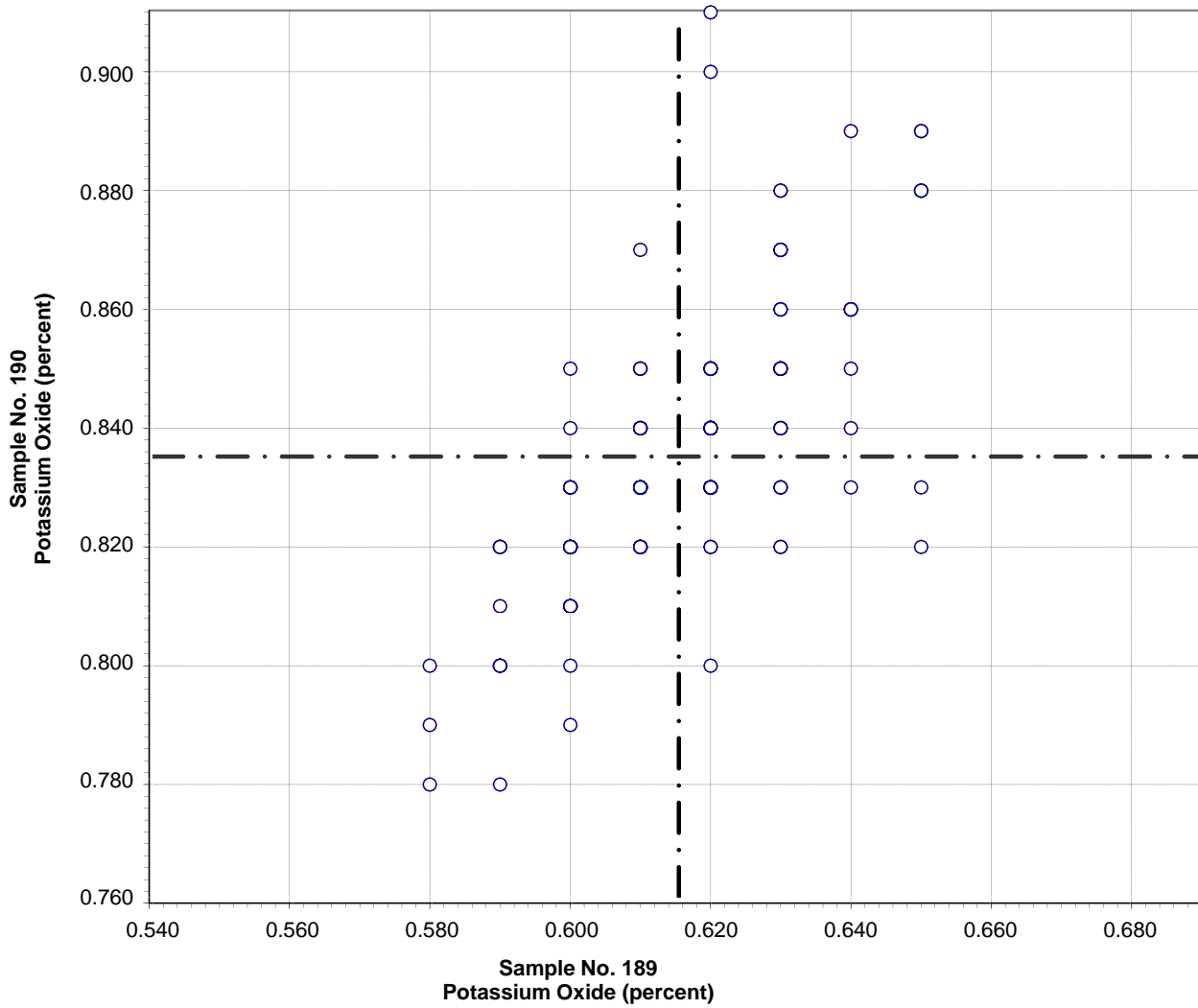
Sample No. 190 Ave 0.254 S.D. 0.031 C.V. 12

Labs Eliminated: 125, 181, 221, 494, 667, 684, 840, 1251, 1940, 2360, 2490,  
3235, 3279, 3695, 3807

Labs off Diagram: 36, 504, 2466, 3057



**CCRL Proficiency Sample Program  
Potassium Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



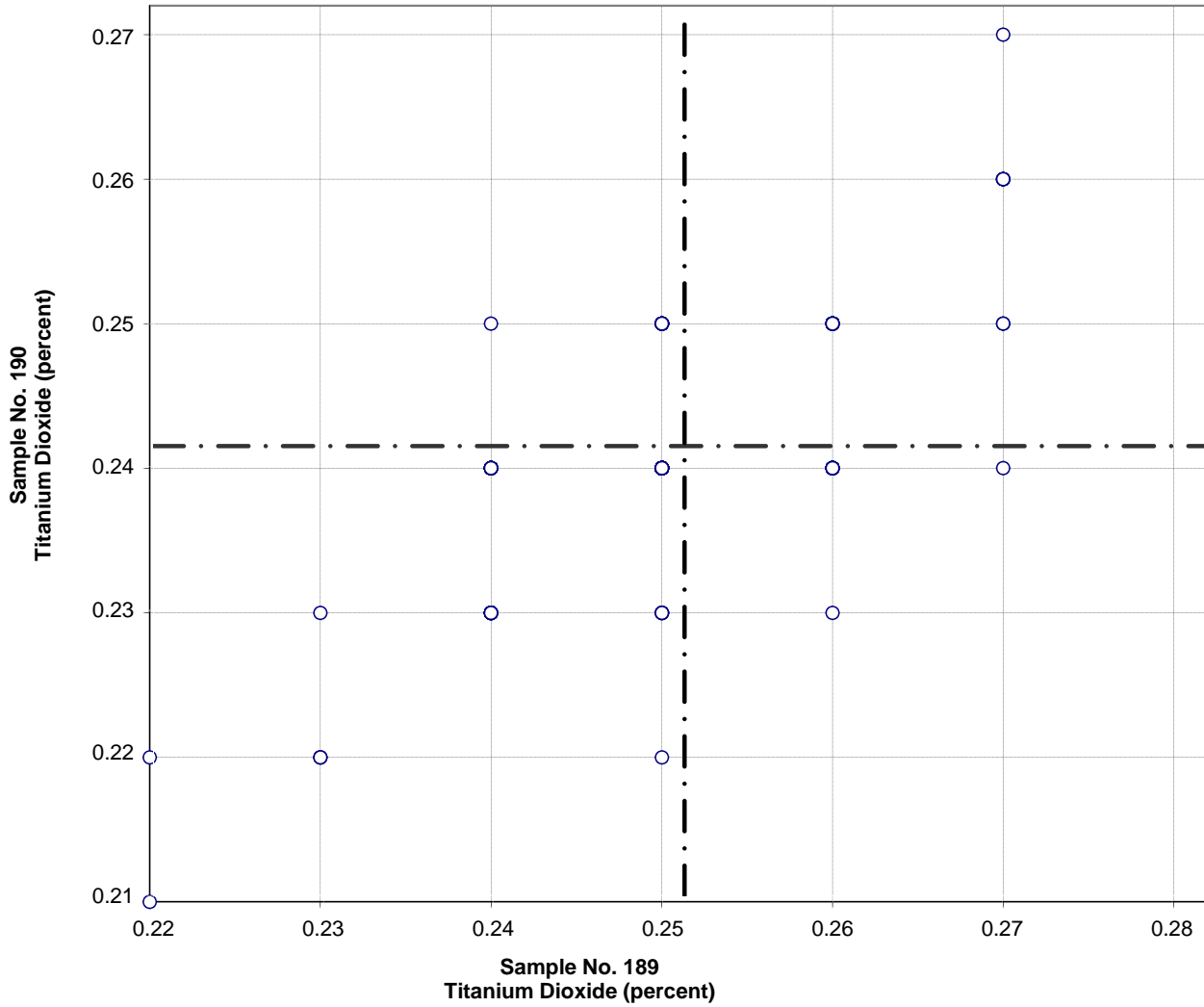
Test No. 100 Potassium Oxide 202 Points

Sample No. 189 Ave 0.615 S.D. 0.014 C.V. 2.3

Sample No. 190 Ave 0.835 S.D. 0.020 C.V. 2.4

Labs Eliminated: 17, 40, 98, 110, 181, 438, 667, 768, 840, 1942, 1956, 2293, 2360, 2465, 2491, 3233, 3235, 3279, 3606, 3661, 3752, 3791

**CCRL Proficiency Sample Program  
Titanium Dioxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 103 Titanium Dioxide 179 Points

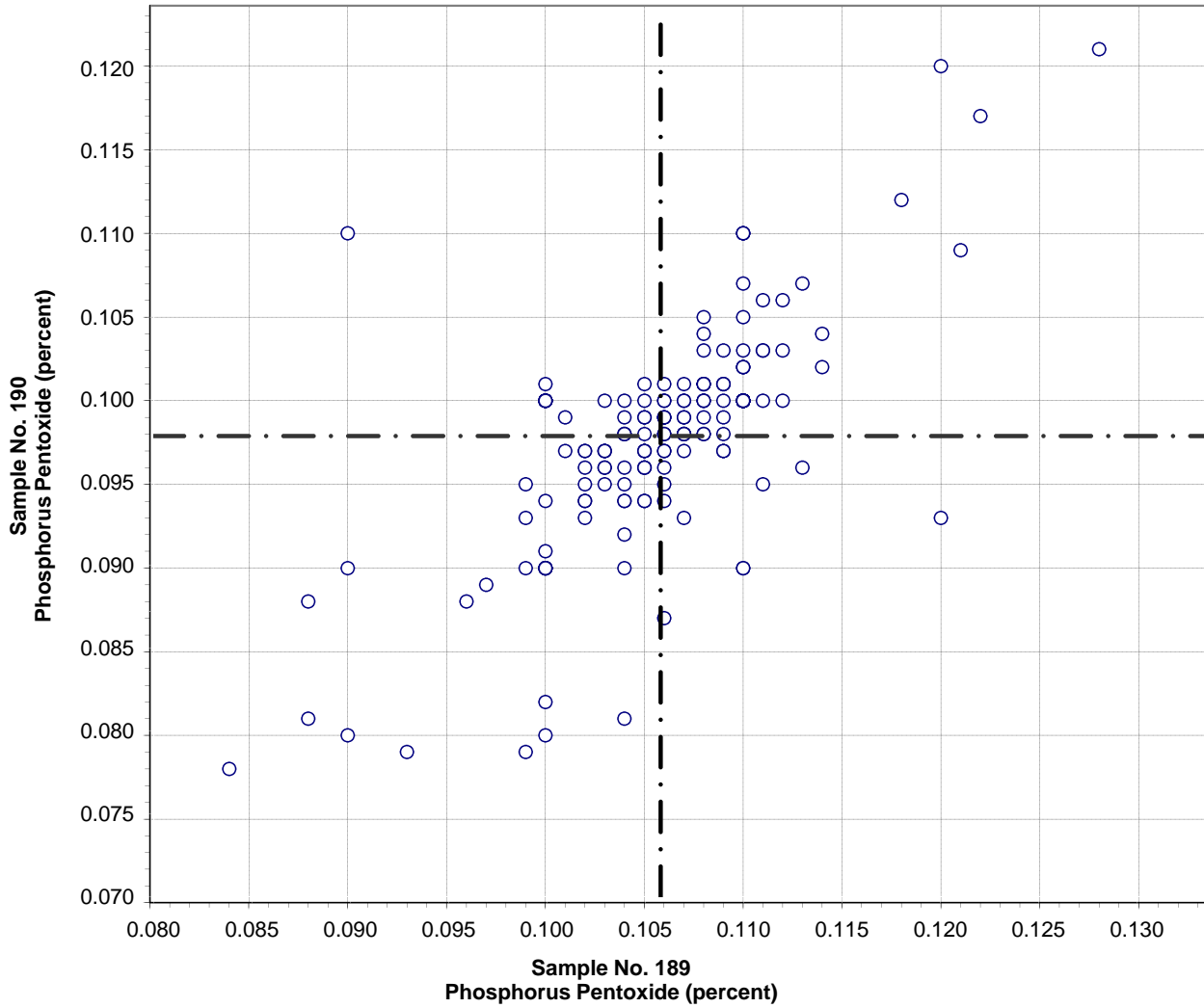
Sample No. 189 Ave 0.25 S.D. 0.010 C.V. 3.8

Sample No. 190 Ave 0.24 S.D. 0.009 C.V. 3.7

Labs Eliminated: 169, 494, 2437, 3233, 3807

Labs off Diagram: 1942, 2621

**CCRL Proficiency Sample Program  
Phosphorus Pentoxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



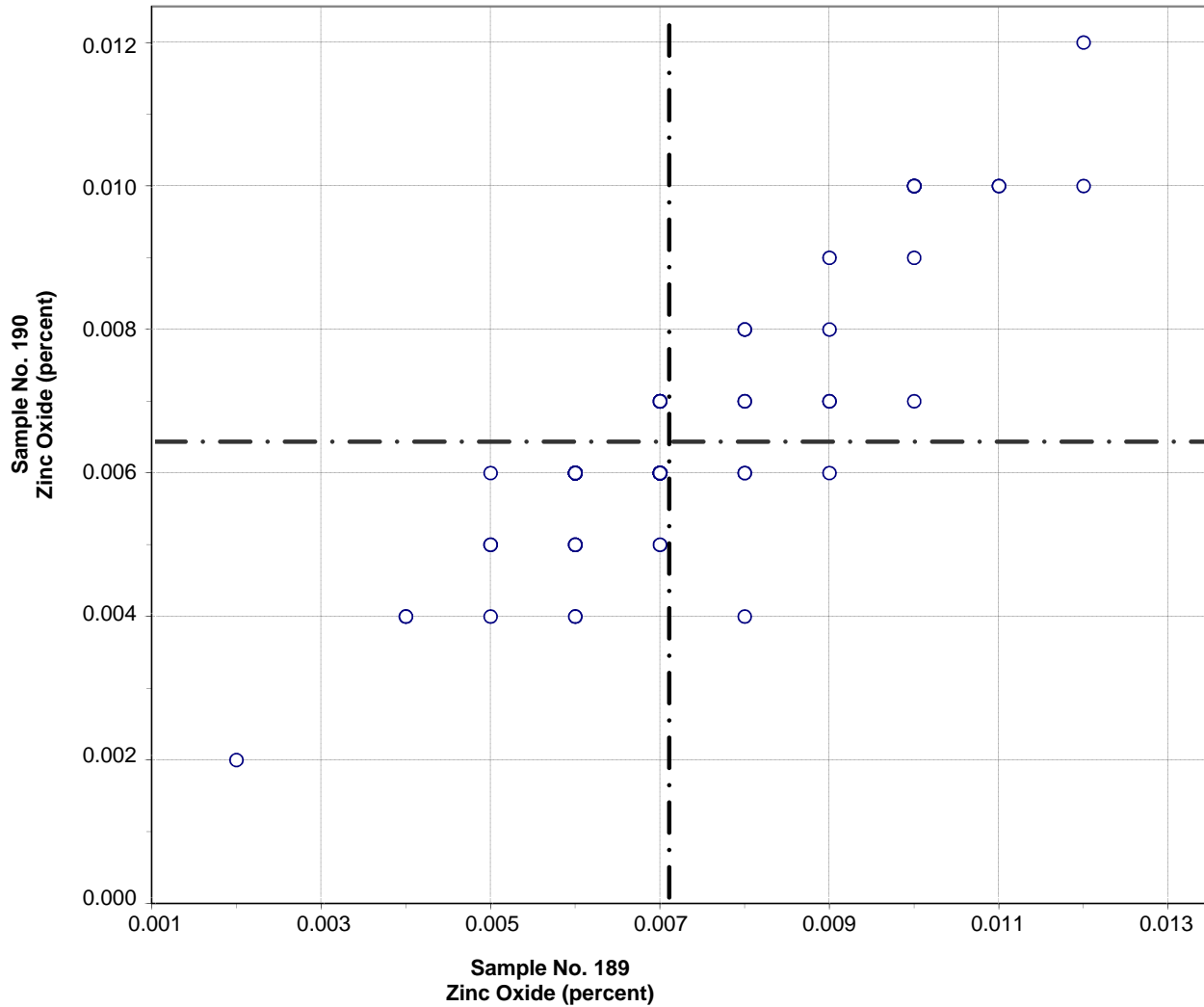
Test No. 102 Phosphorus Pentoxide 167 Points

Sample No. 189 Ave 0.106 S.D. 0.006 C.V. 5.7

Sample No. 190 Ave 0.098 S.D. 0.007 C.V. 6.8

Labs Eliminated: 27, 48, 139, 169, 1799, 1942, 2412, 2462, 2490, 3059, 3233,  
3235, 3662, 3695

**CCRL Proficiency Sample Program  
Zinc Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 99 Zinc Oxide 82 Points

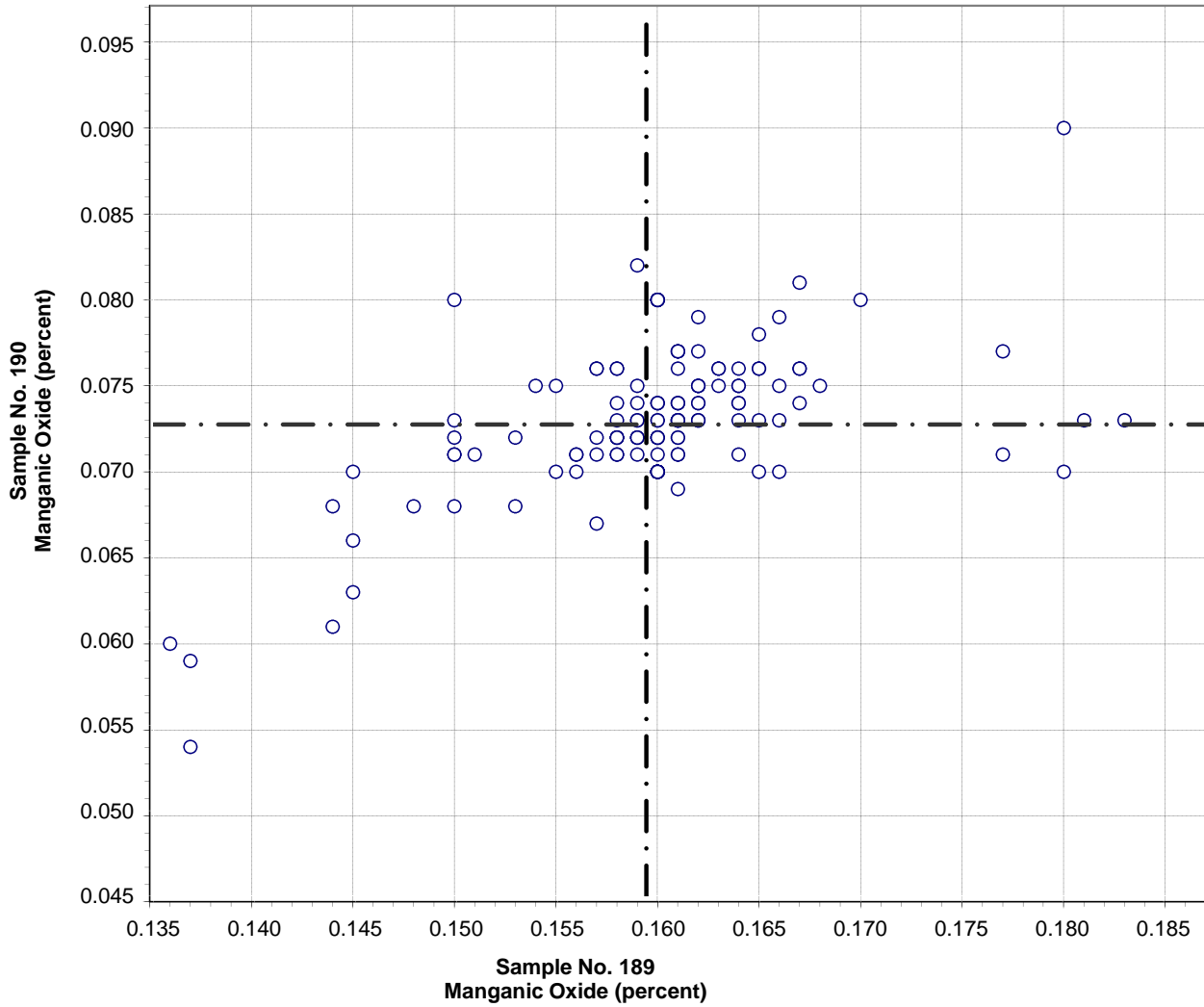
Sample No. 189 Ave 0.007 S.D. 0.002 C.V. 29

Sample No. 190 Ave 0.006 S.D. 0.002 C.V. 31

Labs Eliminated: 95, 151, 416, 768, 1466, 1942, 2484, 3662

Labs off Diagram: 407, 2296

**CCRL Proficiency Sample Program  
Manganic Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 101 Manganic Oxide 136 Points

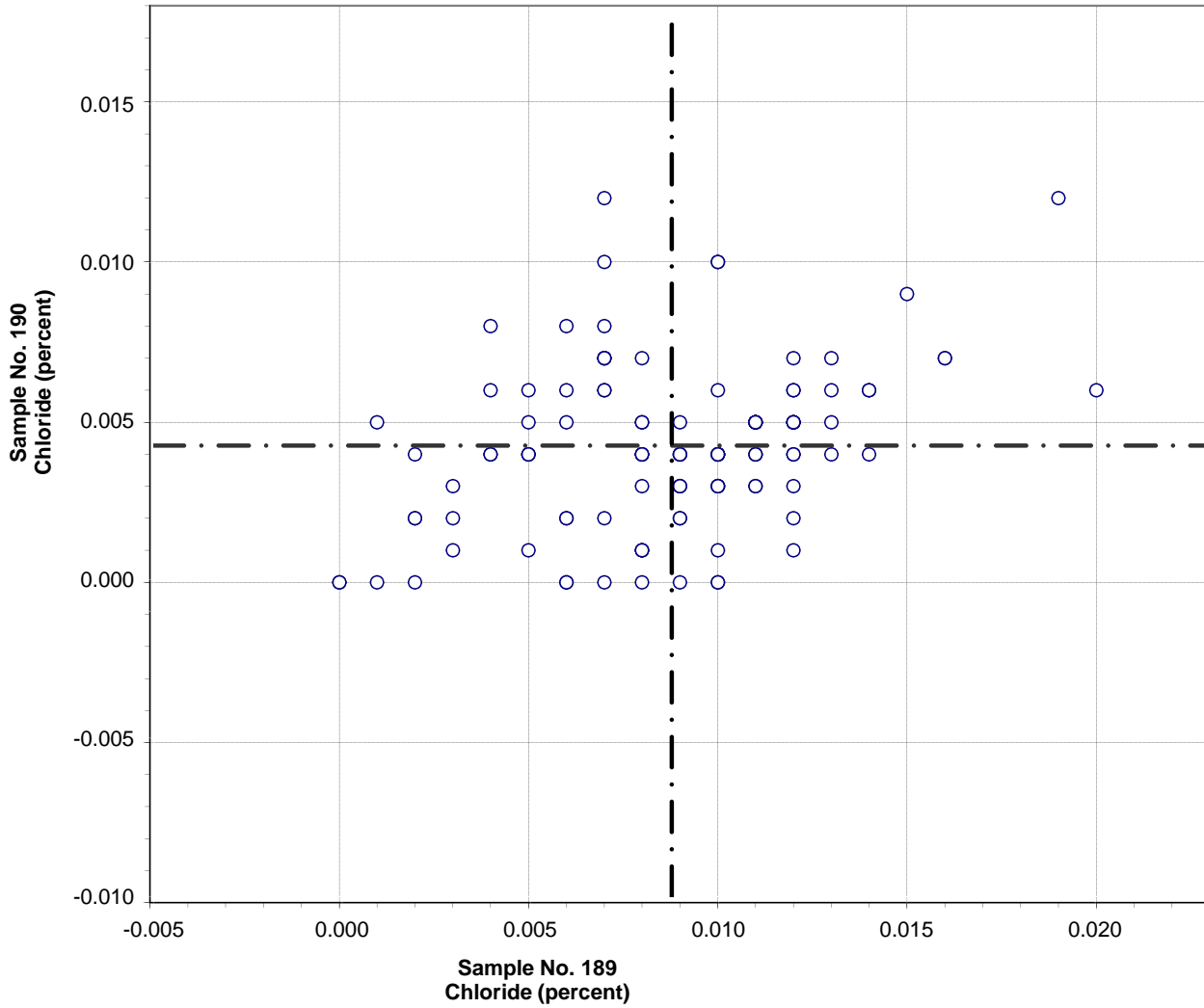
Sample No. 189 Ave 0.159 S.D. 0.008 C.V. 5.0

Sample No. 190 Ave 0.073 S.D. 0.005 C.V. 7.0

Labs Eliminated: 181, 416, 438, 932, 1466, 1942, 2305, 2491, 3807

Labs off Diagram: 2462, 3859

**CCRL Proficiency Sample Program**  
**Chloride**  
**PORTLAND CEMENT Samples No. 189 and No. 190**

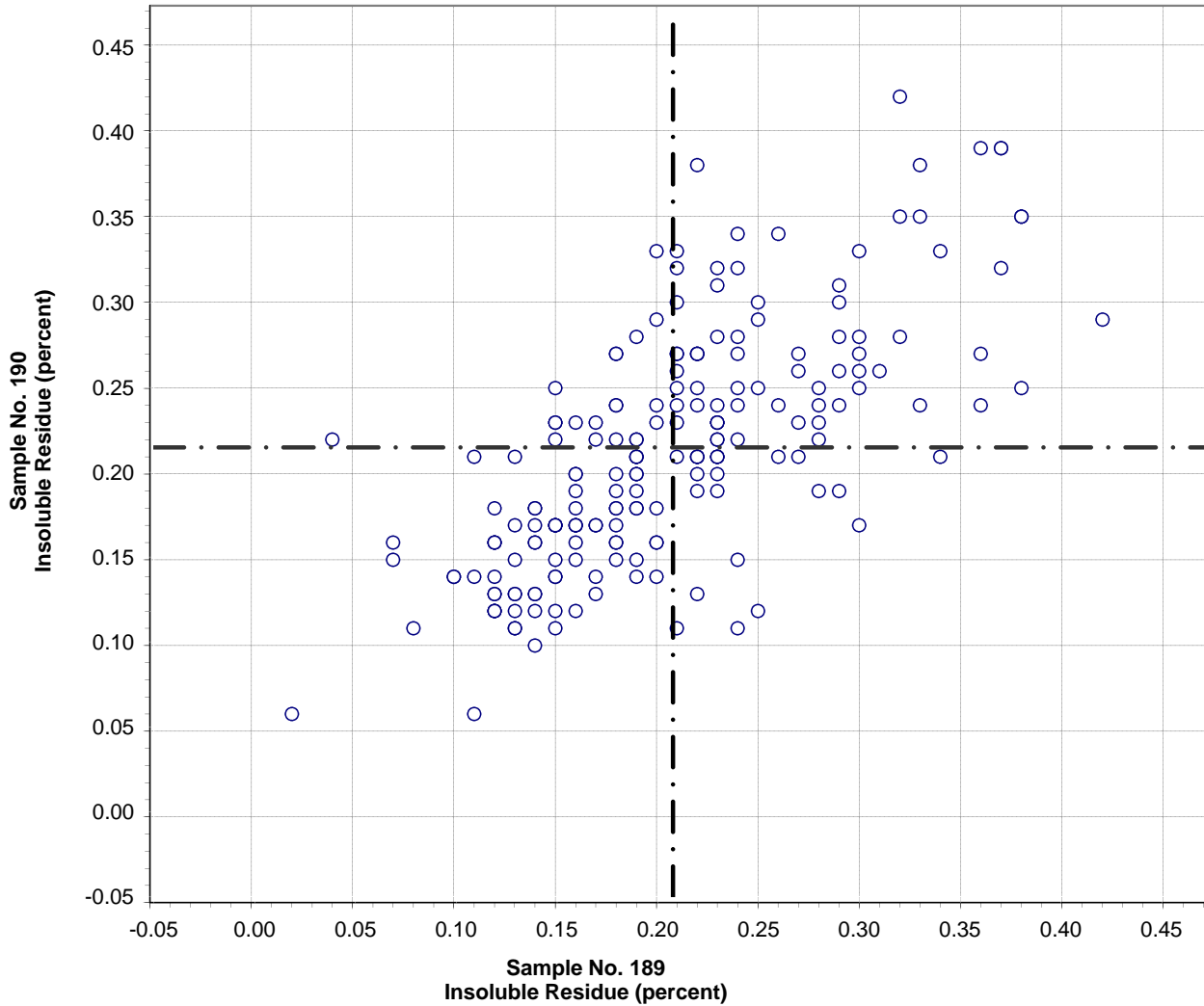


Test No. 104 Chloride 115 Points

Sample No. 189 Ave 0.009 S.D. 0.004 C.V. 42  
Sample No. 190 Ave 0.004 S.D. 0.003 C.V. 60

Labs Eliminated: 43, 75, 96, 105, 129, 491, 2293, 2296, 2412, 2491

**CCRL Proficiency Sample Program  
Insoluble Residue  
PORTLAND CEMENT Samples No. 189 and No. 190**



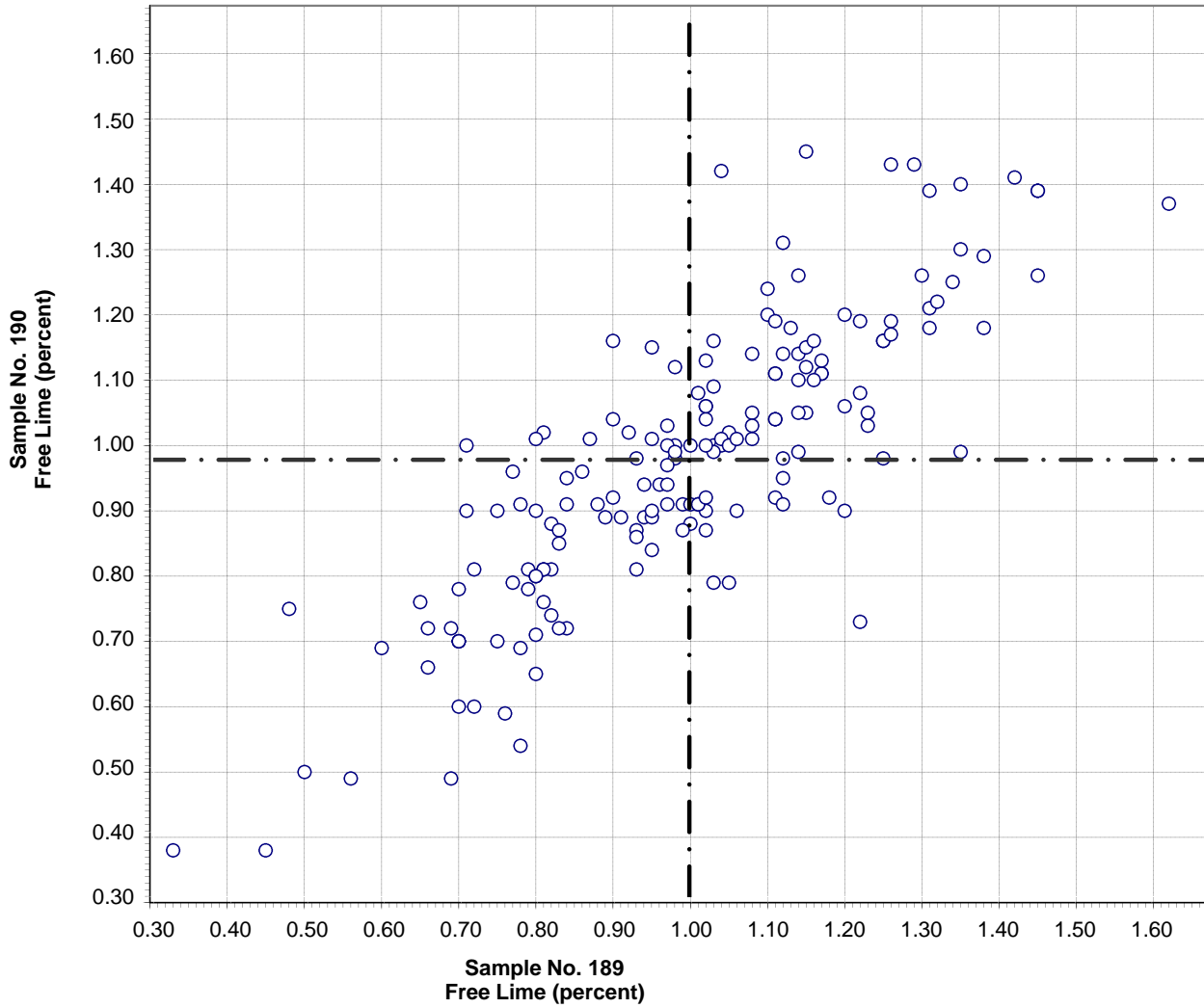
Test No. 80 Insoluble Residue 194 Points

Sample No. 189 Ave 0.21 S.D. 0.07 C.V. 35

Sample No. 190 Ave 0.21 S.D. 0.07 C.V. 33

Labs Eliminated: 51, 52, 56, 107, 206, 222, 246, 254, 413, 691, 1025, 1053, 1799,  
2360, 2412, 2466, 2491, 3057, 3233

**CCRL Proficiency Sample Program**  
**Free Lime**  
**PORTLAND CEMENT Samples No. 189 and No. 190**



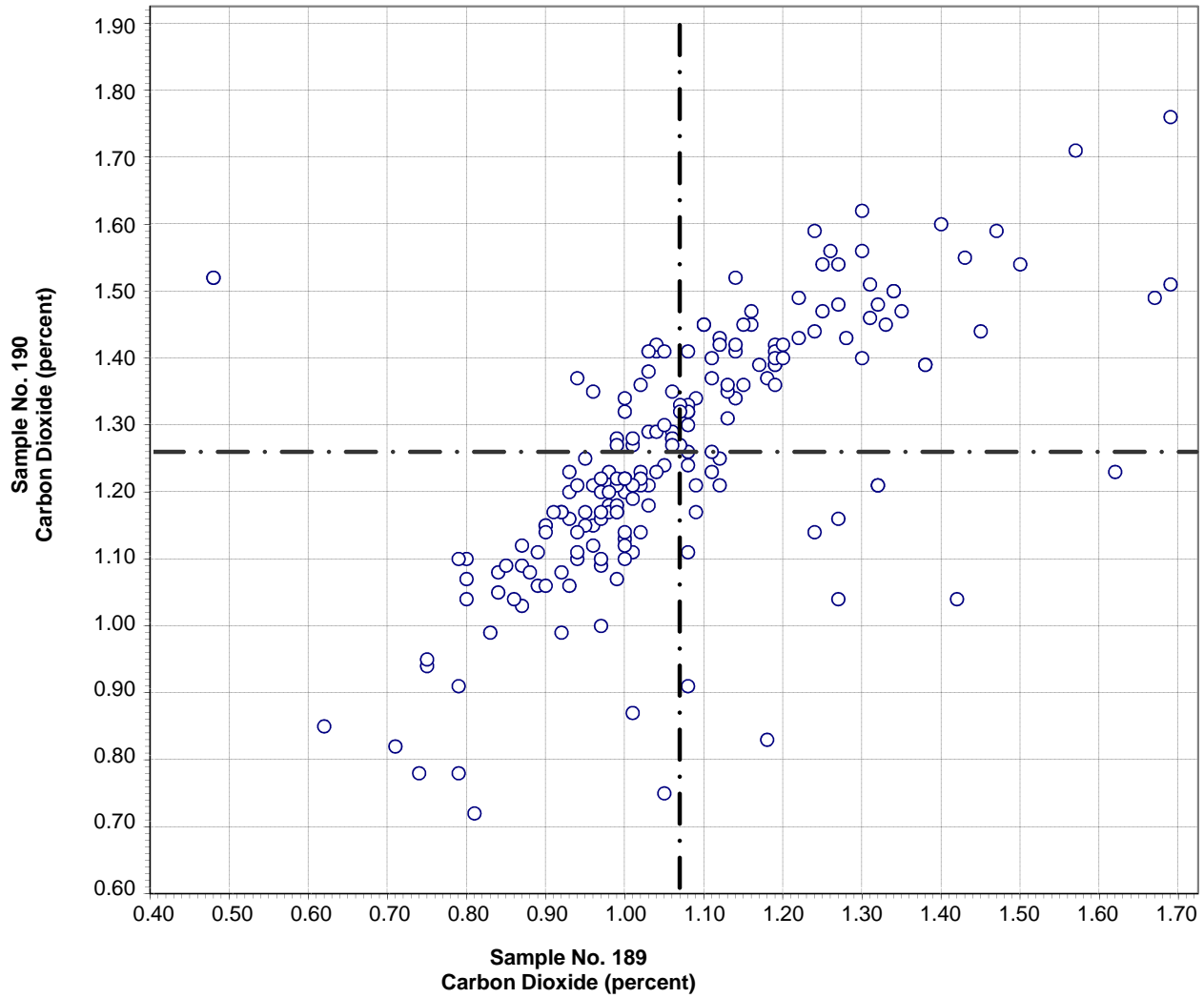
Test No. 41 Free Lime 172 Points

Sample No. 189	Ave 1.00	S.D. 0.22	C.V. 22
Sample No. 190	Ave 0.98	S.D. 0.21	C.V. 22

Labs Eliminated: 244, 684, 3443, 3752



**CCRL Proficiency Sample Program  
Carbon Dioxide  
PORTLAND CEMENT Samples No. 189 and No. 190**

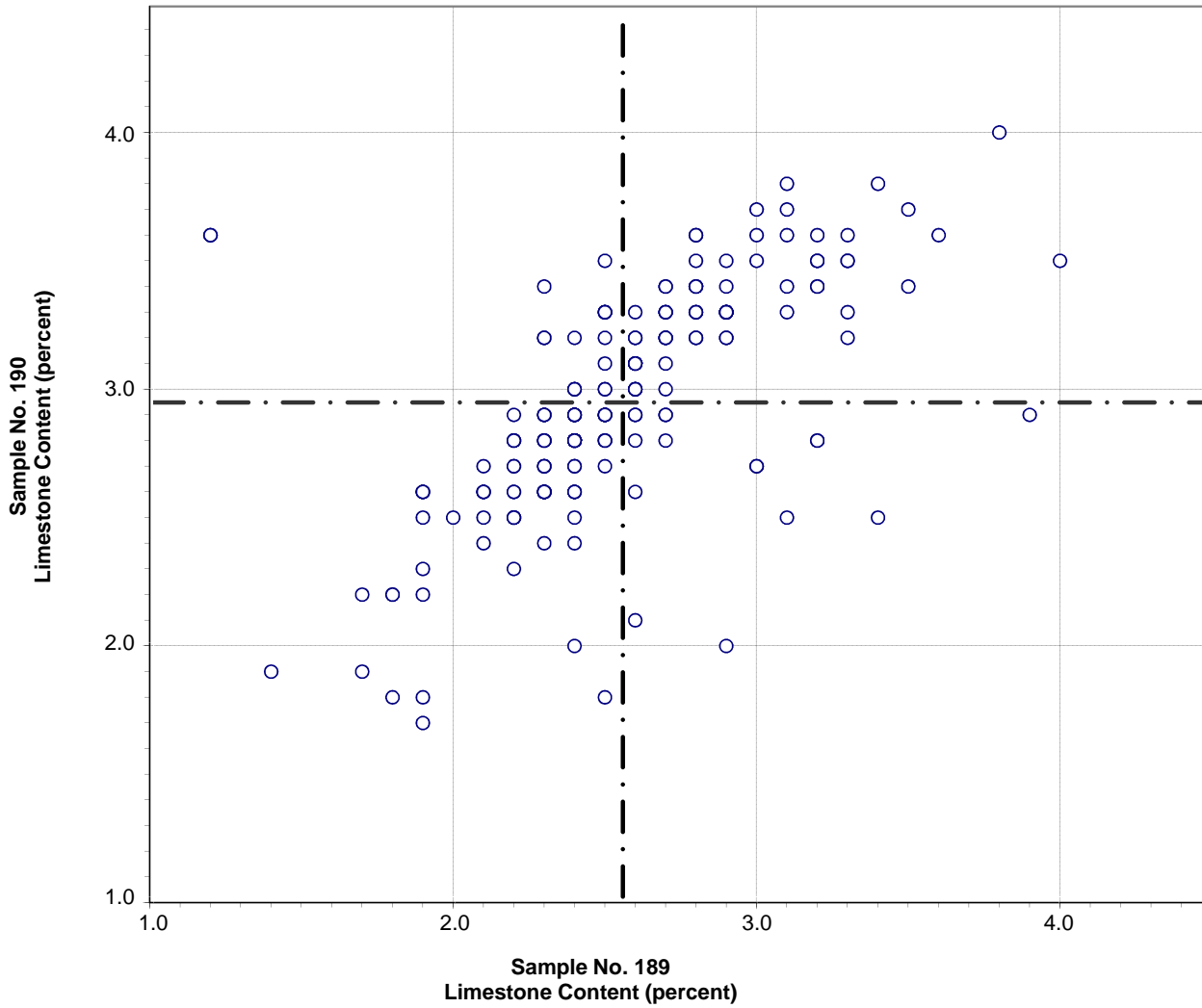


Test No. 97 Carbon Dioxide 194 Points

Sample No. 189 Ave 1.07 S.D. 0.19 C.V. 18  
Sample No. 190 Ave 1.26 S.D. 0.19 C.V. 15

Labs Eliminated: 131, 176, 219, 886, 1251, 1956, 2254, 2296, 2466, 3233

**CCRL Proficiency Sample Program  
Limestone Content  
PORTLAND CEMENT Samples No. 189 and No. 190**



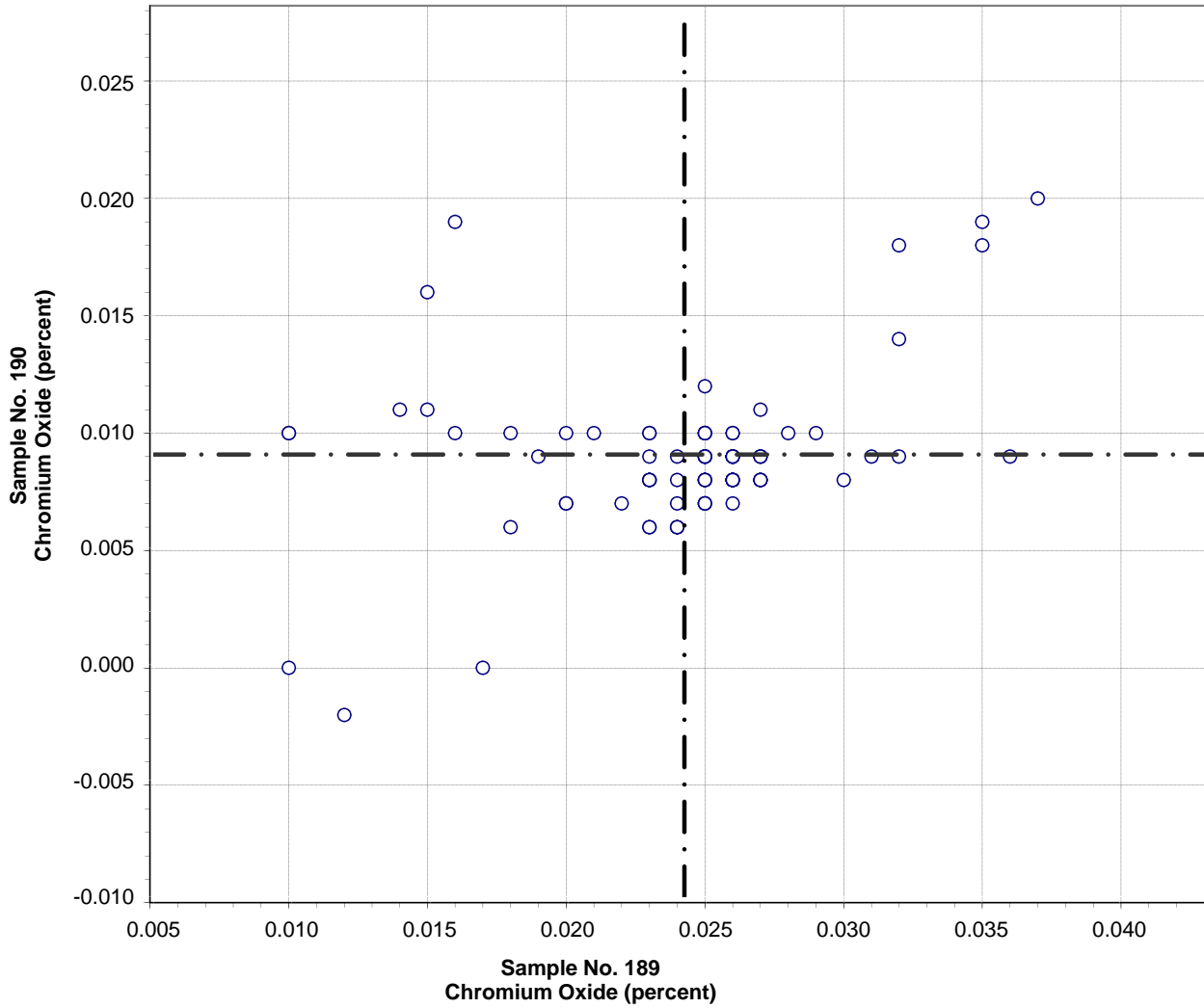
Test No. 98 Limestone Content 188 Points

Sample No. 189 Ave 2.6 S.D. 0.4 C.V. 18

Sample No. 190 Ave 2.9 S.D. 0.4 C.V. 15

Labs Eliminated: 46, 131, 176, 219, 221, 252, 886, 1251, 1956, 2254, 2296, 2466

**CCRL Proficiency Sample Program  
Chromium Oxide  
PORTLAND CEMENT Samples No. 189 and No. 190**

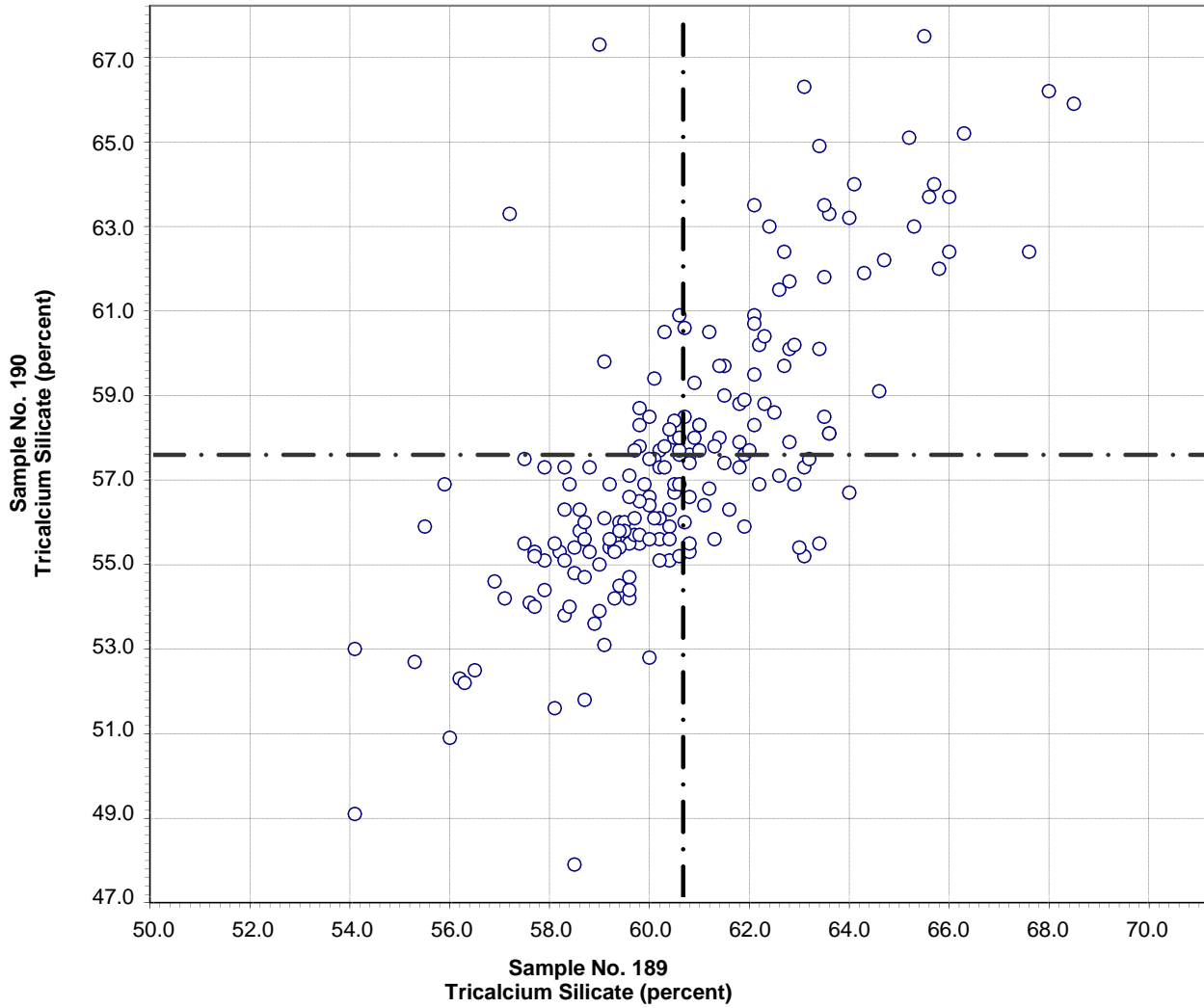


Test No. 105 Chromium Oxide 86 Points

Sample No. 189	Ave 0.024	S.D. 0.005	C.V. 22
Sample No. 190	Ave 0.009	S.D. 0.003	C.V. 38

Labs Eliminated: 407, 1466, 2296, 3662

CCRL Proficiency Sample Program  
Tricalcium Silicate  
PORTLAND CEMENT Samples No. 189 and No. 190



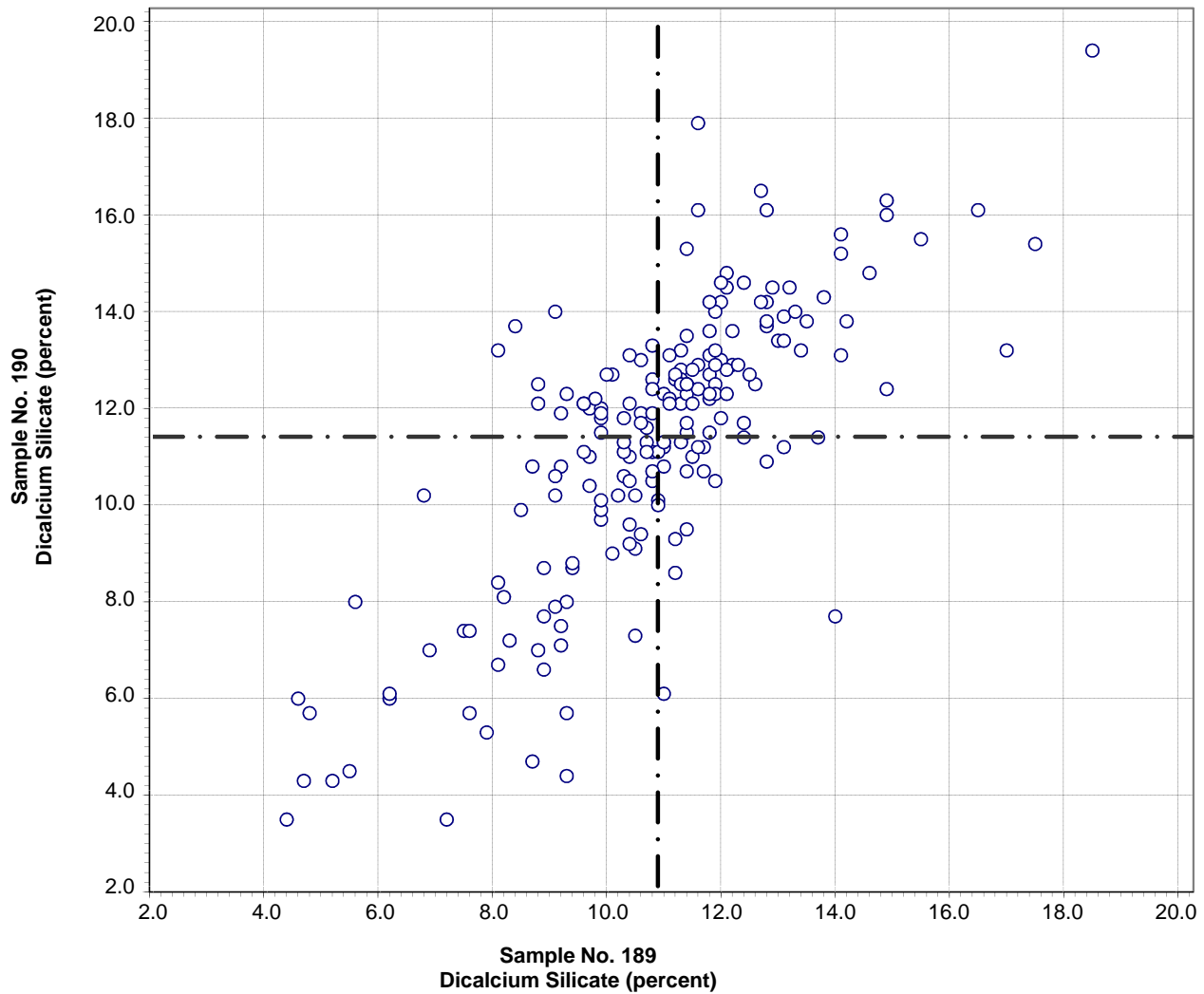
Test No. 106 Tricalcium Silicate 192 Points

Sample No. 189 Ave 60.7 S.D. 2.5 C.V. 4.1

Sample No. 190 Ave 57.6 S.D. 3.3 C.V. 5.8

Labs Eliminated: 50, 93, 206, 289, 840, 3238, 3752

**CCRL Proficiency Sample Program  
Dicalcium Silicate  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 107 Dicalcium Silicate 193 Points

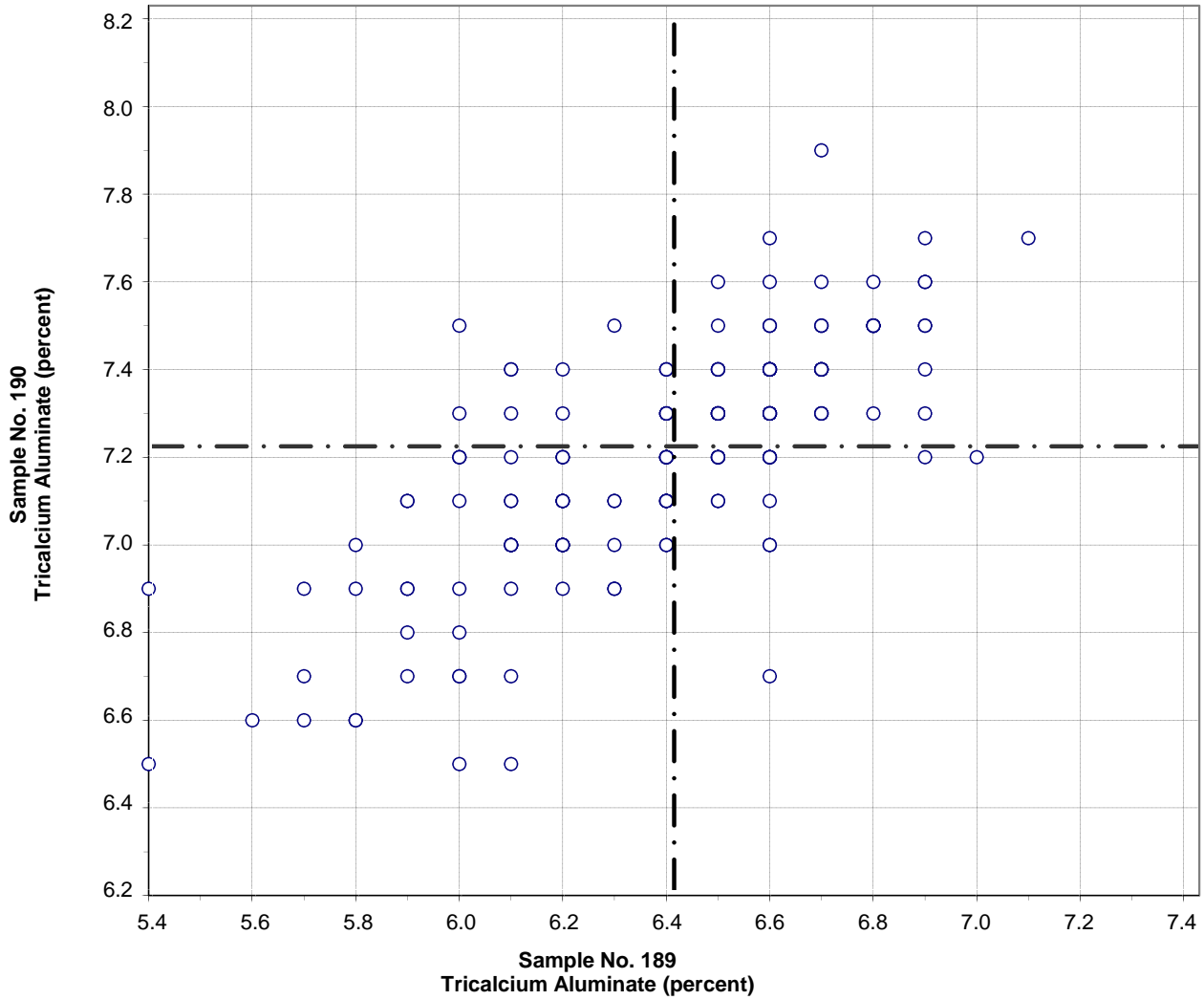
Sample No. 189 Ave 10.9 S.D. 2.3 C.V. 21

Sample No. 190 Ave 11.4 S.D. 2.9 C.V. 26

Labs Eliminated: 50, 93, 206, 3752

Labs off Diagram: 125

**CCRL Proficiency Sample Program  
Tricalcium Aluminate  
PORTLAND CEMENT Samples No. 189 and No. 190**



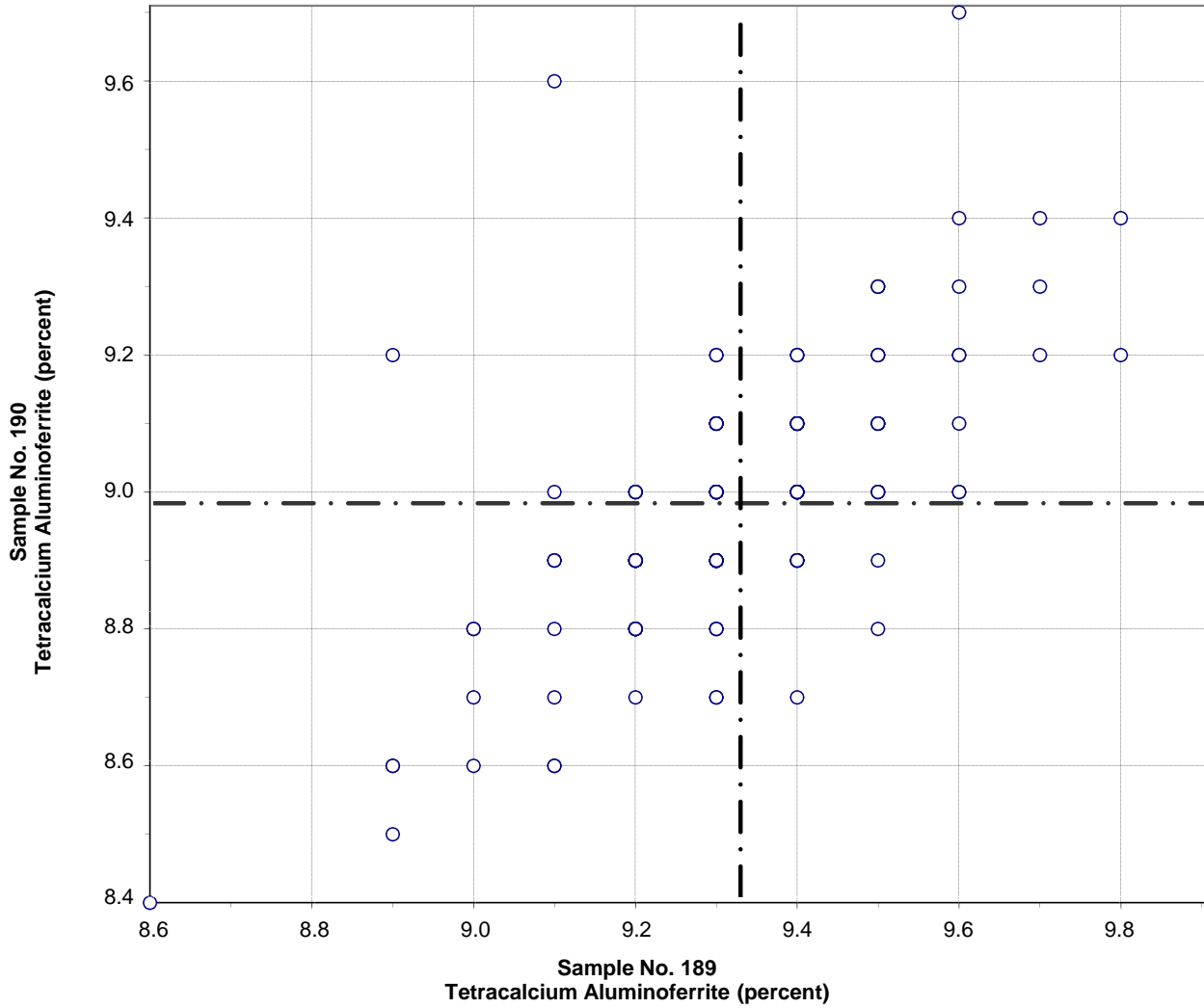
Test No. 108 Tricalcium Aluminate 192 Points

Sample No. 189 Ave 6.4 S.D. 0.3 C.V. 4.9

Sample No. 190 Ave 7.2 S.D. 0.3 C.V. 3.5

Labs Eliminated: 35, 101, 181, 222, 1715, 2484, 3752

**CCRL Proficiency Sample Program  
Tetracalcium Aluminoferrite  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 109 Tetracalcium Aluminoferrite 192 Points

Sample No. 189 Ave 9.3 S.D. 0.2 C.V. 2.1  
 Sample No. 190 Ave 9.0 S.D. 0.2 C.V. 1.9

Labs Eliminated: 101, 1644

Labs off Diagram: 132, 284, 1715, 2491

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Physical Results  
 September 6, 2013

SUMMARY OF RESULTS

Sample No.189

Sample No. 190

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

243	25.6	2.27	8.9	26.7	2.28	8.5
*234	25.6	0.45	1.8	26.7	0.46	1.7

\* Labs Eliminated - 5, 47, 51, 75, 169, 360, 958, 1435, 2352

**Vicat Time of Set - Initial (minutes)**

241	138	15	10.6	113	15	13.3
*226	137	11	8.2	111	10	9.1

\* Labs Eliminated - 5, 23, 24, 26, 40, 64, 90, 103, 116, 360, 1435, 3144, 3236, 3368, 3779

**Vicat Time of Set - Final (minutes)**

232	240	32	14	221	31	14
*227	240	30	12	220	28	13

\* Labs Eliminated - 34, 116, 3127, 3236, 3859

**Gillmore Time of Set - Initial (minutes)**

144	173	24	14	151	23	15
*142	171	22	13	150	22	14

\* Labs Eliminated - 54, 116

**Gillmore Time of Set - Final (minutes)**

144	273	35	13	255	37	15
*143	272	35	13	254	35	14

\* Labs Eliminated - 54

**False Set - Paste Method (percent)**

185	79	9.8	12.5	74	10.4	14
*182	79	7.6	9.6	75	8.0	11

\* Labs Eliminated - 84, 768, 1942



**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Physical Results  
 September 6, 2013

SUMMARY OF RESULTS

Test (unit)	Sample No.189				Sample No. 190		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Autoclave Expansion (percent)</b>							
	225	0.01	0.081	595	0.15	0.096	66
	*205	0.00	0.014	446	0.15	0.074	50
	* Labs Eliminated - 5, 25, 51, 54, 92, 116, 124, 169, 222, 354, 416, 1054, 1251, 1644, 1715, 1940, 2360, 2363, 3279, 3859						
<b>Air Content % (percent)</b>							
	218	8.6	1.3	15	9.5	1.4	14
	*216	8.6	1.1	13	9.5	1.2	13
	* Labs Eliminated - 103, 3695						
<b>Air Content - % Water (percent)</b>							
	215	67.3	10.7	15.9	67.4	10.9	16.2
	*207	69.0	2.3	3.3	68.9	2.3	3.4
	* Labs Eliminated - 110, 165, 243, 244, 823, 2412, 3279, 3695						
<b>Air Content - Flow (percent)</b>							
	217	87	3.6	4.1	89	4.2	4.8
	*214	87	3.5	4.1	88	3.4	3.9
	* Labs Eliminated - 86, 169, 3779						
<b>Compressive Strength - 3 day (psi)</b>							
	250	3993	302	7.6	4002	272	6.8
	*248	4007	261	6.5	4014	239	6.0
	* Labs Eliminated - 2080, 2468						
<b>Compressive Strength - 7 day (psi)</b>							
	250	4848	317	6.5	4684	316	6.8
	*246	4849	298	6.2	4675	255	5.5
	* Labs Eliminated - 103, 958, 2080, 3144						

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Physical Results  
 September 6, 2013

SUMMARY OF RESULTS

Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Compressive Strength - 28 day (psi)</b>							
	228	6010	448	7.5	5551	391	7.0
	*226	6024	418	6.9	5571	334	6.0
* Labs Eliminated - 116, 2080							
<b>Compressive Strength - Flow (percent)</b>							
	222	115	9	8.0	111	10	9.0
	*219	116	9	7.7	112	9	8.3
* Labs Eliminated - 9, 1435, 1466							
<b>Fineness - Air Permeability (m<sup>2</sup>/kg)</b>							
	242	397	13	3.2	398	13	3.2
	*230	398	9	2.3	399	9	2.2
* Labs Eliminated - 40, 95, 98, 103, 116, 129, 207, 219, 413, 840, 2763, 3859							
<b>Fineness - Wagner Turbidimeter (m<sup>2</sup>/kg)</b>							
	5	219	13	5.8	219	10	4.5
No Labs Eliminated for This Test							
<b>Fineness - 45µm Sieve (percent)</b>							
	228	97.56	0.57	0.6	97.68	0.55	0.6
	*216	97.59	0.36	0.4	97.73	0.36	0.4
* Labs Eliminated - 23, 25, 42, 45, 47, 50, 69, 95, 254, 441, 823, 1435							
<b>C1038 Mortar Bar Expansion (percent)</b>							
	156	0.009	0.011	125	0.009	0.021	227
	*147	0.008	0.004	51	0.006	0.003	51
* Labs Eliminated - 56, 125, 246, 252, 309, 413, 2360, 3279, 3752							
<b>C1038 Mortar - Water (ml)</b>							
	152	239	15	6.2	242	15	6.4
	*147	239	5	2.3	242	6	2.5
* Labs Eliminated - 6, 26, 46, 151, 440							

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Physical Results  
 September 6, 2013

SUMMARY OF RESULTS

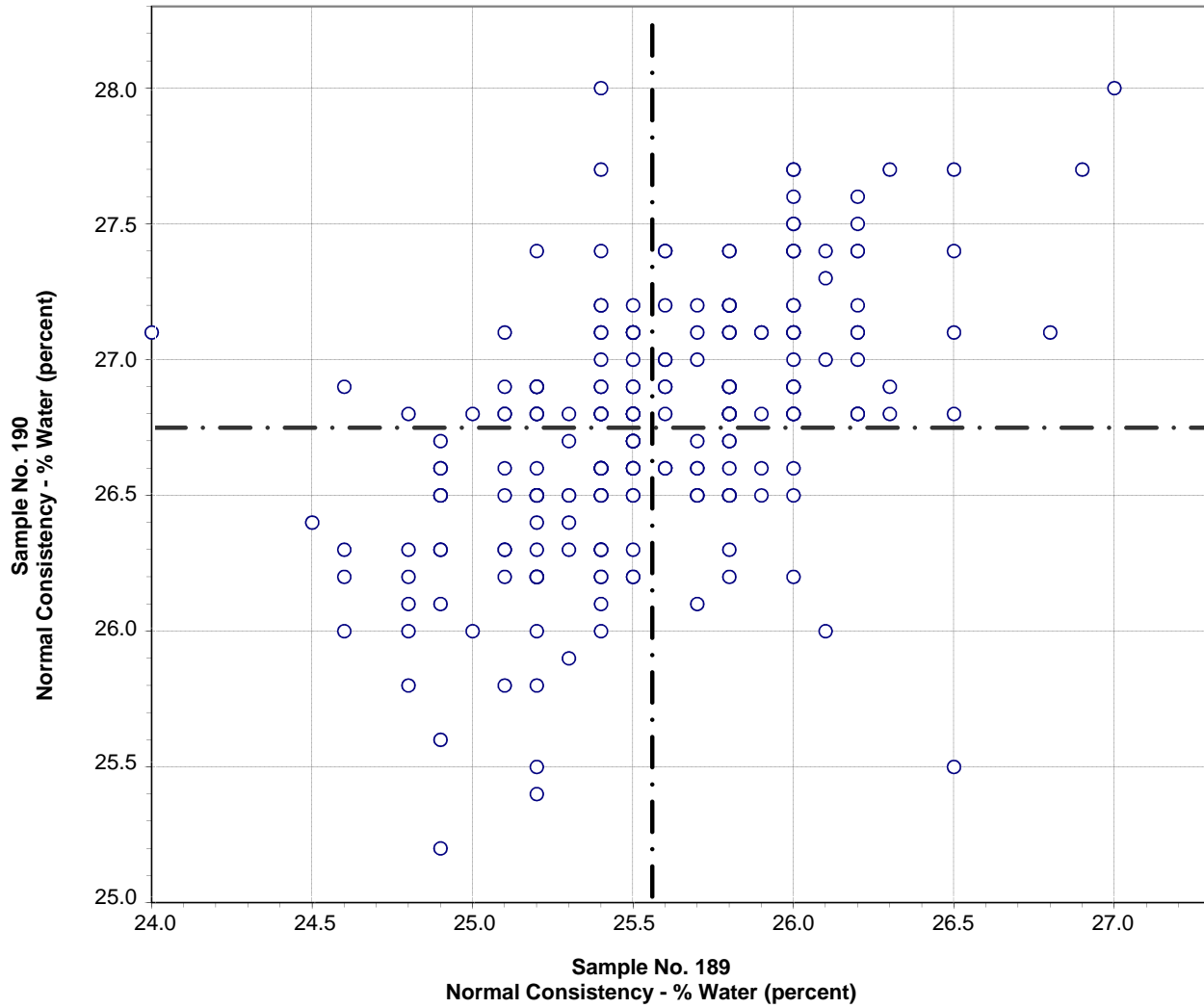
Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>C1038 Mortar - Flow (percent)</b>							
	150	109	6	5.5	109	6	5.9
	*142	110	3	2.5	109	3	2.3

\* Labs Eliminated - 151, 243, 440, 565, 690, 1251, 1715, 2412

**CCRL Proficiency Sample Program  
Normal Consistency - % Water  
PORTLAND CEMENT Samples No. 189 and No. 190**



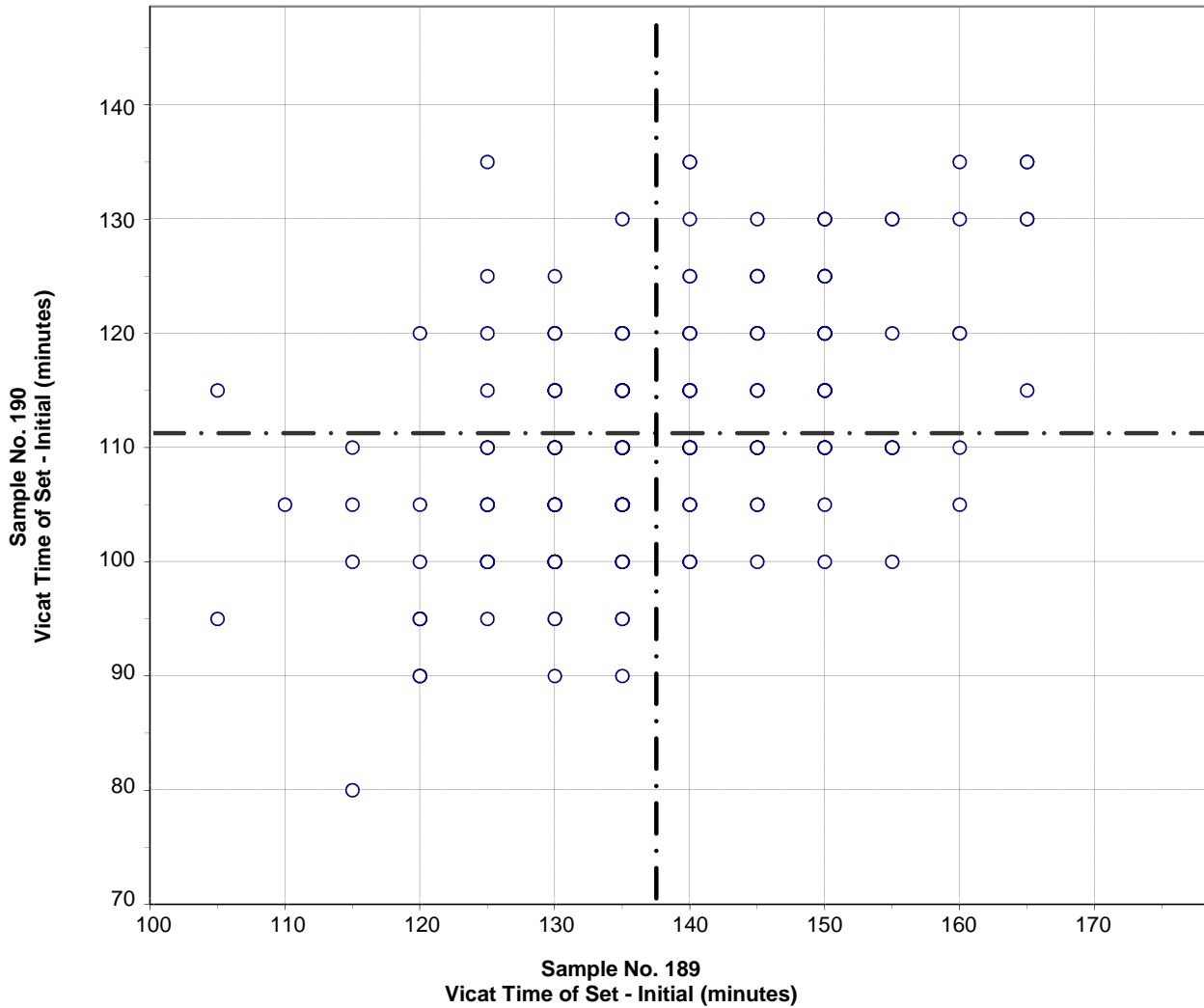
Test No. 110 Normal Consistency - % Water 234 Points

Sample No. 189 Ave 25.6 S.D. 0.45 C.V. 1.8

Sample No. 190 Ave 26.7 S.D. 0.46 C.V. 1.7

Labs Eliminated: 5, 47, 51, 75, 169, 360, 958, 1435, 2352

**CCRL Proficiency Sample Program  
 Vicat Time of Set - Initial  
 PORTLAND CEMENT Samples No. 189 and No. 190**



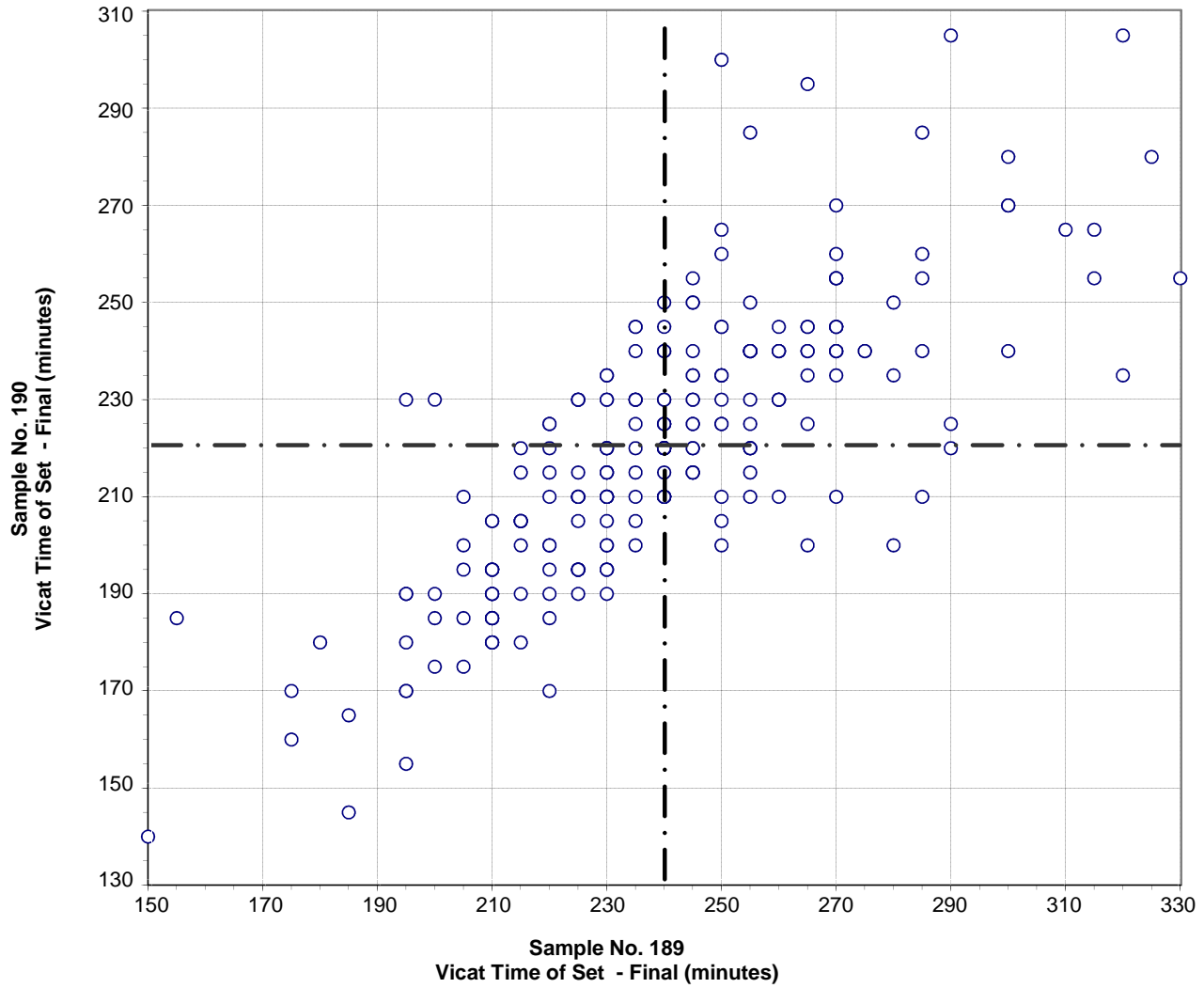
Test No. 120 Vicat Time of Set - Initial 226 Points

Sample No. 189 Ave 137 S.D. 11 C.V. 8.2

Sample No. 190 Ave 111 S.D. 10 C.V. 9.1

Labs Eliminated: 5, 23, 24, 26, 40, 64, 90, 103, 116, 360, 1435, 3144, 3236, 3368, 3779

**CCRL Proficiency Sample Program  
 Vicat Time of Set - Final  
 PORTLAND CEMENT Samples No. 189 and No. 190**



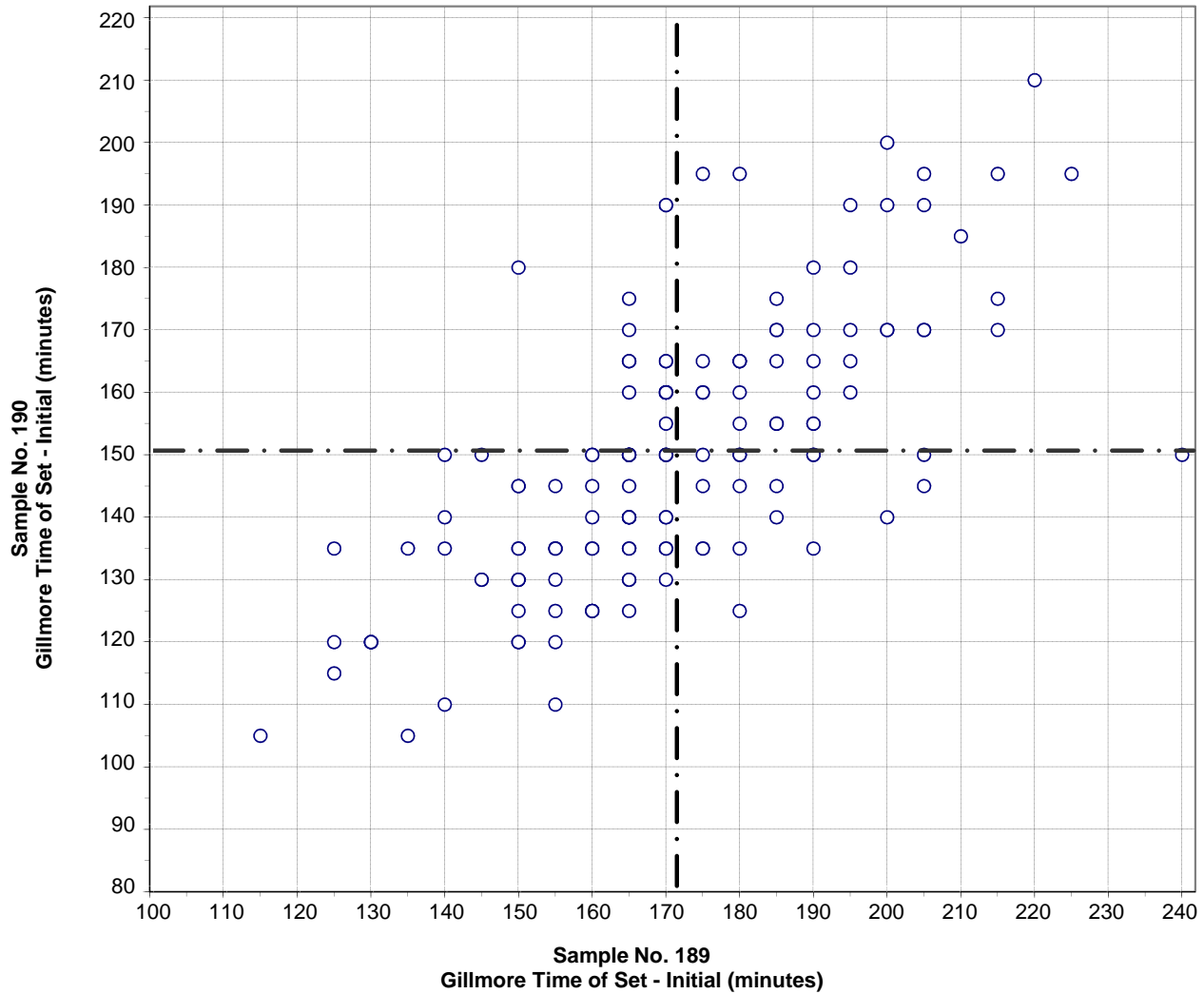
Test No. 121 Vicat Time of Set - Final 227 Points

Sample No. 189 Ave 240 S.D. 30 C.V. 12

Sample No. 190 Ave 220 S.D. 28 C.V. 13

Labs Eliminated: 34, 116, 3127, 3236, 3859

**CCRL Proficiency Sample Program  
Gillmore Time of Set - Initial  
PORTLAND CEMENT Samples No. 189 and No. 190**

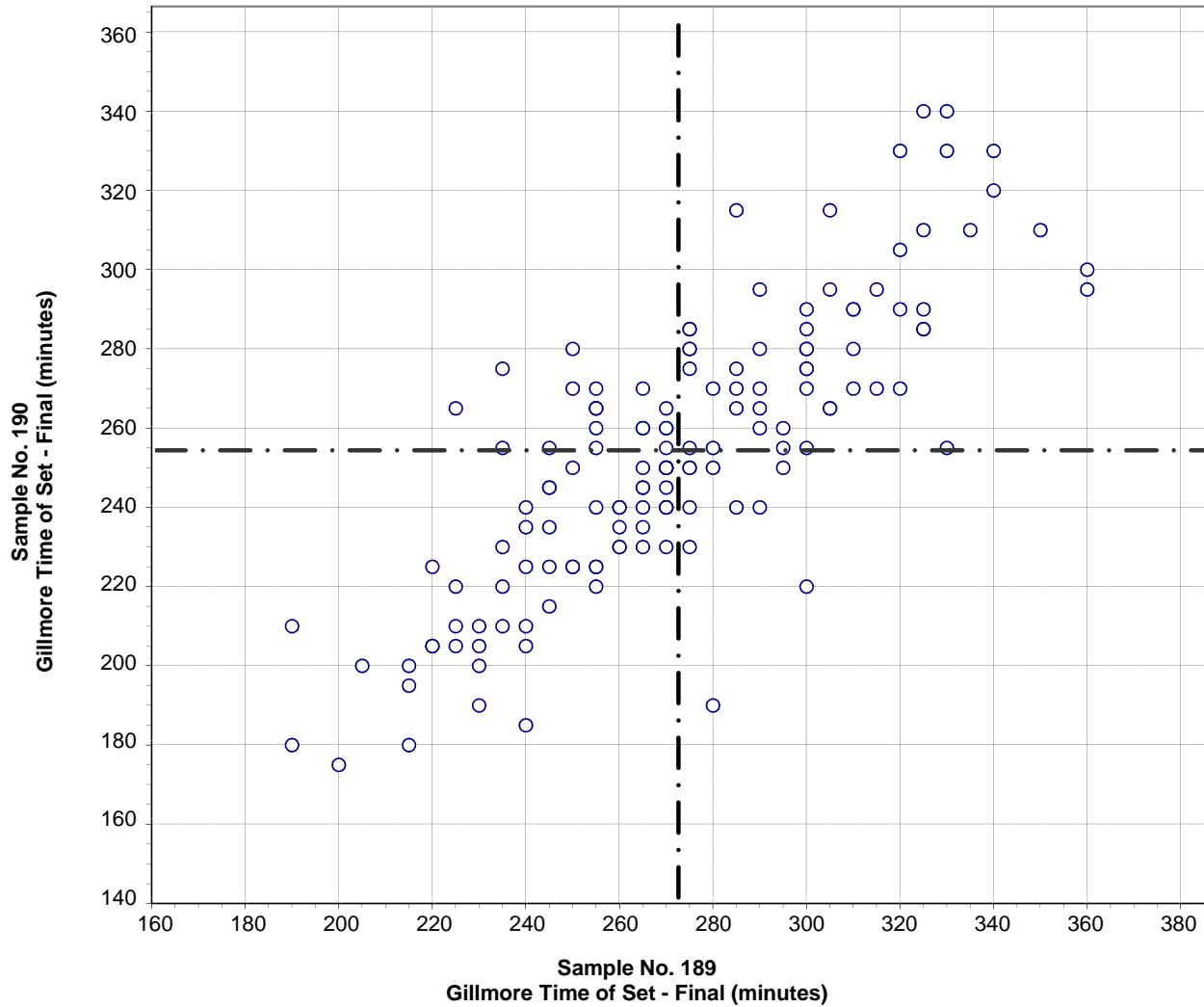


Test No. 130 Gillmore Time of Set - Initial 142 Points

Sample No. 189	Ave 171	S.D. 22	C.V. 13
Sample No. 190	Ave 150	S.D. 22	C.V. 14

Labs Eliminated: 54, 116

**CCRL Proficiency Sample Program  
Gillmore Time of Set - Final  
PORTLAND CEMENT Samples No. 189 and No. 190**



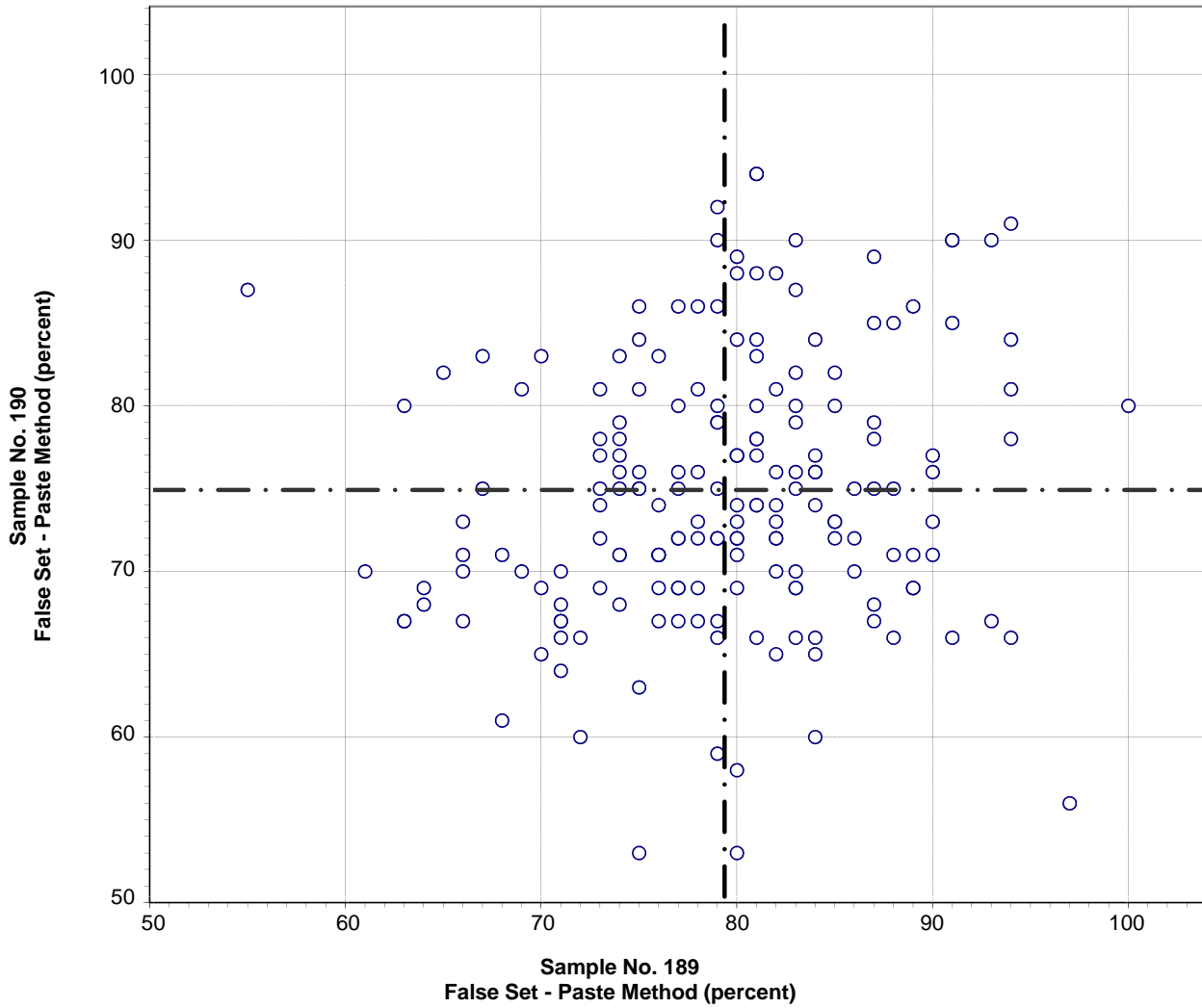
Test No. 140 Gillmore Time of Set - Final 143 Points

Sample No. 189	Ave 272	S.D. 35	C.V. 13
Sample No. 190	Ave 254	S.D. 35	C.V. 14

Labs Eliminated: 54



**CCRL Proficiency Sample Program  
False Set - Paste Method  
PORTLAND CEMENT Samples No. 189 and No. 190**

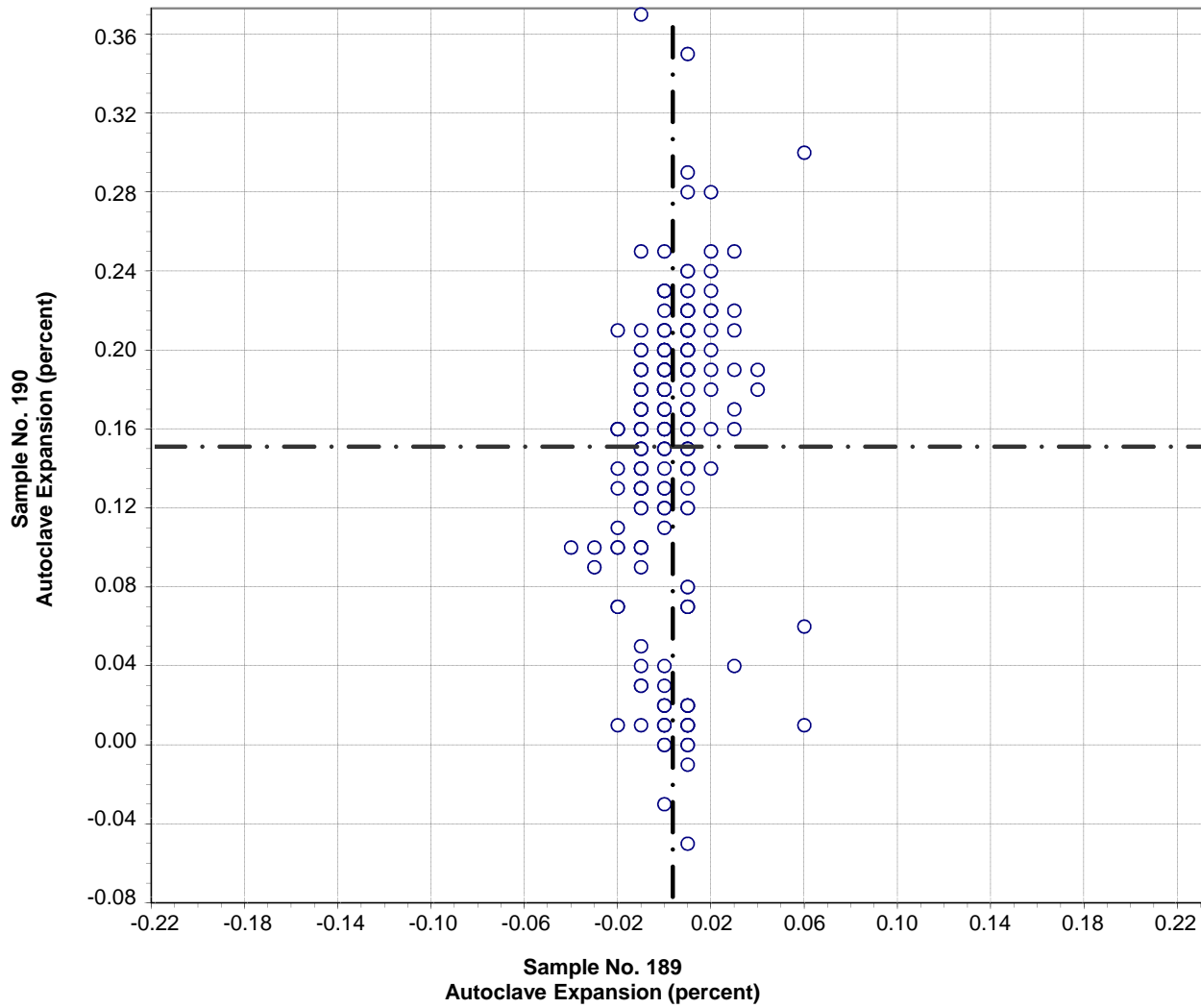


Test No. 150 False Set - Paste Method 182 Points

Sample No. 189	Ave 79	S.D. 7.6	C.V. 9.6
Sample No. 190	Ave 75	S.D. 8.0	C.V. 11

Labs Eliminated: 84, 768, 1942

**CCRL Proficiency Sample Program  
Autoclave Expansion  
PORTLAND CEMENT Samples No. 189 and No. 190**



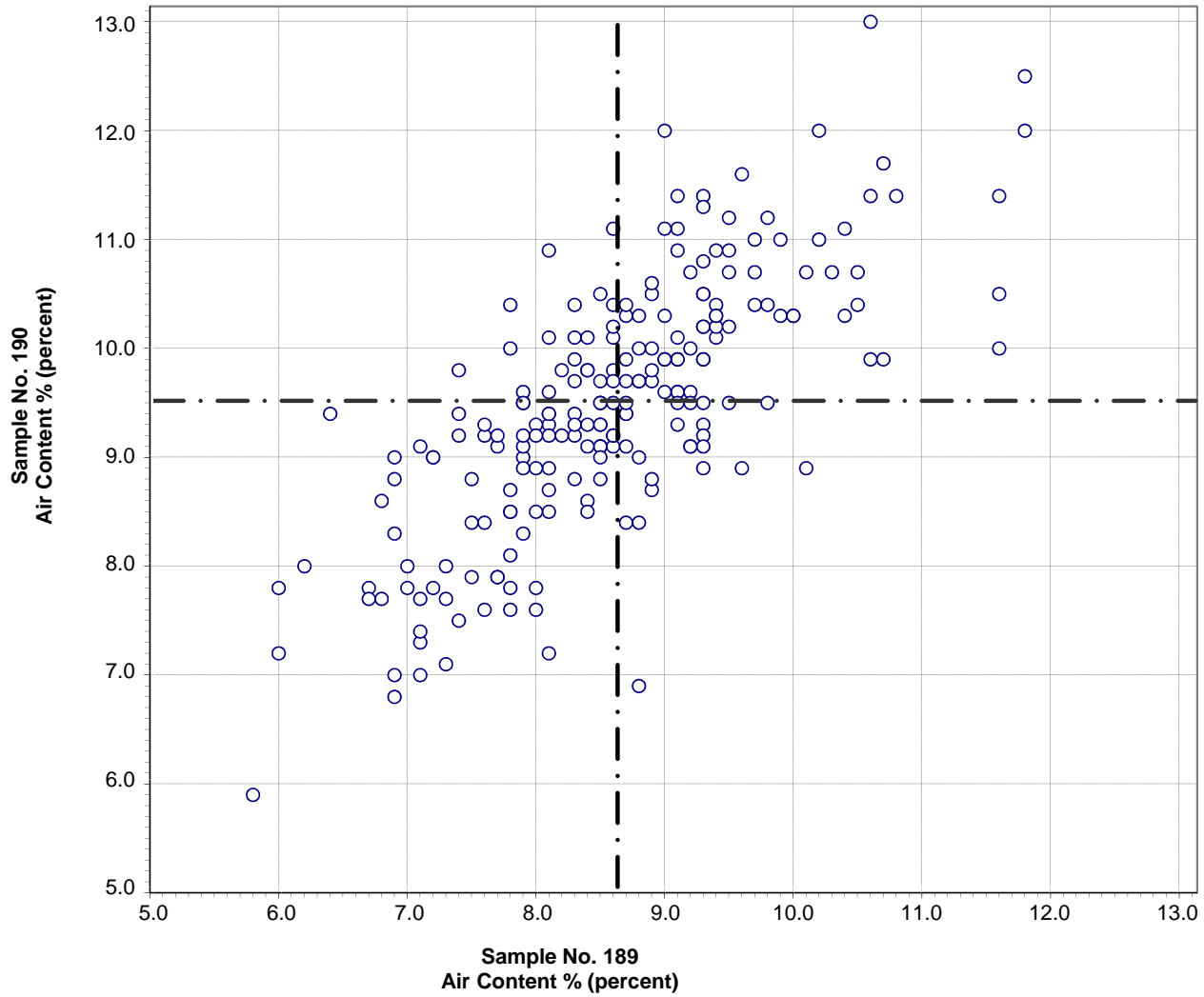
Test No. 160 Autoclave Expansion 205 Points

Sample No. 189 Ave 0.00 S.D. 0.014 C.V. 446

Sample No. 190 Ave 0.15 S.D. 0.074 C.V. 50

Labs Eliminated: 5, 25, 51, 54, 92, 116, 124, 169, 222, 354, 416, 1054, 1251, 1644,  
1715, 1940, 2360, 2363, 3279, 3859

**CCRL Proficiency Sample Program**  
**Air Content %**  
**PORTLAND CEMENT Samples No. 189 and No. 190**



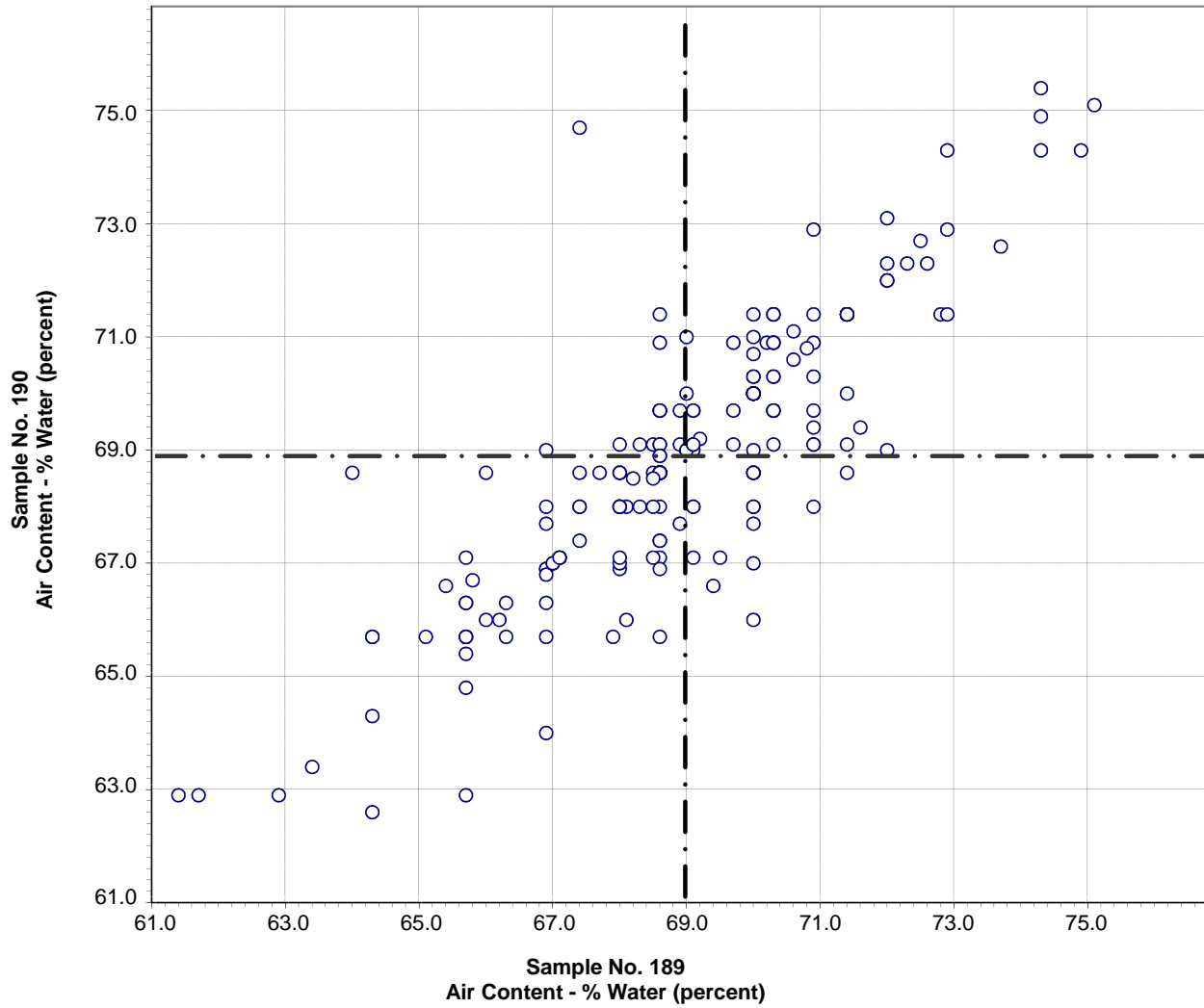
Test No. 170 Air Content % 215 Points

Sample No. 189 Ave 8.6 S.D. 1.1 C.V. 13  
Sample No. 190 Ave 9.5 S.D. 1.2 C.V. 13

Labs Eliminated: 103, 3695

Labs off Diagram: 36

**CCRL Proficiency Sample Program**  
**Air Content - % Water**  
**PORTLAND CEMENT Samples No. 189 and No. 190**



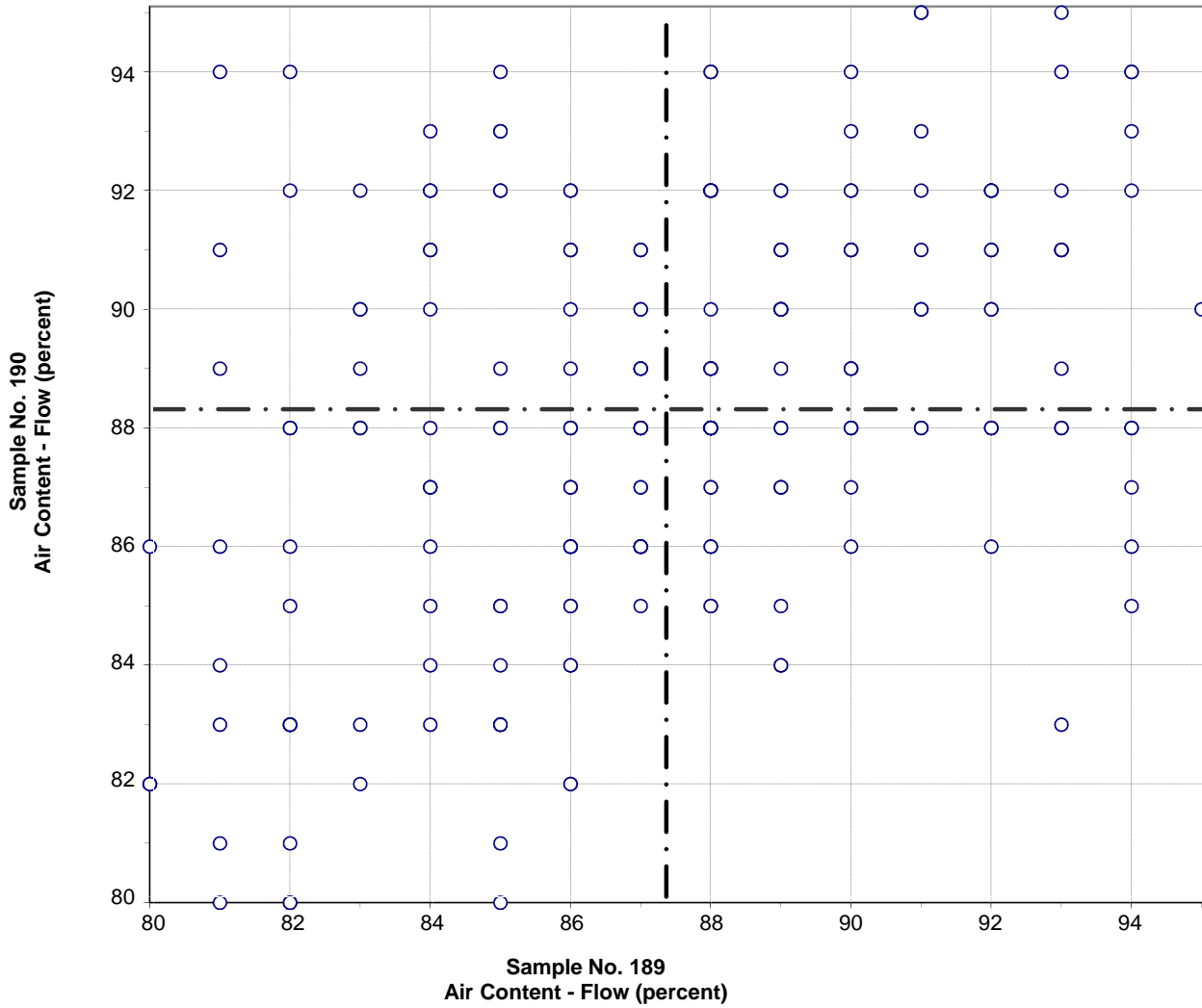
Test No. 180 Air Content - % Water 207 Points

Sample No. 189 Ave 69.0 S.D. 2.3 C.V. 3.3

Sample No. 190 Ave 68.9 S.D. 2.3 C.V. 3.4

Labs Eliminated: 110, 165, 243, 244, 823, 2412, 3279, 3695

**CCRL Proficiency Sample Program  
Air Content - Flow  
PORTLAND CEMENT Samples No. 189 and No. 190**

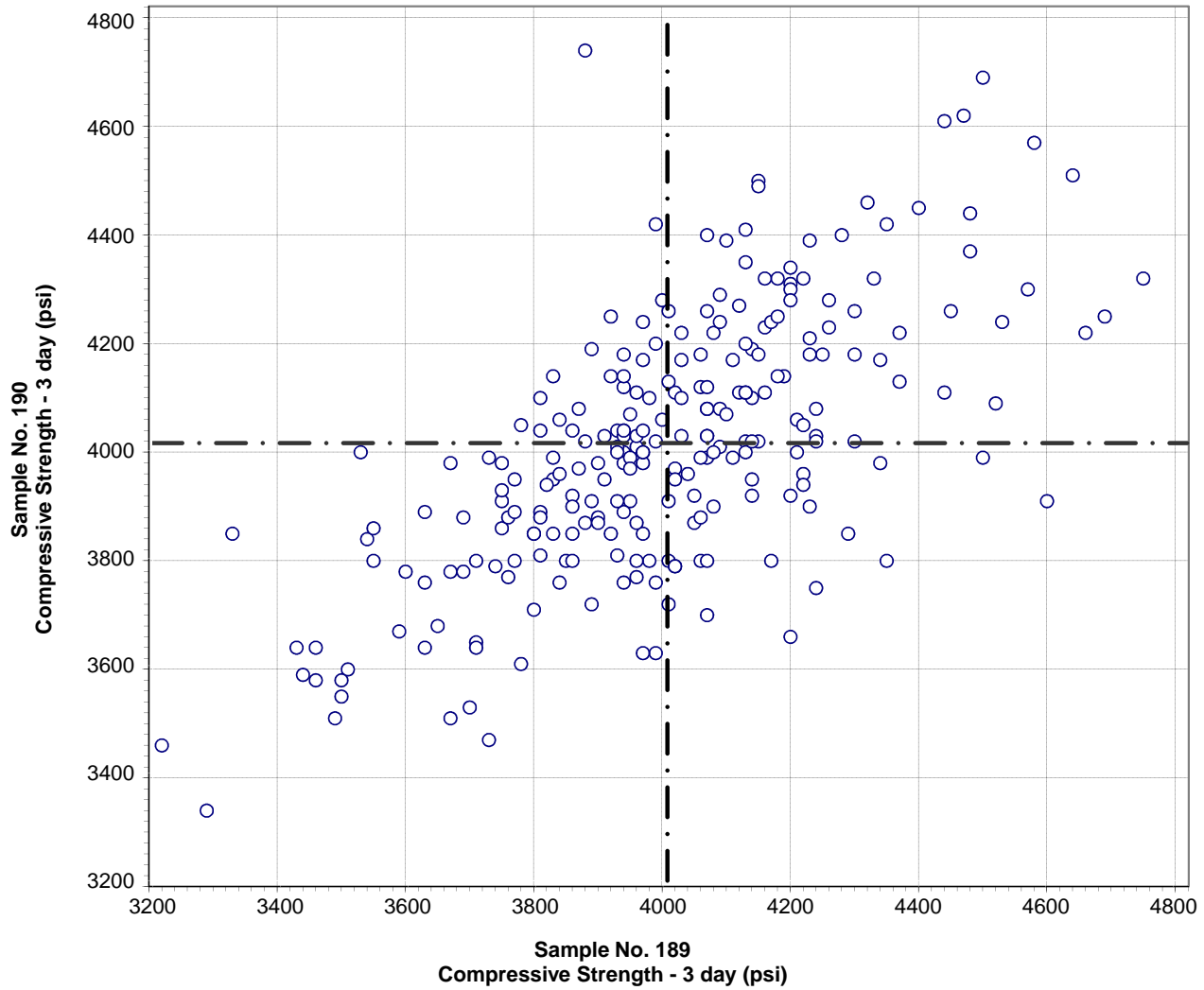


Test No. 190 Air Content - Flow 214 Points

Sample No. 189 Ave 87 S.D. 3.5 C.V. 4.1  
 Sample No. 190 Ave 88 S.D. 3.4 C.V. 3.9

Labs Eliminated: 86, 169, 3779

**CCRL Proficiency Sample Program  
Compressive Strength - 3 day  
PORTLAND CEMENT Samples No. 189 and No. 190**

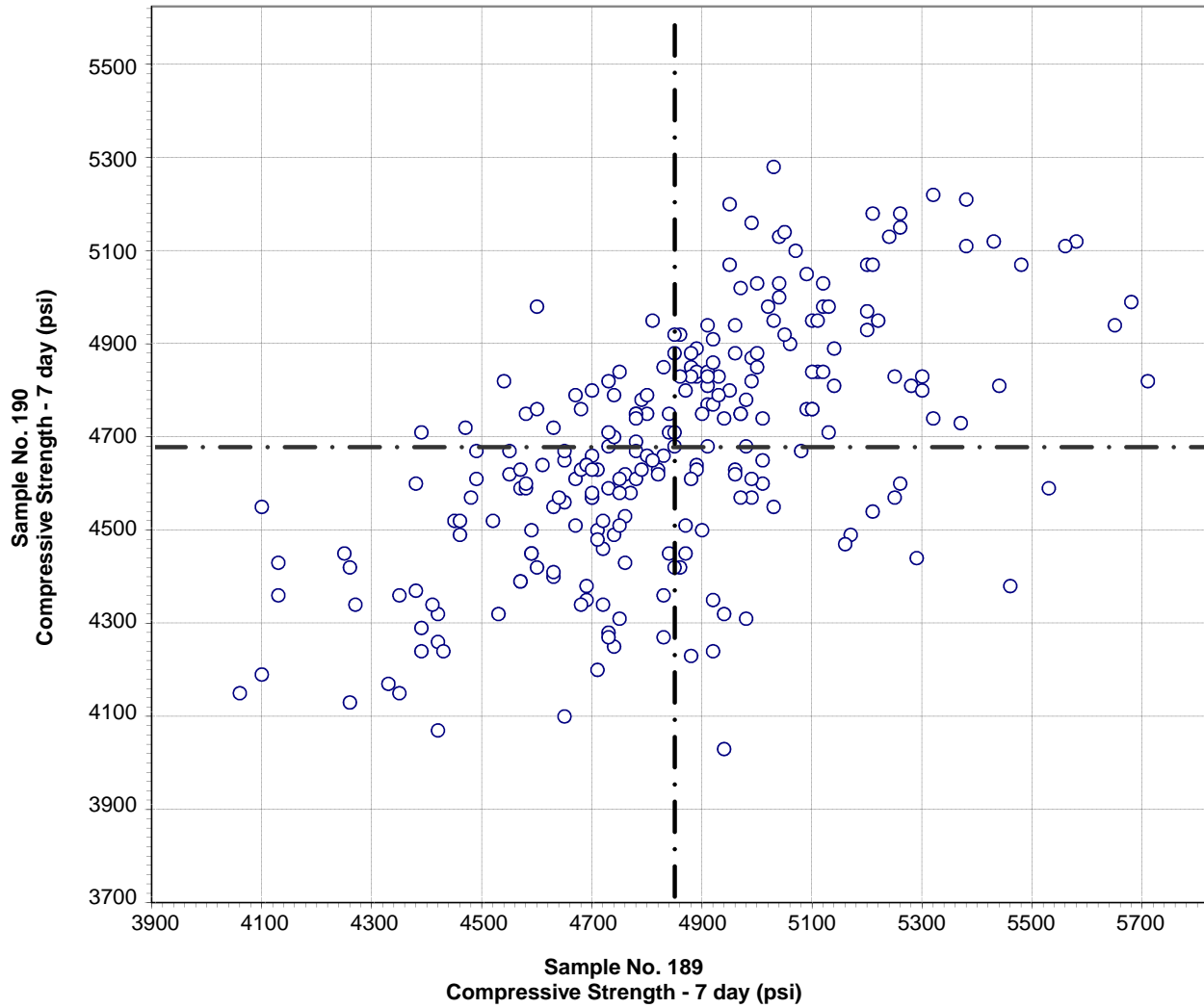


Test No. 200    Compressive Strength - 3 day    248 Points

Sample No. 189	Ave 4007	S.D. 261	C.V. 6.5
Sample No. 190	Ave 4014	S.D. 239	C.V. 6.0

Labs Eliminated: 2080, 2468

**CCRL Proficiency Sample Program  
Compressive Strength - 7 day  
PORTLAND CEMENT Samples No. 189 and No. 190**

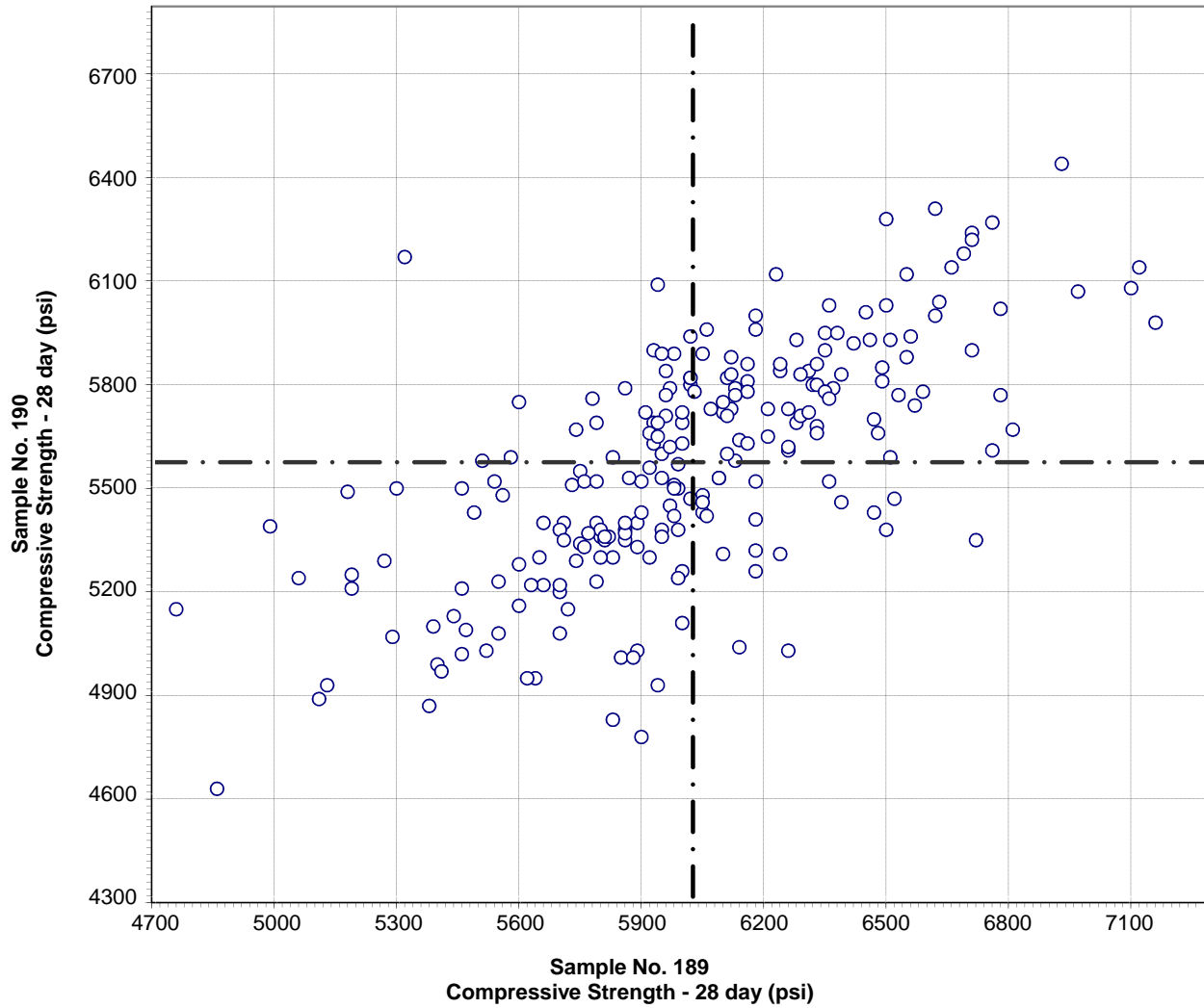


Test No. 210    Compressive Strength - 7 day    246 Points

Sample No. 189	Ave 4849	S.D. 298	C.V. 6.2
Sample No. 190	Ave 4675	S.D. 255	C.V. 5.5

Labs Eliminated: 103, 958, 2080, 3144

**CCRL Proficiency Sample Program  
Compressive Strength - 28 day  
PORTLAND CEMENT Samples No. 189 and No. 190**



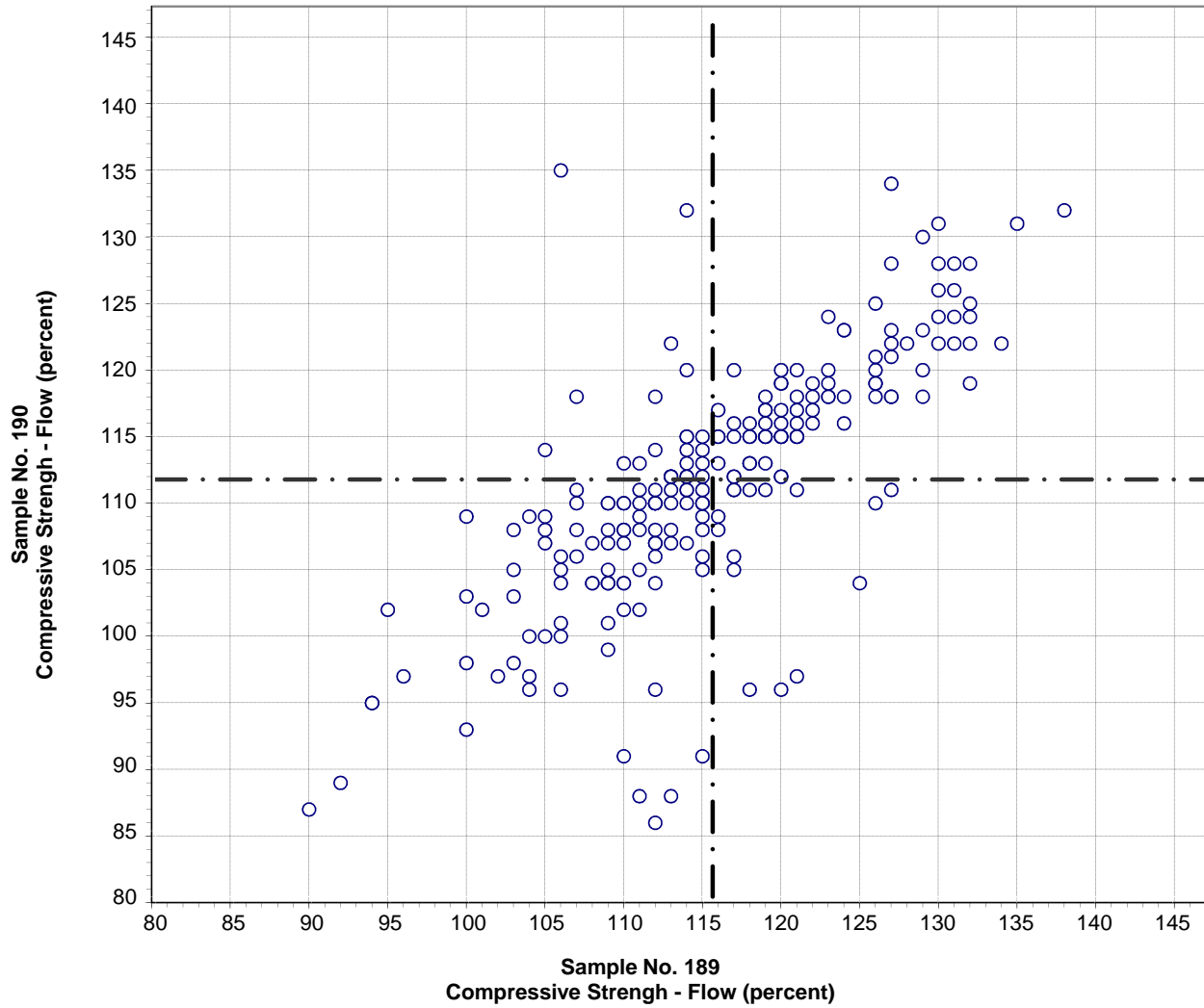
Test No. 211    Compressive Strength - 28 day    226 Points

Sample No. 189	Ave 6024	S.D. 418	C.V. 6.9
Sample No. 190	Ave 5571	S.D. 334	C.V. 6.0

Labs Eliminated: 116, 2080



**CCRL Proficiency Sample Program  
Compressive Strength - Flow  
PORTLAND CEMENT Samples No. 189 and No. 190**



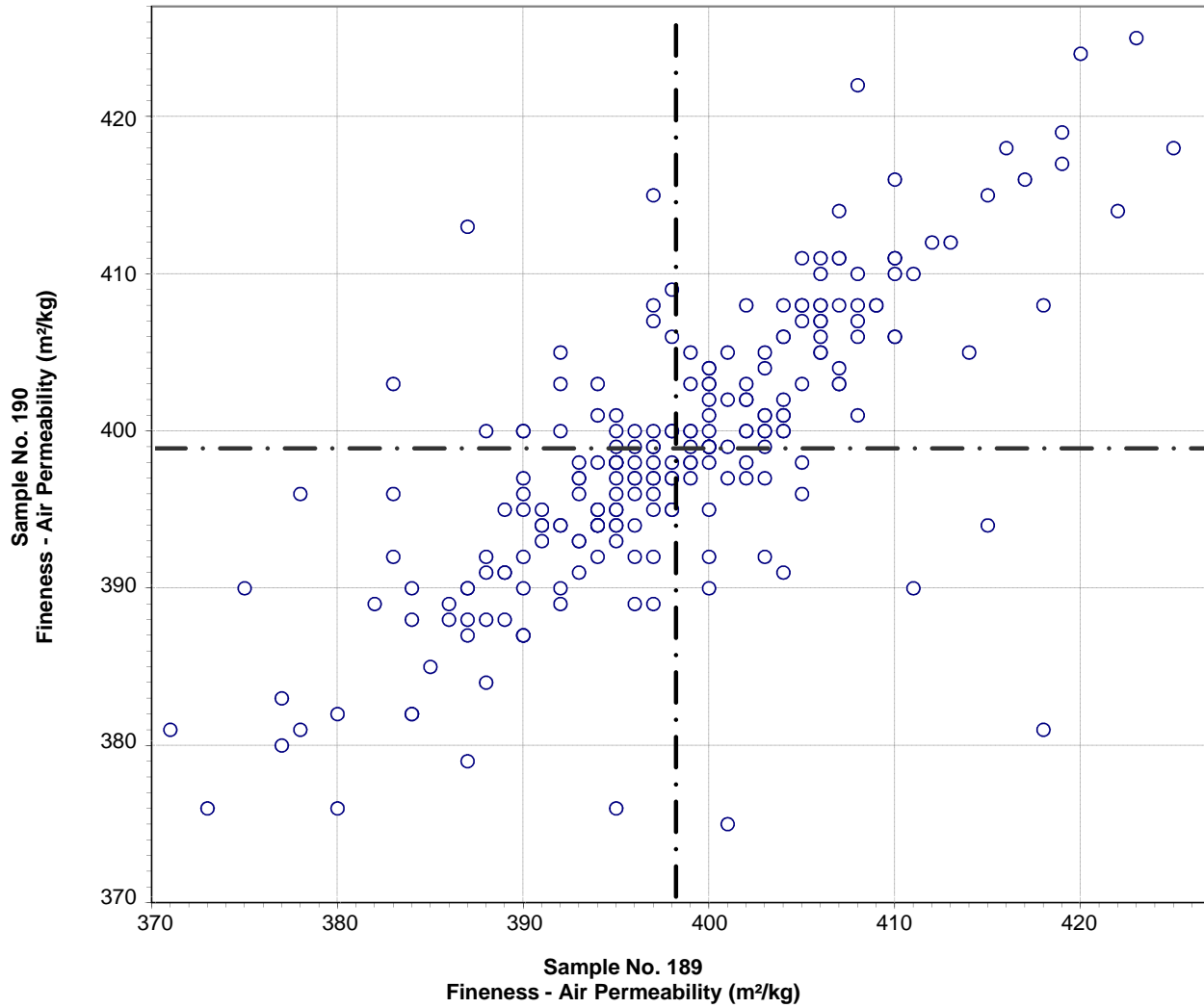
Test No. 230 Compressive Strength - Flow 219 Points

Sample No. 189 Ave 116 S.D. 9 C.V. 7.7

Sample No. 190 Ave 112 S.D. 9 C.V. 8.3

Labs Eliminated: 9, 1435, 1466

**CCRL Proficiency Sample Program  
Fineness - Air Permeability  
PORTLAND CEMENT Samples No. 189 and No. 190**



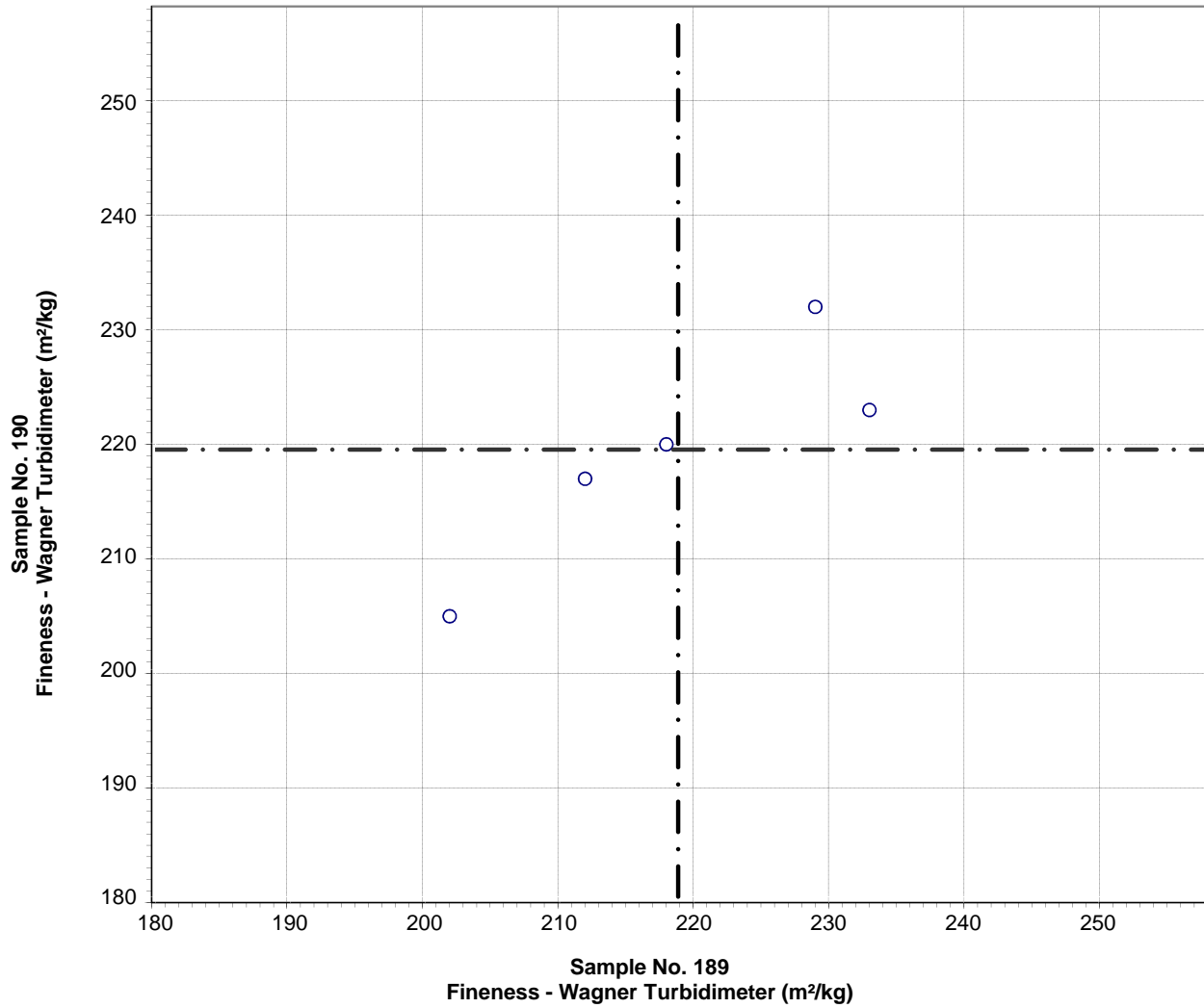
Test No. 270 Fineness - Air Permeability 230 Points

Sample No. 189 Ave 398 S.D. 9 C.V. 2.3

Sample No. 190 Ave 399 S.D. 9 C.V. 2.2

Labs Eliminated: 40, 95, 98, 103, 116, 129, 207, 219, 413, 840, 2763, 3859

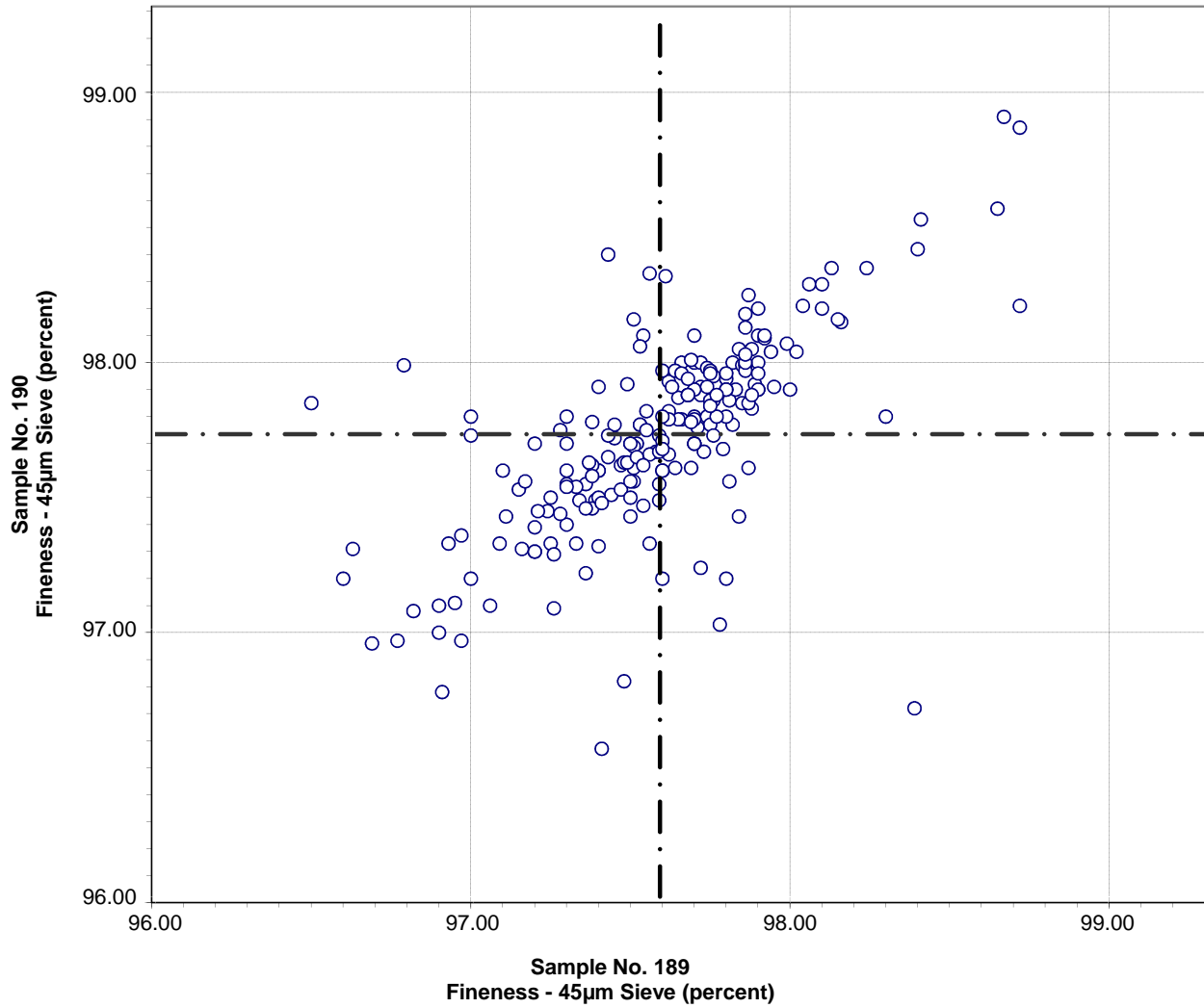
CCRL Proficiency Sample Program  
Fineness - Wagner Turbidimeter  
PORTLAND CEMENT Samples No. 189 and No. 190



Test No. 280 Fineness - Wagner Turbidimeter 5 Points

Sample No. 189 Ave 219 S.D. 13 C.V. 5.8  
Sample No. 190 Ave 219 S.D. 10 C.V. 4.5

**CCRL Proficiency Sample Program  
Fineness - 45 $\mu$ m Sieve  
PORTLAND CEMENT Samples No. 189 and No. 190**



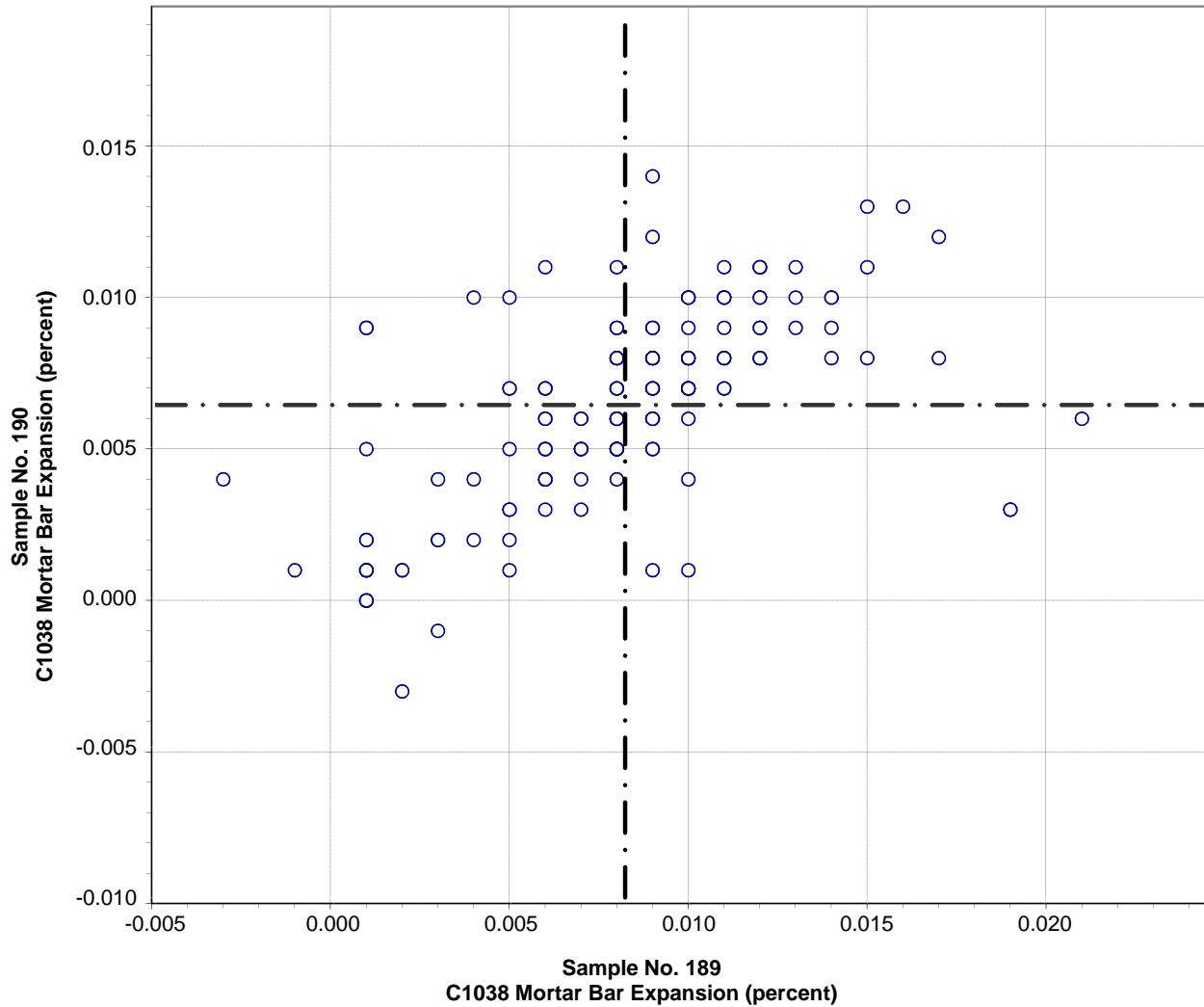
Test No. 281    Fineness - 45 $\mu$ m Sieve    216 Points

Sample No. 189    Ave 97.59    S.D. 0.36    C.V. 0.4

Sample No. 190    Ave 97.73    S.D. 0.36    C.V. 0.4

Labs Eliminated: 23, 25, 42, 45, 47, 50, 69, 95, 254, 441, 823, 1435

**CCRL Proficiency Sample Program  
C1038 Mortar Bar Expansion  
PORTLAND CEMENT Samples No. 189 and No. 190**



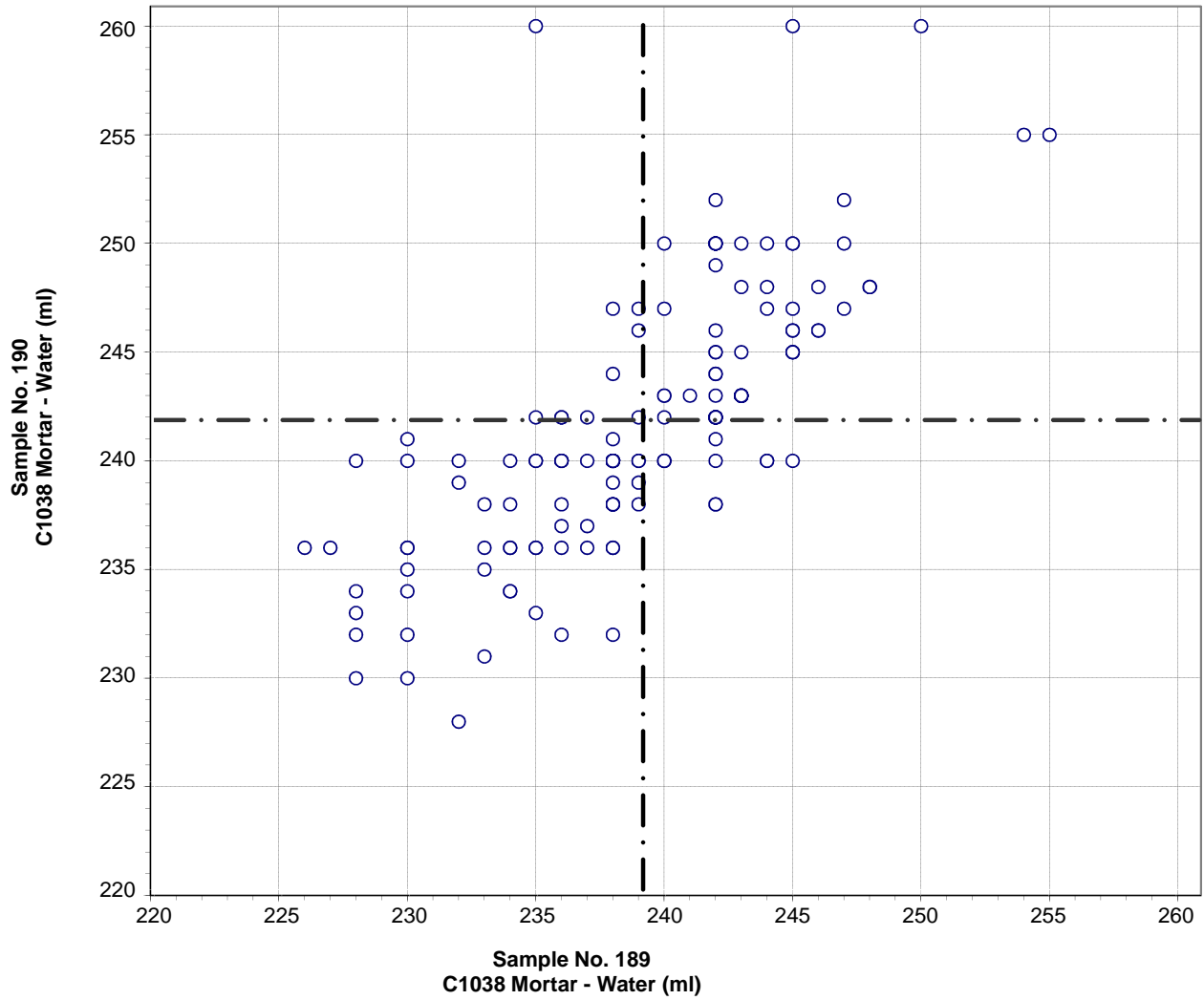
Test No. 400 C1038 Mortar Bar Expansion 147 Points

Sample No. 189 Ave 0.008 S.D. 0.004 C.V. 51

Sample No. 190 Ave 0.006 S.D. 0.003 C.V. 51

Labs Eliminated: 56, 125, 246, 252, 309, 413, 2360, 3279, 3752

**CCRL Proficiency Sample Program  
C1038 Mortar - Water  
PORTLAND CEMENT Samples No. 189 and No. 190**

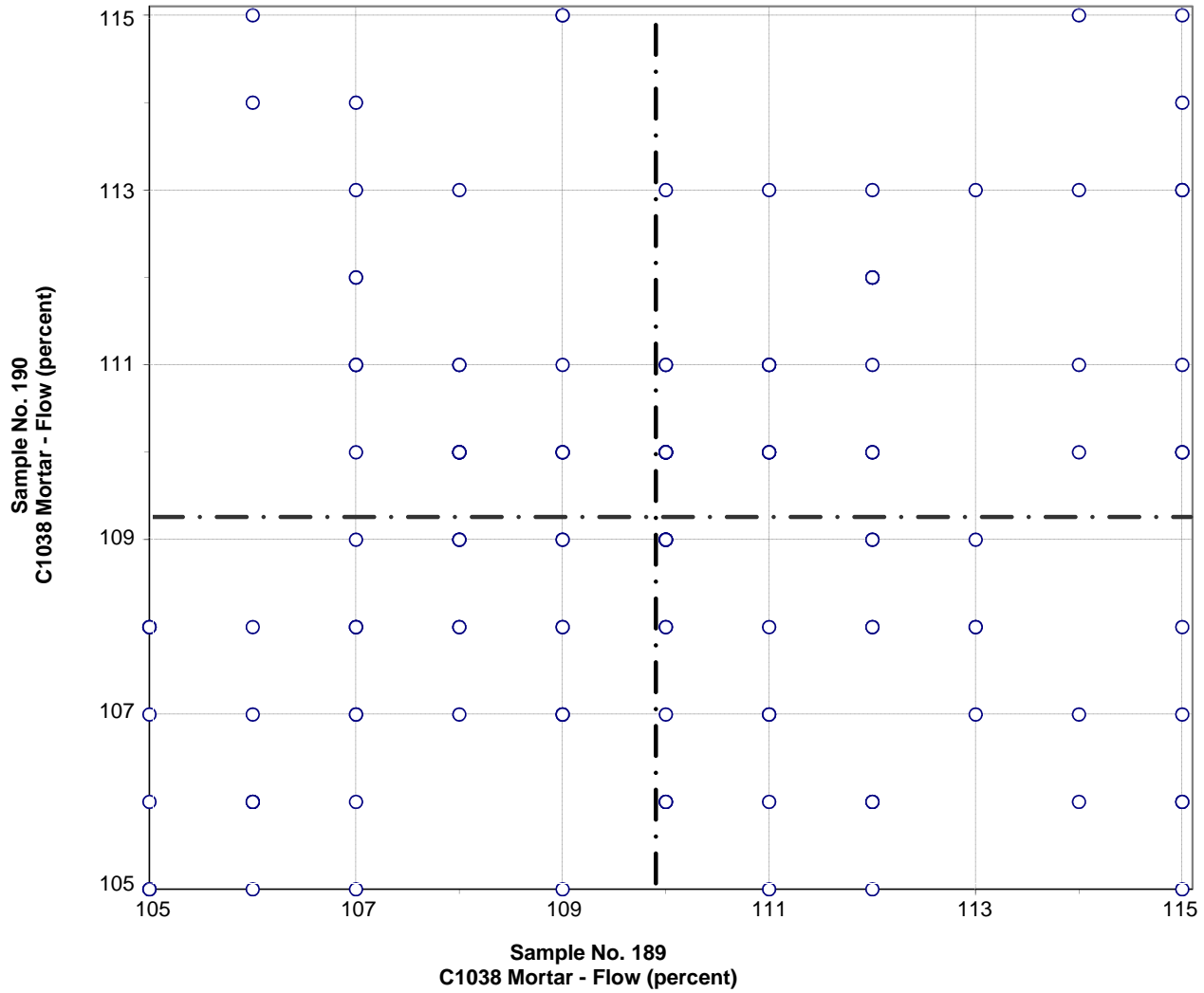


Test No. 401 C1038 Mortar - Water 147 Points

Sample No. 189 Ave 239 S.D. 5 C.V. 2.3  
 Sample No. 190 Ave 242 S.D. 6 C.V. 2.5

Labs Eliminated: 6, 26, 46, 151, 440

**CCRL Proficiency Sample Program  
C1038 Mortar - Flow  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 402 C1038 Mortar - Flow 142 Points

Sample No. 189 Ave 110 S.D. 3 C.V. 2.5  
 Sample No. 190 Ave 109 S.D. 3 C.V. 2.3

Labs Eliminated: 151, 243, 440, 565, 690, 1251, 1715, 2412

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Portland Cement Proficiency Samples No. 189 and No. 190

Final Report – Heat of Hydration Results  
 September 6, 2013

SUMMARY OF RESULTS

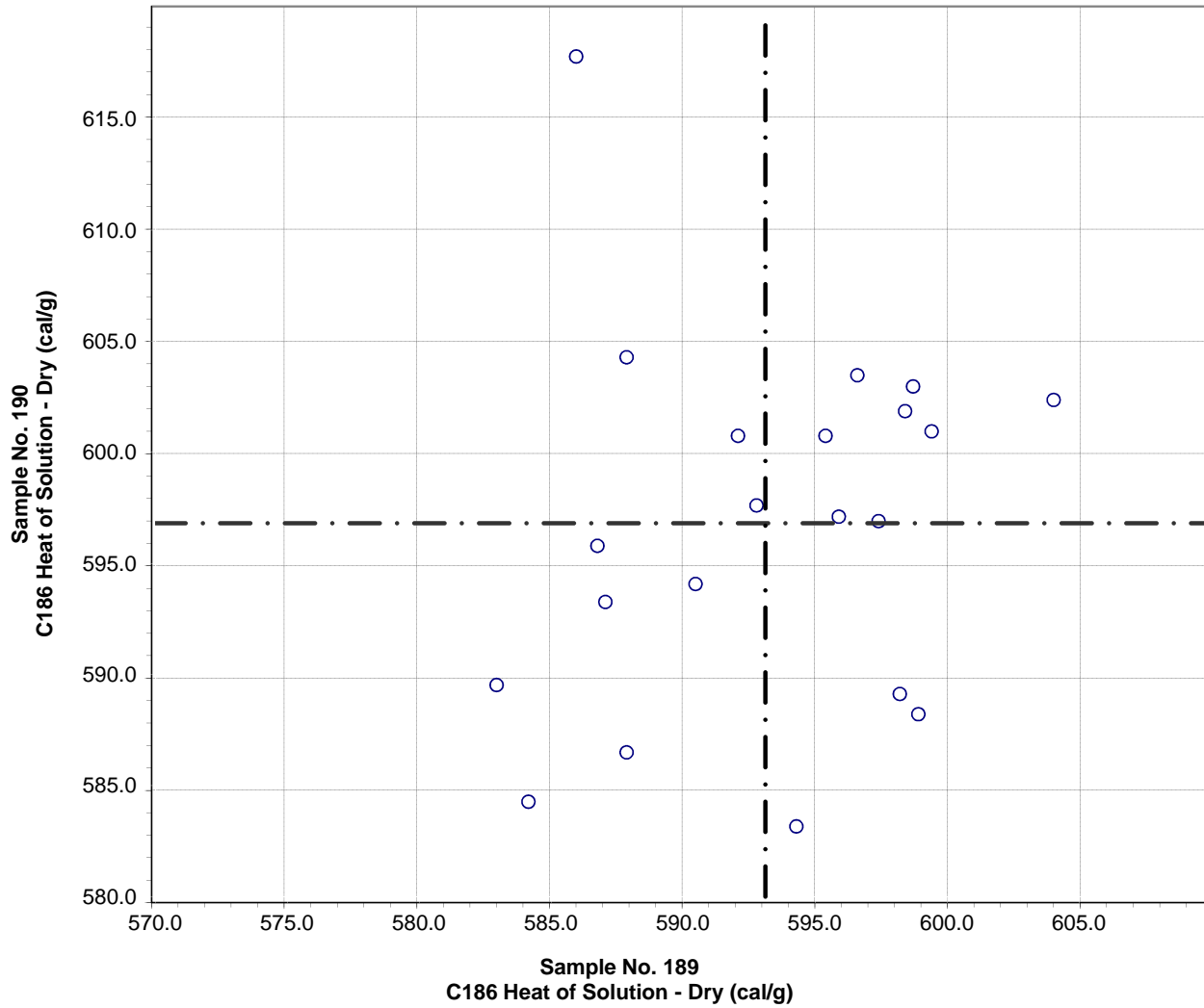
Sample No.189

Sample No. 190

Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>C186 Heat of Solution - Dry (cal/g)</b>							
	21	593.0	5.9	1.0	597.0	8.1	1.4
No Labs Eliminated for This Test							
<b>C186 Heat of Solution - 7 day (cal/g)</b>							
	21	510.3	9.2	1.8	514.2	9.8	1.9
	*20	511.7	6.6	1.3	515.0	9.4	1.8
* Labs Eliminated - 110							
<b>C186 Heat of Solution 28 day (cal/g)</b>							
	16	501.6	8.8	1.8	506.3	9.2	1.8
No Labs Eliminated for This Test							
<b>C186 Heat of Hydration - 7 day (cal/g)</b>							
	23	83.0	9.4	11.3	83.0	5.7	6.8
	*21	80.6	4.4	5.4	82.5	5.7	6.9
* Labs Eliminated - 110, 126							
<b>C186 Heat of Hydration - 28 day (cal/g)</b>							
	17	92.3	8.4	9.1	90.4	3.9	4.3
	*16	90.6	4.4	4.8	90.4	4.0	4.4
* Labs Eliminated - 110							
<b>C1702 Heat of Hydration - 3 day (J/g)</b>							
	4	320	12	3.7	350	37	11
No Labs Eliminated for This Test							
<b>C1702 Heat of Hydration - 7 day (J/g)</b>							
	5	398	89	22	379	27	7.2
No Labs Eliminated for This Test							



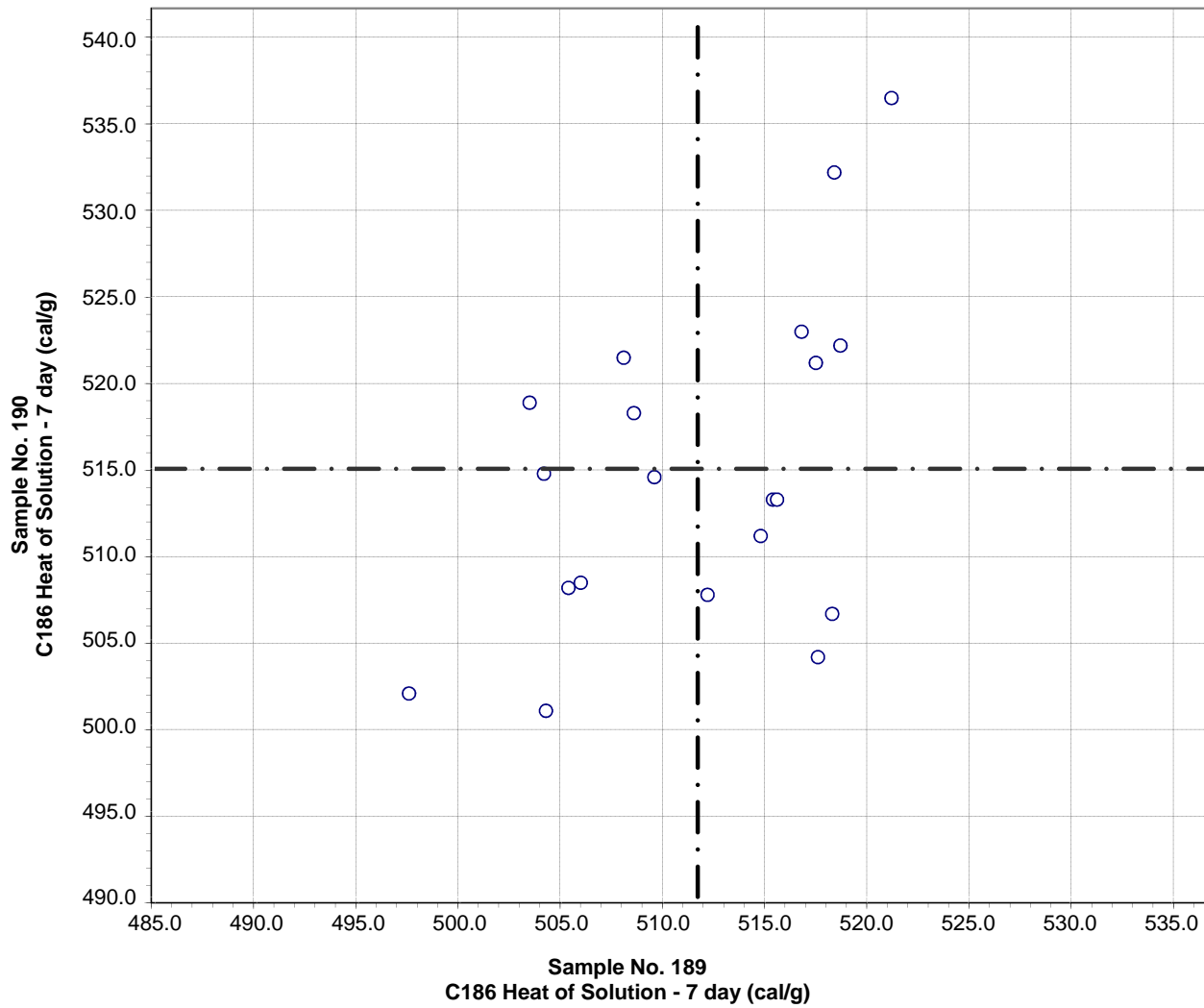
**CCRL Proficiency Sample Program  
C186 Heat of Solution - Dry  
PORTLAND CEMENT Samples No. 189 and No. 190**



Test No. 291 C186 Heat of Solution - Dry 21 Points

Sample No. 189	Ave 593.0	S.D. 5.9	C.V. 1.0
Sample No. 190	Ave 597.0	S.D. 8.1	C.V. 1.4

**CCRL Proficiency Sample Program  
C186 Heat of Solution - 7 day  
PORTLAND CEMENT Samples No. 189 and No. 190**



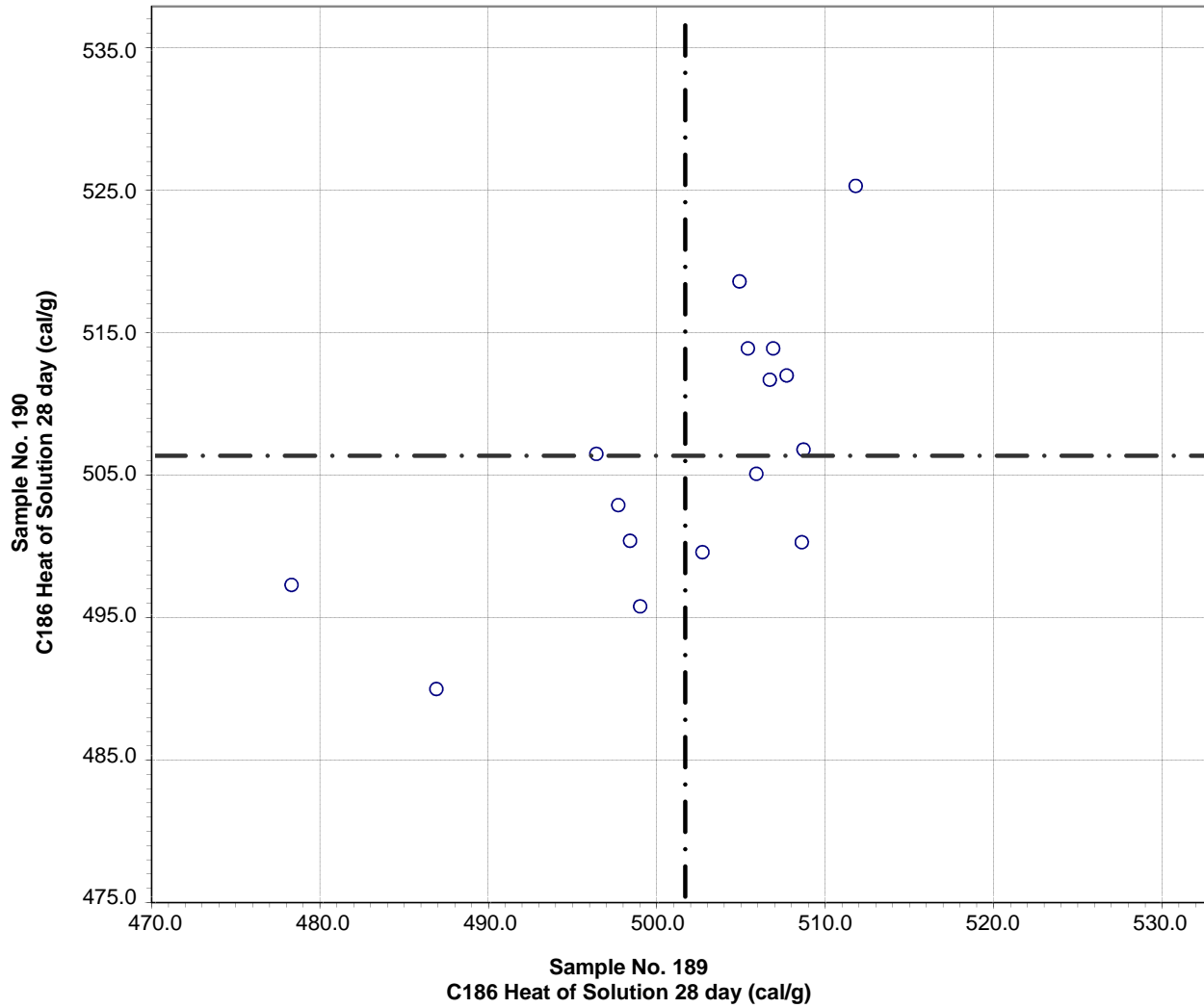
Test No. 292 C186 Heat of Solution - 7 day 20 Points

Sample No. 189 Ave 511.7 S.D. 6.6 C.V. 1.3

Sample No. 190 Ave 515.0 S.D. 9.4 C.V. 1.8

Labs Eliminated: 110

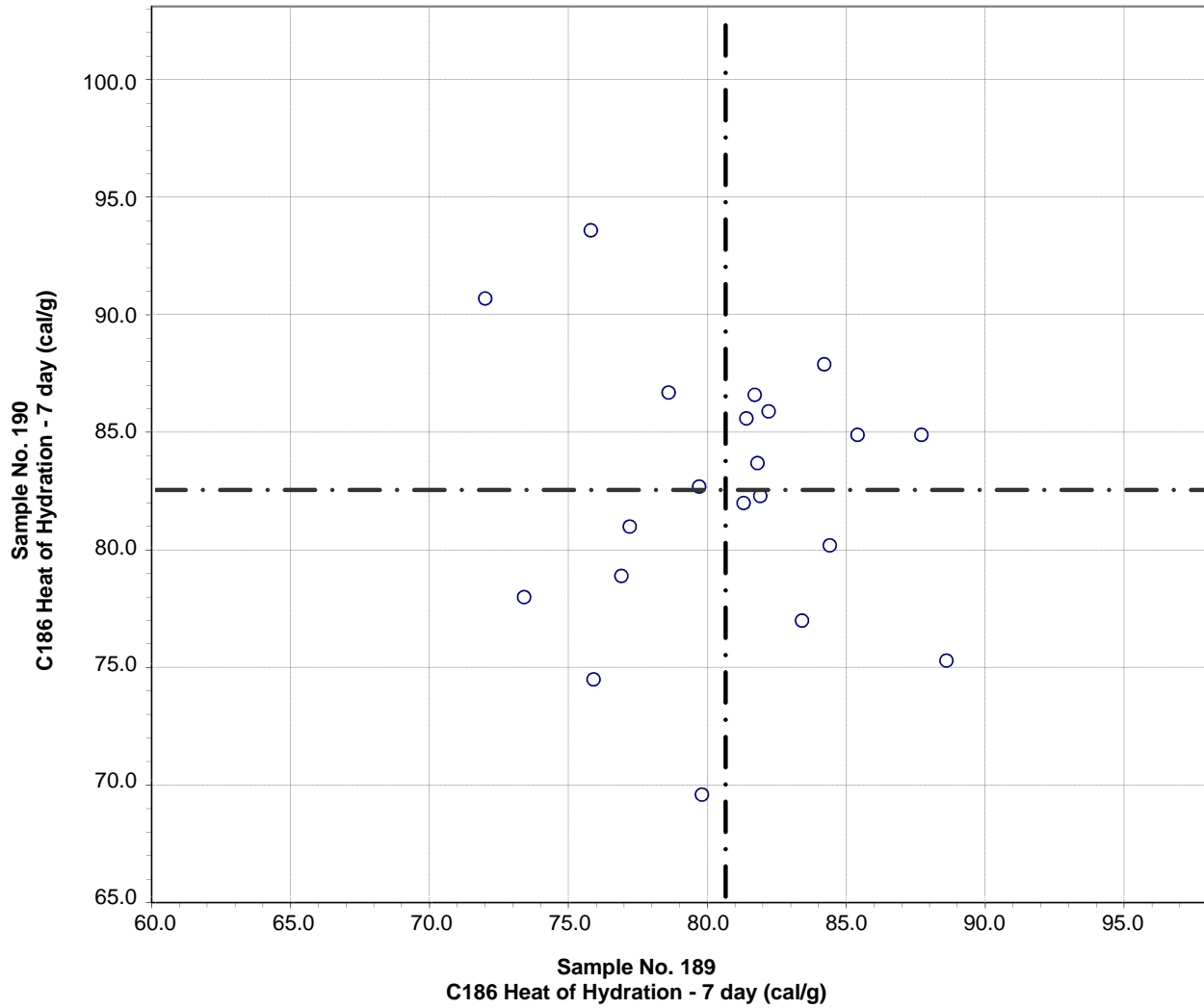
CCRL Proficiency Sample Program  
C186 Heat of Solution 28 day  
PORTLAND CEMENT Samples No. 189 and No. 190



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

Sample No. 189 Ave 501.6 S.D. 8.8 C.V. 1.8  
Sample No. 190 Ave 506.3 S.D. 9.2 C.V. 1.8

**CCRL Proficiency Sample Program  
C186 Heat of Hydration - 7 day  
PORTLAND CEMENT Samples No. 189 and No. 190**

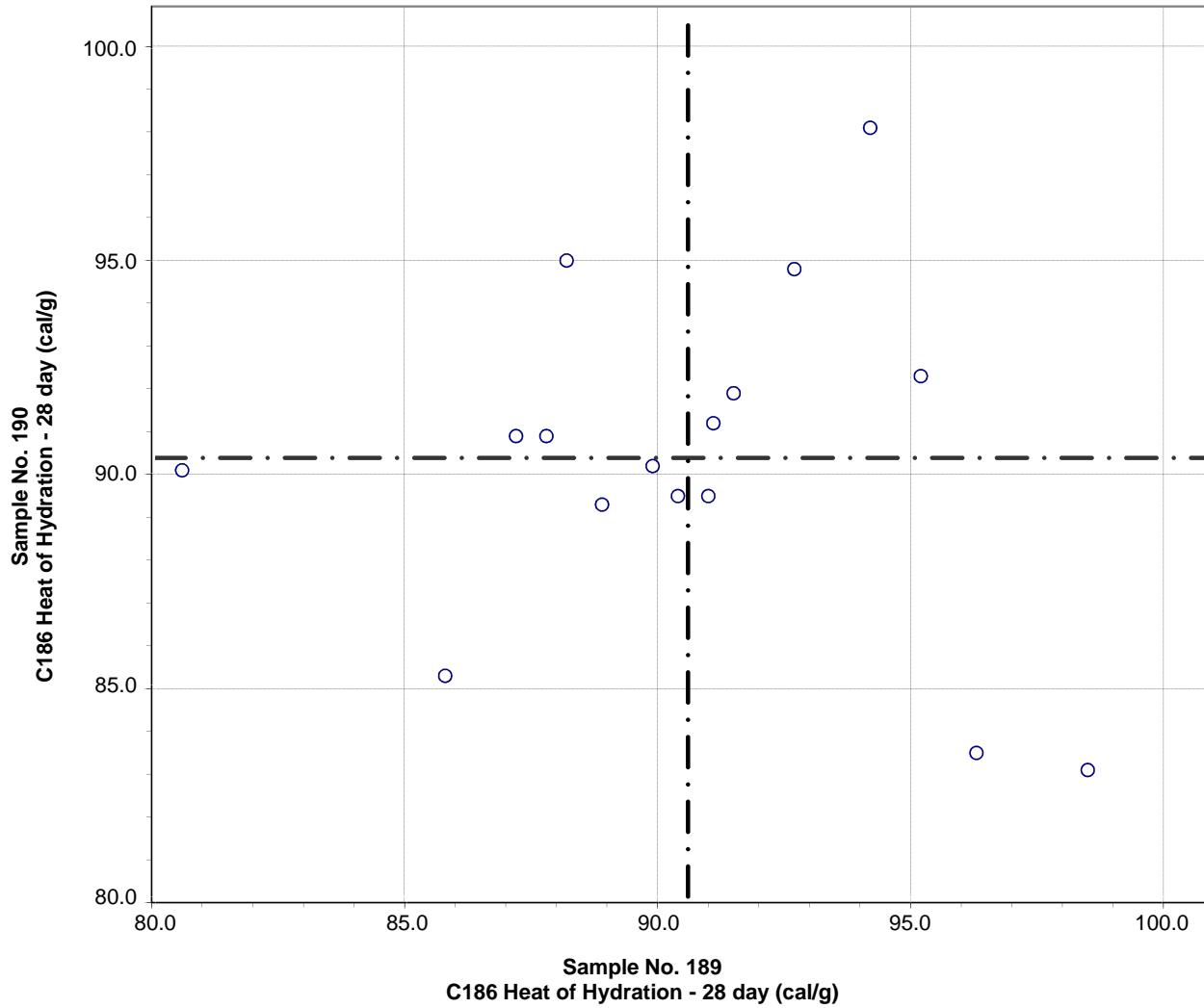


Test No. 290 C186 Heat of Hydration - 7 day 21 Points

Sample No. 189 Ave 80.6 S.D. 4.4 C.V. 5.4  
 Sample No. 190 Ave 82.5 S.D. 5.7 C.V. 6.9

Labs Eliminated: 110, 126

**CCRL Proficiency Sample Program  
C186 Heat of Hydration - 28 day  
PORTLAND CEMENT Samples No. 189 and No. 190**

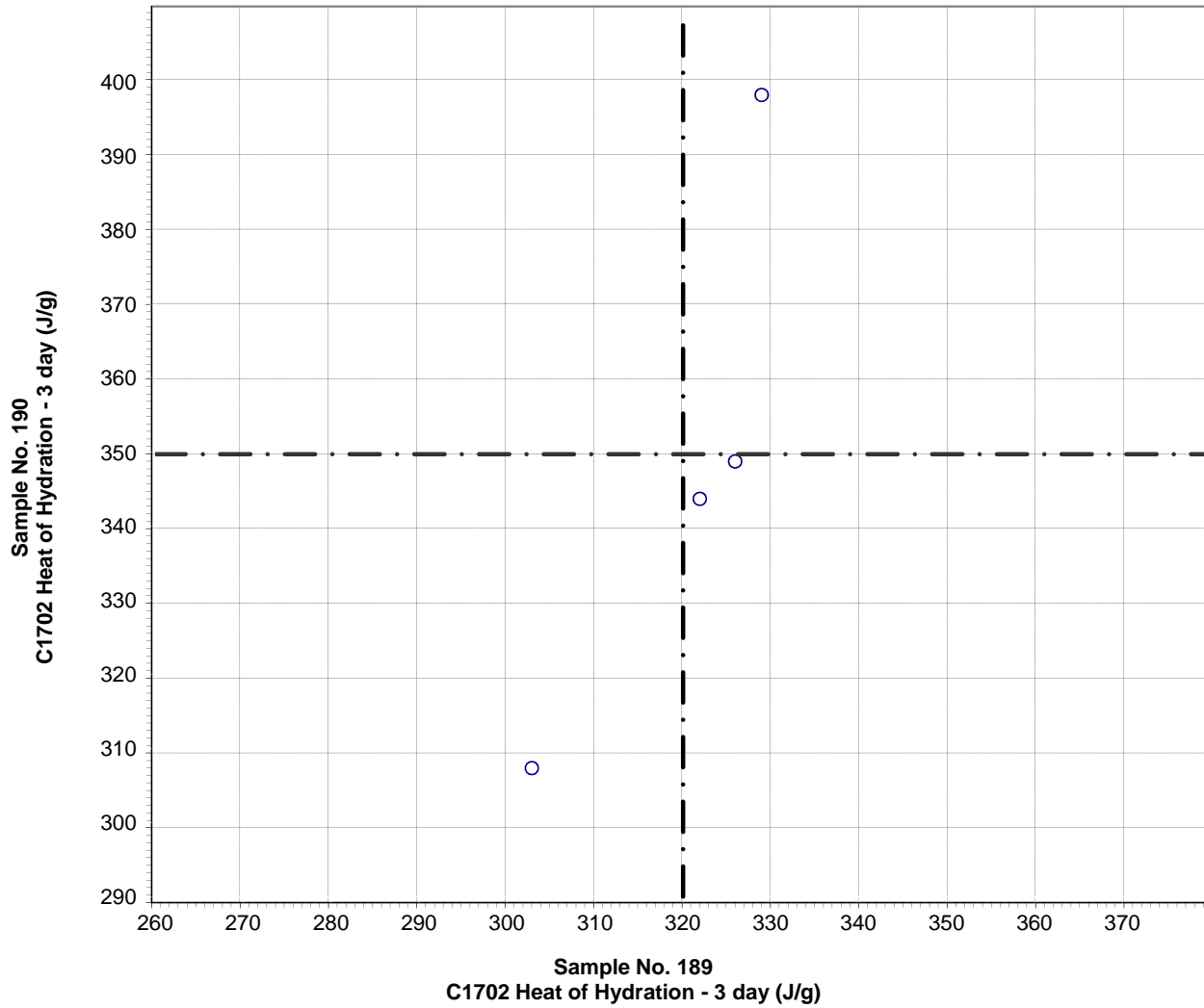


Test No. 300 C186 Heat of Hydration - 28 day 16 Points

Sample No. 189 Ave 90.6 S.D. 4.4 C.V. 4.8  
 Sample No. 190 Ave 90.4 S.D. 4.0 C.V. 4.4

Labs Eliminated: 110

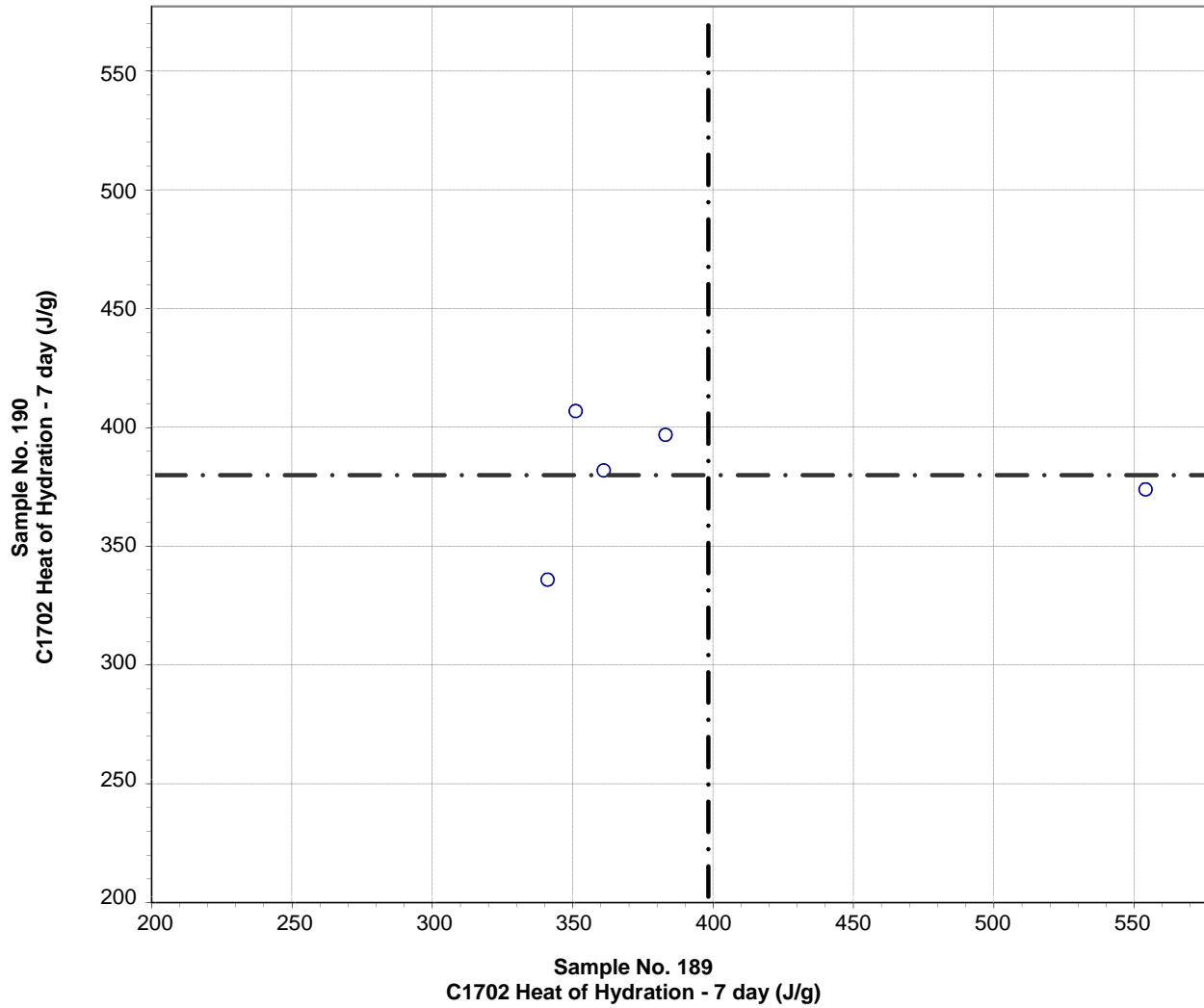
CCRL Proficiency Sample Program  
C1702 Heat of Hydration - 3 day  
PORTLAND CEMENT Samples No. 189 and No. 190



Test No. 500 C1702 Heat of Hydration - 3 day 4 Points

Sample No. 189	Ave 320	S.D. 12	C.V. 3.7
Sample No. 190	Ave 350	S.D. 37	C.V. 11

CCRL Proficiency Sample Program  
C1702 Heat of Hydration - 7 day  
PORTLAND CEMENT Samples No. 189 and No. 190



Test No. 510 C1702 Heat of Hydration - 7 day 5 Points

Sample No. 189	Ave 398	S.D. 89	C.V. 22
Sample No. 190	Ave 379	S.D. 27	C.V. 7.2