

CEMENT AND CONCRETE REFERENCE LABORATORY
PROFICIENCY SAMPLE PROGRAM

Final Report
Portland Cement Proficiency Samples
Number 173 and Number 174

September 2009



CCRL

CEMENT AND CONCRETE
REFERENCE LABORATORY





September 11, 2009

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 173 and No. 174

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in July 2009. Portland Cement Sample No. 173 was an ASTM C150 Type I/TY\type II with limestone additions and No. 174 was an ASTM C150 Type V without limestone additions.

This report consists of a statistical Summary of Results, a set of general Scatter Diagrams, and associated detailed information. The Table of Results with individualized information for participating laboratories can be downloaded at our website located at: <http://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 2010.

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. 173 and No. 174

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 July 2009. This material includes a Table of Results for individual laboratory data, a statistical Summary of Results, and a set of general Scatter Diagrams. Your unique laboratory number is displayed at the top of the individual Table of Results.

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

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

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

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

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

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

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

Please note that individual laboratory ratings were not given for the flow of air content mortar (test no. 190) and compressive strength mortar (test no. 230). Air content flows in the range of 87.5 ± 7.5 are satisfactory, labs with flow values outside this range will be flagged as a "Labs Eliminated" or "Labs Off Diagram" on

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

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 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.

Calculations of tricalcium silicate and dicalcium silicate - C150 requires the use of CO₂ content when calculating these two components for cements containing limestone additions. For Sample No. 173, tricalcium silicate and dicalcium silicate from laboratories not reporting CO₂ content were not included in calculation of statistics and were not assigned ratings.

Summary of Results

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

Scatter Diagrams

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

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

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Chemical Results
 September 11, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 173			Sample No. 174		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Silicon Dioxide	prcnt 235	20.03	0.58	2.91	20.75	0.69	3.34
Silicon Dioxide	prcnt *228	20.01	0.23	1.13	20.75	0.21	1.02
Aluminum Oxide	prcnt 232	4.49	0.12	2.58	3.72	0.13	3.56
Aluminum Oxide	prcnt *228	4.49	0.10	2.21	3.71	0.10	2.79
Ferric Oxide	prcnt 233	2.63	0.080	3.05	3.64	0.108	2.97
Ferric Oxide	prcnt *222	2.62	0.041	1.55	3.62	0.056	1.53
Calcium Oxide	prcnt 232	62.48	0.63	1.00	62.43	0.70	1.13
Calcium Oxide	prcnt *222	62.45	0.36	0.57	62.43	0.38	0.610
Magnesium Oxide	prcnt 232	3.02	0.10	3.42	4.81	0.18	3.72
Magnesium Oxide	prcnt *219	3.03	0.06	2.08	4.83	0.11	2.31
Sulfur Trioxide	prcnt 238	4.07	0.32	7.76	2.64	0.19	7.16
Sulfur Trioxide	prcnt *226	4.10	0.13	3.05	2.64	0.09	3.29
Loss on Ignition	prcnt 239	2.03	0.24	12.0	1.15	0.16	13.6
Loss on Ignition	prcnt *227	2.02	0.11	5.47	1.14	0.08	6.70
Sodium Oxide	prcnt 221	0.302	0.051	17.0	0.187	0.044	23.3
Sodium Oxide	prcnt *213	0.309	0.036	11.5	0.189	0.030	16.1

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* ELIMINATED LABS: Data over three S.D. from the mean

Silicon Dioxide 51 93 1054 2308 3368 3454 3457
 Aluminum Oxide 94 252 3457 3464
 Ferric Oxide 176 289 768 2464 3235 3454 50 52 687 1715 3457
 Calcium Oxide 52 222 2463 107 125 206 684 2621 3297 3457
 Magnesium Oxide 206 1956 2621 3 110 137 169 177 289 690 3135 3368 3422
 Sulfur Trioxide 51 222 690 736 1644 3 407 2464 3422 3428 3457 3464
 Loss on Ignition 51 493 3235 162 1054 1251 2463 2621 3059 3422 3454 3457
 Sodium Oxide 84 98 176 1190 2463 3127 3235 3279

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Chemical Results
 September 11, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 173			Sample No. 174		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Potassium Oxide	prcnt 224	0.441	0.057	12.9	0.420	0.062	14.8
Potassium Oxide	prcnt *211	0.447	0.016	3.52	0.430	0.015	3.42
Titan Dioxide	prcnt 185	0.27	0.039	14.4	0.21	0.029	13.9
Titan Dioxide	prcnt *166	0.27	0.008	2.91	0.21	0.007	3.11
Phosphorus Pent	prcnt 179	0.189	0.057	29.9	0.068	0.024	34.5
Phosphorus Pent	prcnt *157	0.192	0.008	4.18	0.067	0.005	8.18
Zinc Oxide	prcnt 78	0.024	0.0045	18.8	0.013	0.0036	27.0
Zinc Oxide	prcnt * 74	0.024	0.0027	11.1	0.014	0.0028	20.7
Manganic Oxide	prcnt 139	0.061	0.014	23.1	0.073	0.014	19.7
Manganic Oxide	prcnt *129	0.060	0.0037	6.07	0.073	0.0043	5.81
Chloride	prcnt 113	0.025	0.017	67.3	0.006	0.010	158.6
Chloride	prcnt *106	0.023	0.0100	43.3	0.005	0.0026	58.3
Insoluble Residue	prcnt 221	0.37	0.12	31.1	0.29	0.28	95.3
Insoluble Residue	prcnt *209	0.36	0.080	22.5	0.26	0.083	32.7
Free Lime	prcnt 184	1.64	0.38	23.1	1.03	0.24	23.0
Free Lime	prcnt *181	1.65	0.34	20.4	1.04	0.21	20.2

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* ELIMINATED LABS: Data over three S.D. from the mean

Potassium Oxide 28 84 557 736 2463 137 206 975 1025 2491 3454 3457 3464
 Titan Dioxide 691 2363 2621 3127 93 129 206 289 736 3235 3428 27 46 94 491 696 2484 3454 3457
 Phosphorus Pentoxide 98 736 1644 2484 2934 3127 66 139 176 696 1525 2363 2466 2477 3279 8 132
 137 1053 1190 2490 3454
 Zinc Oxide 206 2476 3127 3454
 Manganic Oxide 3 1525 2477 3127 162 205 413 457 3368 3454
 Chloride 98 154 2491 3057 158 2522 3454
 Insoluble Residue 154 2437 2491 3057 51 98 255 1466 1956 3235 3279 3454
 Free Lime 74 2491 3454

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Chemical Results
 September 11, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 173			Sample No. 174		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Carbon Dioxide	prcnt 185	0.64	0.35	54.1	---	---	---
Carbon Dioxide	prcnt *173	0.57	0.21	37.4	---	---	---
Limestone Content	prcnt 185	1.5	0.8	53.6	---	---	---
Limestone Content	prcnt *173	1.2	0.3	28.5	---	---	---
Chromium Oxide	prcnt 82	0.009	0.0040	44.2	0.006	0.0045	69.8
Chromium Oxide	prcnt * 80	0.009	0.0038	41.9	0.006	0.0038	63.0
⁽¹⁾ Tricalcium Silicate	prcnt 175	53.7	3.3	6.12	58.2	2.7	4.59
⁽¹⁾ Tricalcium Silicate	prcnt *169	53.8	2.6	4.78	58.4	2.3	3.98
⁽¹⁾ Dicalcium Silicate	prcnt 175	16.8	2.9	17.4	15.6	2.5	15.9
⁽¹⁾ Dicalcium Silicate	prcnt *171	16.8	2.5	14.7	15.6	2.2	14.2
⁽¹⁾ Tricalc Aluminate	prcnt 202	7.4	0.49	6.64	3.7	0.51	13.80
⁽¹⁾ Tricalc Aluminate	prcnt *198	7.4	0.26	3.46	3.7	0.33	8.90
⁽¹⁾ Tetracalc Alumino	prcnt 201	8.1	1.08	13.40	11.0	0.47	4.24
⁽¹⁾ Tetracalc Alumino	prcnt *188	8.0	0.12	1.51	11.0	0.16	1.48

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* ELIMINATED LABS: Data over three S.D. from the mean

Carbon Dioxide 78 98 130 162 252 289 416 975 1054 1251 1799 2296 2477
 Limestone Content 78 130 162 252 289 416 1054 1251 1799 2296 2477 3454
 Chromium Oxide 1525 3428
 Tricalcium Silicate 270 736 1054 1715 1940 2463
 Dicalcium Silicate 270 289 1054 2463
 Tricalcium Aluminate 10 142 2464 3464
 Tetracalcium Aluminoferrite 10 142 289 493 50 137 176 206 687 1715 2464 3235 3454

NOTES:

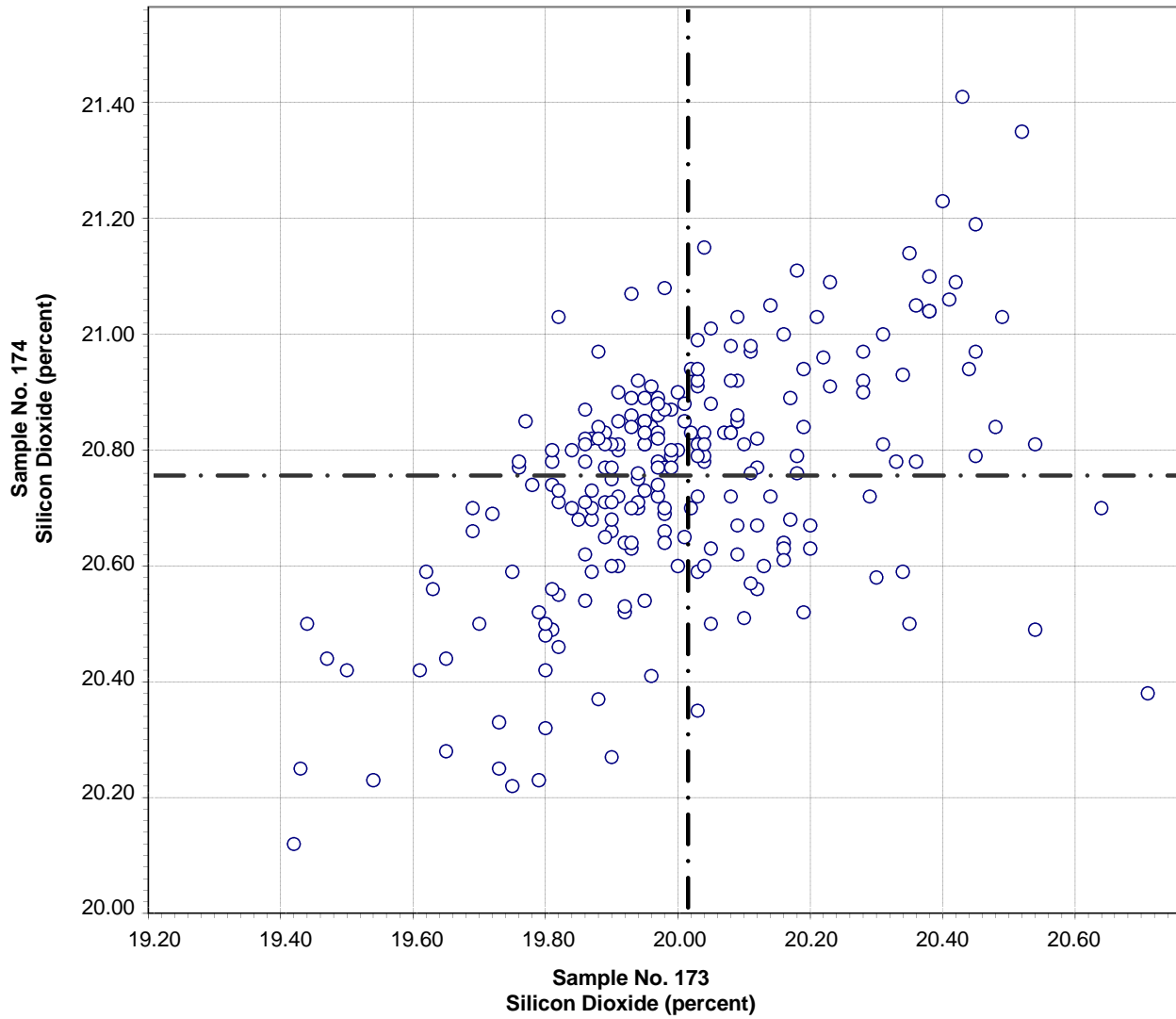
(1) Tricalcium silicate and Dicalcium silicate - ASTM C150 requires that cements containing limestone additions use CO₂ in the calculation of these two phases. Sample 173 contains limestone additions, therefore, test results of 23 laboratories not determining CO₂ were not used in calculating the statistics. See the following list of excluded labs.

Test Results Not Used in Calculating Statistics for
Tricalcium Silicate and Dicalcium Silicate

List of laboratories reporting test results for tricalcium silicate and dicalcium silicate but did not report values for CO₂.

8	696
10	1525
44	2021
66	2363
86	2435
95	2483
110	2484
181	3279
206	3297
497	3415
542	3464
557	

**CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 173 and No. 174**



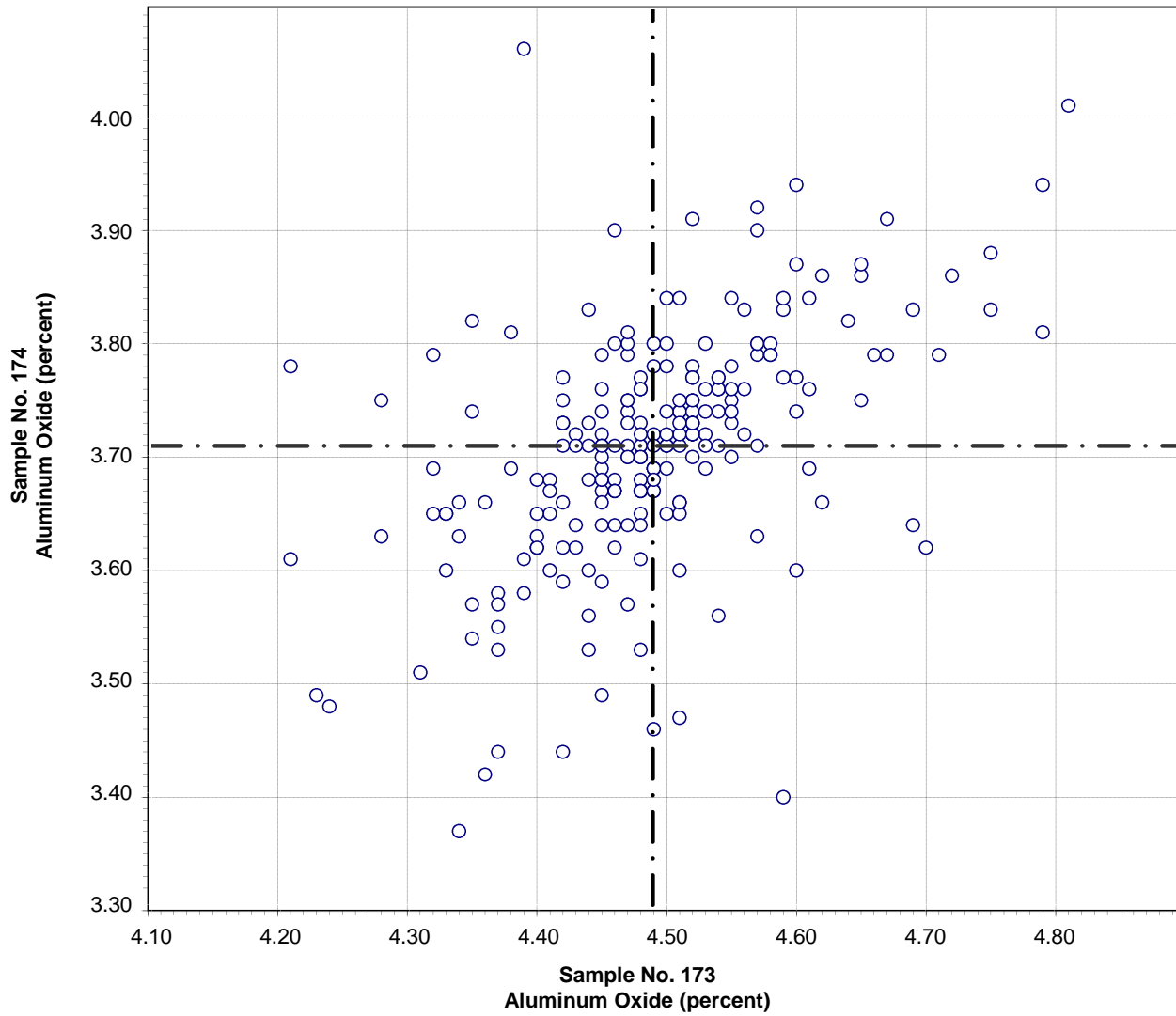
Test No. 10 Silicon Dioxide 227 Points

Sample No. 173	Ave 20.01	S.D. 0.23	C.V. 1.1
Sample No. 174	Ave 20.75	S.D. 0.21	C.V. 1.0

Labs eliminated: 51, 93, 1054, 2308, 3368, 3454, 3457

Labs off Diagram: 222

**CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**

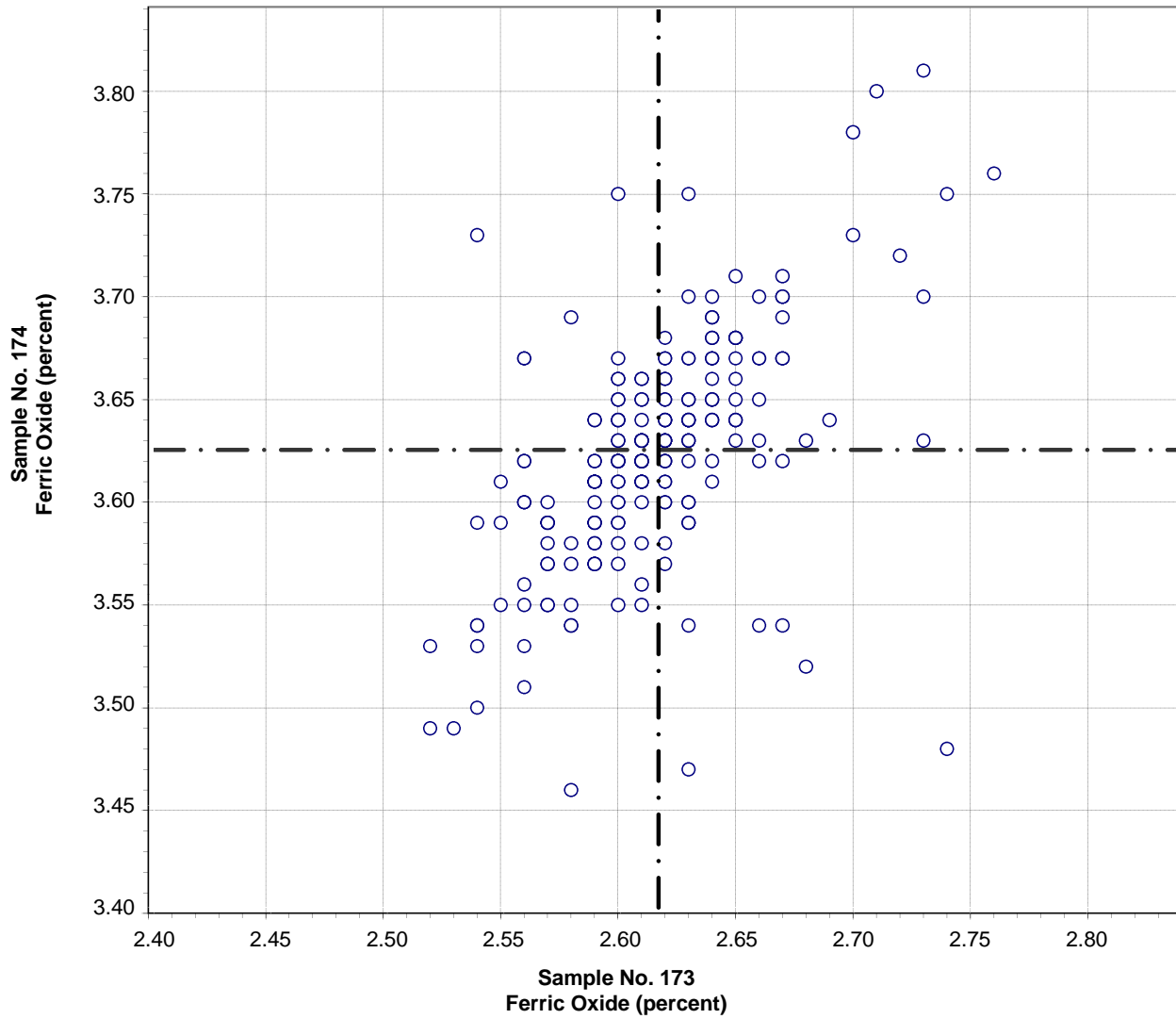


Test No. 21 Aluminum Oxide 228 Points

Sample No. 173	Ave 4.49	S.D. 0.10	C.V. 2.2
Sample No. 174	Ave 3.71	S.D. 0.10	C.V. 2.8

Labs eliminated: 94, 252, 3457, 3464

**CCRL Proficiency Sample Program
 Ferric Oxide
 PORTLAND CEMENT Samples No. 173 and No. 174**



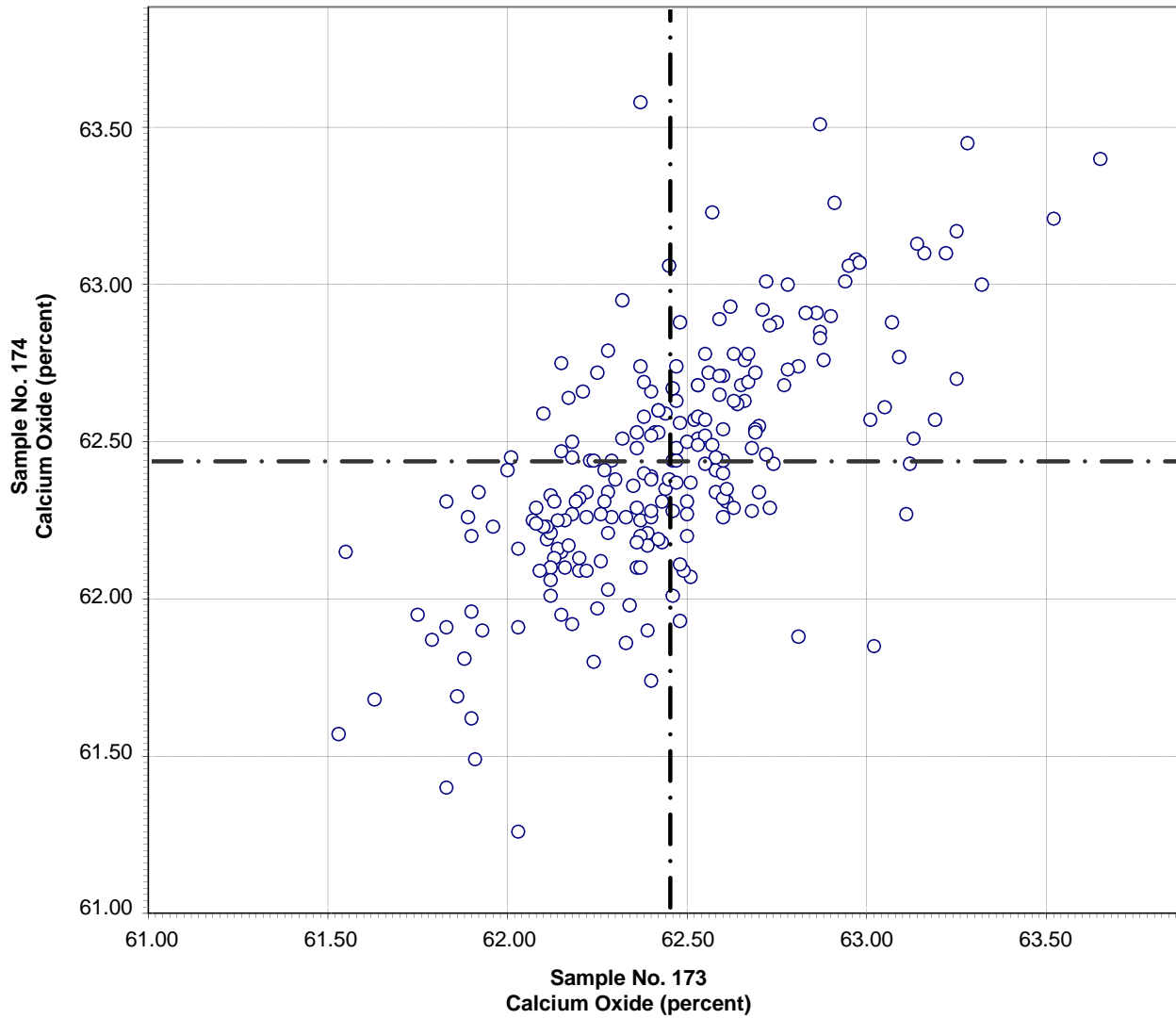
Test No. 30 Ferric Oxide 222 Points

Sample No. 173 Ave 2.62 S.D. 0.04 C.V. 1.6

Sample No. 174 Ave 3.62 S.D. 0.06 C.V. 1.5

Labs eliminated: 176, 289, 768, 2464, 3235, 3454, 50, 52, 687, 1715, 3457

**CCRL Proficiency Sample Program
Calcium Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**

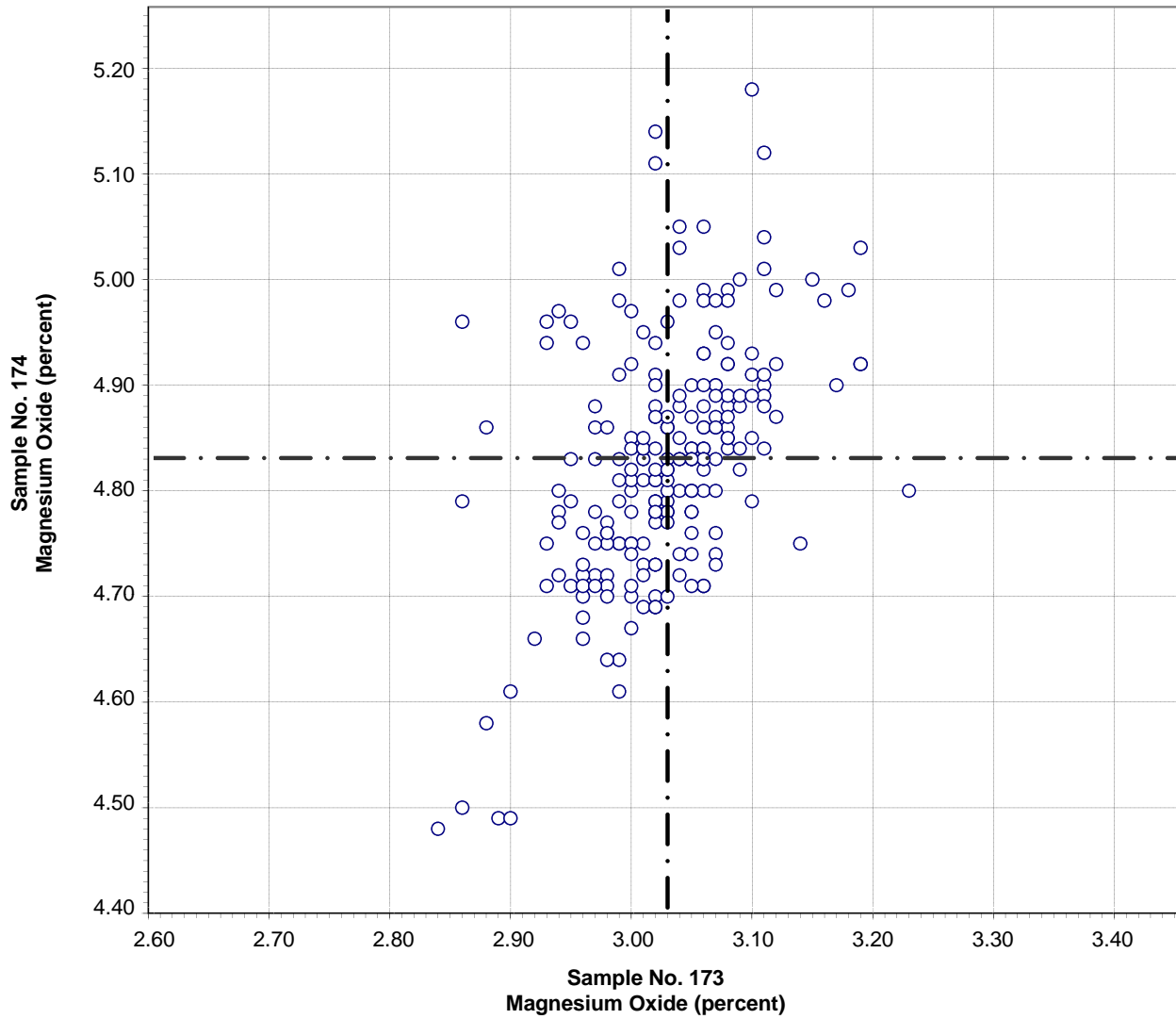


Test No. 40 Calcium Oxide 222 Points

Sample No. 173	Ave 62.45	S.D. 0.36	C.V. 0.6
Sample No. 174	Ave 62.43	S.D. 0.38	C.V. 0.6

Labs eliminated: 52, 222, 2463, 107, 125, 206, 684, 2621, 3297, 3457

**CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**

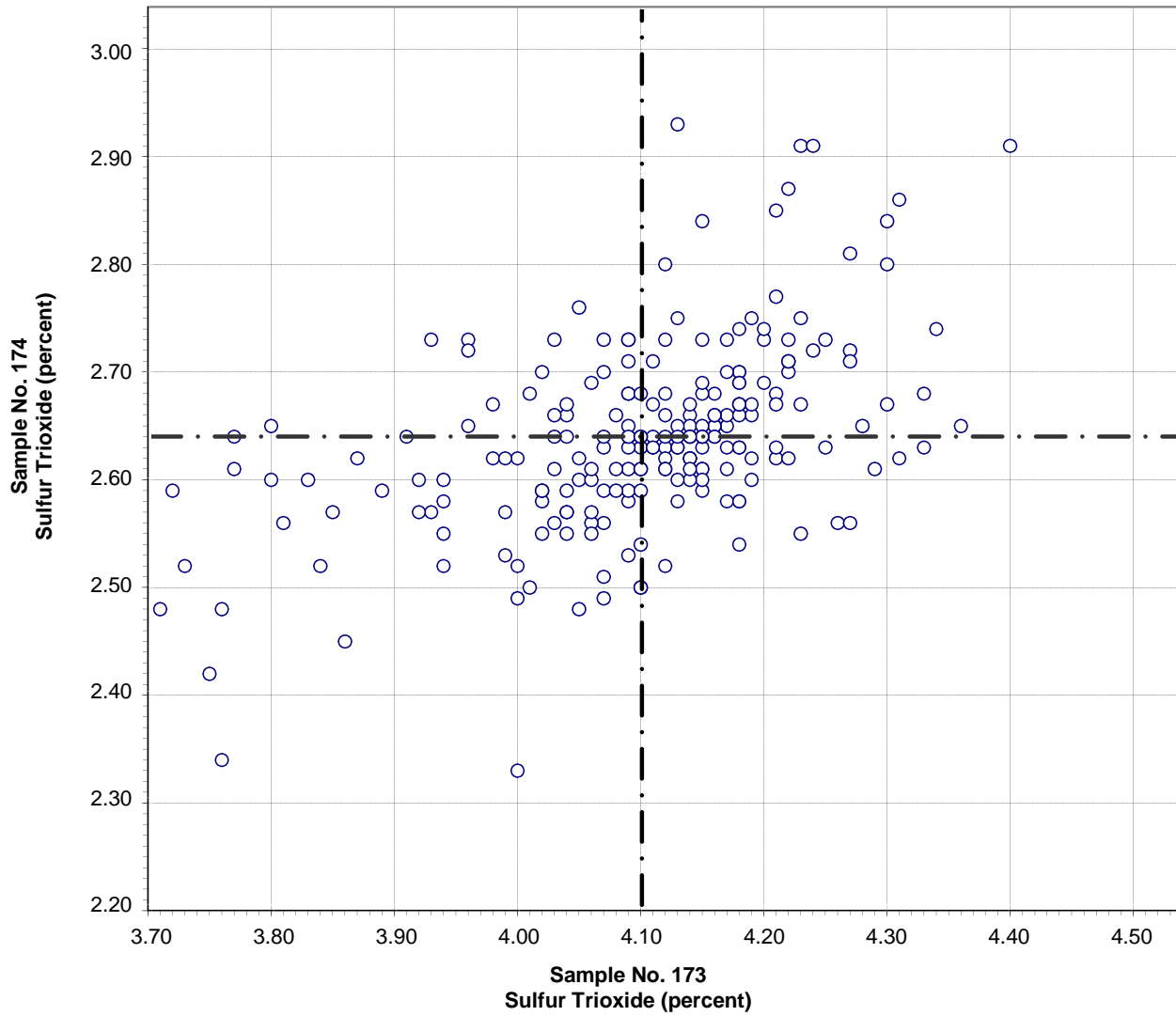


Test No. 50 Magnesium Oxide 219 Points

Sample No. 173 Ave 3.03 S.D. 0.06 C.V. 2.1
Sample No. 174 Ave 4.83 S.D. 0.11 C.V. 2.3

Labs eliminated: 206, 1956, 2621, 3, 110, 137, 169, 177, 289, 690, 3135, 3368, 3422

CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 173 and No. 174

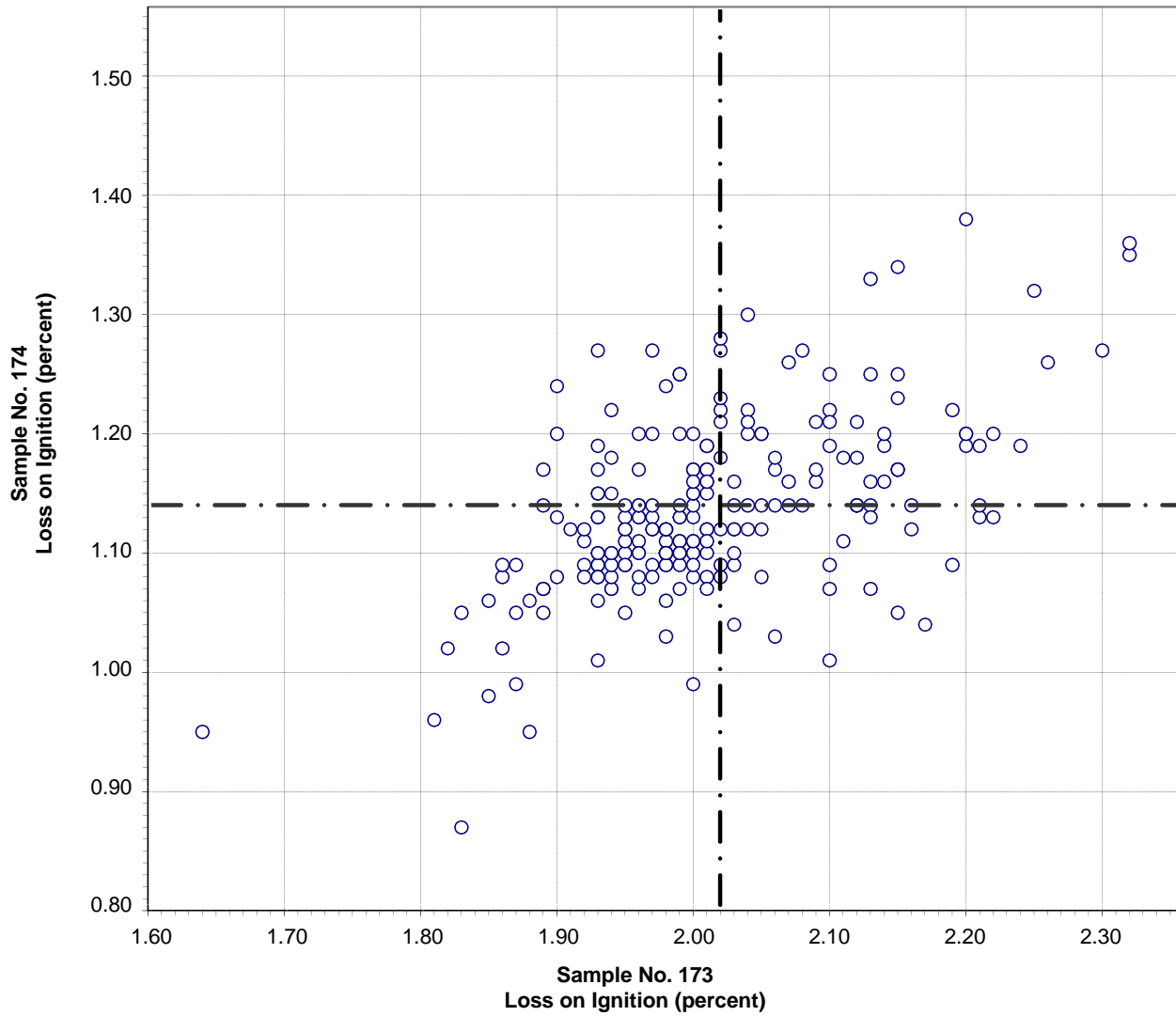


Test No. 60 Sulfur Trioxide 226 Points

Sample No. 173	Ave 4.10	S.D. 0.13	C.V. 3.1
Sample No. 174	Ave 2.64	S.D. 0.09	C.V. 3.3

Labs eliminated: 51, 222, 690, 736, 1644, 3, 407, 2464, 3422, 3428, 3457, 3464

**CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 173 and No. 174**



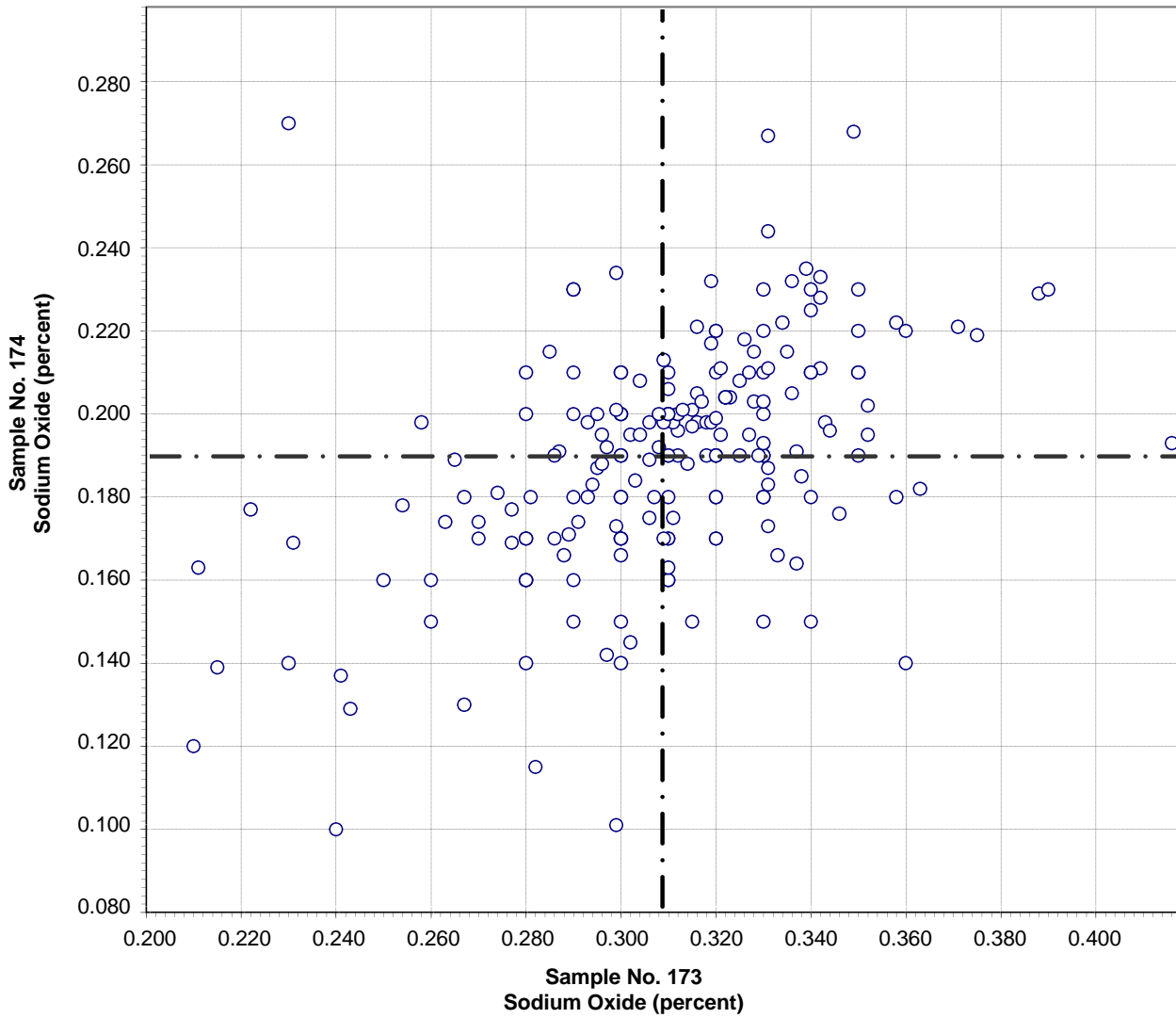
Test No. 70 Loss on Ignition 224 Points

Sample No. 173 Ave 2.02 S.D. 0.11 C.V. 5.5
 Sample No. 174 Ave 1.14 S.D. 0.08 C.V. 6.7

Labs eliminated: 51, 493, 3235, 162, 1054, 1251, 2463, 2621, 3059, 3422, 3454, 3457

Labs off Diagram: 1053, 1956, 2308

**CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**



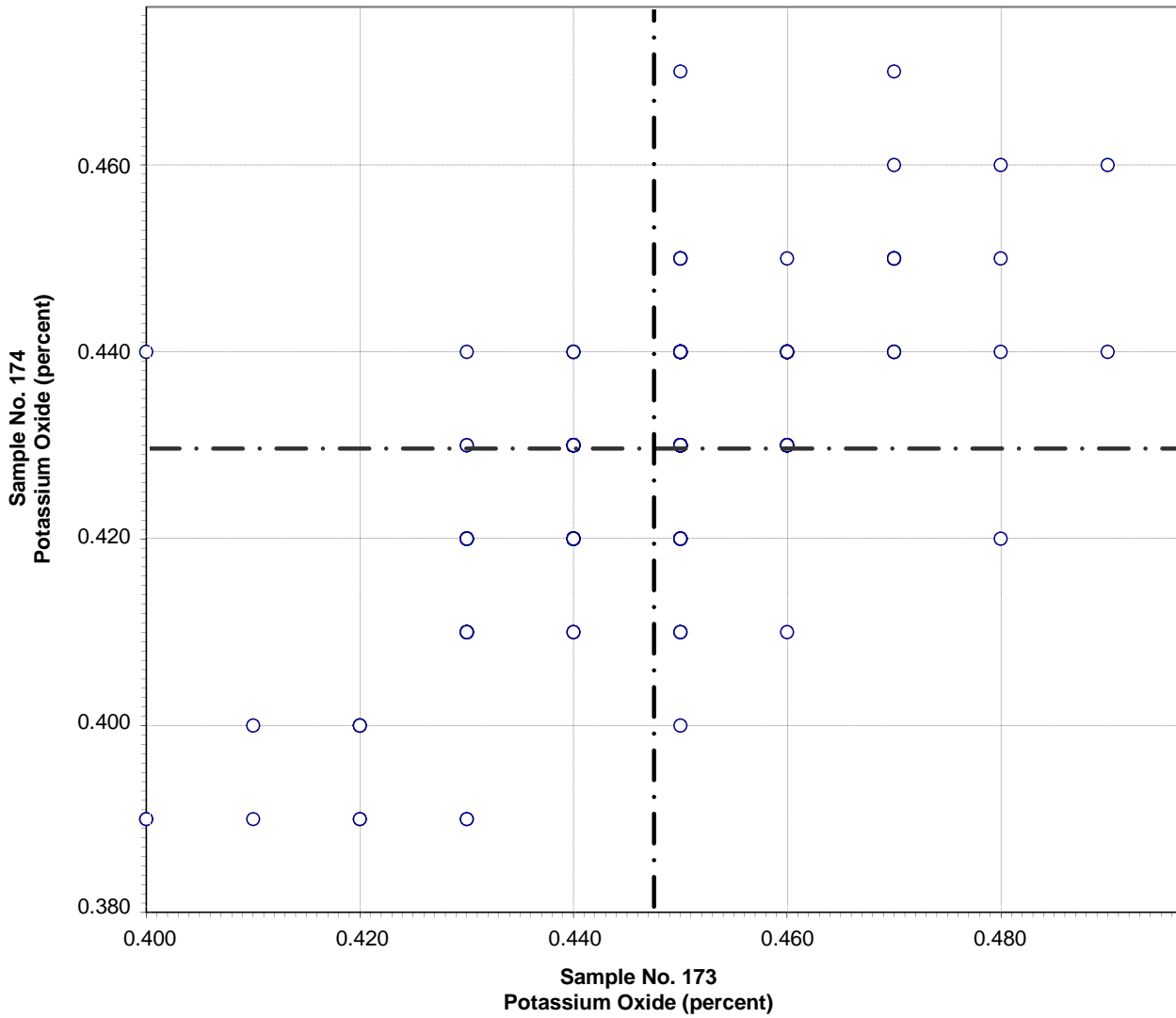
Test No. 90 Sodium Oxide 208 Points

Sample No. 173 Ave 0.309 S.D. 0.036 C.V. 11.5
 Sample No. 174 Ave 0.189 S.D. 0.030 C.V. 16.1

Labs eliminated: 84, 98, 176, 1190, 2463, 3127, 3235, 3279

Labs off Diagram: 152, 2296, 2464, 2466, 3057

**CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**



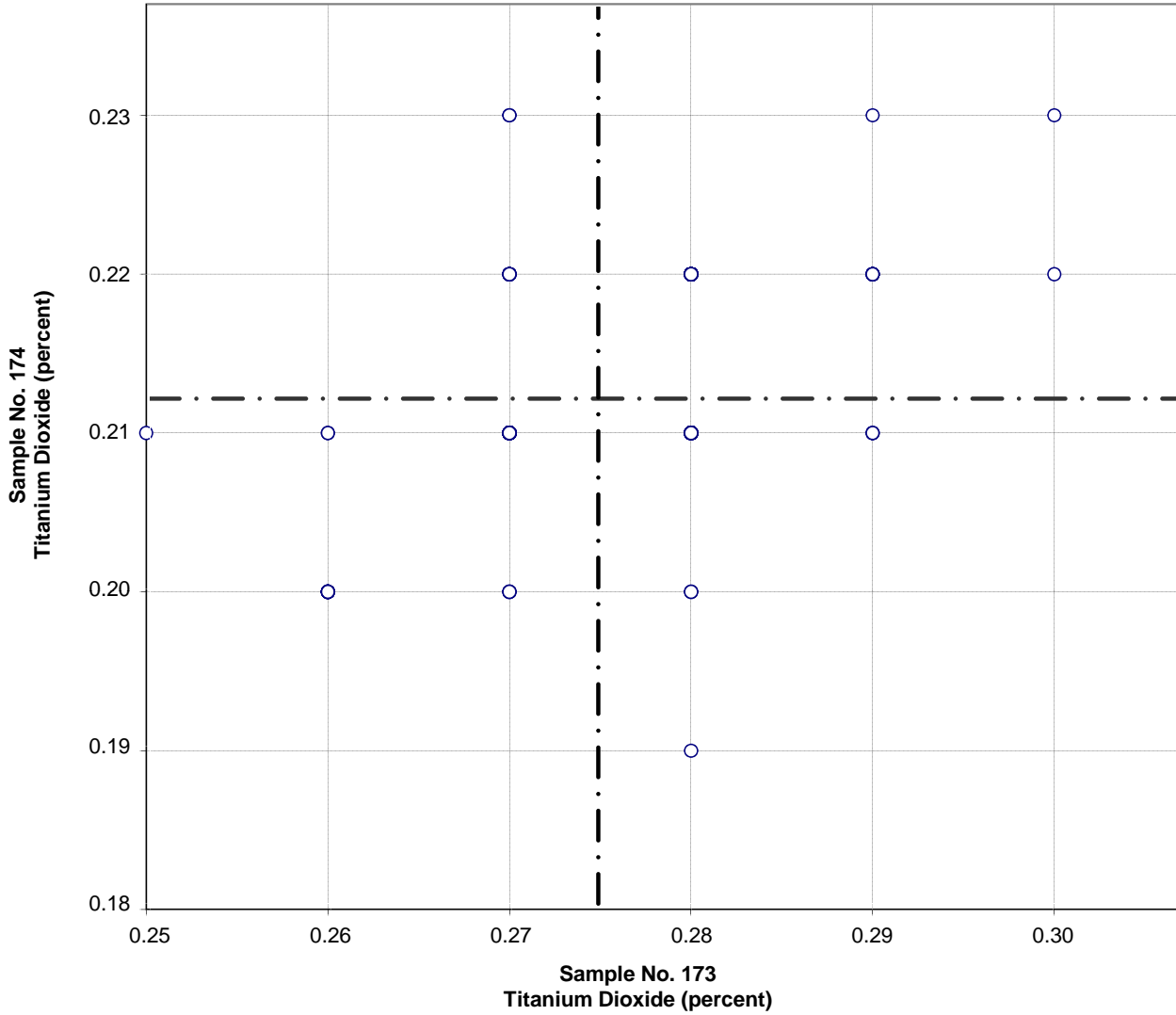
Test No. 100 Potassium Oxide 208 Points

Sample No. 173 Ave 0.447 S.D. 0.016 C.V. 3.5
 Sample No. 174 Ave 0.430 S.D. 0.015 C.V. 3.4

Labs eliminated: 28, 84, 557, 736, 2463, 137, 206, 975, 1025, 2491, 3454, 3457, 3464

Labs off Diagram: 36, 696, 1523

**CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 173 and No. 174**

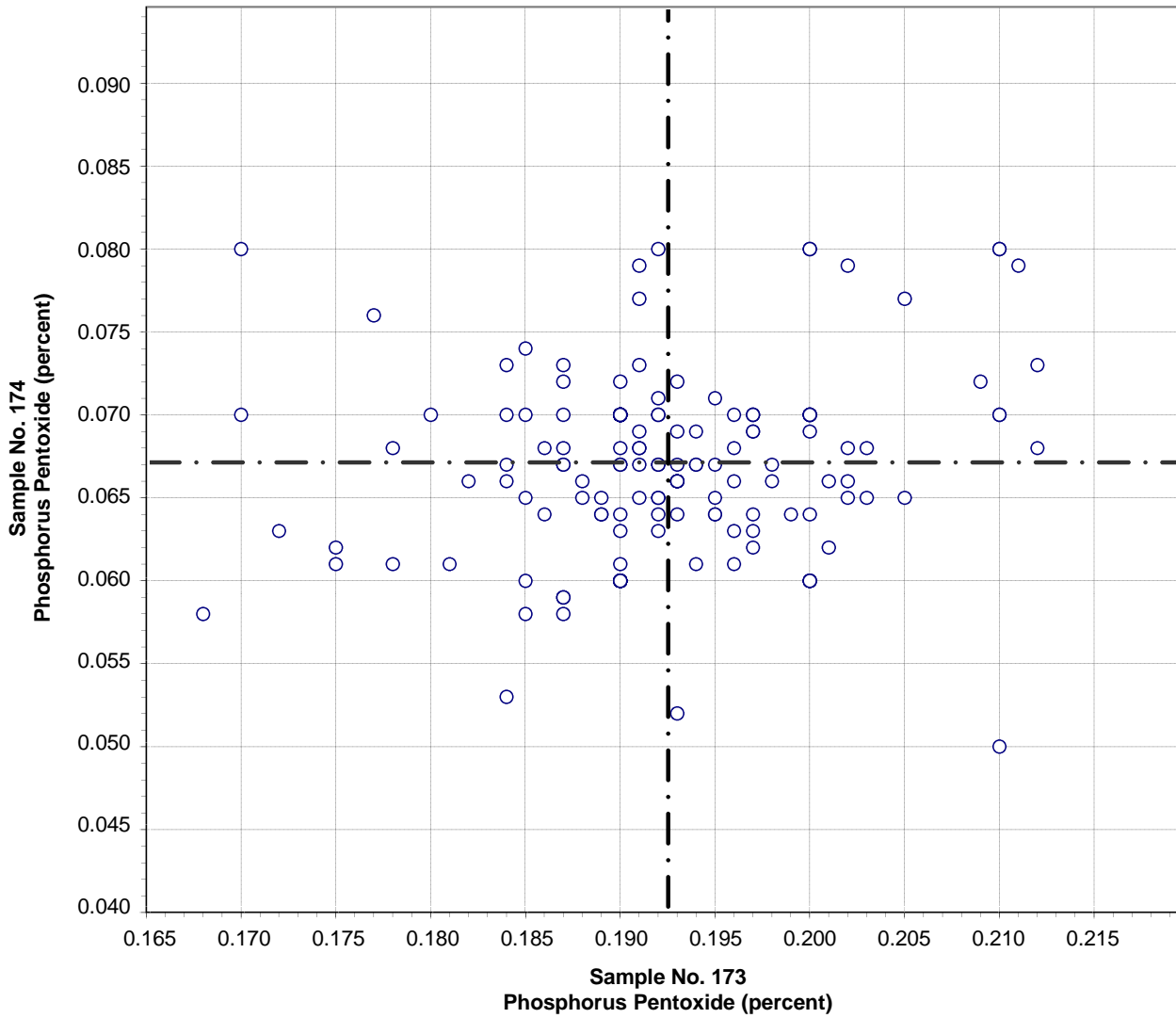


Test No. 103 Titanium Dioxide 166 Points

Sample No. 173 Ave 0.27 S.D. 0.008 C.V. 2.9
 Sample No. 174 Ave 0.21 S.D. 0.007 C.V. 3.1

Labs eliminated: 691, 2363, 2621, 3127, 93, 129, 206, 289, 736, 3235, 3428, 27, 46, 94, 491, 696, 2484, 3454, 3457

**CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 173 and No. 174**

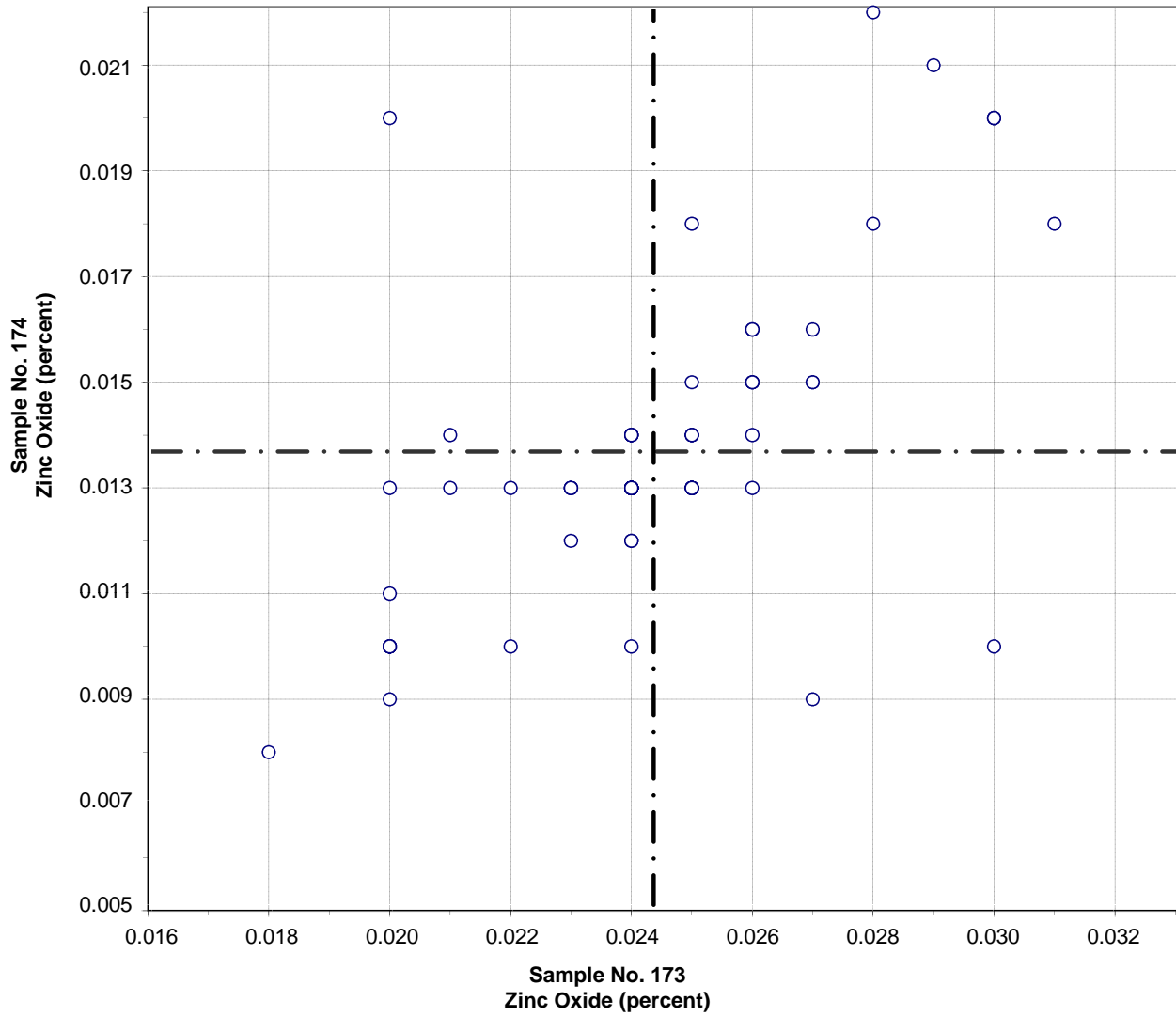


Test No. 102 Phosphorus Pentoxide 157 Points

Sample No. 173 Ave 0.192 S.D. 0.008 C.V. 4.2
 Sample No. 174 Ave 0.067 S.D. 0.005 C.V. 8.2

Labs eliminated: 98, 736, 1644, 2484, 2934, 3127, 66, 139, 176, 696, 1525, 2363,
 2466, 2477, 3279, 8, 132, 137, 1053, 1190, 2490, 3454

**CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**

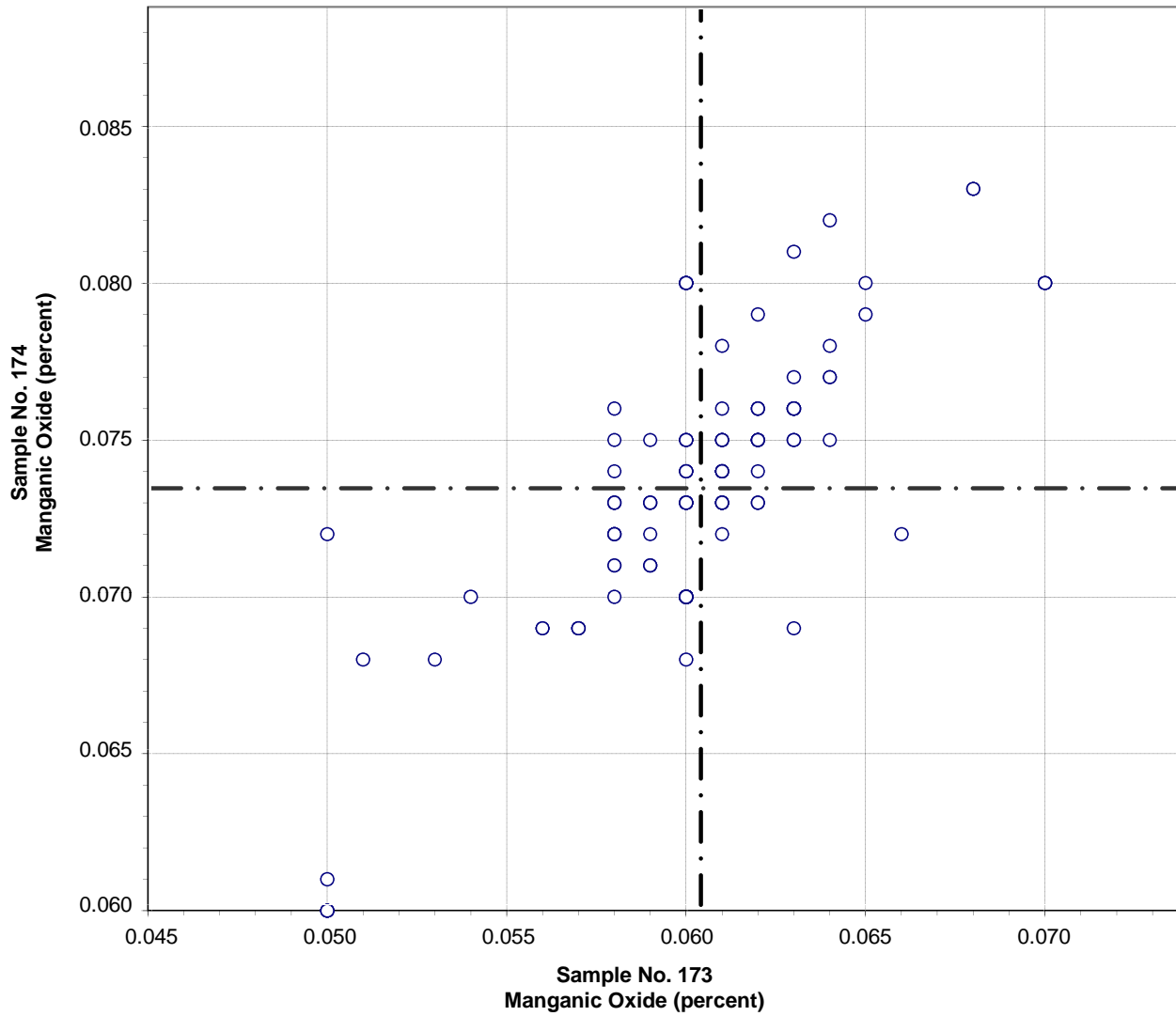


Test No. 99 Zinc Oxide 74 Points

Sample No. 173 Ave 0.024 S.D. 0.003 C.V. 11.1
 Sample No. 174 Ave 0.014 S.D. 0.003 C.V. 20.7

Labs eliminated: 206, 2476, 3127, 3454

CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 173 and No. 174



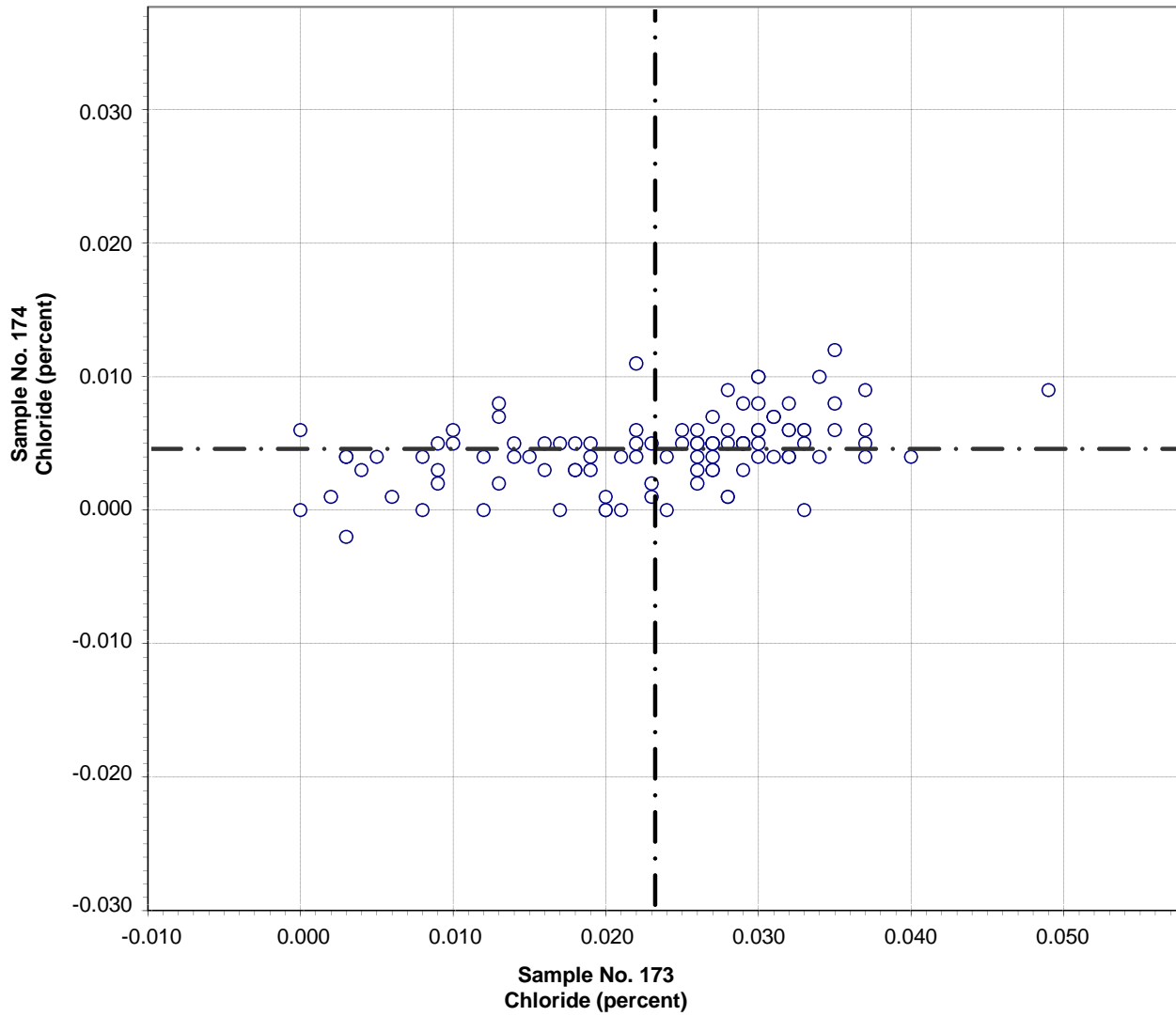
Test No. 101 Manganic Oxide 128 Points

Sample No. 173 Ave 0.060 S.D. 0.004 C.V. 6.1
 Sample No. 174 Ave 0.073 S.D. 0.004 C.V. 5.8

Labs eliminated: 3, 1525, 2477, 3127, 162, 205, 413, 457, 3368, 3454

Labs off Diagram: 3457

**CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 173 and No. 174**



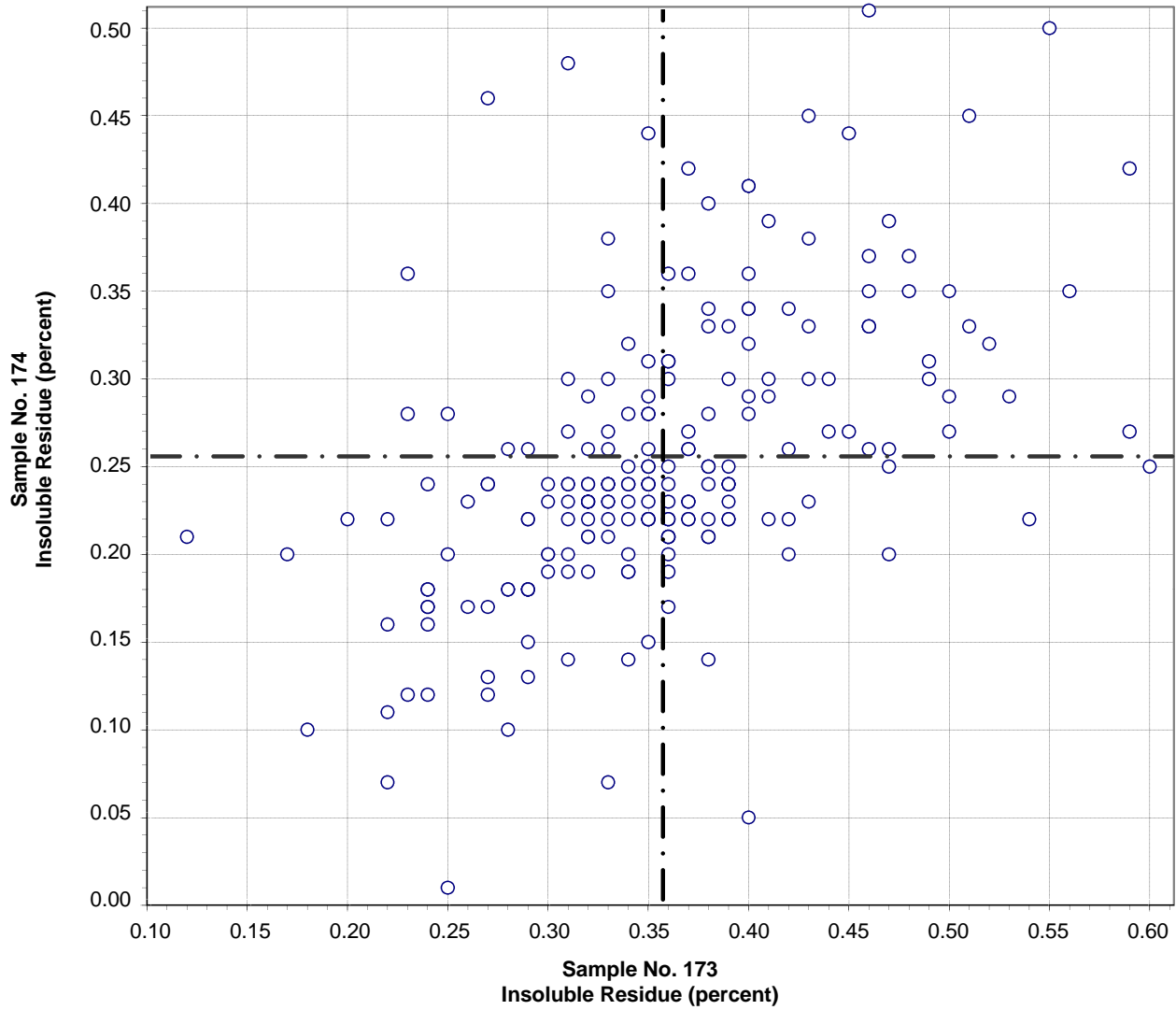
Test No. 104 Chloride 106 Points

Sample No. 173 Ave 0.023 S.D. 0.010 C.V. 43.3

Sample No. 174 Ave 0.005 S.D. 0.003 C.V. 58.3

Labs eliminated: 98, 154, 2491, 3057, 158, 2522, 3454

**CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 173 and No. 174**



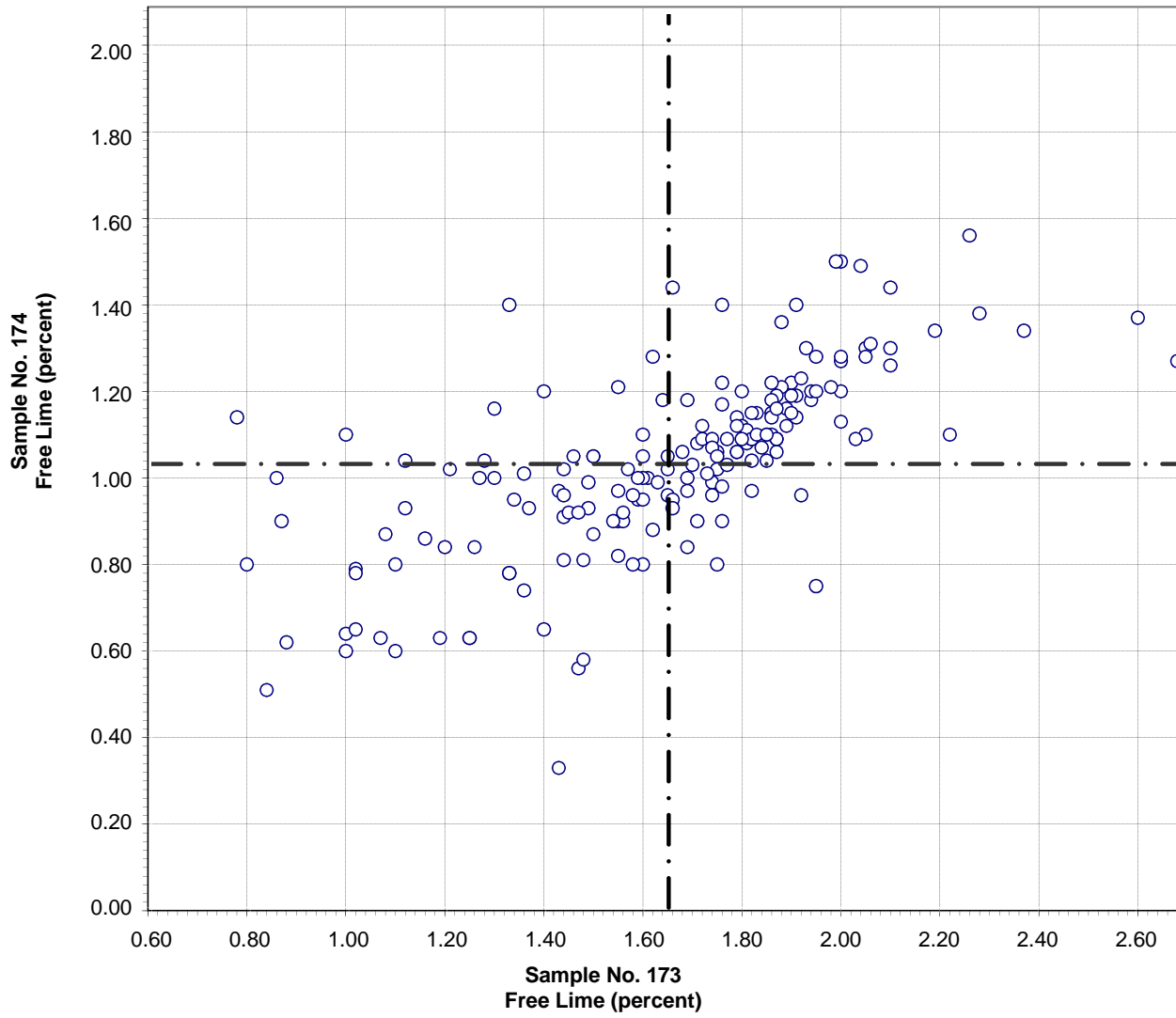
Test No. 80 Insoluble Residue 208 Points

Sample No. 173 Ave 0.36 S.D. 0.08 C.V. 22.5
 Sample No. 174 Ave 0.26 S.D. 0.08 C.V. 32.7

Labs eliminated: 154, 2437, 2491, 3057, 51, 98, 255, 1466, 1956, 3235, 3279, 3454

Labs off Diagram: 78

CCRL Proficiency Sample Program
Free Lime
PORTLAND CEMENT Samples No. 173 and No. 174



Test No. 41 Free Lime 181 Points

Sample No. 173	Ave 1.65	S.D. 0.34	C.V. 20.4
Sample No. 174	Ave 1.04	S.D. 0.21	C.V. 20.2

Labs eliminated: 74, 2491, 3454

CCRL Proficiency Sample Program
Carbon Dioxide
PORTLAND CEMENT Samples No. 173 & No. 174

No Diagram Printed for this Component

Sample No. 174 did not
Contain Limestone Additions.
Test Results Were Analyzed for
Sample No. 173 Only.

Test No. 97

Carbon Dioxide

173 labs

Sample No. 173

AVE 0.57

S.D. 0.21

C.V. 37.4

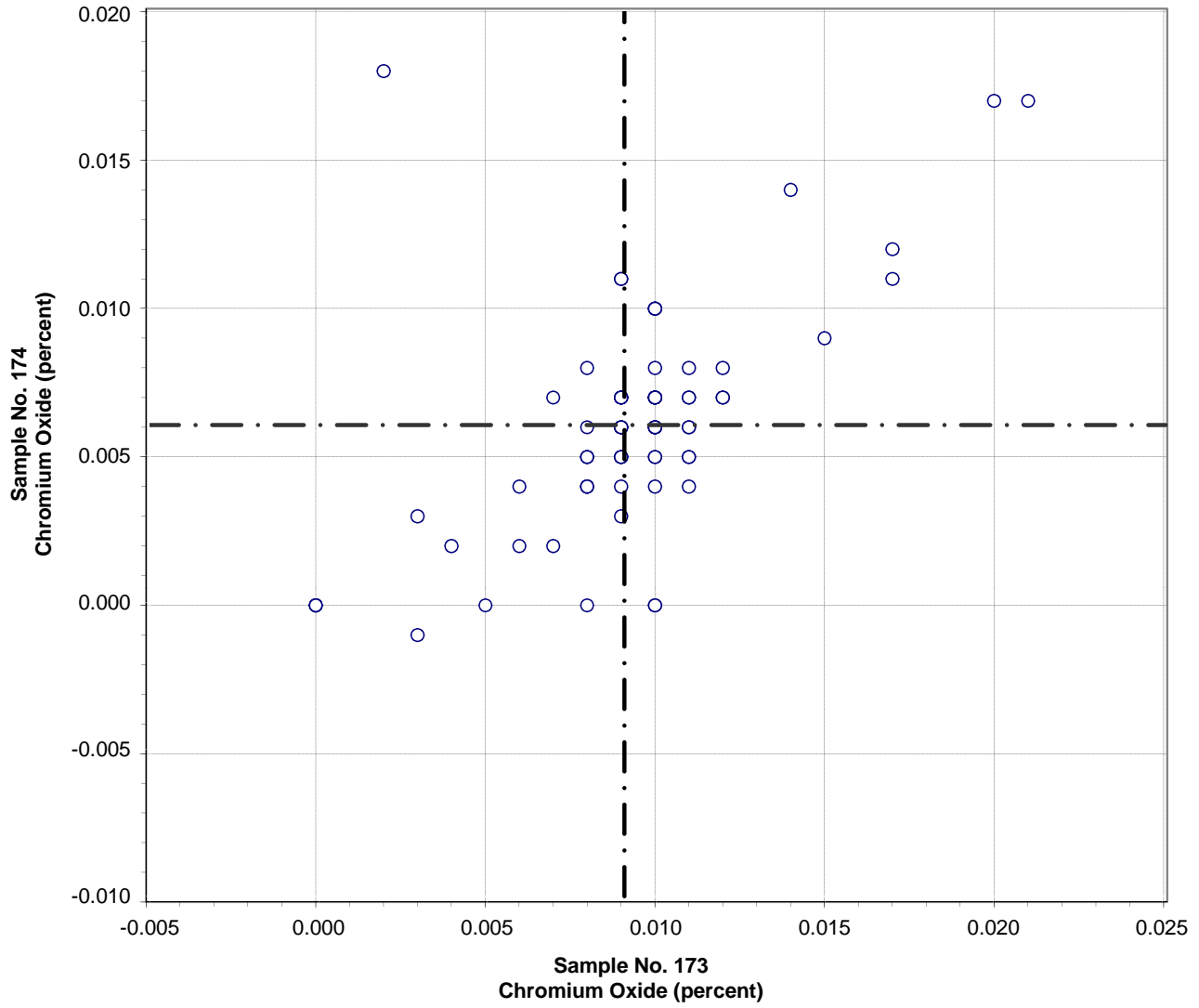
CCRL Proficiency Sample Program
Limestone Content
PORTLAND CEMENT Samples No. 173 & No. 174

No Diagram Printed for this Component

Sample No. 174 did not
Contain Limestone Additions.
Test Results Were Analyzed for
Sample No. 173 Only.

Test No. 98	Limestone Content	173 labs
Sample No. 173	AVE 1.2	S.D. 0.3
		C.V. 28.5

**CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 173 and No. 174**

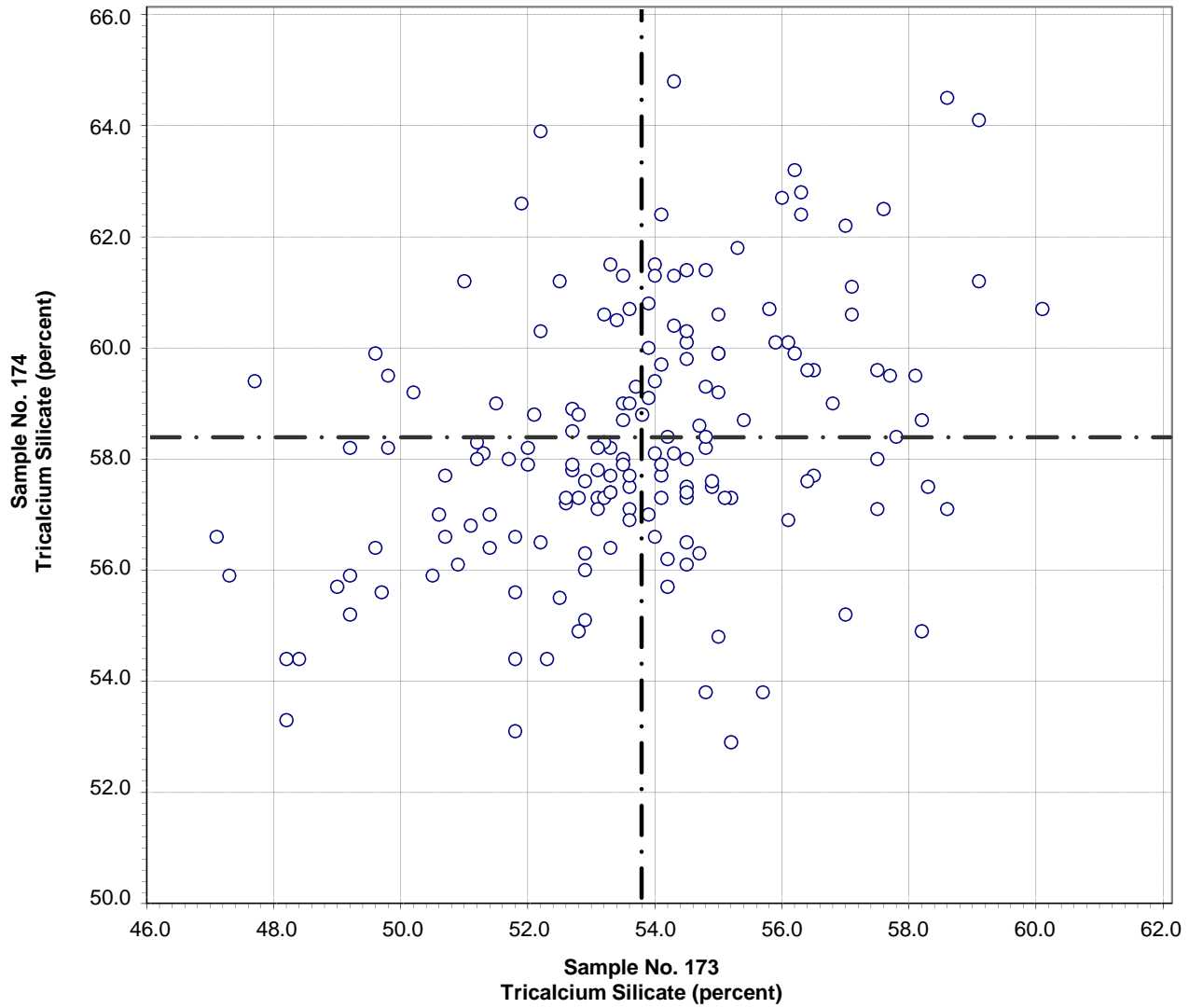


Test No. 105 Chromium Oxide 80 Points

Sample No. 173	Ave 0.009	S.D. 0.004	C.V. 41.9
Sample No. 174	Ave 0.006	S.D. 0.004	C.V. 63.1

Labs eliminated: 1525, 3428

**CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 173 and No. 174**



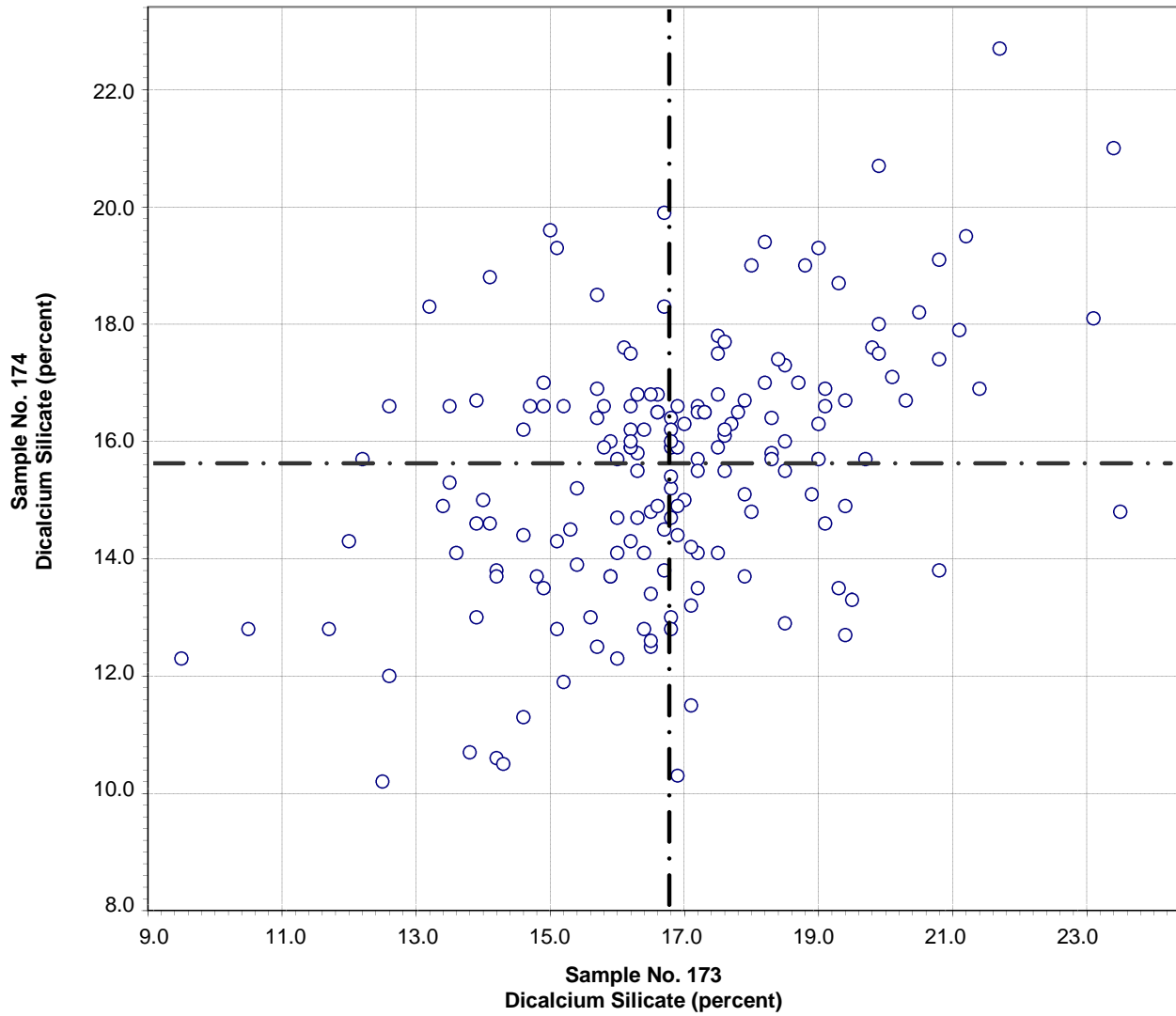
Test No. 106 Tricalcium Silicate 168 Points

Sample No. 173 Ave 53.8 S.D. 2.6 C.V. 4.8
 Sample No. 174 Ave 58.4 S.D. 2.3 C.V. 4.0

Labs eliminated: 270, 736, 1054, 1715, 1940, 2463

Labs off Diagram: 176

**CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 107 Dicalcium Silicate 169 Points

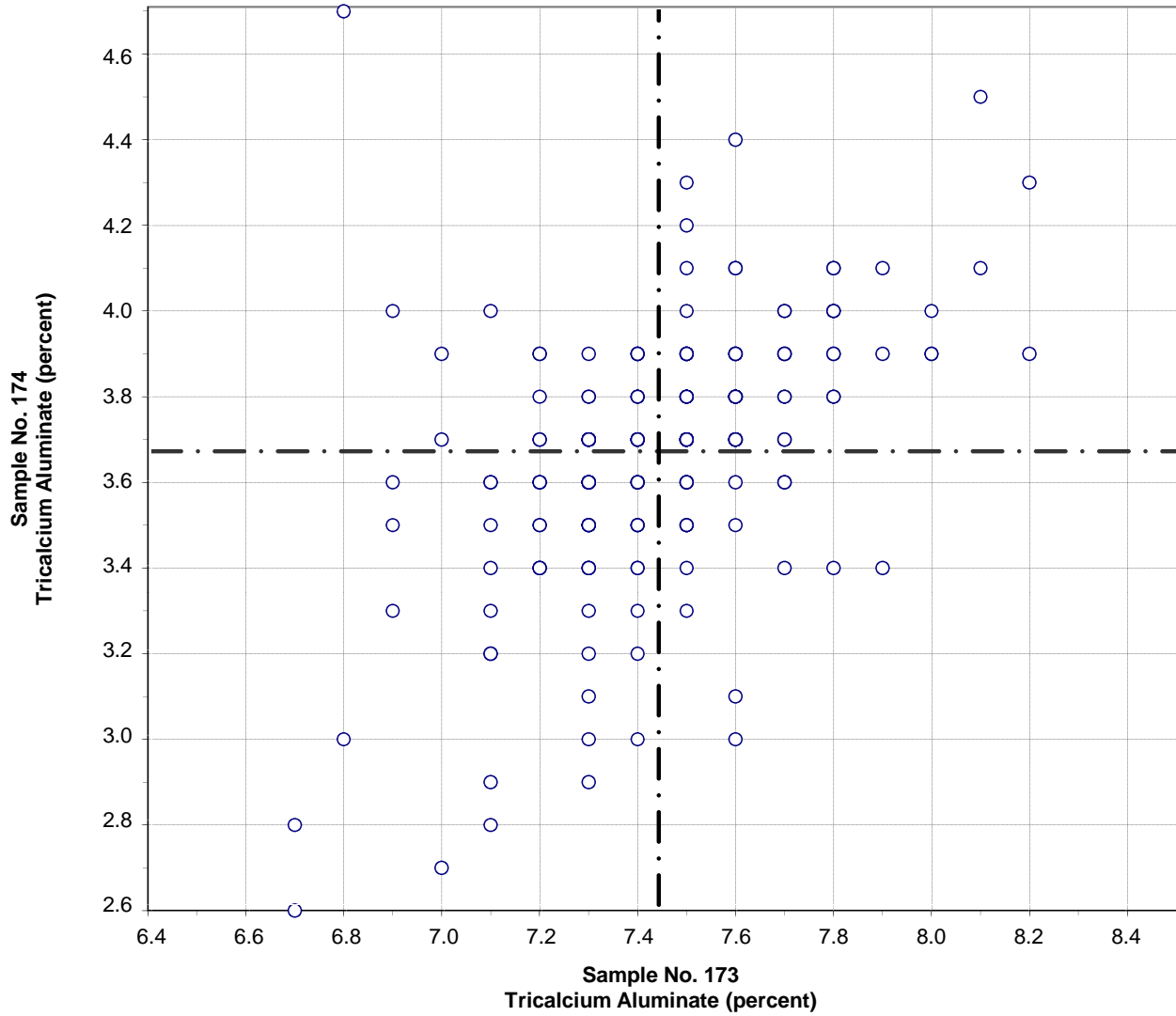
Sample No. 173 Ave 16.8 S.D. 2.5 C.V. 14.7

Sample No. 174 Ave 15.6 S.D. 2.2 C.V. 14.2

Labs eliminated: 270, 289, 1054, 2463

Labs off Diagram: 736, 1940

**CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 173 and No. 174**



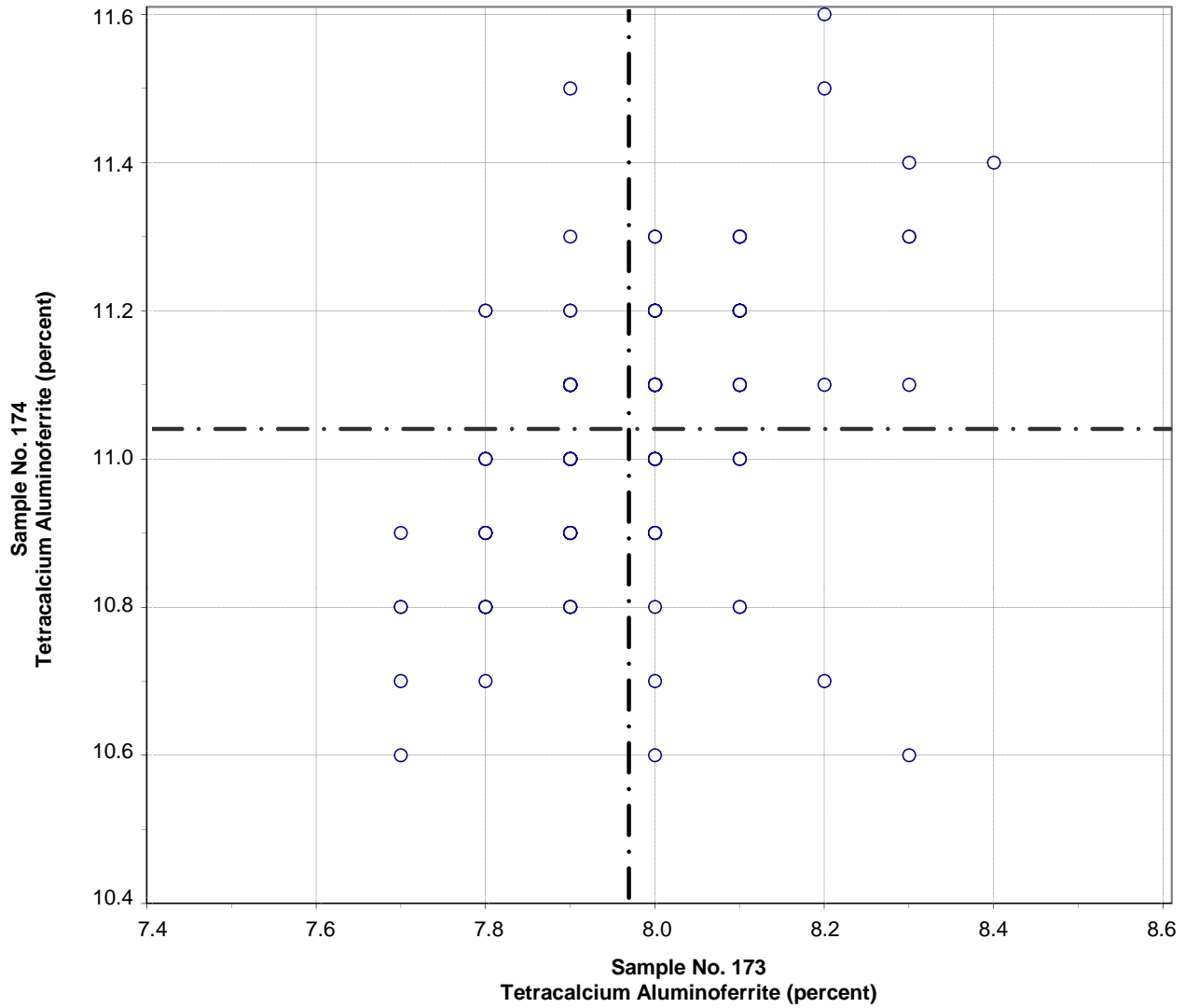
Test No. 108 Tricalcium Aluminate 196 Points

Sample No. 173 Ave 7.4 S.D. 0.3 C.V. 3.5
 Sample No. 174 Ave 3.7 S.D. 0.3 C.V. 8.9

Labs eliminated: 10, 142, 2464, 3464

Labs off Diagram: 252, 1956

**CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 109 Tetracalcium Aluminoferrite 188 Points

Sample No. 173 Ave 8.0 S.D. 0.1 C.V. 1.5
 Sample No. 174 Ave 11.0 S.D. 0.2 C.V. 1.5

Labs eliminated: 10, 142, 289, 493, 50, 137, 176, 206, 687, 1715, 2464, 3235, 3454

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Physical Results
 September 11, 2009

SUMMARY OF RESULTS

Test		#Labs	Sample No. 173			Sample No. 174		
			Average	S.D.	C.V.	Average	S.D.	C.V.
N.C. Water	prcnt	247	25.2	1.4	5.69	25.4	1.5	5.76
N.C. Water	prcnt	* 242	25.3	0.4	1.65	25.4	0.4	1.76
Vicat TS Initial	min	243	151	15.9	10.5	134	22.3	16.6
Vicat TS Initial	min	* 236	150	14.1	9.4	132	17.7	13.4
Vicat TS Final	min	236	251	33.2	13.2	242	33.5	13.8
Vicat TS Final	min	* 233	252	30.4	12.0	242	33.3	13.8
Gillmore TS Initial	min	158	183	26.8	14.6	170	27.8	16.3
Gillmore TS Initial	min	* 155	184	23.6	12.8	170	23.8	14.0
Gillmore TS Final	min	157	276	38.4	13.9	273	38.7	14.2
Gillmore TS Final	min	* 155	276	36.4	13.2	273	36.1	13.2
False Set	prcnt	198	67	11.0	16.4	81	8.8	10.8
Autoclave Expan	prcnt	227	0.10	0.094	92.2	0.09	0.050	53.1
Autoclave Expan	prcnt	* 216	0.10	0.035	35.4	0.10	0.034	34.2

CONTINUED ON NEXT PAGE

* ELIMINATED LABS: Data over three S.D. from the mean

Normal Consistency	1 41 169 684 698
Vicat TS Initial	51 162 1483 1942 2522 3144 3422
Vicat TS Final	1942 2522 3057
Gillmore TS Initial	38 180 1942
Gillmore TS Final	180 2484
Autoclave Expansion	26 93 169 5 90 157 196 1715 2462 2982 3413

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Physical Results
 September 11, 2009

SUMMARY OF RESULTS

Test		#Labs	Sample No. 173			Sample No. 174		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Air Content	prcnt	224	8.4	1.2	14.8	7.6	1.3	16.9
Air Content	prcnt	* 222	8.4	1.2	14.1	7.6	1.3	16.6
AC Mix Water	prcnt	221	67.8	6.9	10.2	68.0	6.4	9.4
AC Mix Water	prcnt	* 213	68.6	2.4	3.5	68.6	2.4	3.6
AC Flow	prcnt	221	88	3.3	3.8	88	3.6	4.1
AC Flow	prcnt	* 218	88	3.3	3.8	88	3.5	4.0
Comp Str, 3 day	psi	255	3819	325	8.5	3891	337	8.7
Comp Str, 3 day	psi	* 252	3828	264	6.9	3888	296	7.6
Comp Str, 7 day	psi	254	4847	519	10.7	4862	439	9.0
Comp Str, 7 day	psi	* 249	4828	336	6.76	4847	350	7.2
Comp Str, 28 day	psi	233	6012	565	9.4	6323	586	9.3
Comp Str, 28 day	psi	* 226	5998	369	6.2	6284	425	6.8
Com Str, Flow	prcnt	225	117	11.3	9.6	116	11.0	9.5
Com Str, Flow	prcnt	* 220	118	9.2	7.7	116	9.1	7.8

CONTINUED ON NEXT PAGE

* ELIMINATED LABS: Data over three S.D. from the mean

Air Content 687 2938
 Air Content - % Water 8 146 167 1190 80 106 1956 3368
 Air Content - Flow 94 2363 2464
 Comp Strength - 3 day 2192 2330 2464
 Comp Strength - 7 day 694 2192 2330 2464 3422
 Comp Strength - 28 day 2192 2464 37 49 152 3057 3422
 Comp Strength Flow 619 2330 2476 152 2477

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Physical Results
 September 11, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 173			Sample No. 174			
		Average	S.D.	C.V.	Average	S.D.	C.V.	
FINENESS								
Air Permeability	cm ² /g	251	4210	270	6.4	3915	122	3.1
Air Permeability	cm ² /g	* 238	4216	128	3.0	3924	98	2.5
Wagner Turbidim	cm ² /g	13	2190	114	5.2	2171	138	6.4
45µm Sieve	prcnt	233	95.35	1.92	2.0	96.92	0.59	0.61
45µm Sieve	prcnt	* 220	95.50	0.73	0.77	96.99	0.43	0.45
C1038 MORTAR BAR EXPANSION								
Mortar Expansion	prcnt	141	0.017	0.035	206	0.009	0.030	320
Mortar Expansion	prcnt	* 137	0.013	0.006	42.4	0.007	0.004	62.9
Mortar Water	mL	136	237	14.5	6.1	238	14.7	6.2
Mortar Water	mL	* 131	237	5.0	2.1	238	4.8	2.0
Mortar Flow	prcnt	135	110	4.0	3.6	110	4.0	3.7
Mortar Flow	prcnt	* 130	110	2.8	2.69	110	2.7	2.5

* ELIMINATED LABS: Data over three S.D. from the mean

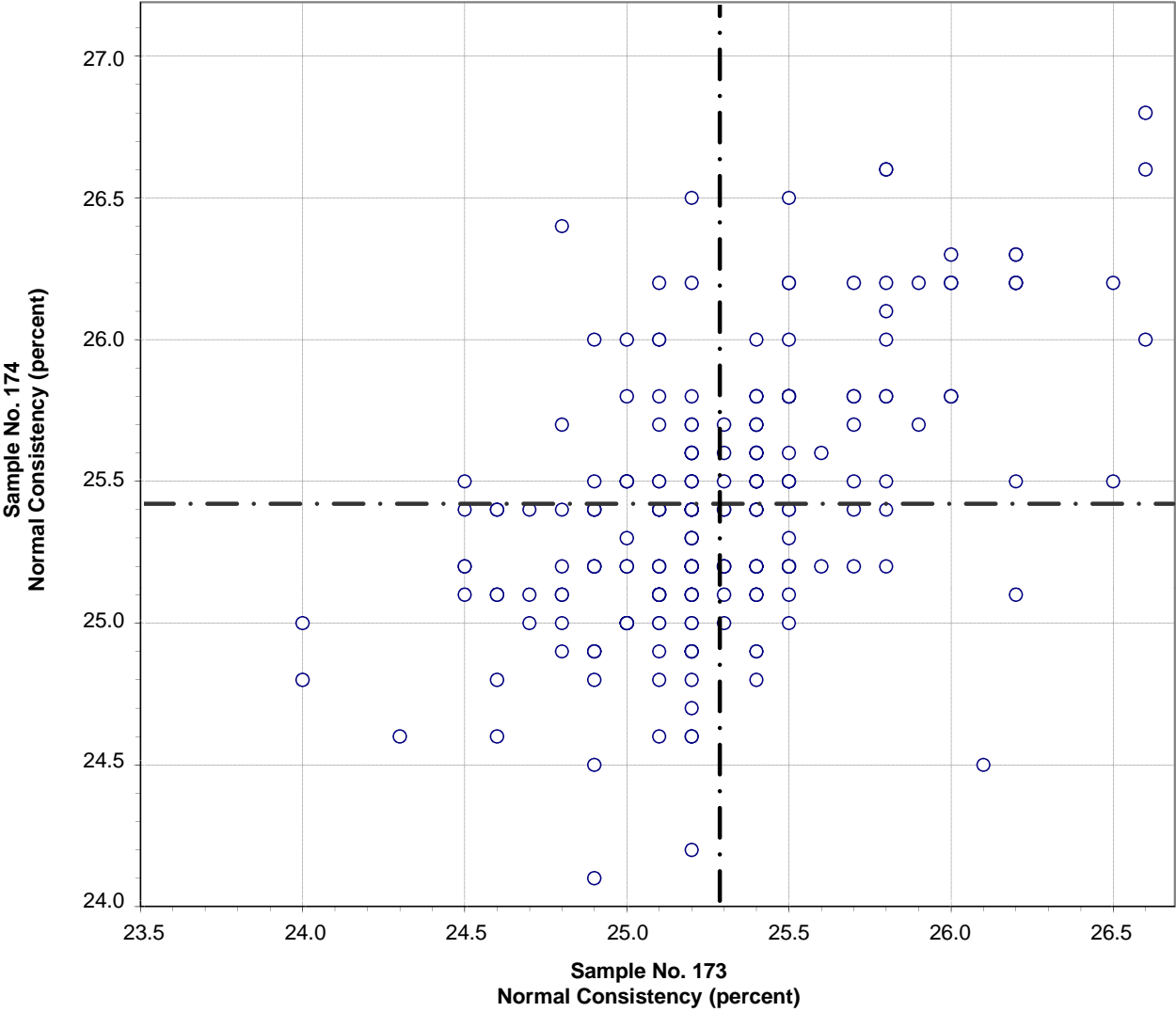
FINENESS

Air Permeability 4 25 36 49 823 2938 24 94 175 207 691 2021 3057
 45µm Sieve 25 146 270 2295 2484 20 222 407 1657 2021 2462 3144 3422

C1038 MORTAR BAR EXPANSION

Mortar Bar Expansion 695 222 2296 2466
 Mortar - Water 49 75 25 157 611
 Mortar - Flow 46 450 667 1251 2462

**CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 173 and No. 174**

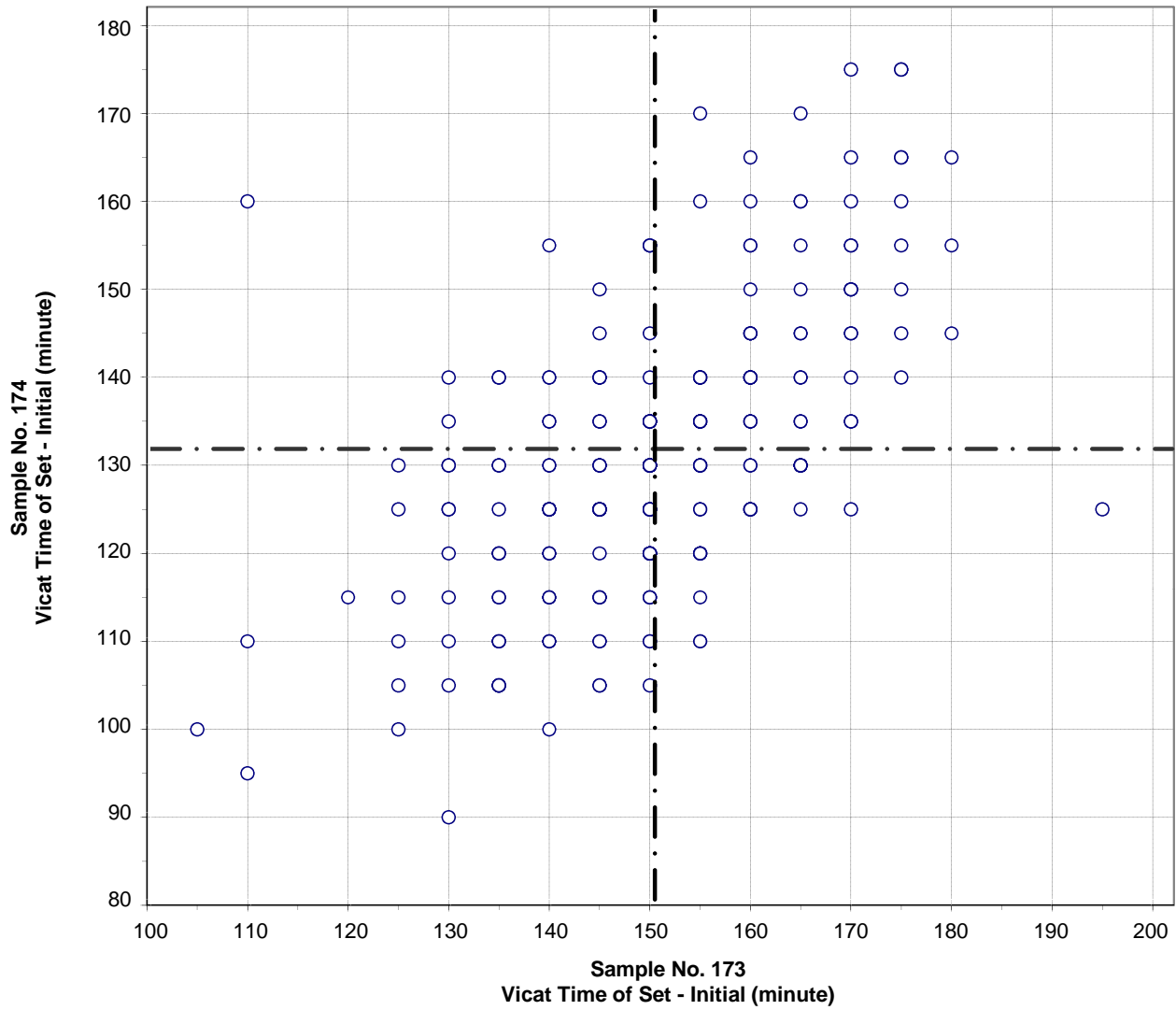


Test No. 110 Normal Consistency - % Water 242 Points

Sample No. 173 Ave 25.3 S.D. 0.4 C.V. 1.6
 Sample No. 174 Ave 25.4 S.D. 0.4 C.V. 1.8

Labs eliminated: 1, 41, 169, 684, 698

**CCRL Proficiency Sample Program
Vicac Time of Set - Initial
PORTLAND CEMENT Samples No. 173 and No. 174**



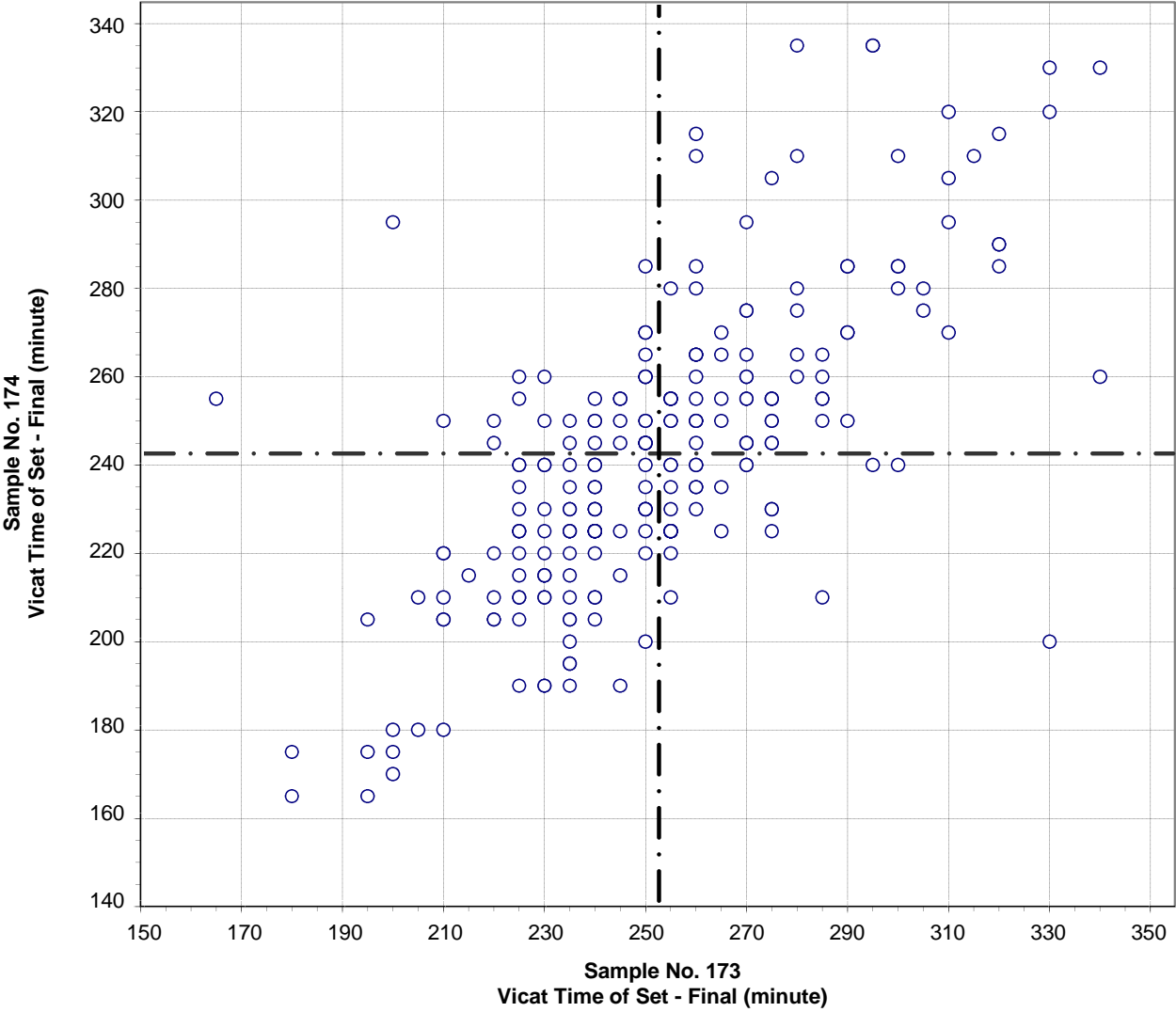
Test No. 120 Vicat Time of Set - Initial 233 Points

Sample No. 173 Ave 150 S.D. 14.1 C.V. 9.4
 Sample No. 174 Ave 132 S.D. 17.7 C.V. 13.4

Labs eliminated: 51, 162, 1483, 1942, 2522, 3144, 3422

Labs off Diagram: 440, 698, 3057

**CCRL Proficiency Sample Program
 Vicat Time of Set - Final
 PORTLAND CEMENT Samples No. 173 and No. 174**

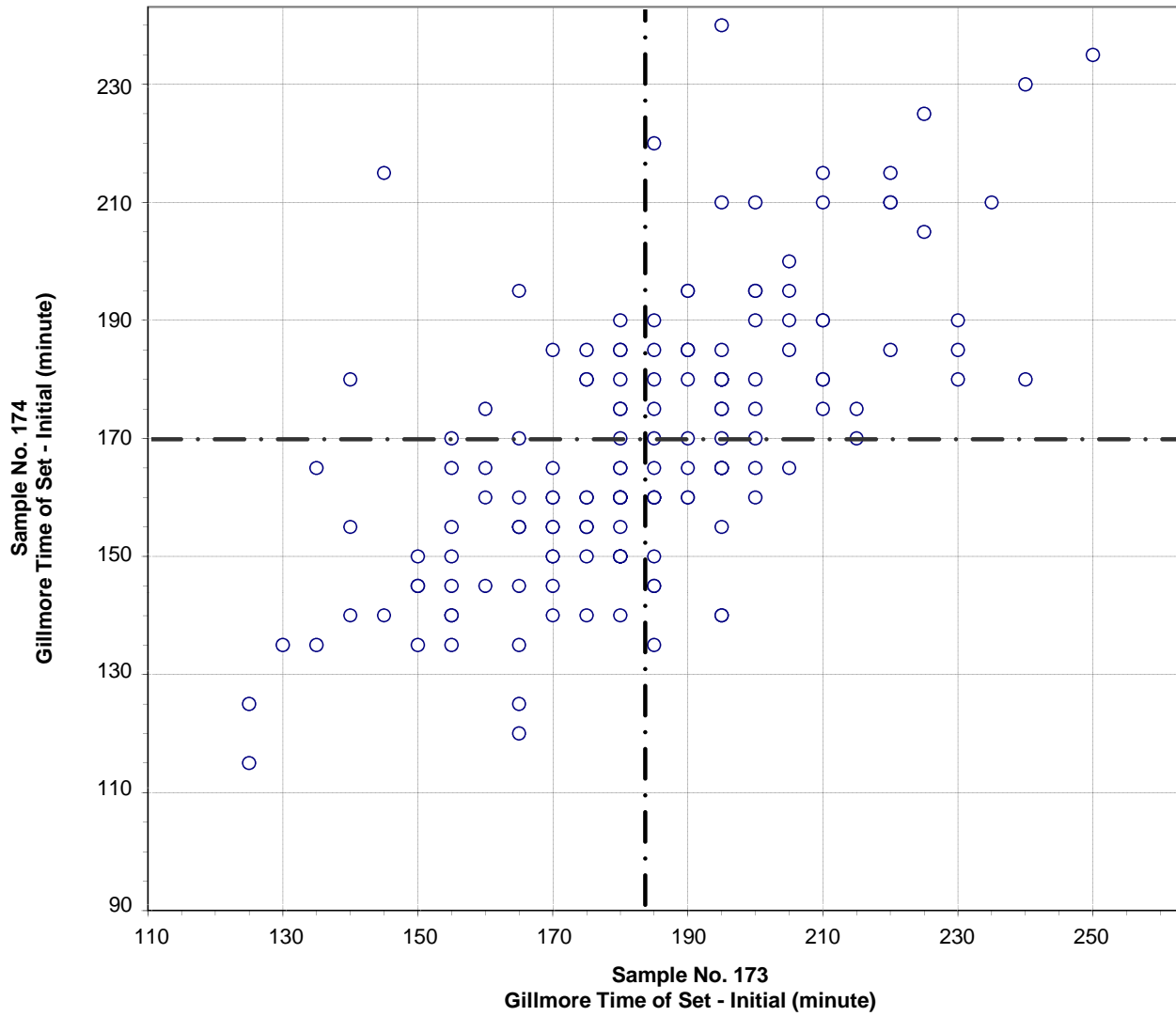


Test No. 121 Vicat Time of Set - Final 233 Points

Sample No. 173	Ave 252	S.D. 30	C.V. 12.0
Sample No. 174	Ave 242	S.D. 33	C.V. 13.8

Labs eliminated: 1942, 2522, 3057

**CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 173 and No. 174**



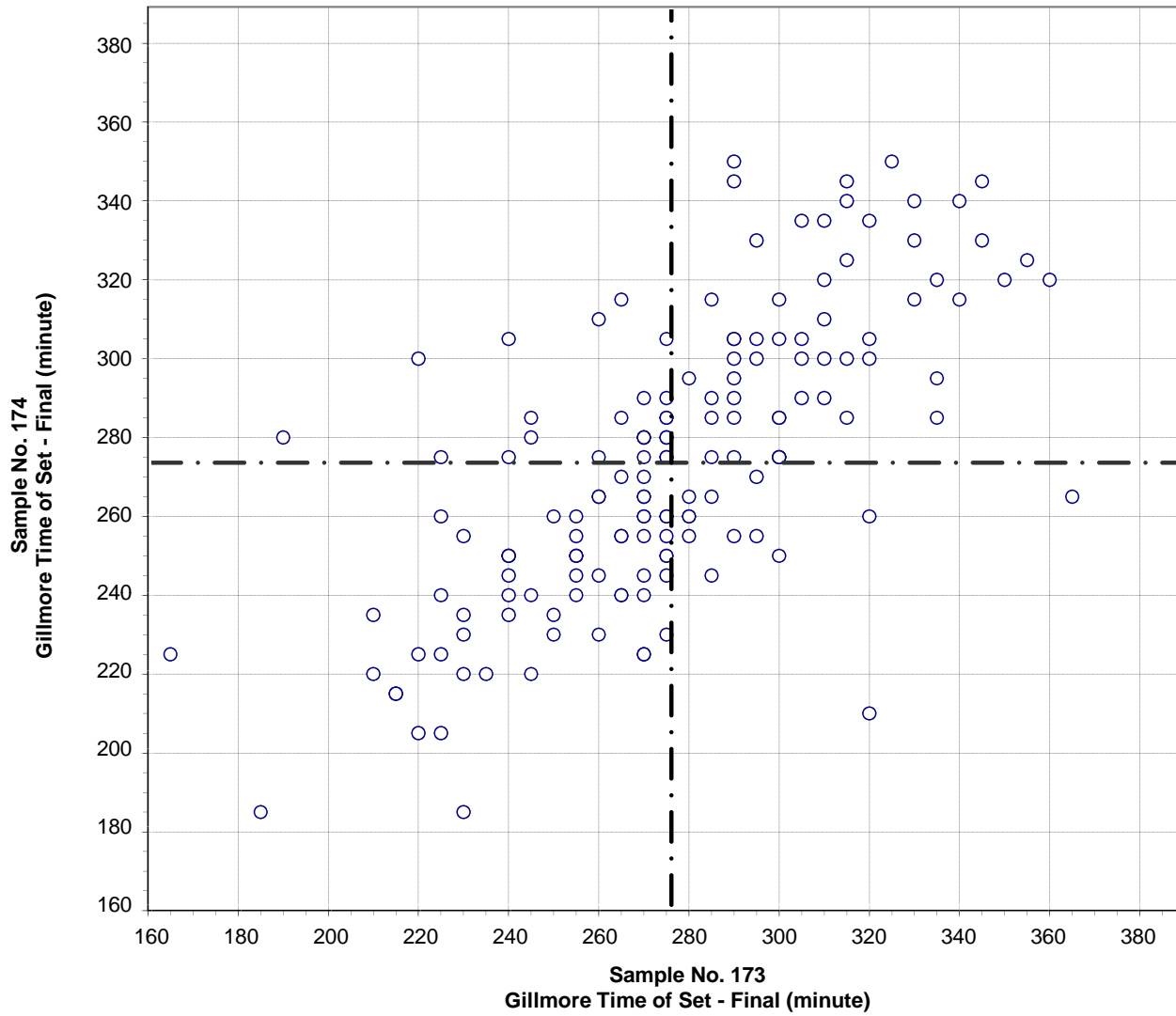
Test No. 130 Gillmore Time of Set - Initial 155 Points

Sample No. 173 Ave 184 S.D. 24 C.V. 12.9

Sample No. 174 Ave 170 S.D. 24 C.V. 14.0

Labs eliminated: 38, 180, 1942

**CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 173 and No. 174**



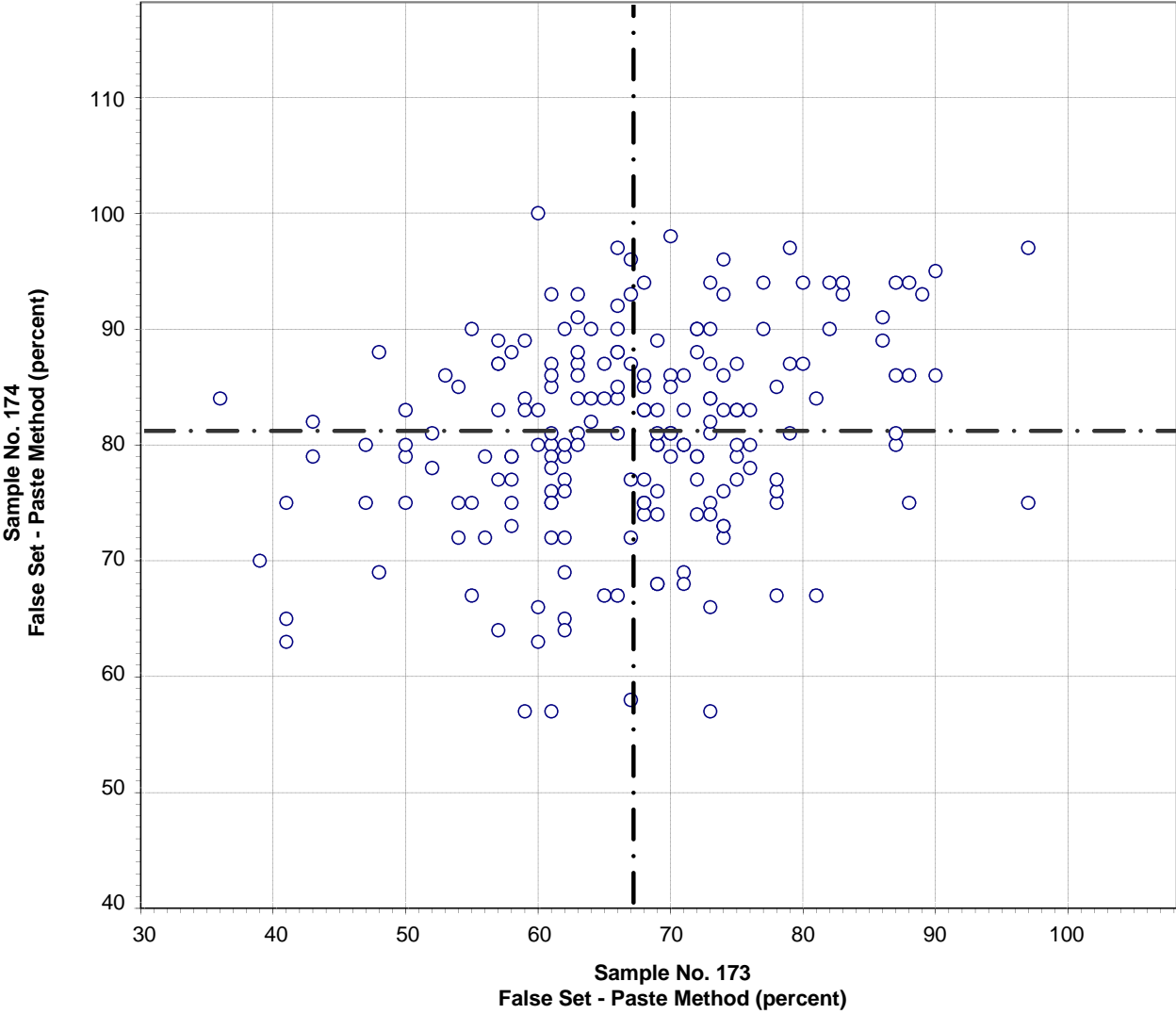
Test No. 140 Gillmore Time of Set - Final 155 Points

Sample No. 173 Ave 276 S.D. 36 C.V. 13.2

Sample No. 174 Ave 273 S.D. 36 C.V. 13.2

Labs eliminated: 180, 2484

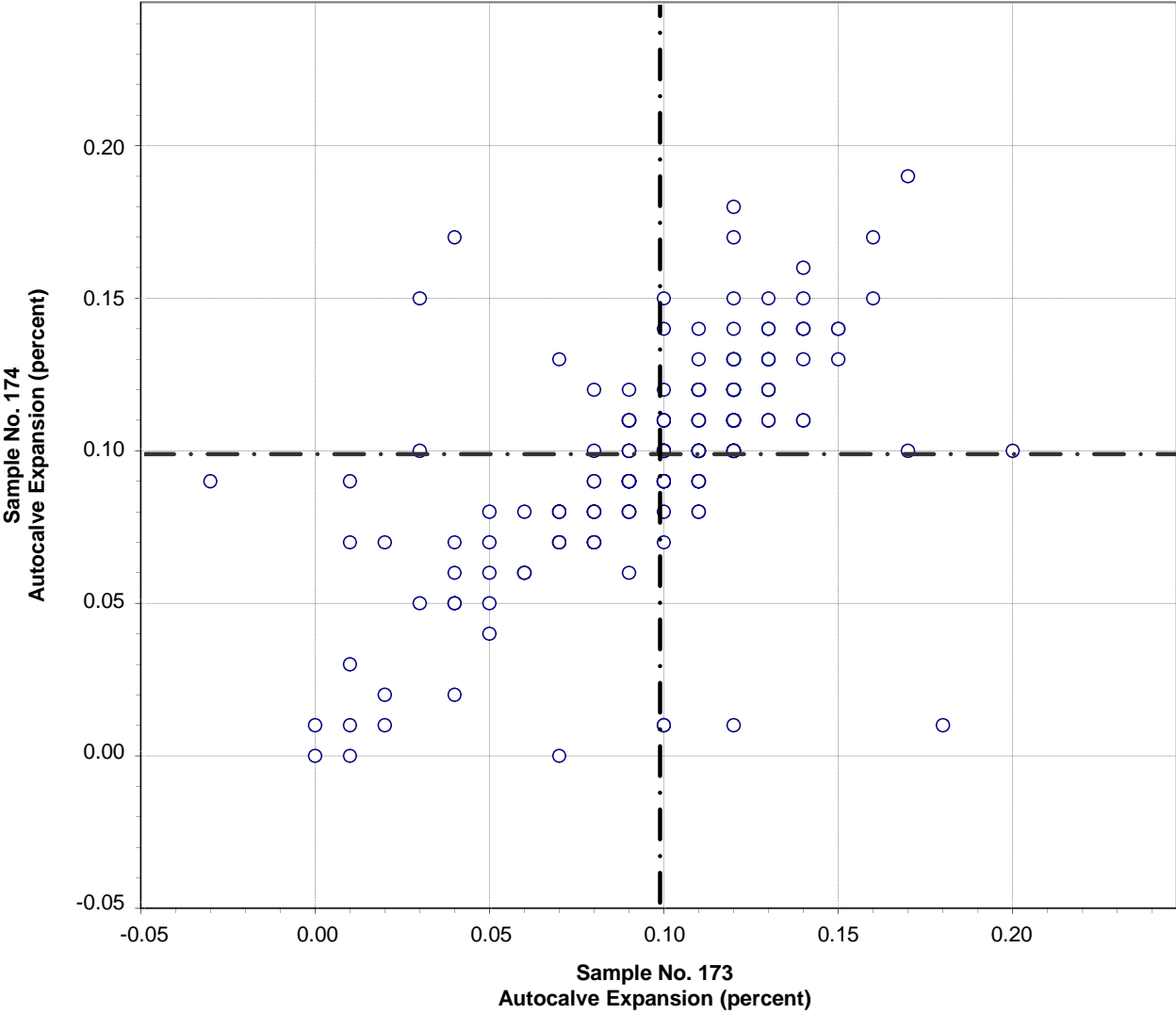
**CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 150 False Set - Paste Method 198 Points

Sample No. 173	Ave 67	S.D. 11.0	C.V. 16.4
Sample No. 174	Ave 81	S.D. 8.8	C.V. 10.8

**CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 173 and No. 174**

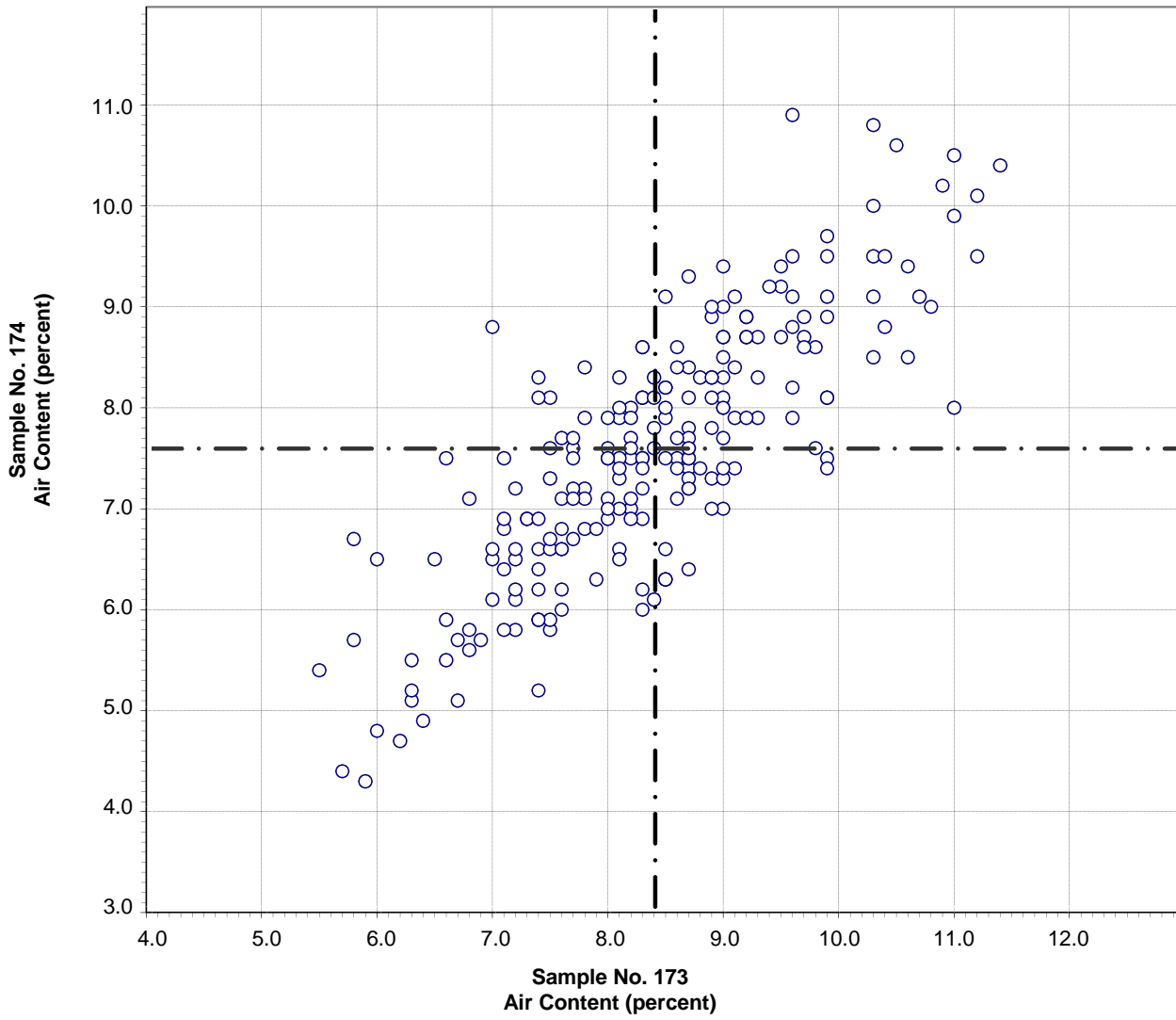


Test No. 160 Autoclave Expansion 216 Points

Sample No. 173 Ave 0.10 S.D. 0.03 C.V. 35.5
 Sample No. 174 Ave 0.10 S.D. 0.03 C.V. 34.2

Labs eliminated: 26, 93, 169, 5, 90, 157, 196, 1715, 2462, 2982, 3413

CCRL Proficiency Sample Program
Air Content %
PORTLAND CEMENT Samples No. 173 and No. 174

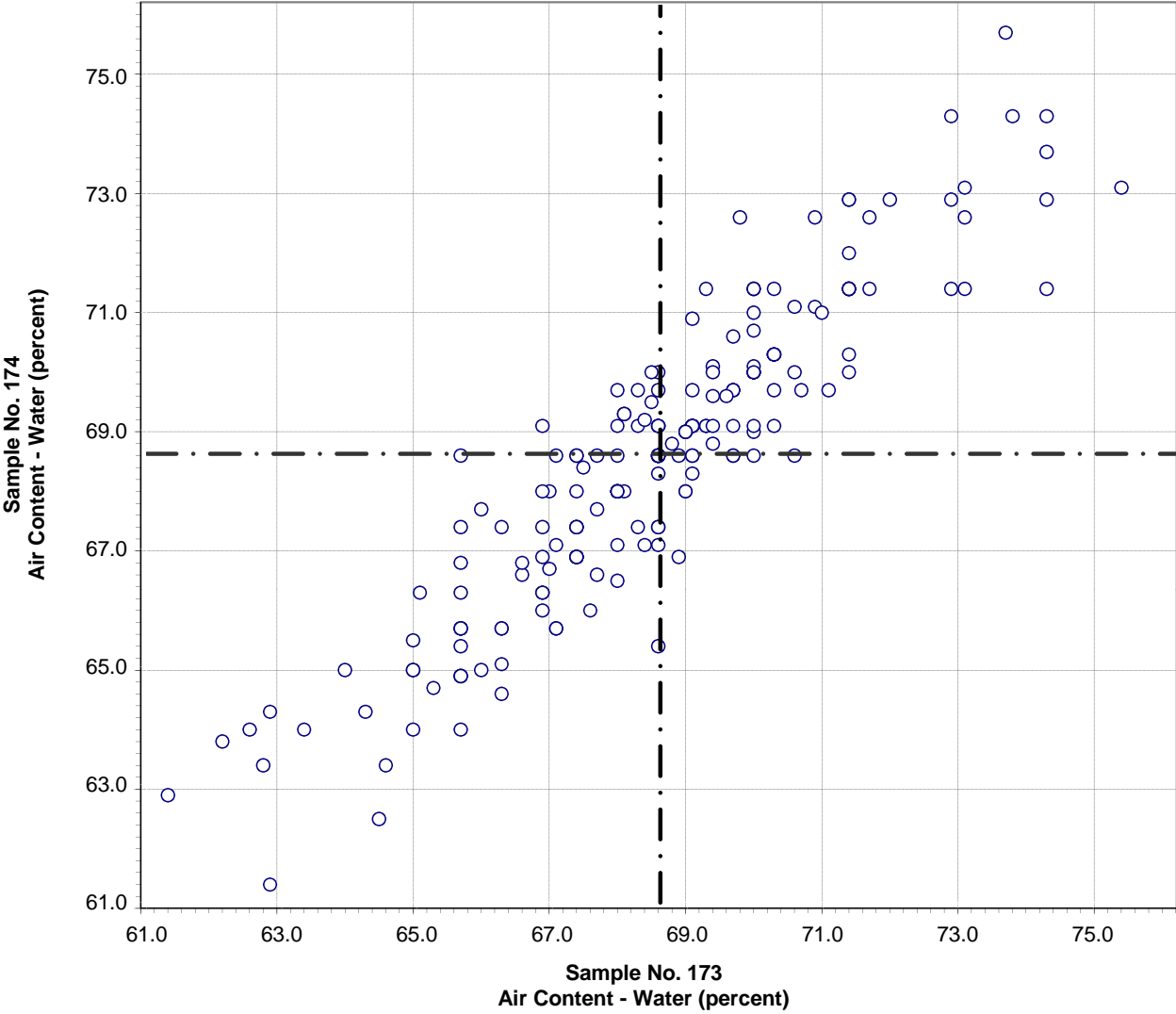


Test No. 170 Air Content % 222 Points

Sample No. 173	Ave 8.4	S.D. 1.2	C.V. 14.1
Sample No. 174	Ave 7.6	S.D. 1.3	C.V. 16.6

Labs eliminated: 687, 2938

CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 173 and No. 174

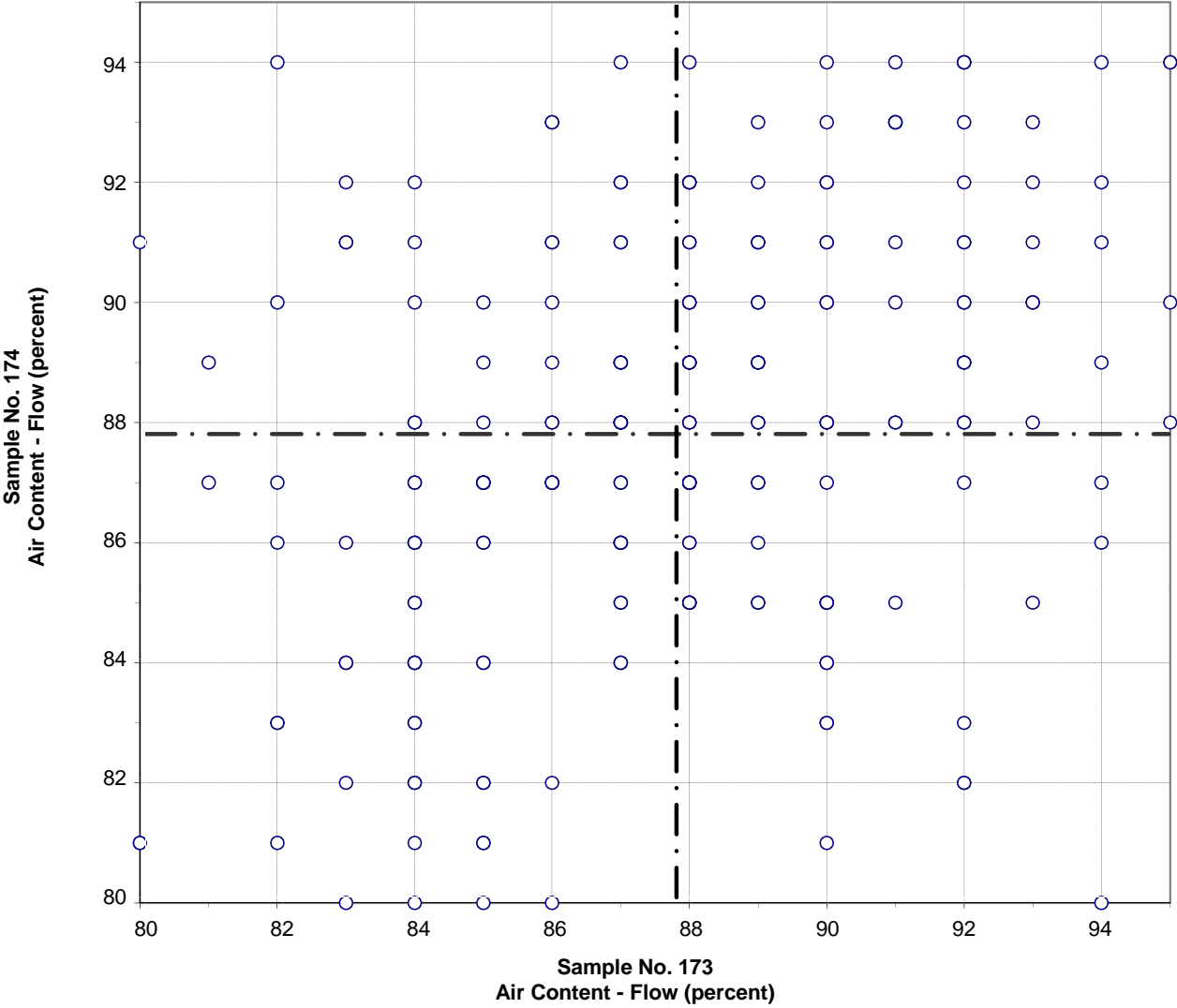


Test No. 180 Air Content - % Water 213 Points

Sample No. 173 Ave 68.6 S.D. 2.4 C.V. 3.5
 Sample No. 174 Ave 68.6 S.D. 2.4 C.V. 3.6

Labs eliminated: 8, 146, 167, 1190, 80, 106, 1956, 3368

**CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 173 and No. 174**

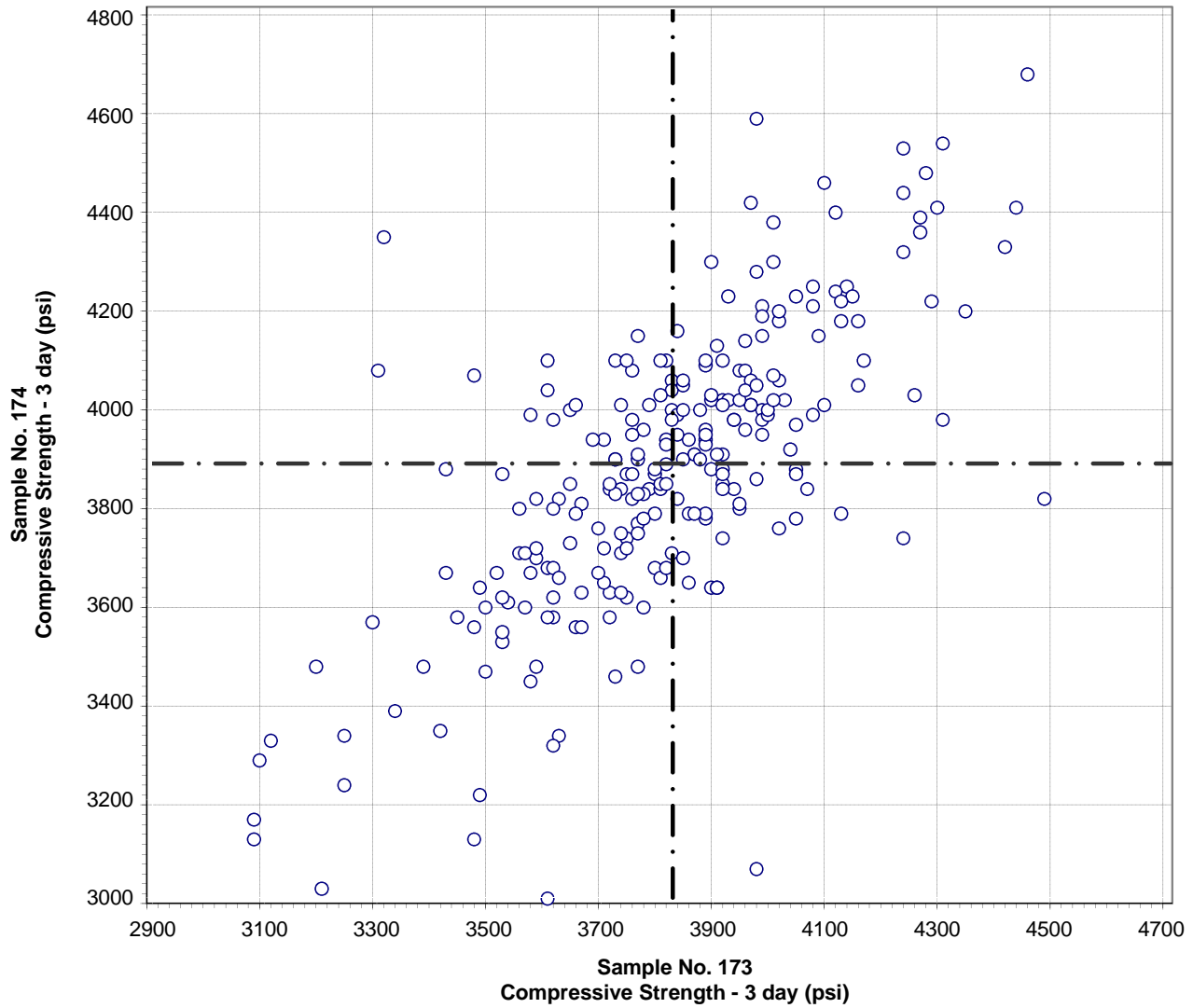


Test No. 190 Air Content - Flow 218 Points

Sample No. 173 Ave 88 S.D. 3.3 C.V. 3.8
 Sample No. 174 Ave 88 S.D. 3.5 C.V. 4.0

Labs eliminated: 94, 2363, 2464

**CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 200 Compressive Strength - 3 day 250 Points

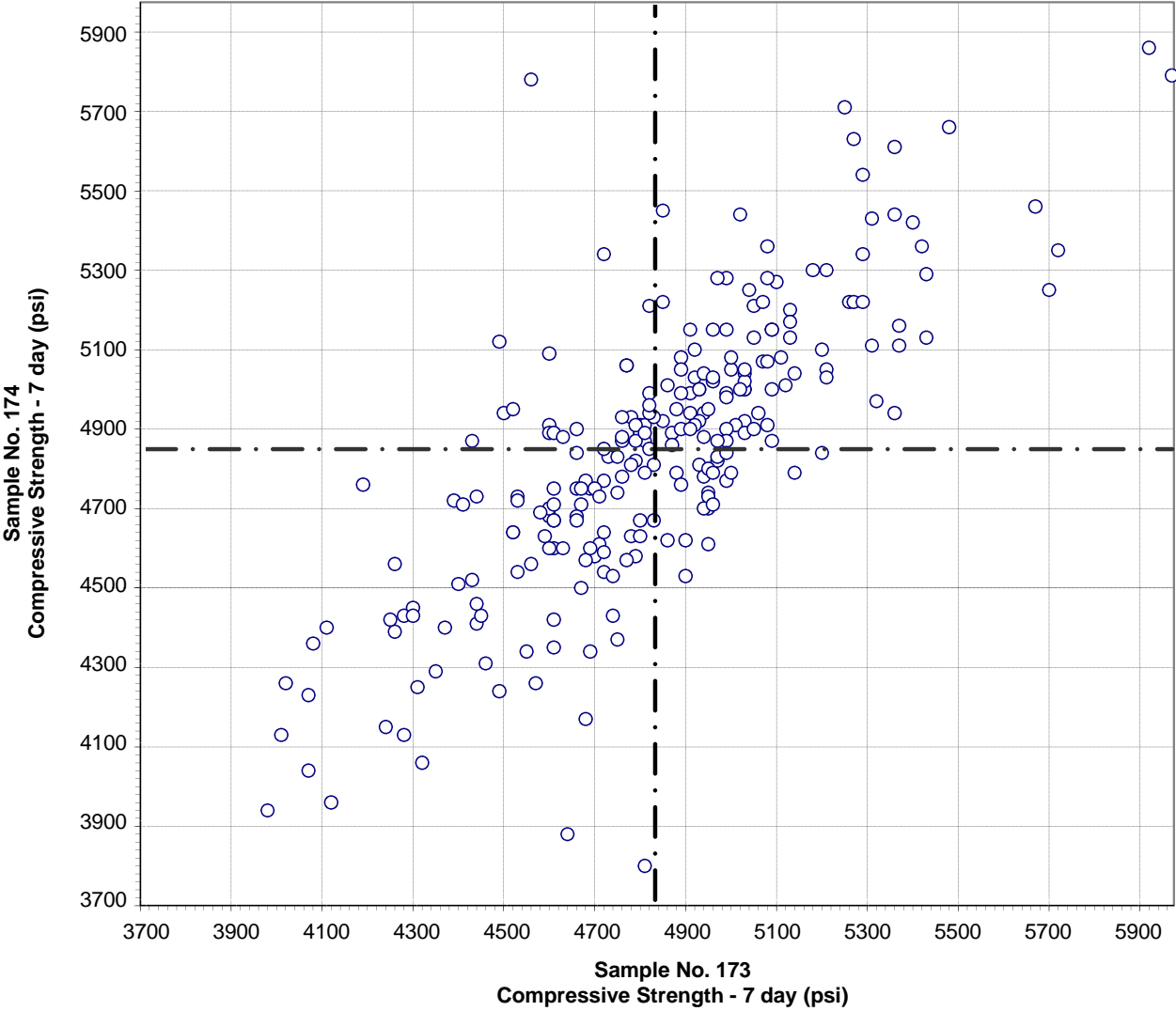
Sample No. 173 Ave 3828 S.D. 264 C.V. 6.9

Sample No. 174 Ave 3888 S.D. 296 C.V. 7.6

Labs eliminated: 2192, 2330, 2464

Labs off Diagram: 49, 3279

**CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 210 Compressive Strength - 7 day 248 Points

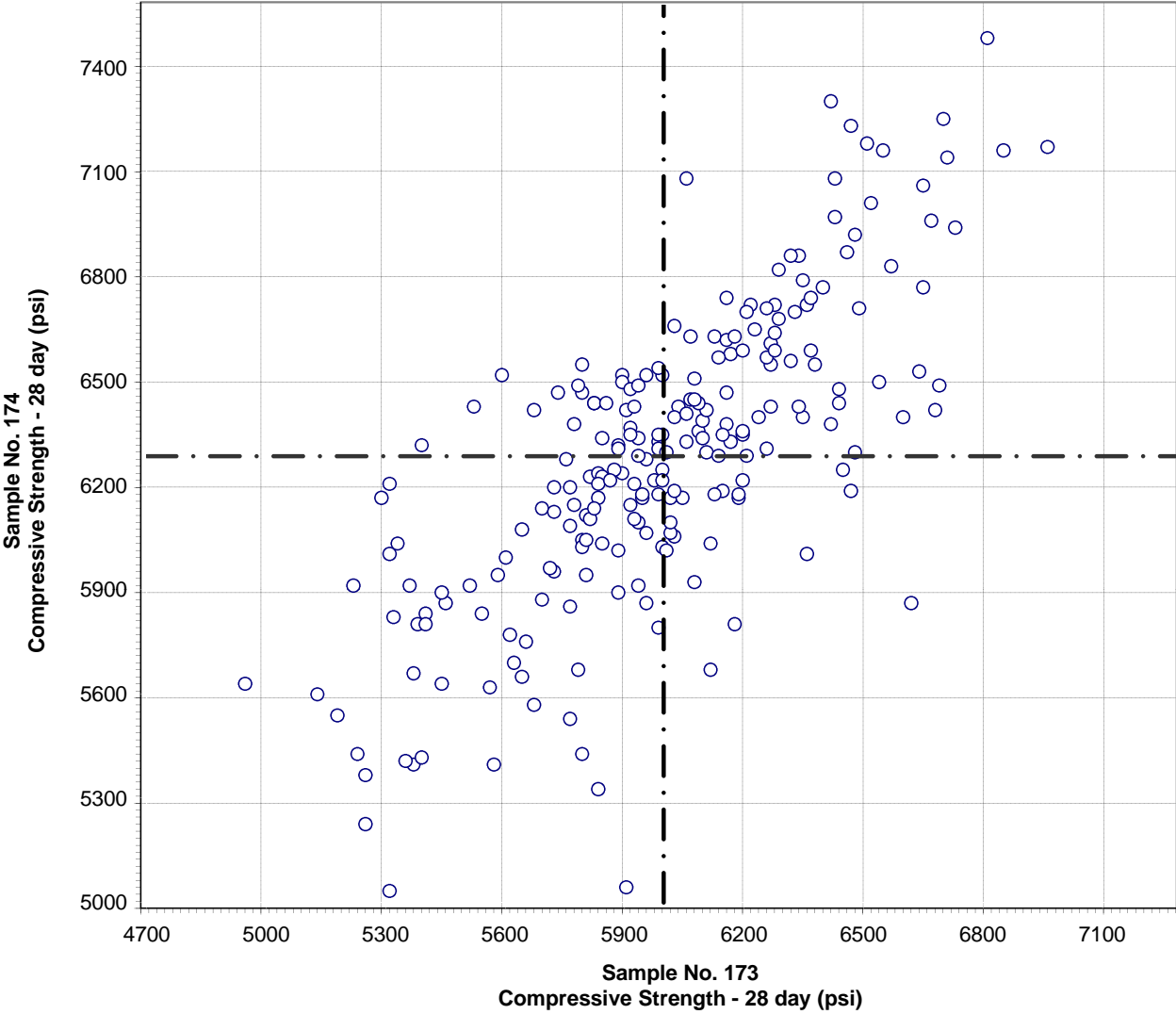
Sample No. 173 Ave 4828 S.D. 336 C.V. 7.0

Sample No. 174 Ave 4847 S.D. 350 C.V. 7.2

Labs eliminated: 694, 2192, 2330, 2464, 3422

Labs off Diagram: 37

**CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 173 and No. 174**

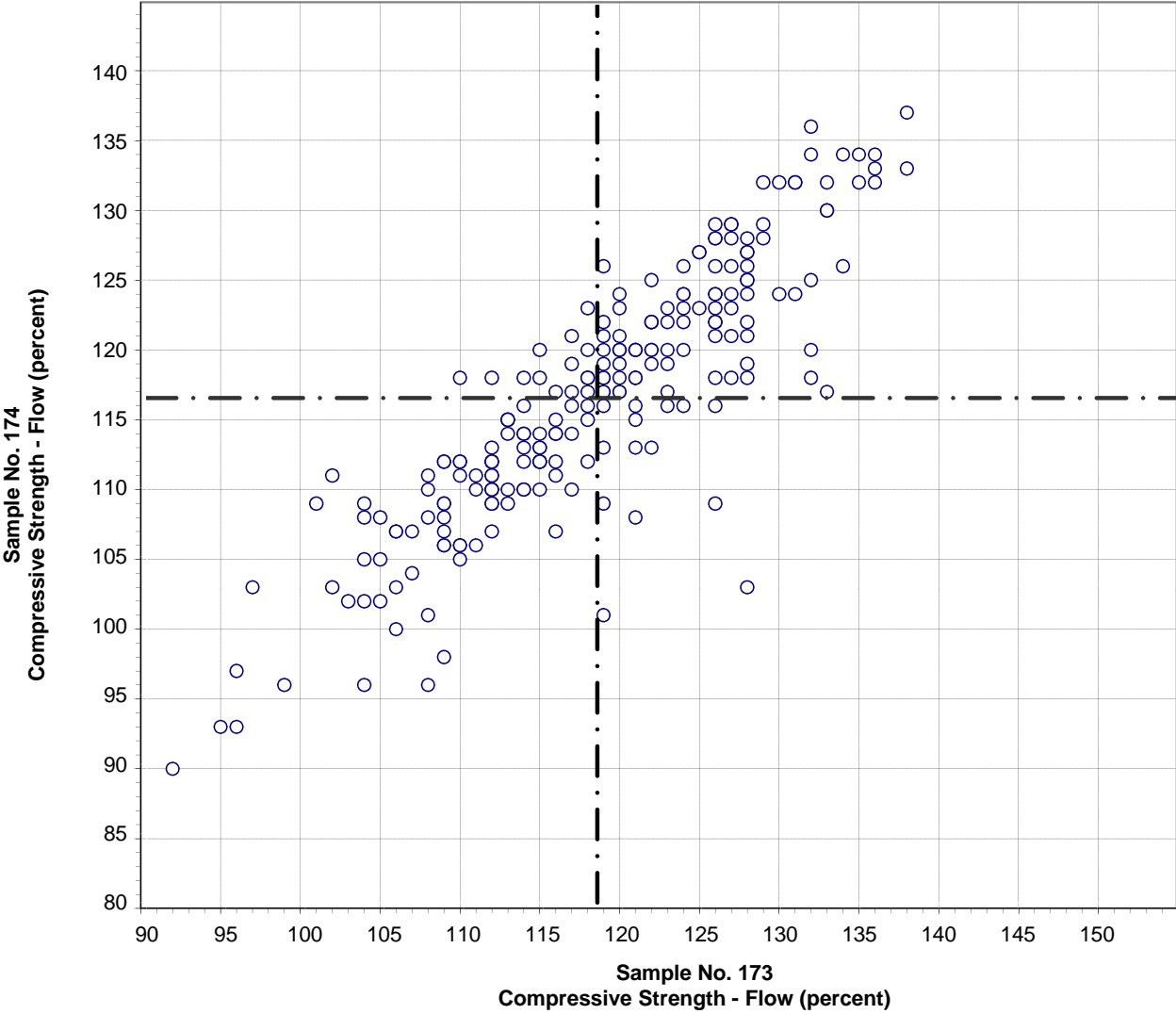


Test No. 211 Compressive Strength - 28 day 226 Points

Sample No. 173 Ave 5998 S.D. 369 C.V. 6.2
 Sample No. 174 Ave 6284 S.D. 425 C.V. 6.8

Labs eliminated: 2192, 2464, 37, 49, 152, 3057, 3422

**CCRL Proficiency Sample Program
Compressive Strength - Flow
PORTLAND CEMENT Samples No. 173 and No. 174**

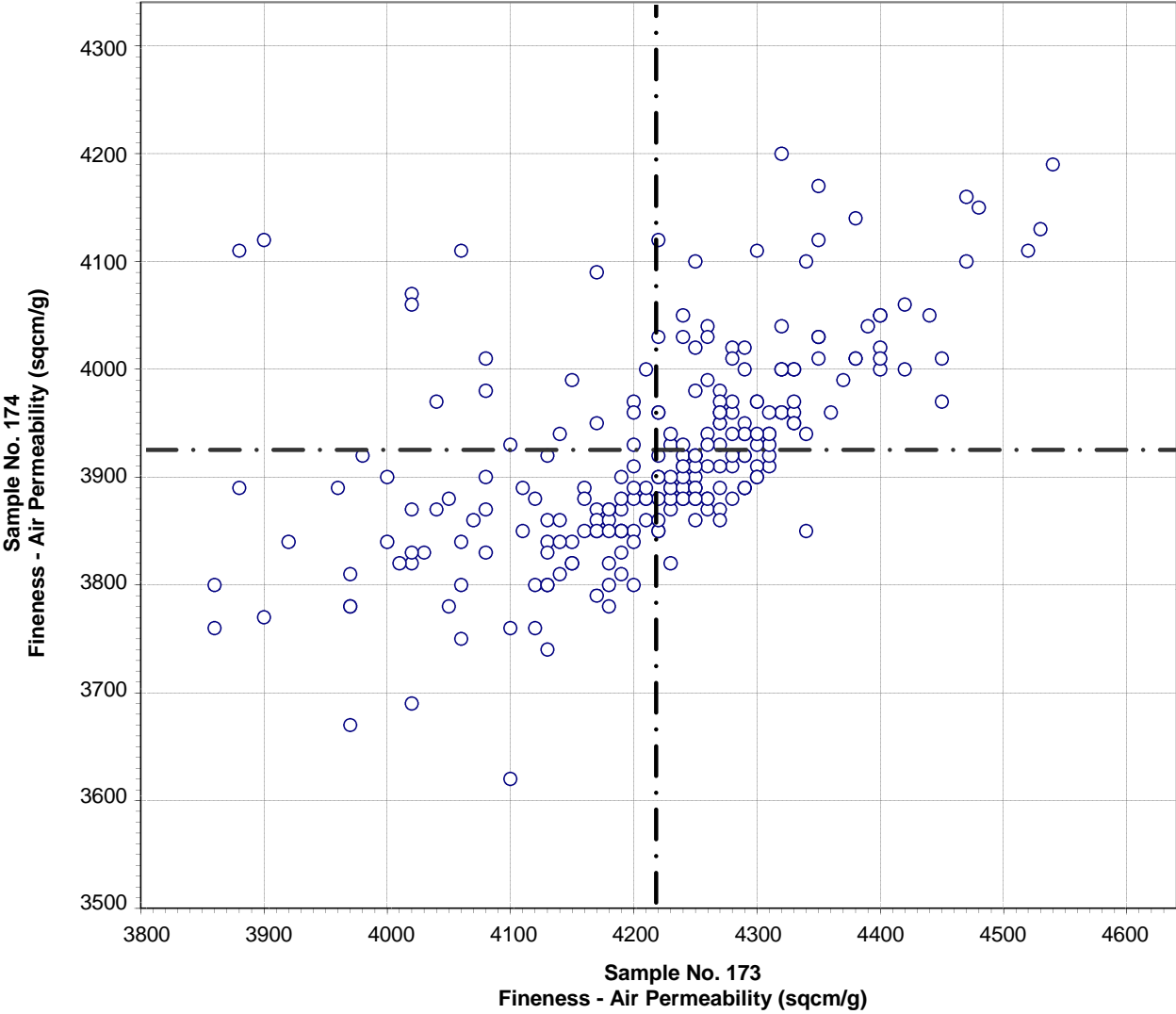


Test No. 230 Compressive Strength - Flow 220 Points

Sample No. 173 Ave 118 S.D. 9 C.V. 7.7
 Sample No. 174 Ave 116 S.D. 9 C.V. 7.8

Labs eliminated: 619, 2330, 2476, 152, 2477

**CCRL Proficiency Sample Program
Fineness - Air Permeability
PORTLAND CEMENT Samples No. 173 and No. 174**



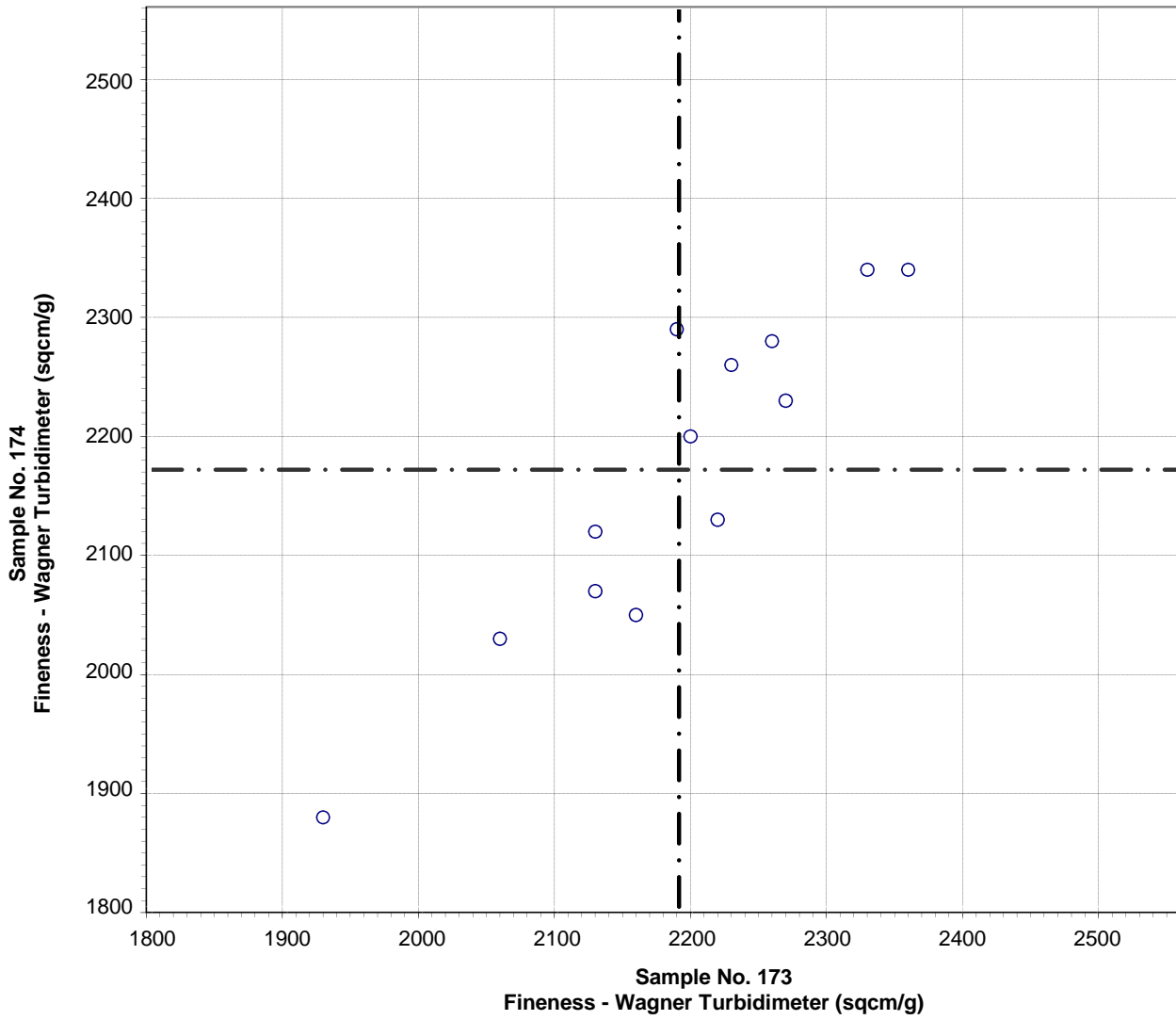
Test No. 270 Fineness - Air Permeability 237 Points

Sample No. 173 Ave 4216 S.D. 128 C.V. 3.0
 Sample No. 174 Ave 3924 S.D. 98 C.V. 2.5

Labs eliminated: 4, 25, 36, 49, 823, 2938, 24, 94, 175, 207, 691, 2021, 3057

Labs off Diagram: 2295

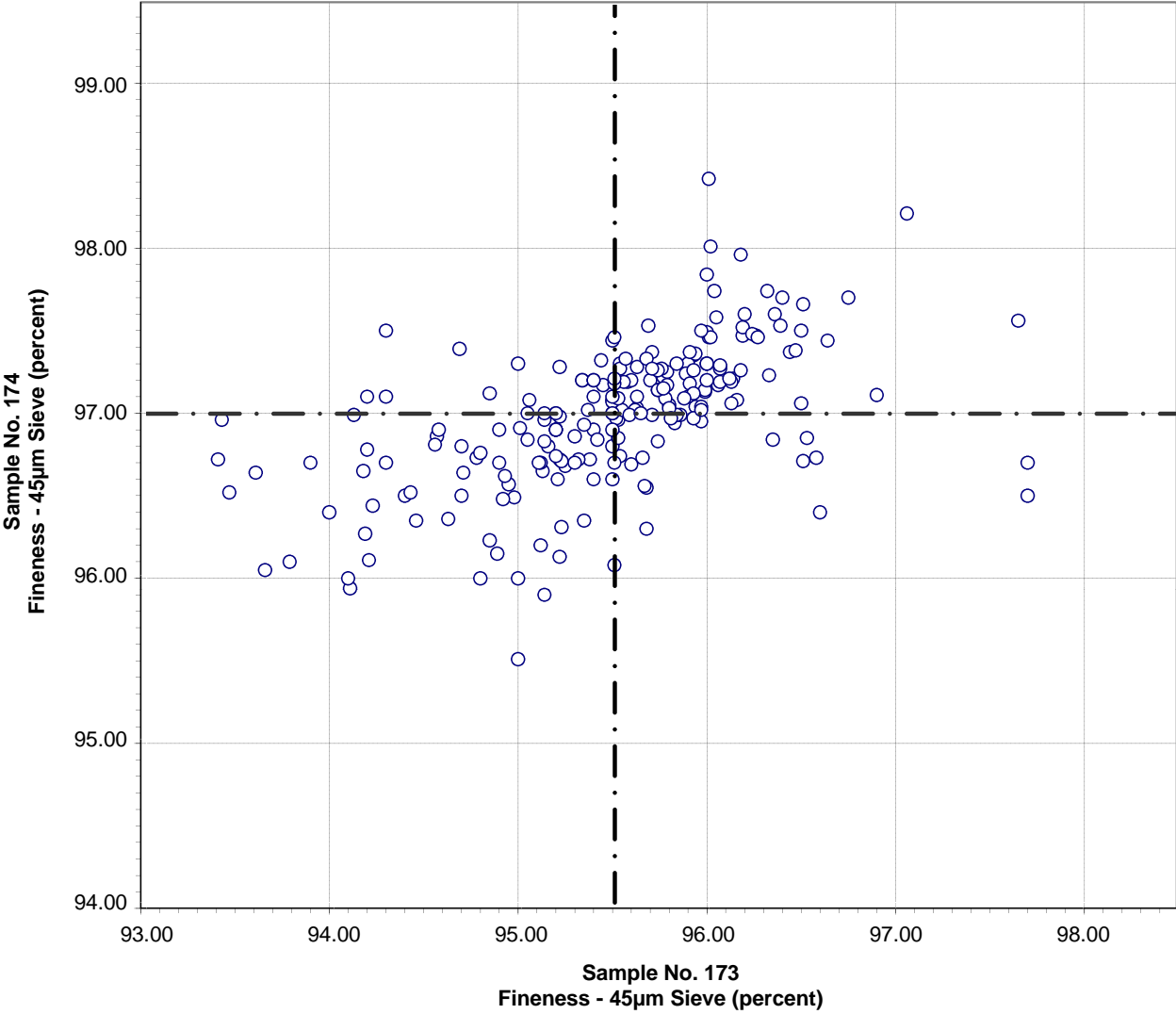
**CCRL Proficiency Sample Program
Fineness - Wagner Turbidimeter
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 280 Fineness - Wagner Turbidimeter 13 Points

Sample No. 173	Ave 2190	S.D. 114	C.V. 5.2
Sample No. 174	Ave 2171	S.D. 138	C.V. 6.4

**CCRL Proficiency Sample Program
Fineness - 45- μ m Sieve
PORTLAND CEMENT Samples No. 173 and No. 174**

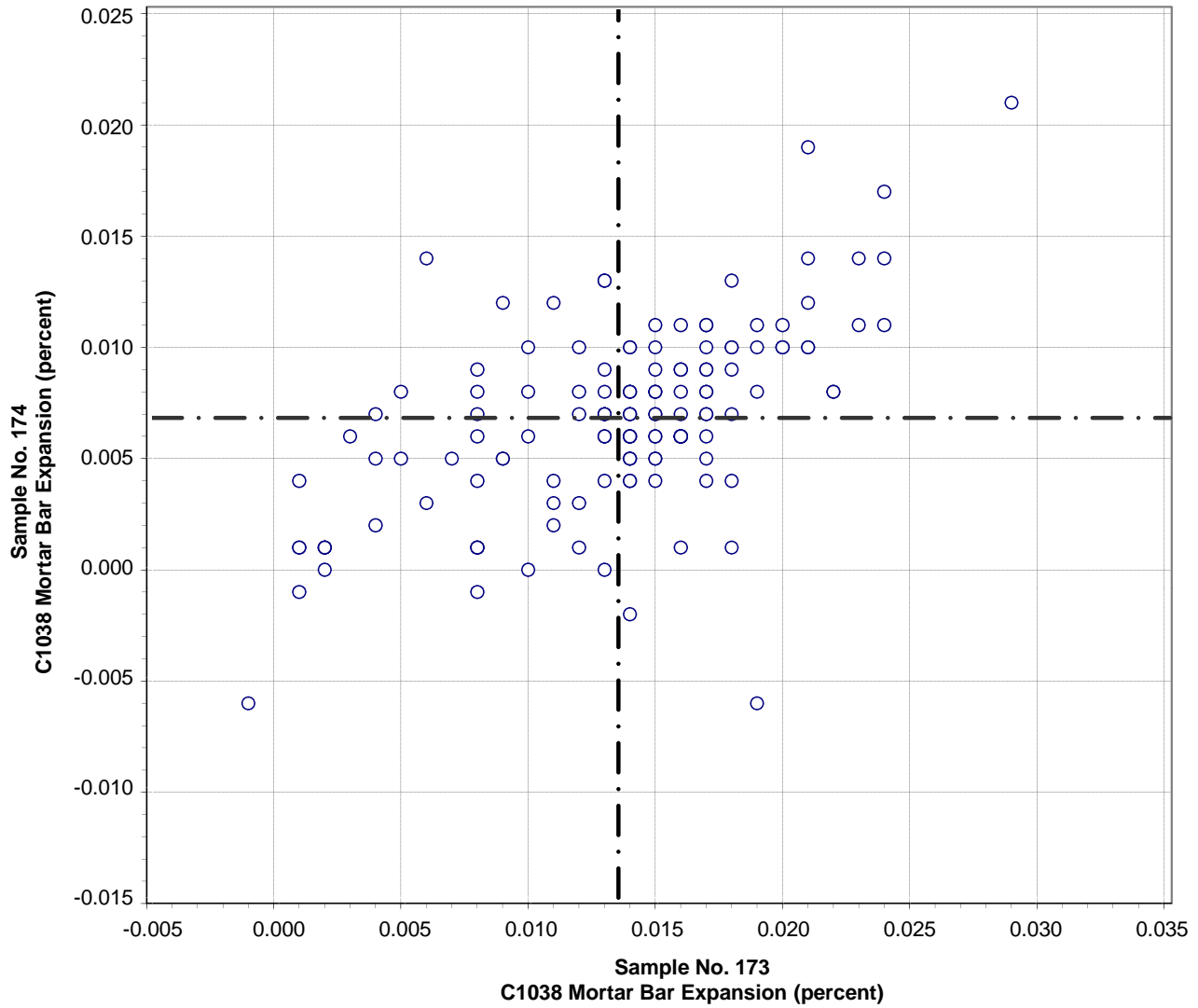


Test No. 281 Fineness - 45- μ m Sieve 220 Points

Sample No. 173	Ave 95.50	S.D. 0.73	C.V. 0.8
Sample No. 174	Ave 96.99	S.D. 0.43	C.V. 0.4

Labs eliminated: 25, 146, 270, 2295, 2484, 20, 222, 407, 1657, 2021, 2462, 3144, 3422

**CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 173 and No. 174**



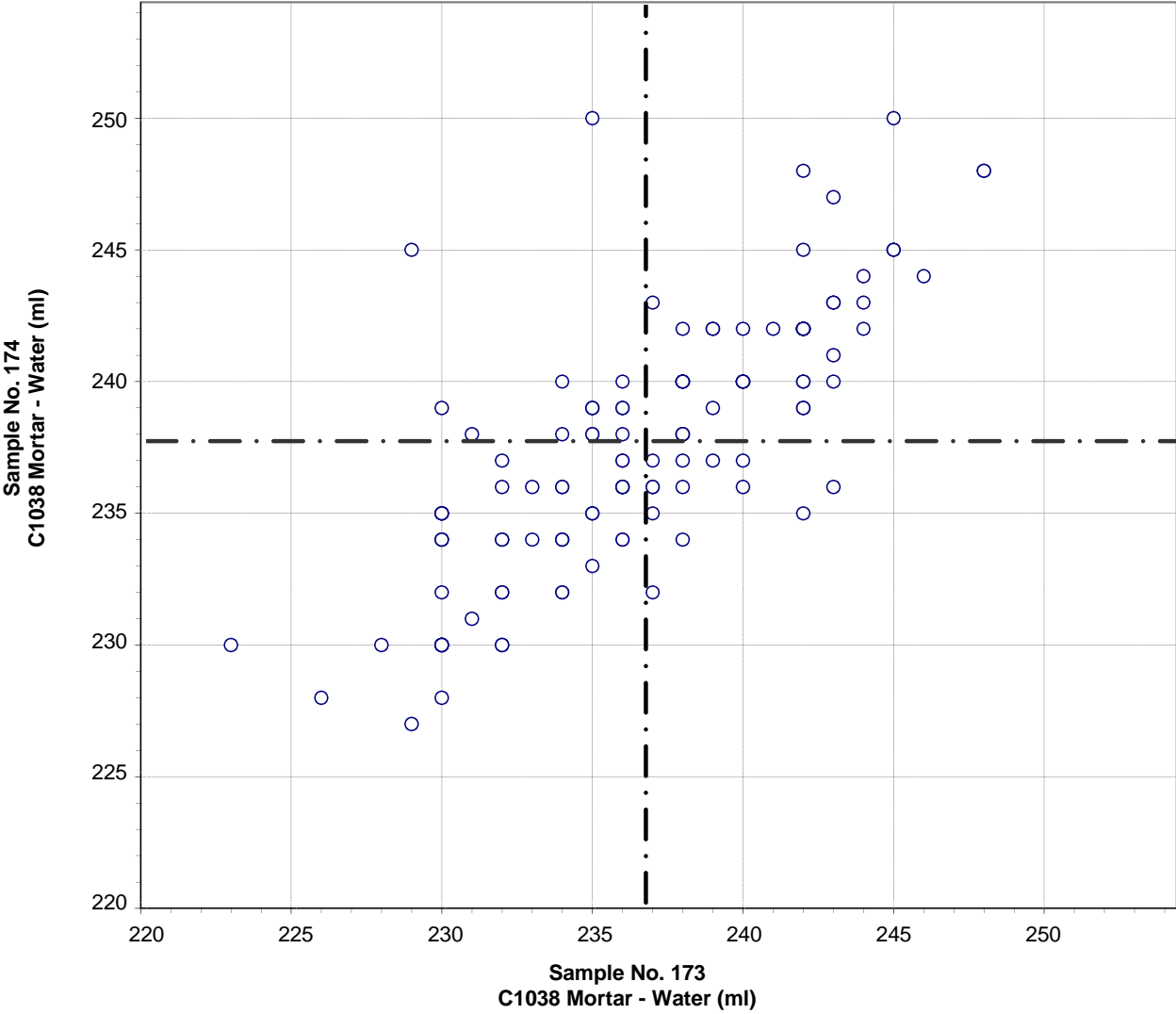
Test No. 400 C1038 Mortar Bar Expansion 137 Points

Sample No. 173 Ave 0.013 S.D. 0.006 C.V. 42.4

Sample No. 174 Ave 0.007 S.D. 0.004 C.V. 62.9

Labs eliminated: 695, 222, 2296, 2466

**CCRL Proficiency Sample Program
C1038 Mortar - Water
PORTLAND CEMENT Samples No. 173 and No. 174**

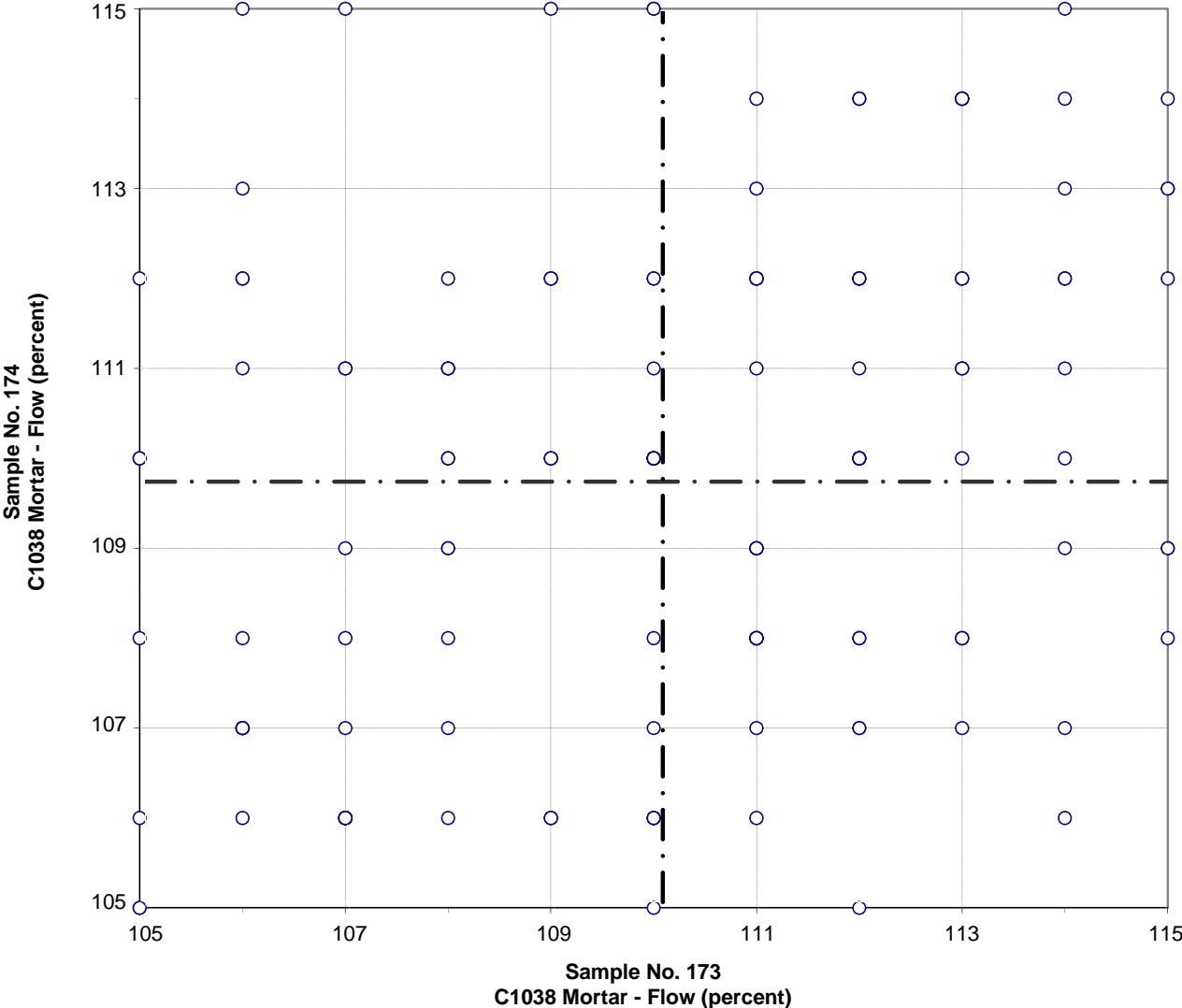


Test No. 401 C1038 Mortar - Water 131 Points

Sample No. 173	Ave 237	S.D. 5	C.V. 2.1
Sample No. 174	Ave 238	S.D. 5	C.V. 2.0

Labs eliminated: 49, 75, 25, 157, 611

**CCRL Proficiency Sample Program
C1038 Mortar - Flow
PORTLAND CEMENT Samples No. 173 and No. 174**



Test No. 402 C1038 Mortar - Flow 130 Points

Sample No. 173 Ave 110 S.D. 3 C.V. 2.6
 Sample No. 174 Ave 110 S.D. 3 C.V. 2.5

Labs eliminated: 46, 450, 667, 1251, 2462

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 173 and No. 174
 Final Report - Heat of Hydration Results
 September 11, 2009

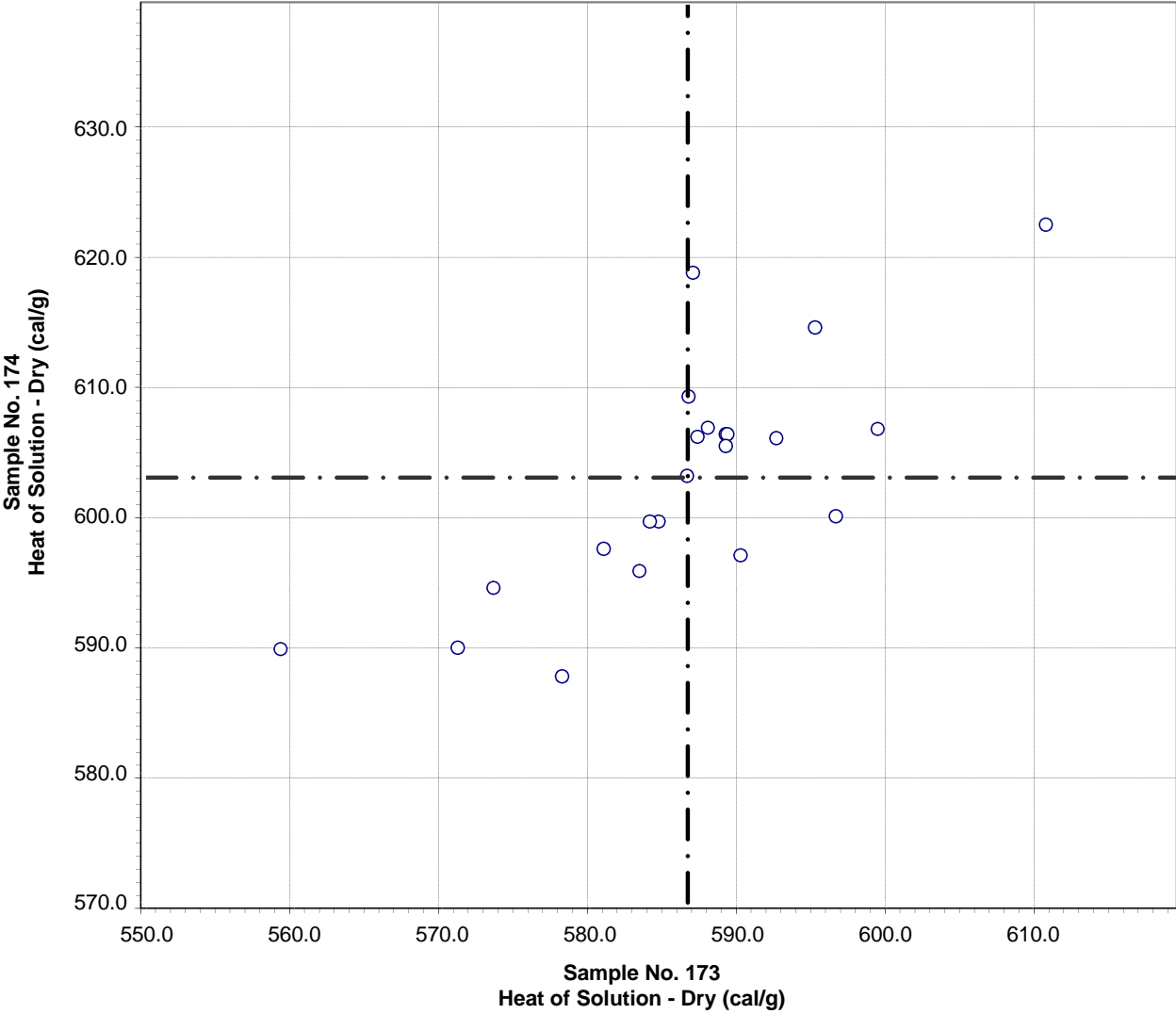
SUMMARY OF RESULTS

Test	#Labs	Sample No. 173			Sample No. 174		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Heat Solution, Dry cal/g	22	586.6	10.4	1.77	603.0	8.9	1.48
Heat Sol, 7 day cal/g	22	505.6	18.7	3.70	522.0	11.3	2.17
Heat Sol, 7 day cal/g	* 20	507.9	8.8	1.74	520.6	8.1	1.56
Heat Sol, 28 day cal/g	15	499.7	8.1	1.62	513.7	9.2	1.79
Heat Hyd, 7 day cal/g	23	81.2	11.6	14.24	80.9	7.5	9.22
Heat Hyd, 7 day cal/g	* 22	79.1	6.4	8.09	81.0	7.6	9.38
Heat Hyd, 28 day cal/g	16	88.8	5.0	5.58	89.5	4.3	4.79

* ELIMINATED LABS: Data over three S.D. from the mean

Heat of Solution, 7 day 491 3057
 Heat of Hydration, 7 day 3057

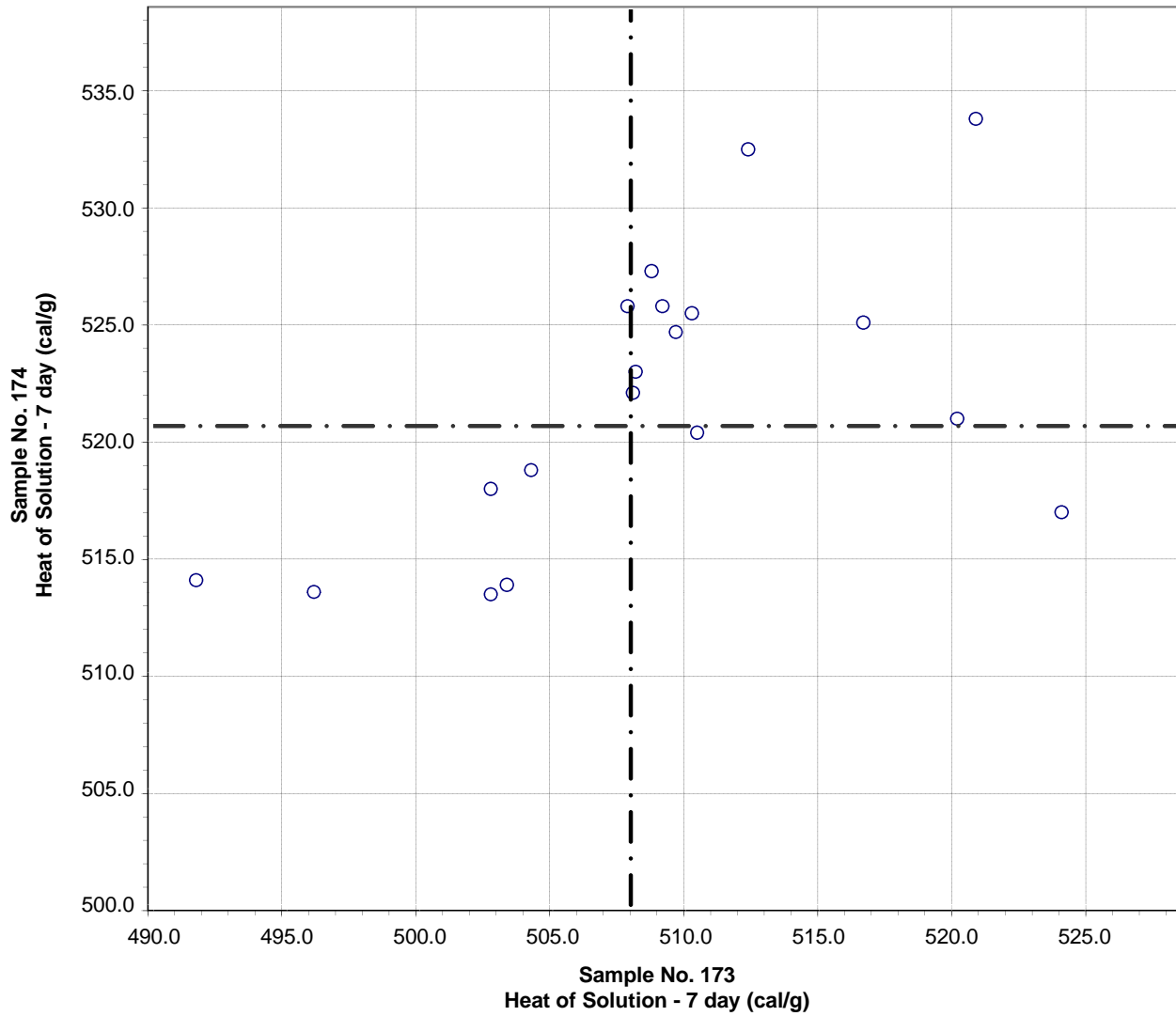
CCRL Proficiency Sample Program
Heat of Solution - Dry
PORTLAND CEMENT Samples No. 173 and No. 174



Test No. 291 Heat of Solution - Dry 22 Points

Sample No. 173	Ave 586.6	S.D. 10.4	C.V. 1.8
Sample No. 174	Ave 603.0	S.D. 8.9	C.V. 1.5

CCRL Proficiency Sample Program
Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 173 and No. 174



Test No. 292 Heat of Solution - 7 day 19 Points

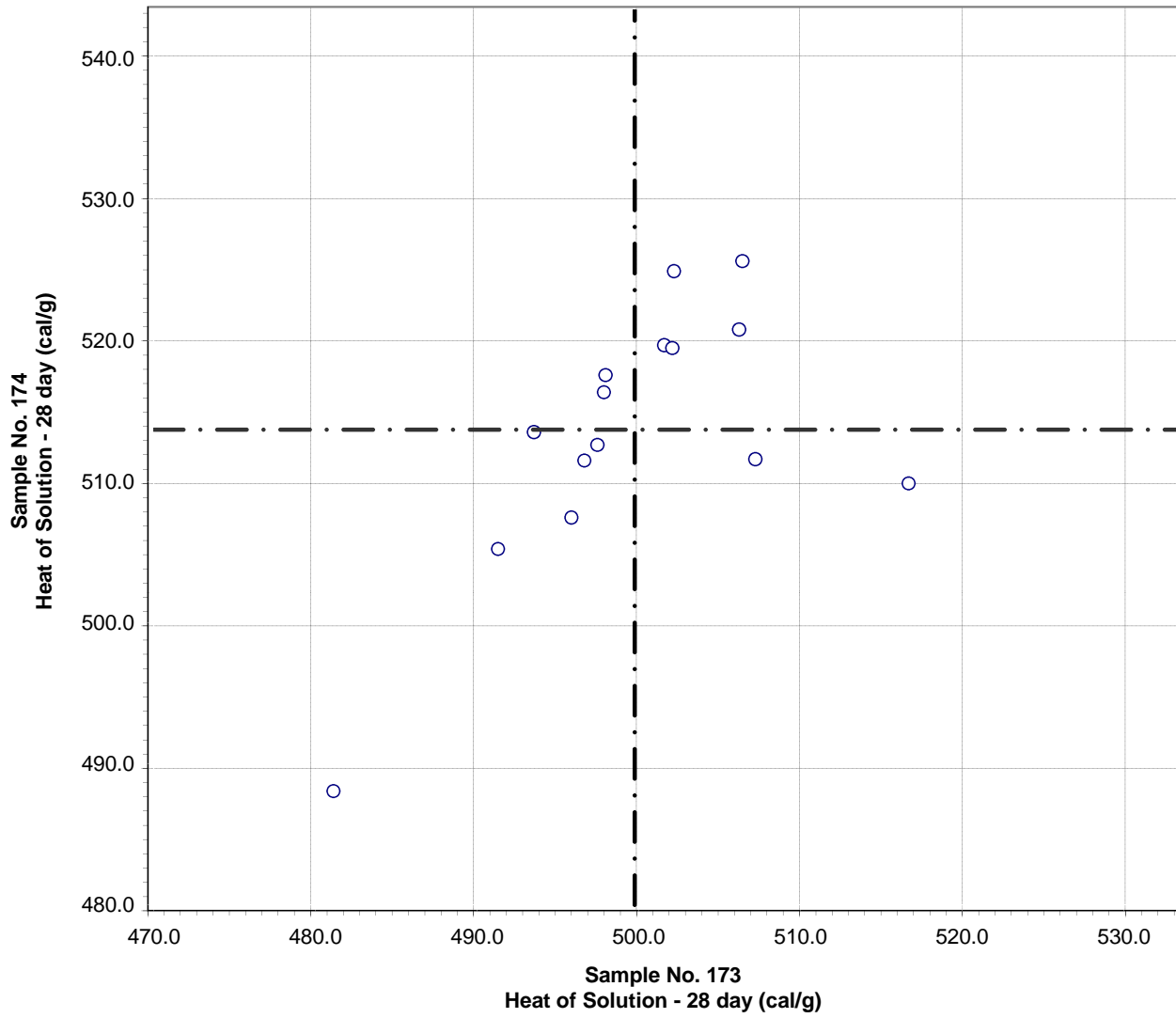
Sample No. 173 Ave 507.9 S.D. 8.9 C.V. 1.7

Sample No. 174 Ave 520.6 S.D. 8.1 C.V. 1.6

Labs eliminated: 491, 3057

Labs off Diagram: 975

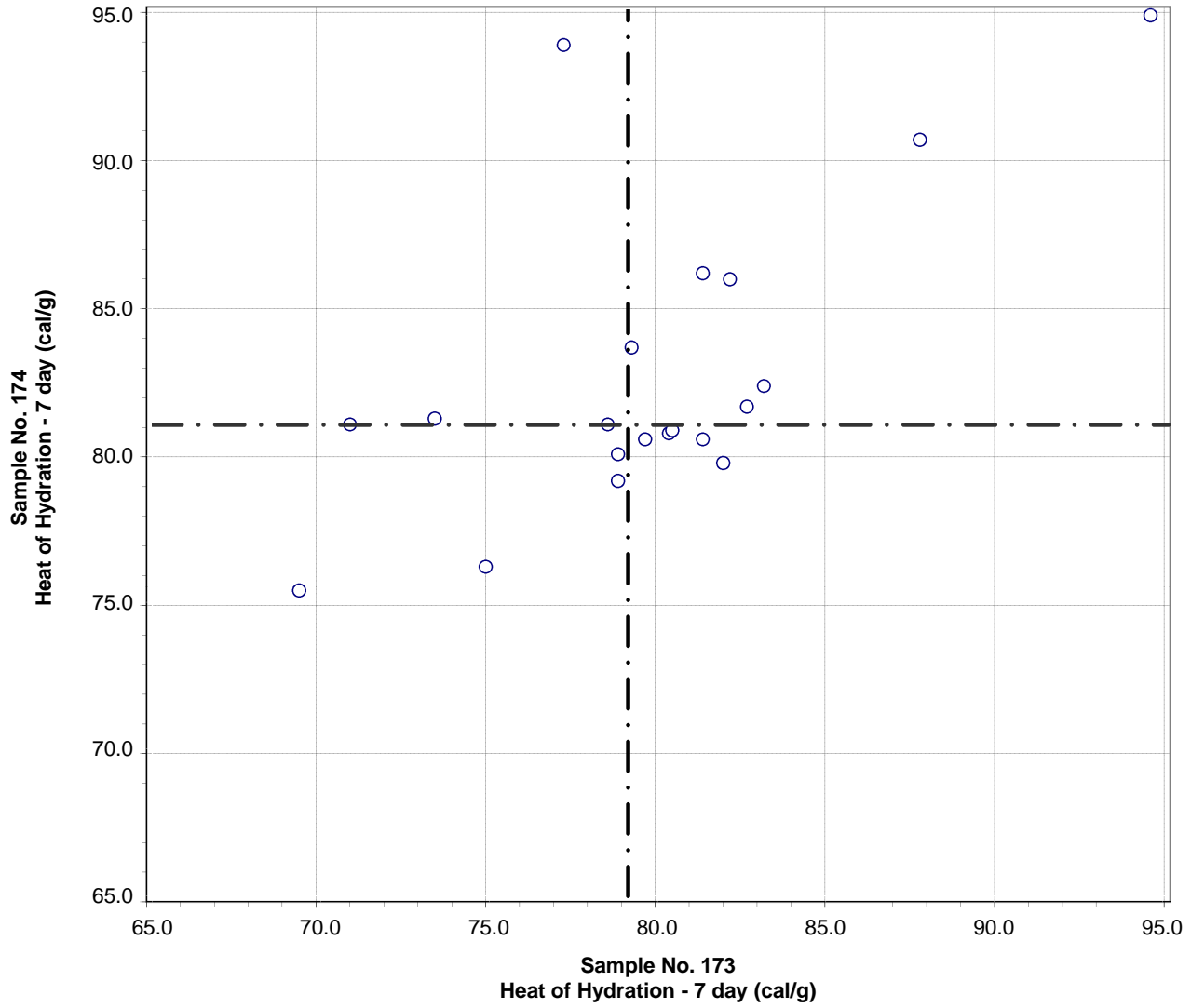
CCRL Proficiency Sample Program
Heat of Solution - 28 day
PORTLAND CEMENT Samples No. 173 and No. 174



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

Sample No. 173	Ave 499.7	S.D. 8.1	C.V. 1.6
Sample No. 174	Ave 513.7	S.D. 9.2	C.V. 1.8

CCRL Proficiency Sample Program
Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 173 and No. 174



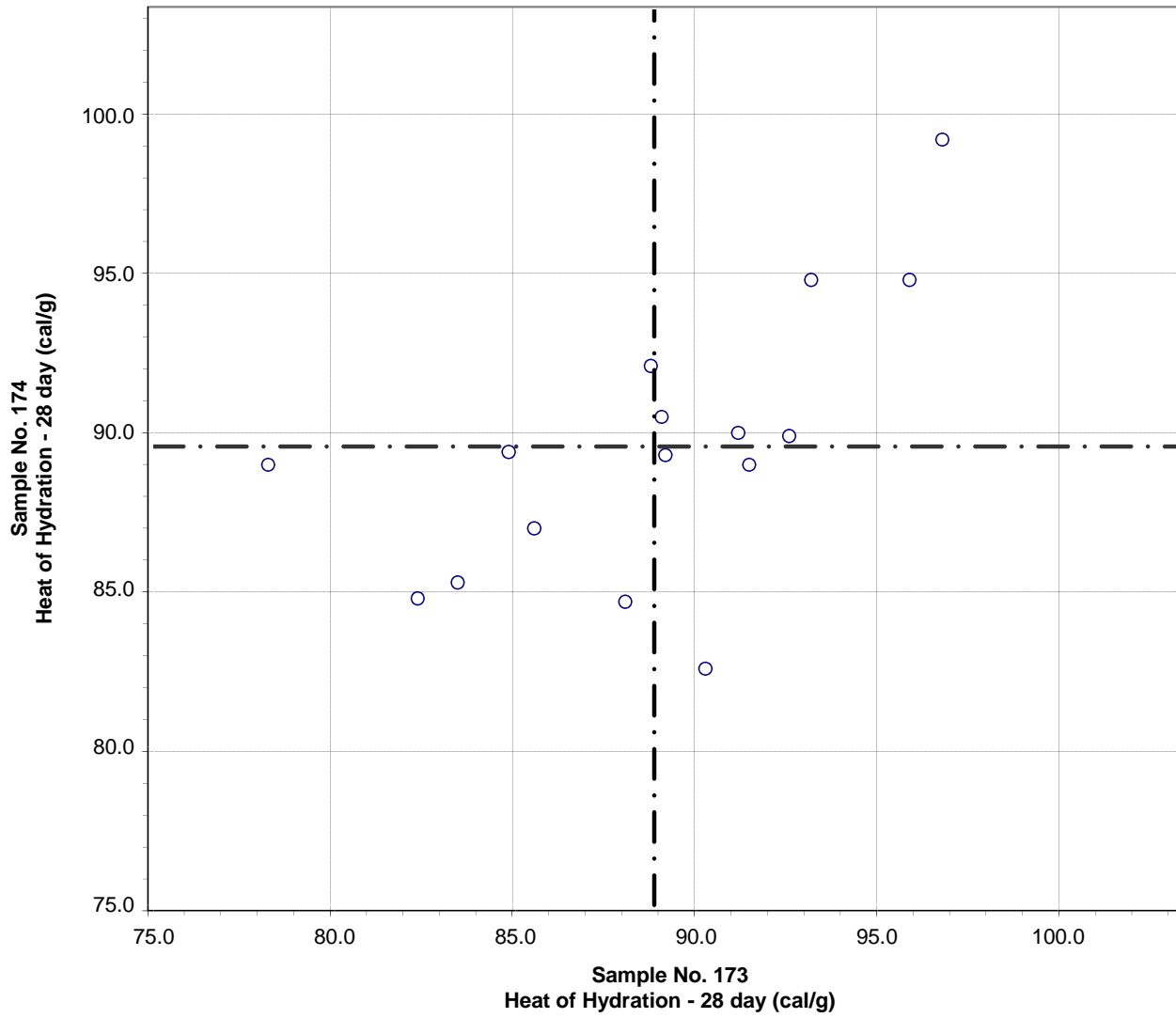
Test No. 290 Heat of Hydration - 7 day 20 Points

Sample No. 173	Ave 79.1	S.D. 6.4	C.V. 8.1
Sample No. 174	Ave 81.0	S.D. 7.6	C.V. 9.4

Labs eliminated: 3057

Labs off Diagram: 491, 1644

**CCRL Proficiency Sample Program
Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 173 and No. 174**



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

Sample No. 173	Ave 88.8	S.D. 5.0	C.V. 5.6
Sample No. 174	Ave 89.5	S.D. 4.3	C.V. 4.8