

CEMENT AND CONCRETE REFERENCE LABORATORY
PROFICIENCY SAMPLE PROGRAM

Final Report
Portland Cement Proficiency Samples
Number 171 and Number 172

March 2009



CCRL CEMENT AND CONCRETE
REFERENCE LABORATORY





March 27, 2009

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 171 and No. 172

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in January 2009. Portland Cement Sample No. 171 was an ASTM C150 Type V and No. 172 was an ASTM C150 Type I/II with 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 July 2009.

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. 171 and No. 172

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 January 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 this pair of samples, 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. 171 and No. 172
 Final Report - Chemical Results
 March 27, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 171			Sample No. 172		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Silicon Dioxide	prcnt 233	21.16	0.40	1.91	19.30	0.46	2.38
Silicon Dioxide	prcnt *223	21.19	0.22	1.02	19.30	0.26	1.37
Aluminum Oxide	prcnt 231	4.17	0.17	4.01	4.67	0.16	3.33
Aluminum Oxide	prcnt *223	4.16	0.12	2.78	4.66	0.11	2.35
Ferric Oxide	prcnt 234	4.51	0.18	3.90	2.94	0.12	4.22
Ferric Oxide	prcnt *221	4.53	0.081	1.80	2.93	0.046	1.56
Calcium Oxide	prcnt 232	63.56	0.59	0.935	61.78	0.60	0.967
Calcium Oxide	prcnt *228	63.60	0.42	0.660	61.78	0.48	0.773
Magnesium Oxide	prcnt 231	2.07	0.20	9.51	4.73	0.24	5.00
Magnesium Oxide	prcnt *222	2.06	0.072	3.49	4.74	0.116	2.46
Sulfur Trioxide	prcnt 237	2.27	0.38	16.8	3.22	0.40	12.6
Sulfur Trioxide	prcnt *223	2.24	0.071	3.17	3.21	0.090	2.80
Loss on Ignition	prcnt 238	1.04	0.17	16.61	2.077	0.19	9.34
Loss on Ignition	prcnt *227	1.02	0.085	8.32	2.09	0.112	5.35
Sodium Oxide	prcnt 216	0.072	0.057	79.5	0.265	0.068	25.5
Sodium Oxide	prcnt *201	0.065	0.022	33.3	0.267	0.038	14.4

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

Silicon Dioxide	24 51 870 1 93 218 270 1526 3009 3422
Aluminum Oxide	18 252 768 870 47 134 1526 2491
Ferric Oxide	51 870 1251 2491 20 93 375 605 1715 3009 3233 3297 3422
Calcium Oxide	270 870 2982 3422
Magnesium Oxide	870 1251 1 8 1526 2251 2466 2491 3249
Sulfur Trioxide	3 51 92 219 501 870 2435 43 207 1054 2491 3009 3127 3287
Loss on Ignition	181 201 870 1053 1054 415 690 886 2464 3235 3422
Sodium Oxide	98 107 116 168 209 870 354 1251 2305 2463 2484 3127 3233 3279 3297

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 171 and No. 172
 Final Report - Chemical Results
 March 27, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 171			Sample No. 172		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Potassium Oxide	prcnt 223	0.698	0.037	5.26	0.923	0.088	9.53
Potassium Oxide	prcnt *209	0.700	0.018	2.61	0.935	0.023	2.48
Titanium Dioxide	prcnt 184	0.22	0.020	8.98	0.26	0.015	5.58
Titanium Dioxide	prcnt *170	0.22	0.008	3.56	0.26	0.007	2.75
Phosphorus Pent	prcnt 176	0.068	0.044	64.0	0.116	0.045	38.6
Phosphorus Pent	prcnt *160	0.064	0.0054	8.54	0.111	0.0055	4.92
Zinc oxide	prcnt 73	0.016	0.0077	47.4	0.005	0.0059	109.6
Zinc oxide	prcnt * 67	0.016	0.0028	17.8	0.004	0.0023	55.0
Manganic Oxide	prcnt 129	0.053	0.032	59.6	0.089	0.019	21.3
Manganic Oxide	prcnt *119	0.050	0.0031	6.27	0.088	0.0036	4.07
Chloride	prcnt 106	0.012	0.019	162	0.011	0.015	129
Chloride	prcnt * 99	0.008	0.0040	50.0	0.008	0.0034	42.5
Insoluble Residue	prcnt 218	0.24	0.22	92.0	0.46	0.21	45.2
Insoluble Residue	prcnt *207	0.21	0.084	39.4	0.44	0.092	20.9
Free Calcium	prcnt 187	0.87	0.23	26.0	1.05	0.26	24.2
Free Calcium	prcnt *182	0.88	0.20	23.4	1.04	0.22	20.8

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

Potassium Oxide	24 94 870 1523 2039 36 46 176 694 975 1251 2492 3009 3144
Titanium Dioxide	125 244 504 2466 48 156 219 494 696 768 2296 2463 2621 3057
Phosphorous Pentoxide	684 413 504 687 1251 1644 2412 3233 27 125 132 137 139 1190 2477 3279
Zinc Oxide	139 768 457 1190 2296 2621
Manganic Oxide	408 2462 2477 3368 162 354 768 2296 3057 3422
Chloride	98 219 354 696 129 1466 2254
Insoluble Residue	1251 3297 222 694 696 1483 2464 2466 2491 3127 3422
Free Calcium Oxide	74 99 129 222 2491

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 171 and No. 172
 Final Report - Chemical Results
 March 27, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 171			Sample No. 172		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Carbon Dioxide	prcnt 182	---	---	---	1.4	0.19	13.7
Carbon Dioxide	prcnt *179	---	---	---	1.4	0.16	11.9
Limestone Content	prcnt 180	---	---	---	3.2	0.42	12.9
Limestone Content	prcnt *176	---	---	---	3.1	0.26	8.3
Chromium Oxide	prcnt 71	0.014	0.014	103	0.011	0.011	101
Chromium Oxide	prcnt * 66	0.011	0.0027	23.6	0.009	0.0031	36.3
⁽¹⁾ Tricalcium Silicate	prcnt 176	56.8	2.7	4.7	54.4	3.9	7.2
⁽¹⁾ Tricalcium Silicate	prcnt *173	57.0	2.4	4.2	54.4	3.9	7.1
⁽¹⁾ Dicalcium Silicate	prcnt 176	17.8	2.6	14.5	14.1	3.4	24.3
⁽¹⁾ Dicalcium Silicate	prcnt *171	17.8	2.2	12.3	14.1	3.3	23.8
Tricalc Aluminate	prcnt 202	3.4	0.55	16.17	7.4	0.62	8.31
Tricalc Aluminate	prcnt *191	3.4	0.30	8.95	7.4	0.27	3.67
Tetracalc Alumino	prcnt 201	13.7	0.90	6.61	8.9	0.41	4.58
Tetracalc Alumino	prcnt *190	13.8	0.25	1.82	8.9	0.13	1.50

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

Carbon Dioxide	26 169 695 2296 2363 2463 162 222 881
Limestone Content	162 169 695 881 2296 222 1715 1025 1054
Chromium Oxide	95 684 15 408 1466
Tricalcium Silicate	176 270 2464
Dicalcium Silicate	24 93 270 407 2464
Tricalcium Aluminate	18 78 407 870 1251 46 47 48 134 252 2491
Tetracalcium Aluminoferrite	134 157 407 870 93 218 375 605 1251 1715 2491

NOTES:

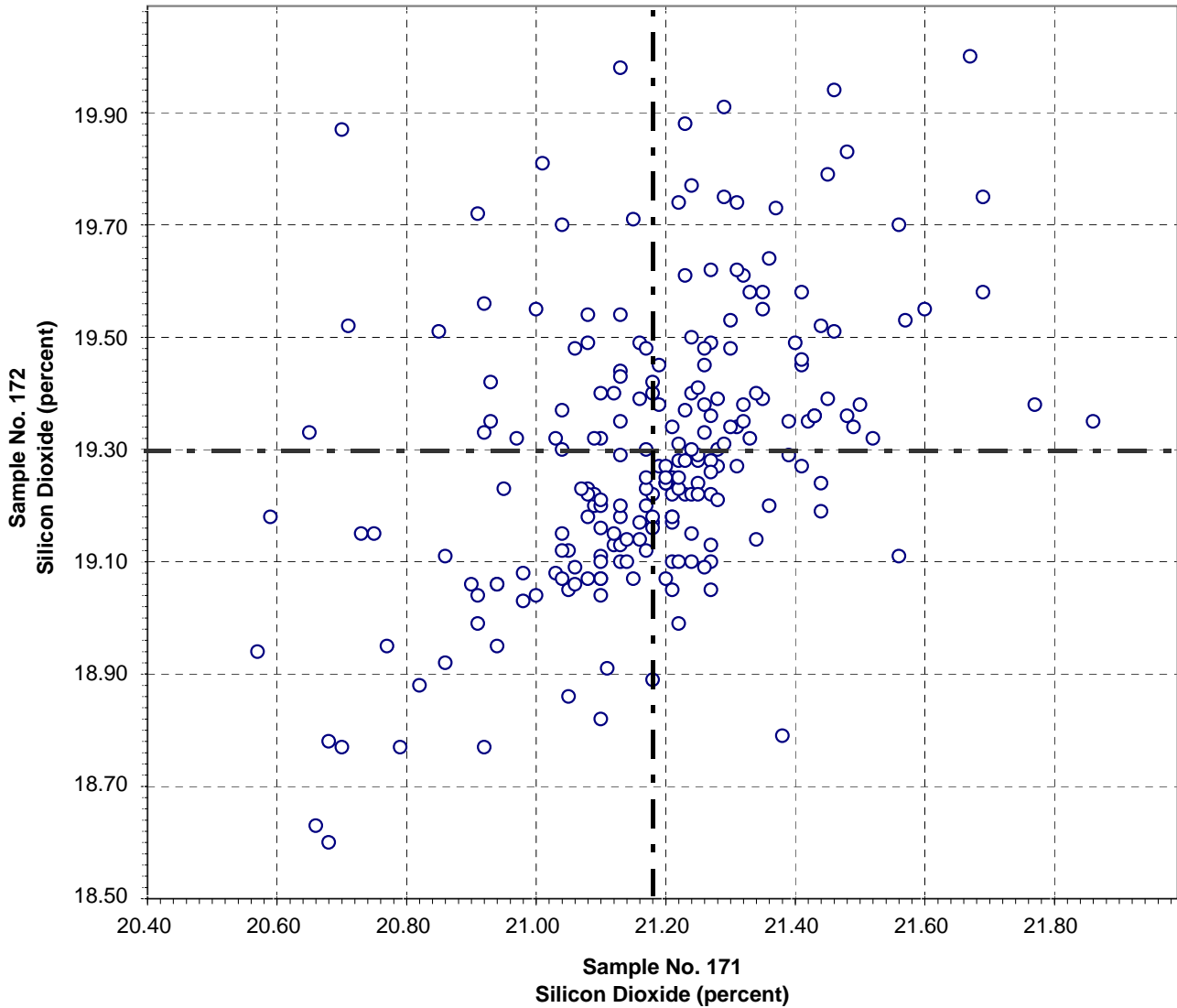
(1) Tricalcium silicate and Dicalcium silicate - ASTM C150 requires that cements containing limestone additions use CO₂ in the calculation of these two phases. Sample 172 contains limestone additions, therefore, test results of 24 laboratories not determining CO₂ were not used in calculating the statistics. 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	1190
80	1196
86	1251
90	1525
95	1940
98	2021
181	2435
218	2483
504	3127
542	3279
557	3297
696	
870	

**CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 171 and No. 172**



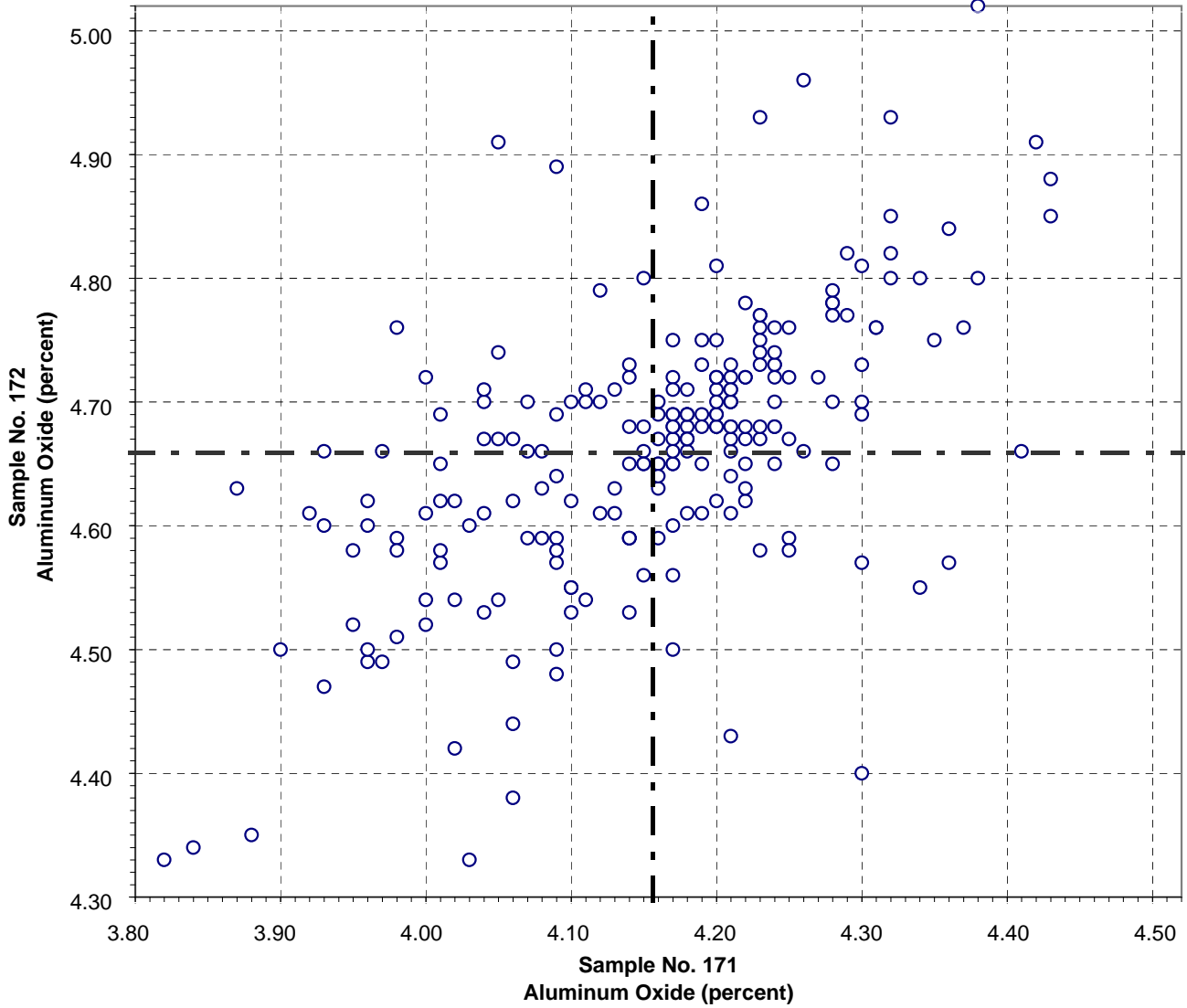
Test No. 10 Silicon Dioxide 220 Points

Sample No. 171 Ave 21.19 S.D. 0.22 C.V. 1.02
 Sample No. 172 Ave 19.30 S.D. 0.26 C.V. 1.37

Labs eliminated: 24, 51, 870, 1, 93, 218, 270, 1526, 3009, 3422

Labs off Diagram: 159, 176, 201

**CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**

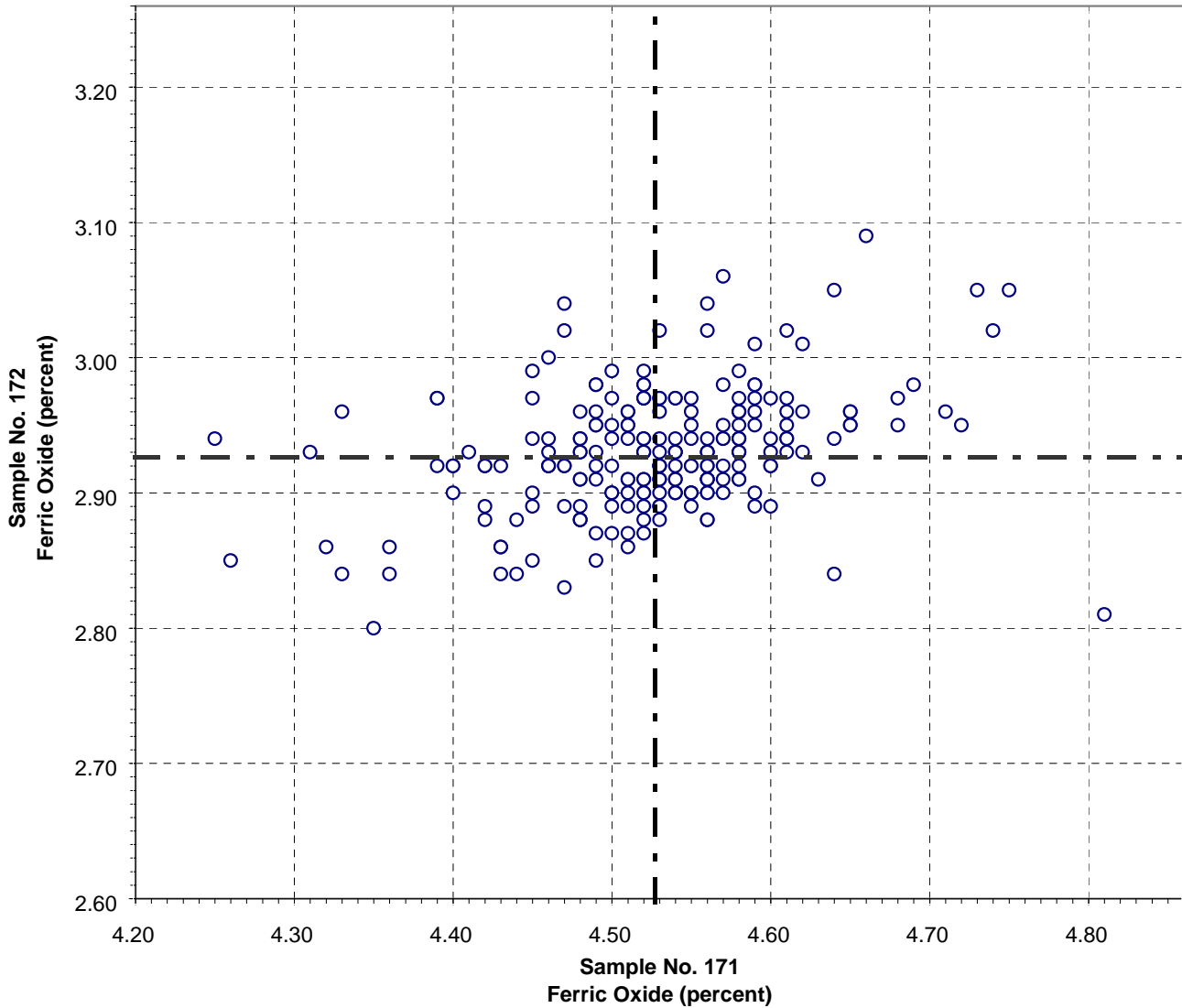


Test No. 21 Aluminum Oxide 223 Points

Sample No. 171	Ave 4.16	S.D. 0.12	C.V. 2.78
Sample No. 172	Ave 4.66	S.D. 0.11	C.V. 2.35

Labs eliminated: 18, 252, 768, 870, 47, 134, 1526, 2491

**CCRL Proficiency Sample Program
 Ferric Oxide
 PORTLAND CEMENT Samples No. 171 and No. 172**

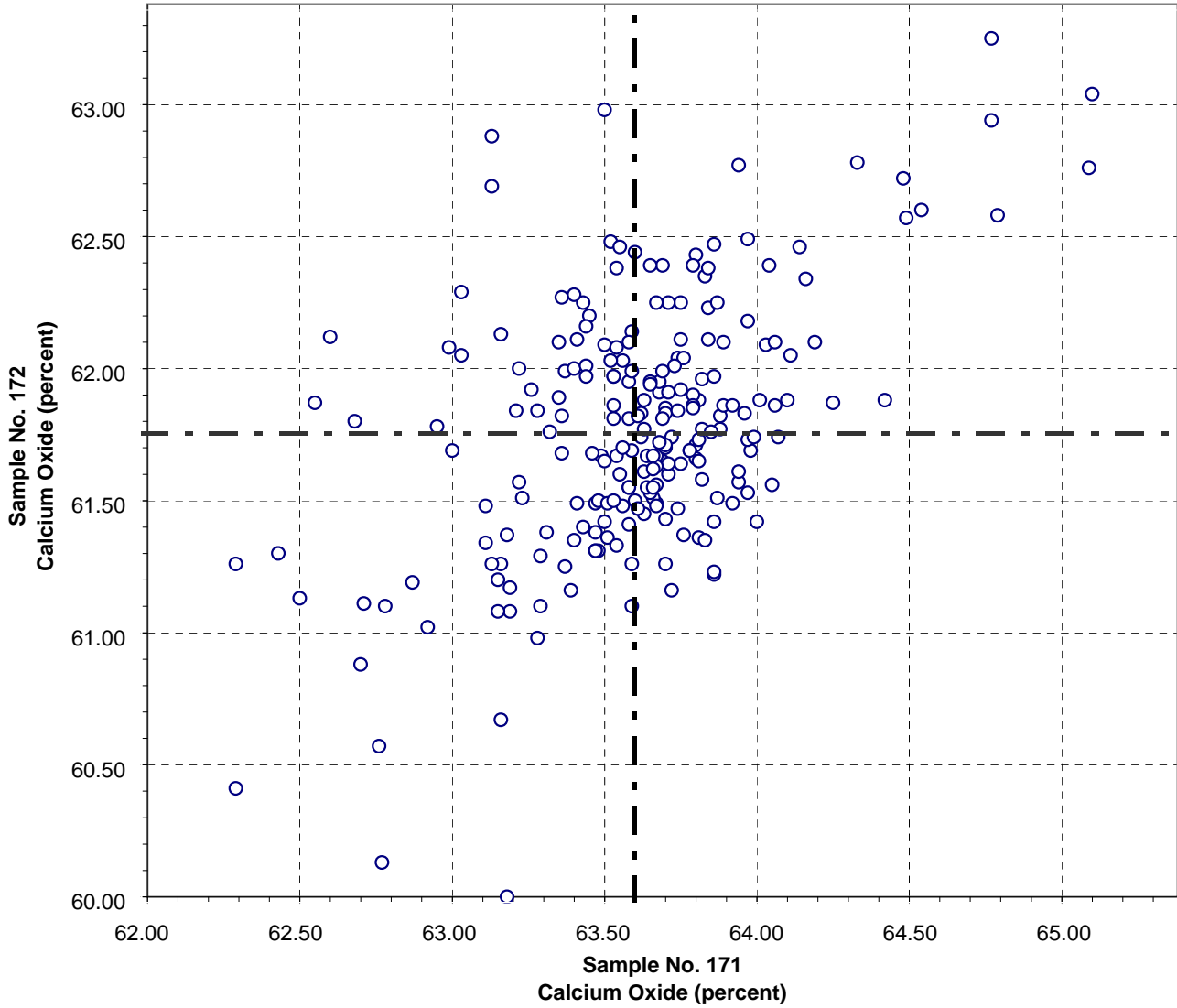


Test No. 30 Ferric Oxide 221 Points

Sample No. 171	Ave 4.53	S.D. 0.081	C.V. 1.80
Sample No. 172	Ave 2.93	S.D. 0.046	C.V. 1.56

Labs eliminated: 51, 870, 1251, 2491, 20, 93, 375, 605, 1715, 3009, 3233, 3297, 3422

**CCRL Proficiency Sample Program
Calcium Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**

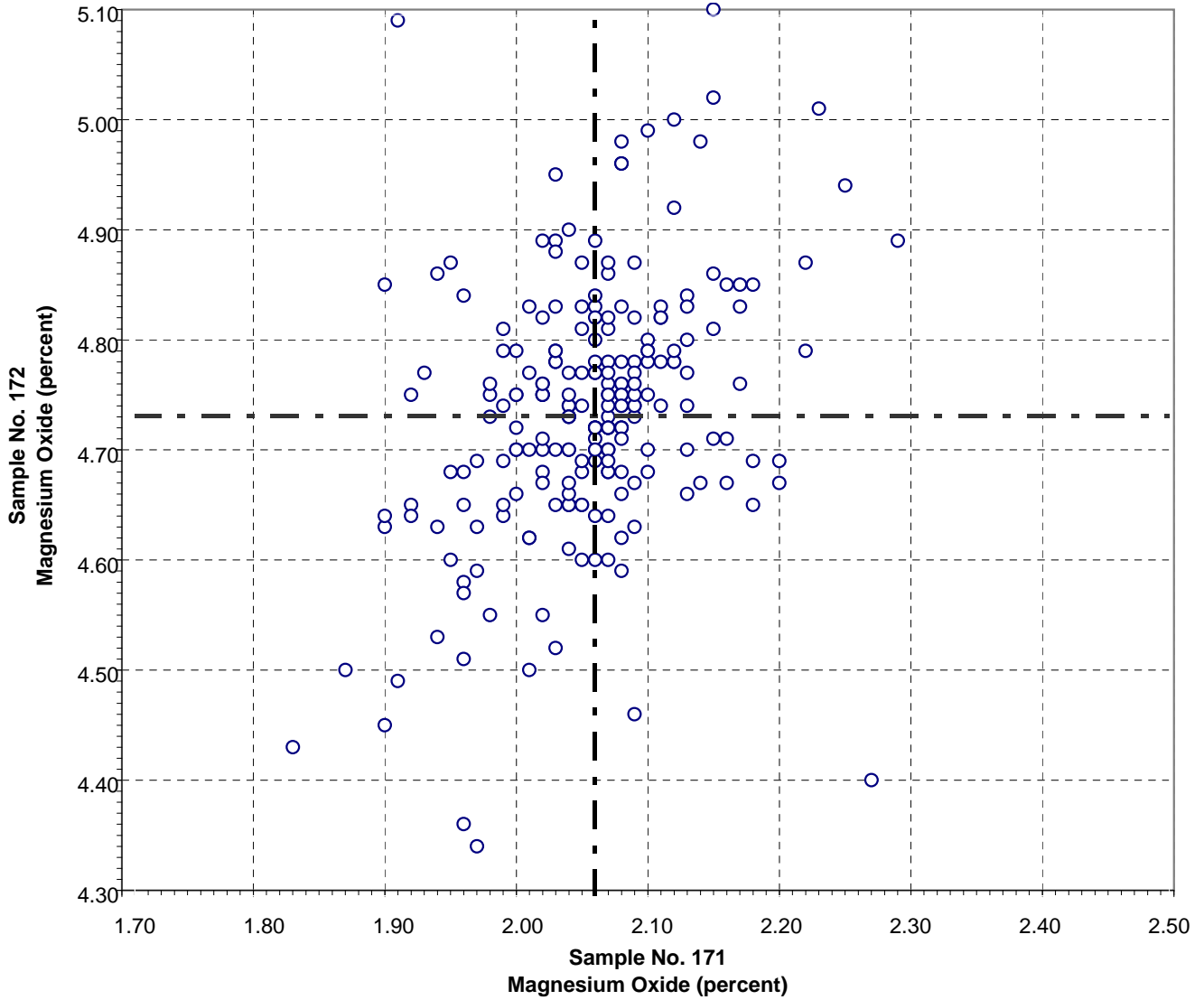


Test No. 40 Calcium Oxide 228 Points

Sample No. 171	Ave 63.60	S.D. 0.42	C.V. 0.660
Sample No. 172	Ave 61.78	S.D. 0.48	C.V. 0.773

Labs eliminated: 270, 870, 2982, 3422

**CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**

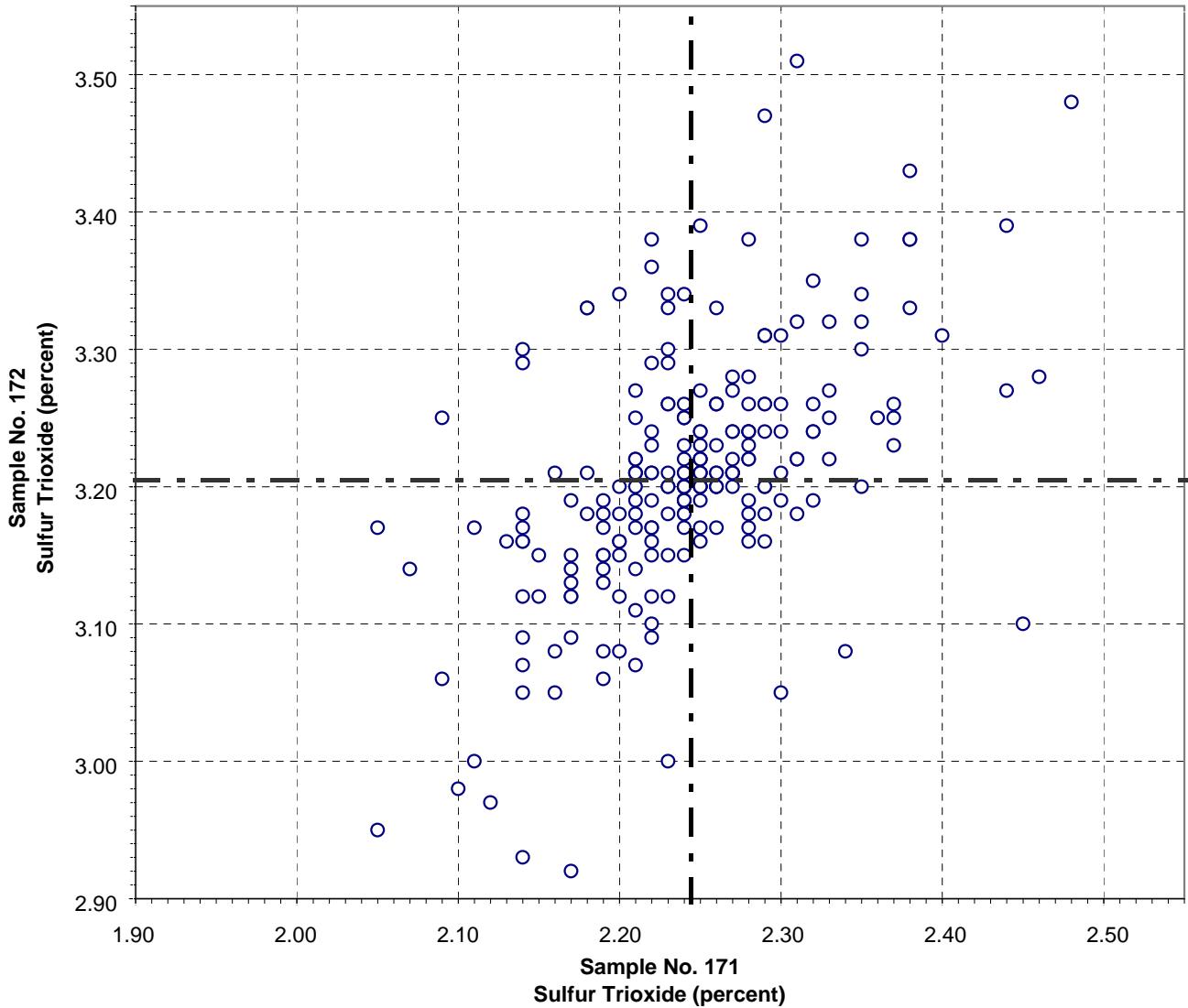


Test No. 50 Magnesium Oxide 222 Points

Sample No. 171	Ave 2.06	S.D. 0.072	C.V. 3.49
Sample No. 172	Ave 4.74	S.D. 0.116	C.V. 2.46

Labs eliminated: 870, 1251, 1, 8, 1526, 2251, 2466, 2491, 3249

**CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 171 and No. 172**

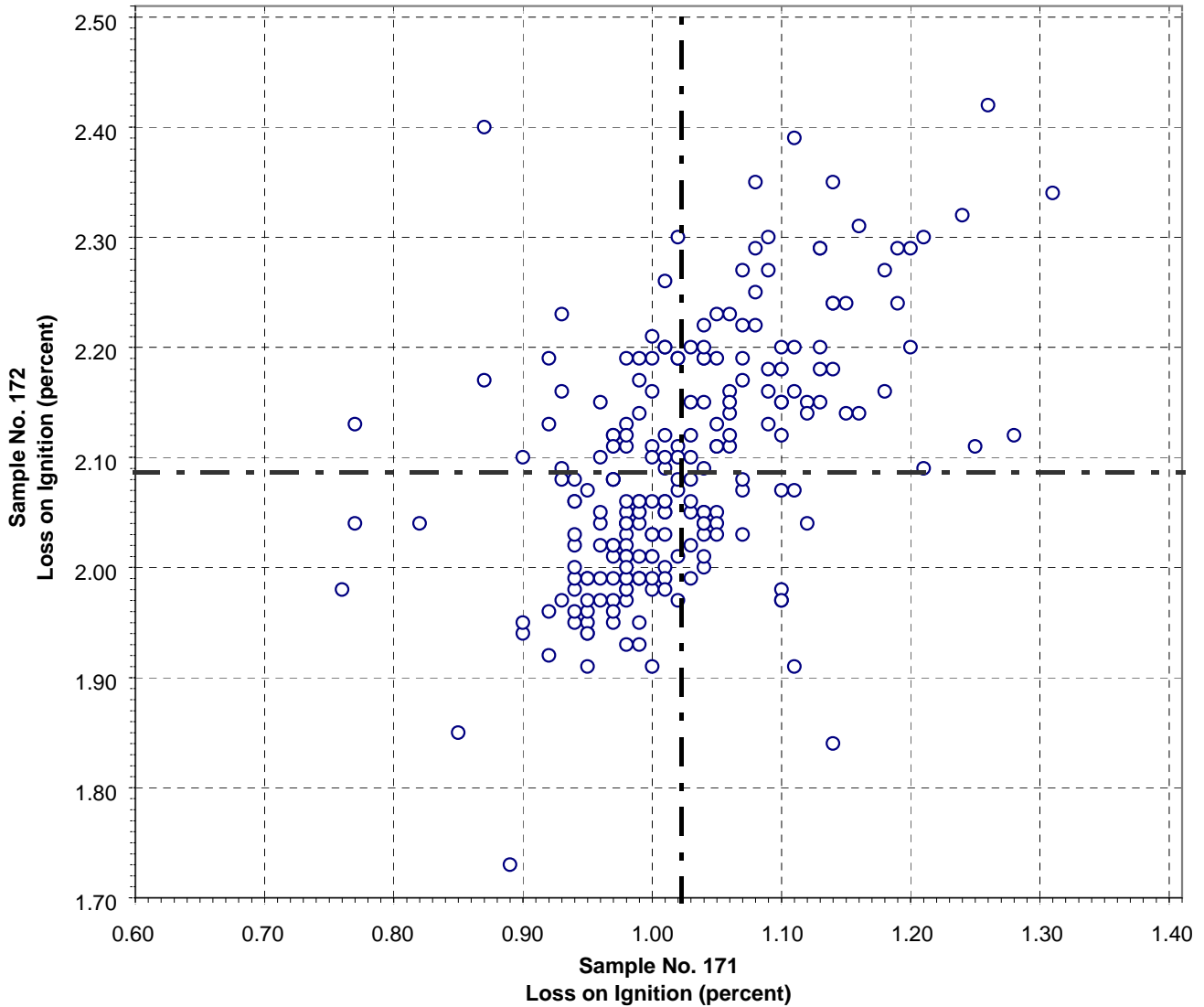


Test No. 60 Sulfur Trioxide 223 Points

Sample No. 171	Ave 2.24	S.D. 0.071	C.V. 3.17
Sample No. 172	Ave 3.21	S.D. 0.090	C.V. 2.80

Labs eliminated: 3, 51, 92, 219, 501, 870, 2435, 43, 207, 1054, 2491, 3009, 3127, 3287

**CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 171 and No. 172**

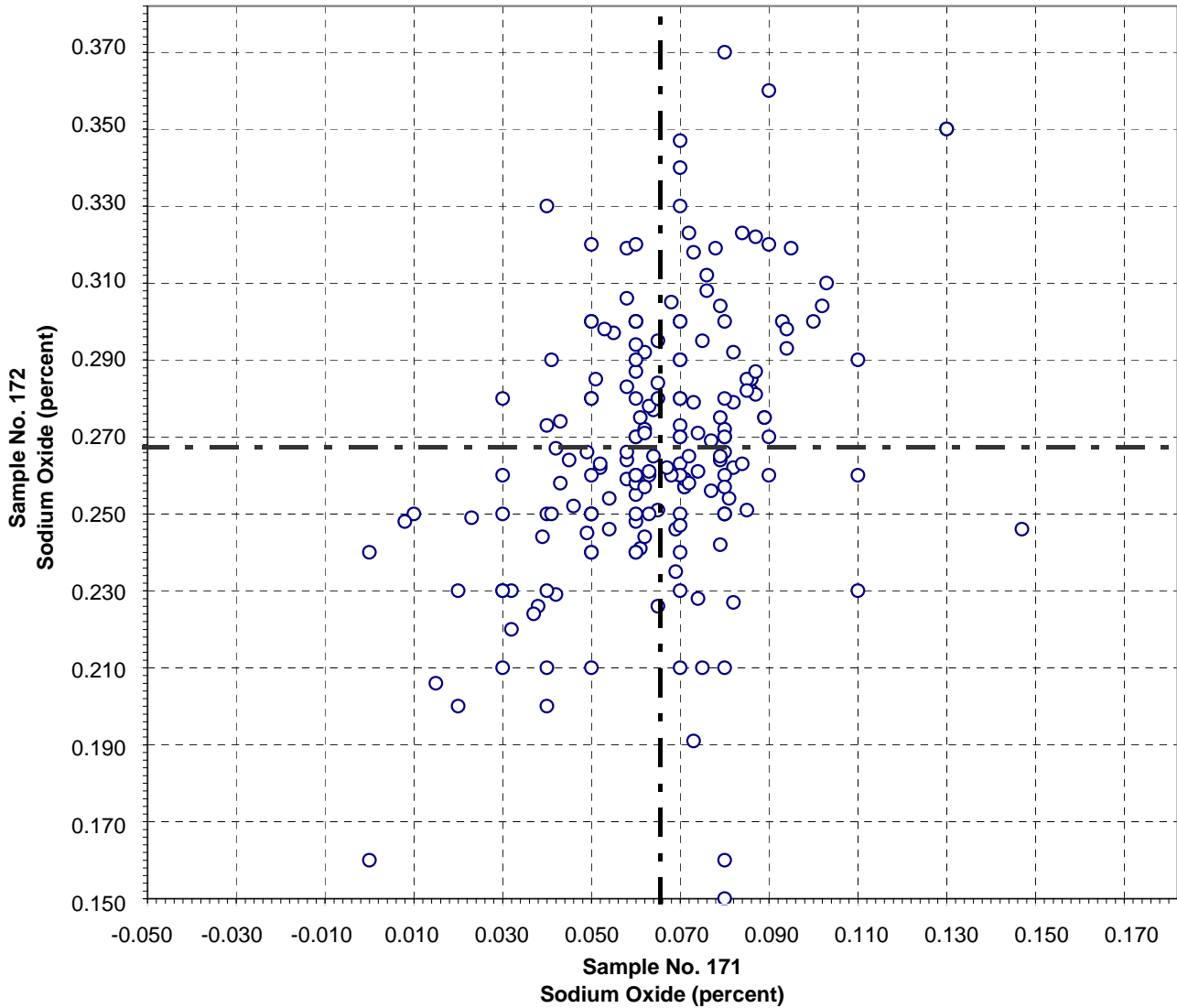


Test No. 70 Loss on Ignition 227 Points

Sample No. 171 Ave 1.02 S.D. 0.085 C.V. 8.32
 Sample No. 172 Ave 2.09 S.D. 0.112 C.V. 5.35

Labs eliminated: 181, 201, 870, 1053, 1054, 415, 690, 886, 2464, 3235, 3422

**CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**



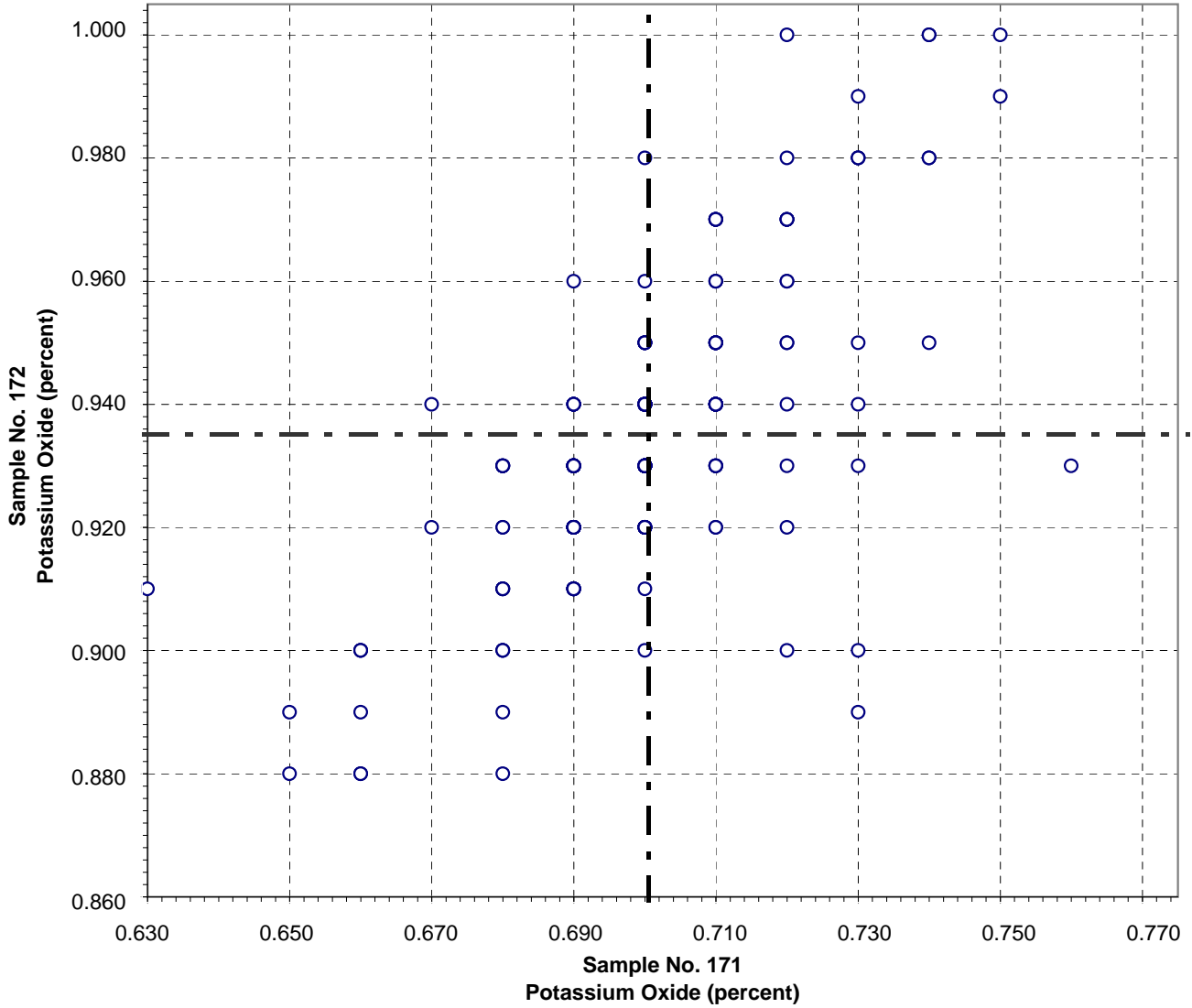
Test No. 90 Sodium Oxide 197 Points

Sample No. 171	Ave 0.065	S.D. 0.022	C.V. 33.3
Sample No. 172	Ave 0.267	S.D. 0.038	C.V. 14.4

Labs eliminated: 98, 107, 116, 168, 209, 870, 354, 1251, 2305, 2463, 2484, 3127, 3233, 3279, 3297

Labs off Diagram: 1196, 2363, 2466, 3057

**CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**



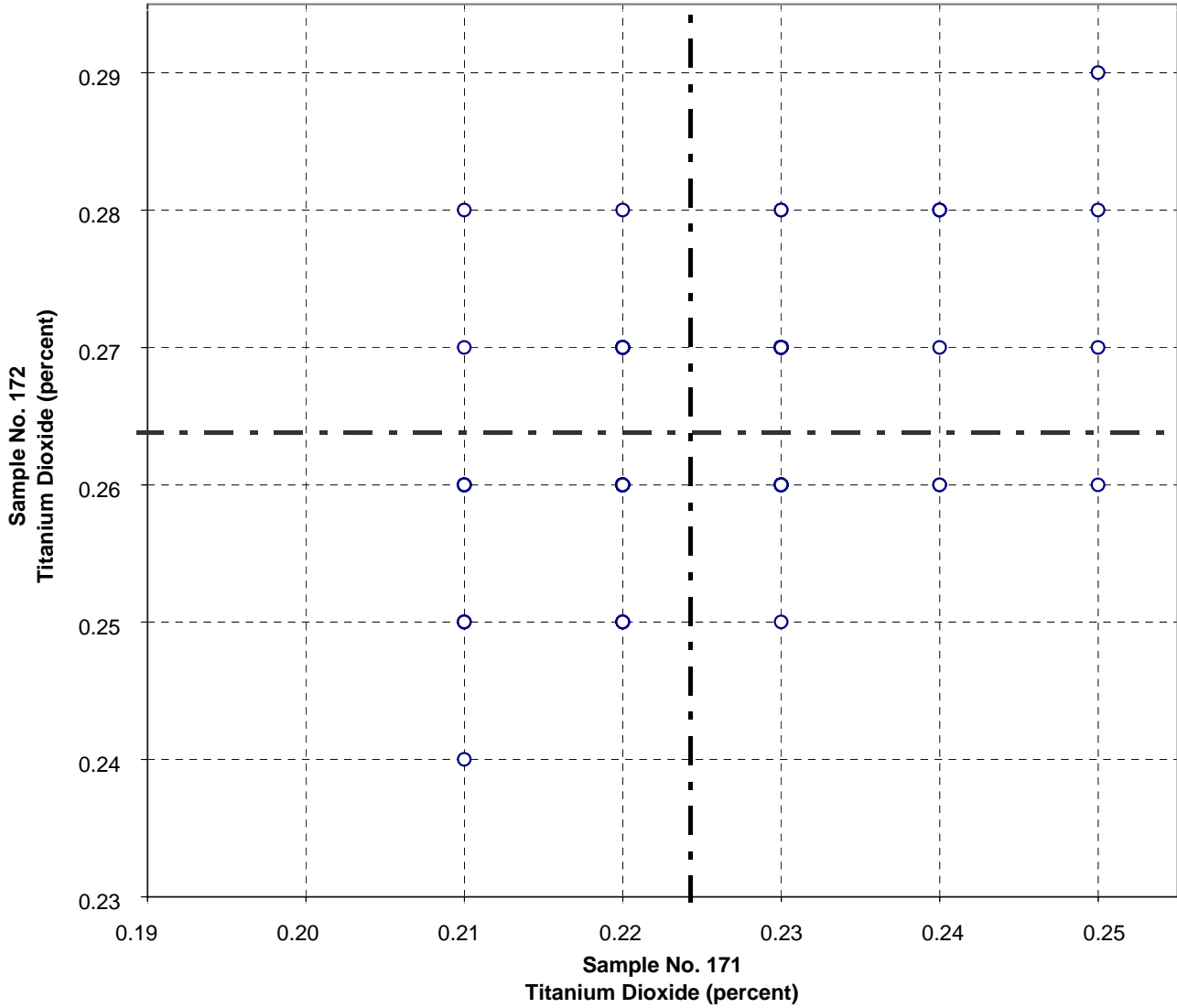
Test No. 100 Potassium Oxide 208 Points

Sample No. 171 Ave 0.700 S.D. 0.018 C.V. 2.61
 Sample No. 172 Ave 0.935 S.D. 0.023 C.V. 2.48

Labs eliminated: 24, 94, 870, 1523, 2039, 36, 46, 176, 694, 975, 1251, 2492, 3009, 3144

Labs off Diagram: 20

**CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 171 and No. 172**

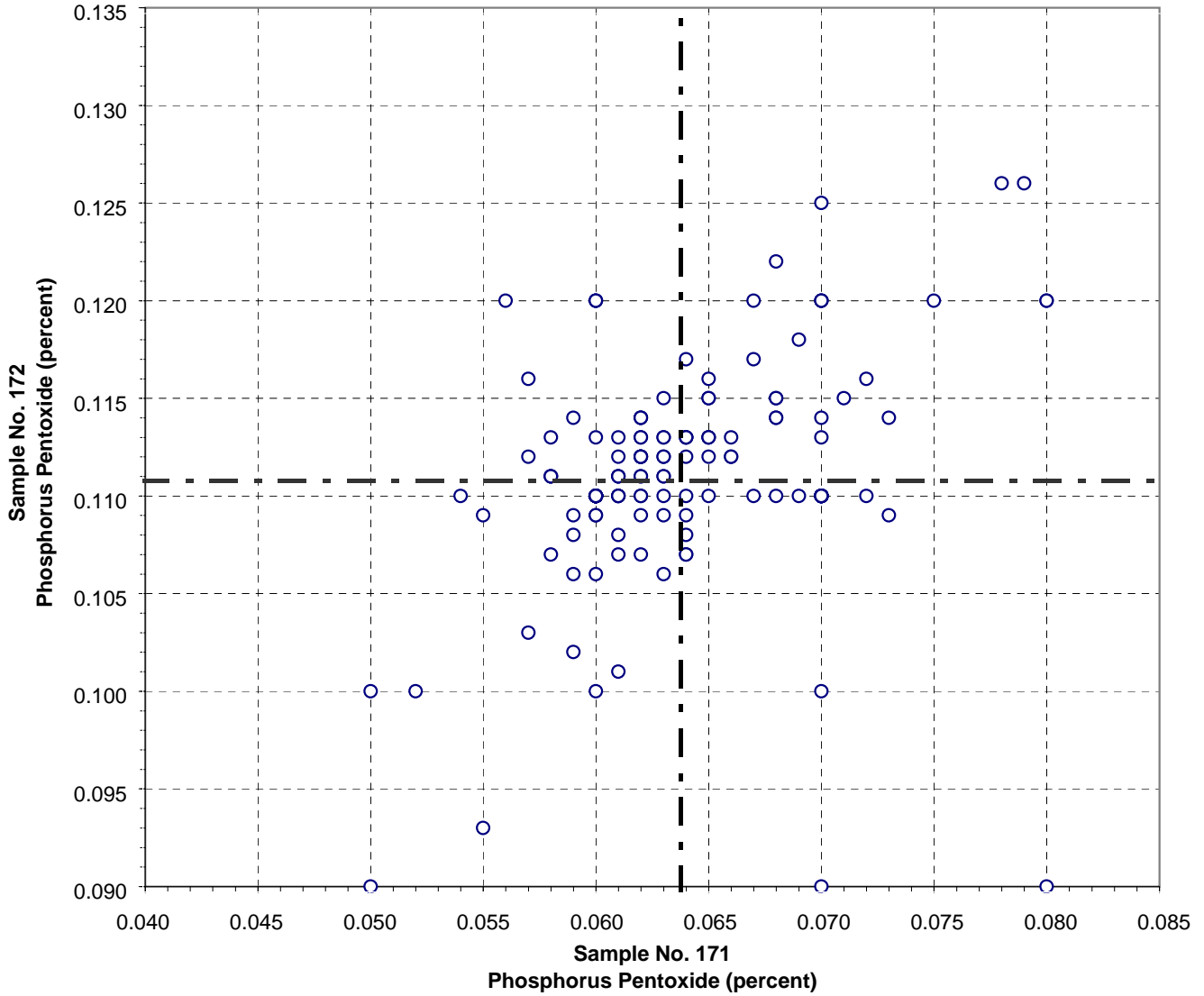


Test No. 103 Titanium Dioxide 170 Points

Sample No. 171 Ave 0.22 S.D. 0.008 C.V. 3.56
 Sample No. 172 Ave 0.26 S.D. 0.007 C.V. 2.75

Labs eliminated: 125, 244, 504, 2466, 48, 156, 219, 494, 696, 768, 2296, 2463, 2621, 3057

**CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 171 and No. 172**

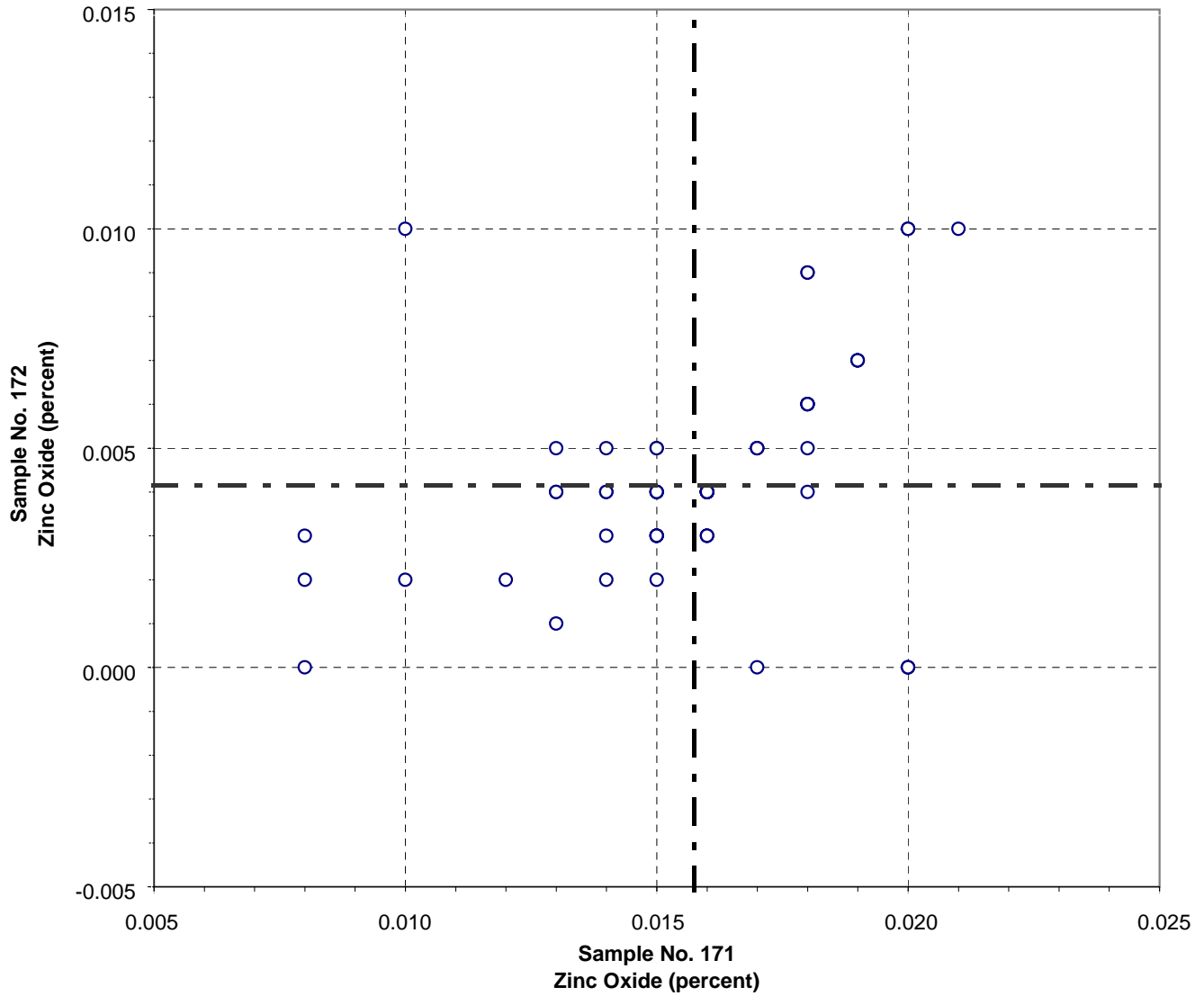


Test No. 102 Phosphorus Pentoxide 160 Points

Sample No. 171 Ave 0.064 S.D. 0.0054 C.V. 8.54
 Sample No. 172 Ave 0.111 S.D. 0.0055 C.V. 4.92

Labs eliminated: 684, 413, 504, 687, 1251, 1644, 2412, 3233, 27, 125, 132, 137, 139, 1190, 2477, 3279

**CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**

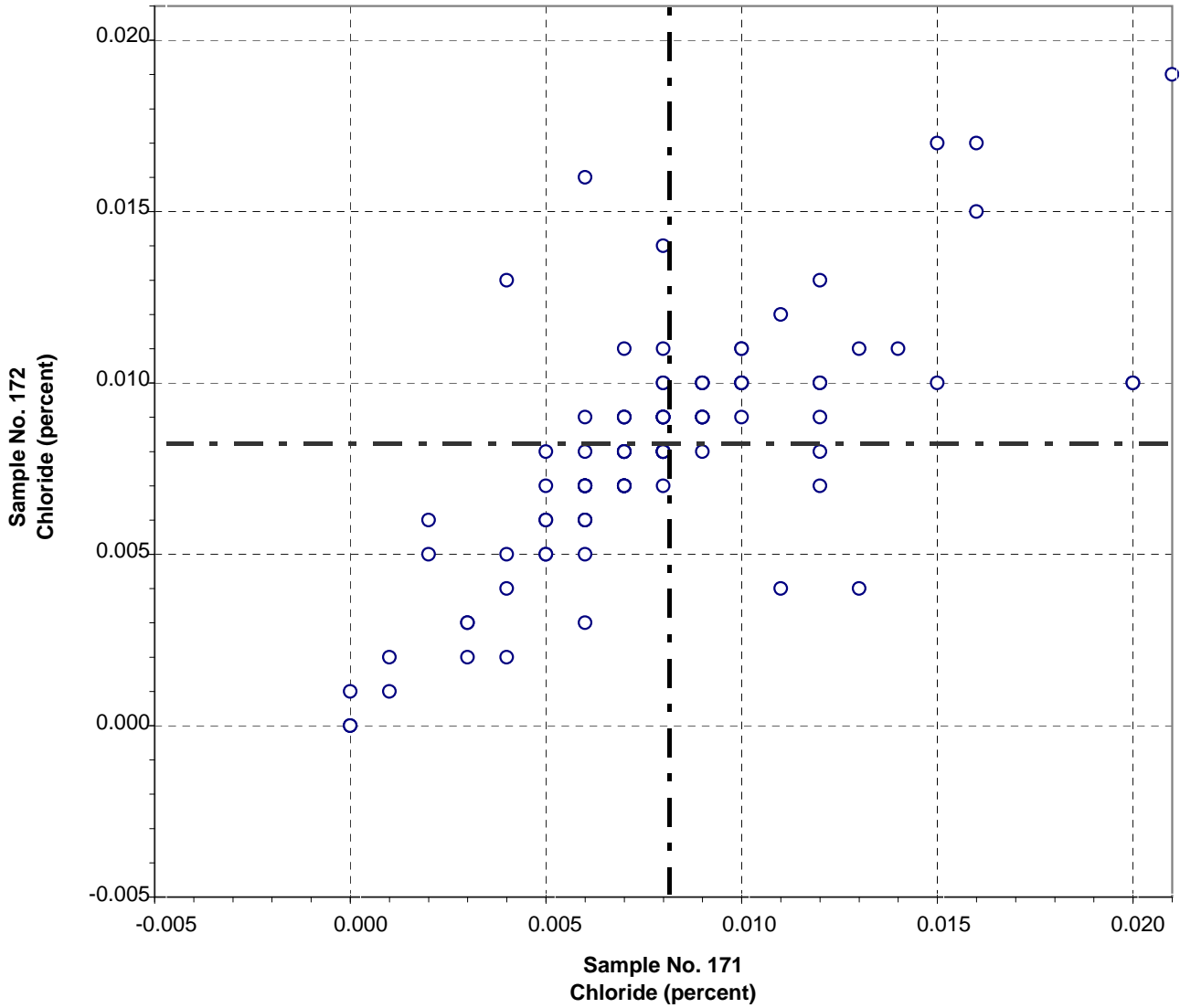


Test No. 99 Zinc Oxide 67 Points

Sample No. 171 Ave 0.016 S.D. 0.0028 C.V. 17.8
 Sample No. 172 Ave 0.004 S.D. 0.0023 C.V. 55.0

Labs eliminated: 139, 768, 457, 1190, 2296, 2621

**CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 171 and No. 172**

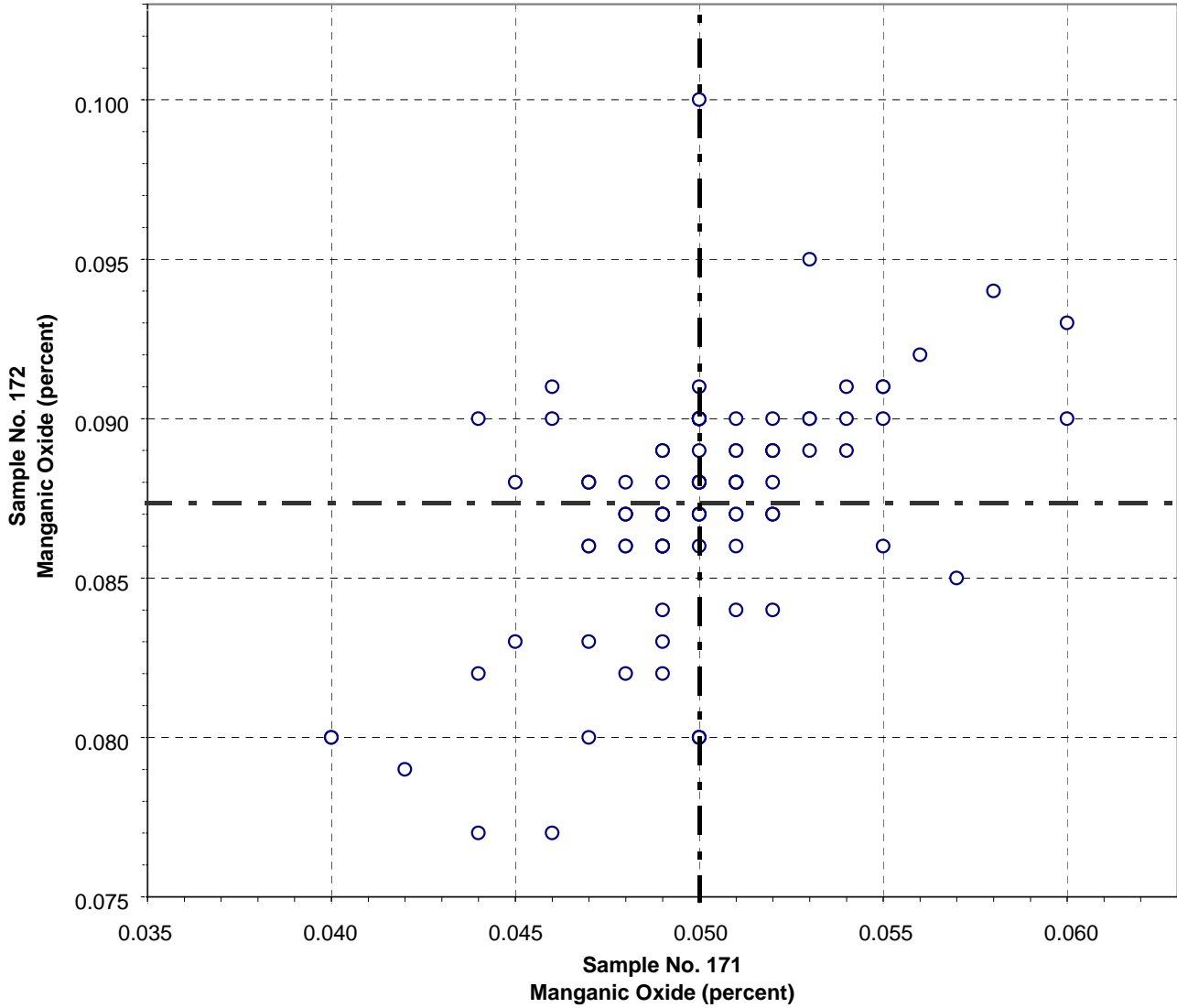


Test No. 104 Chloride 99 Points

Sample No. 171	Ave 0.008	S.D. 0.0040	C.V. 50.0
Sample No. 172	Ave 0.008	S.D. 0.0034	C.V. 42.5

Labs eliminated: 98, 219, 354, 696, 129, 1466, 2254

**CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**

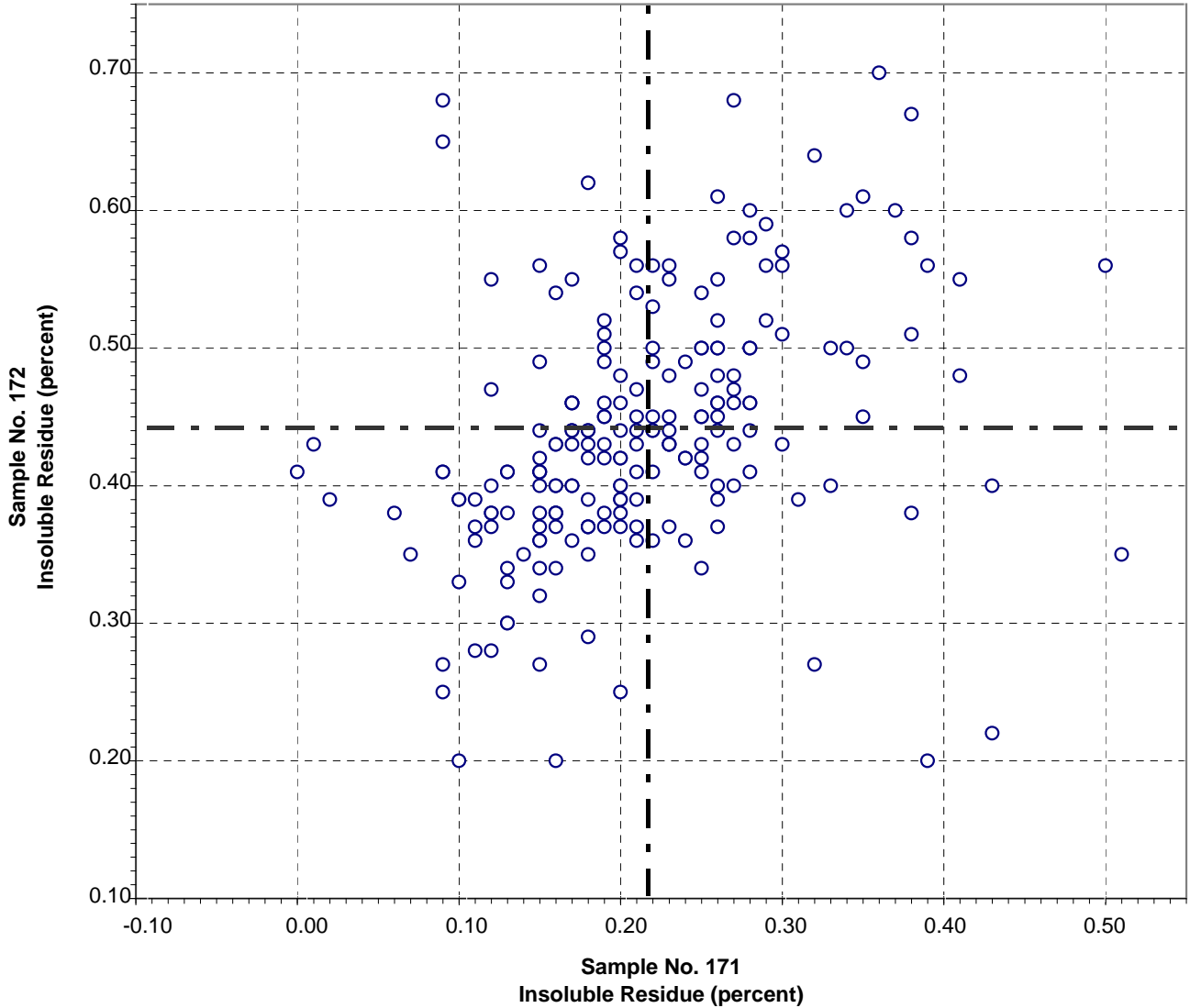


Test No. 101 Manganic Oxide 119 Points

Sample No. 171	Ave 0.050	S.D. 0.0031	C.V. 6.27
Sample No. 172	Ave 0.088	S.D. 0.0036	C.V. 4.07

Labs eliminated: 408, 2462, 2477, 3368, 162, 354, 768, 2296, 3057, 3422

**CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 171 and No. 172**

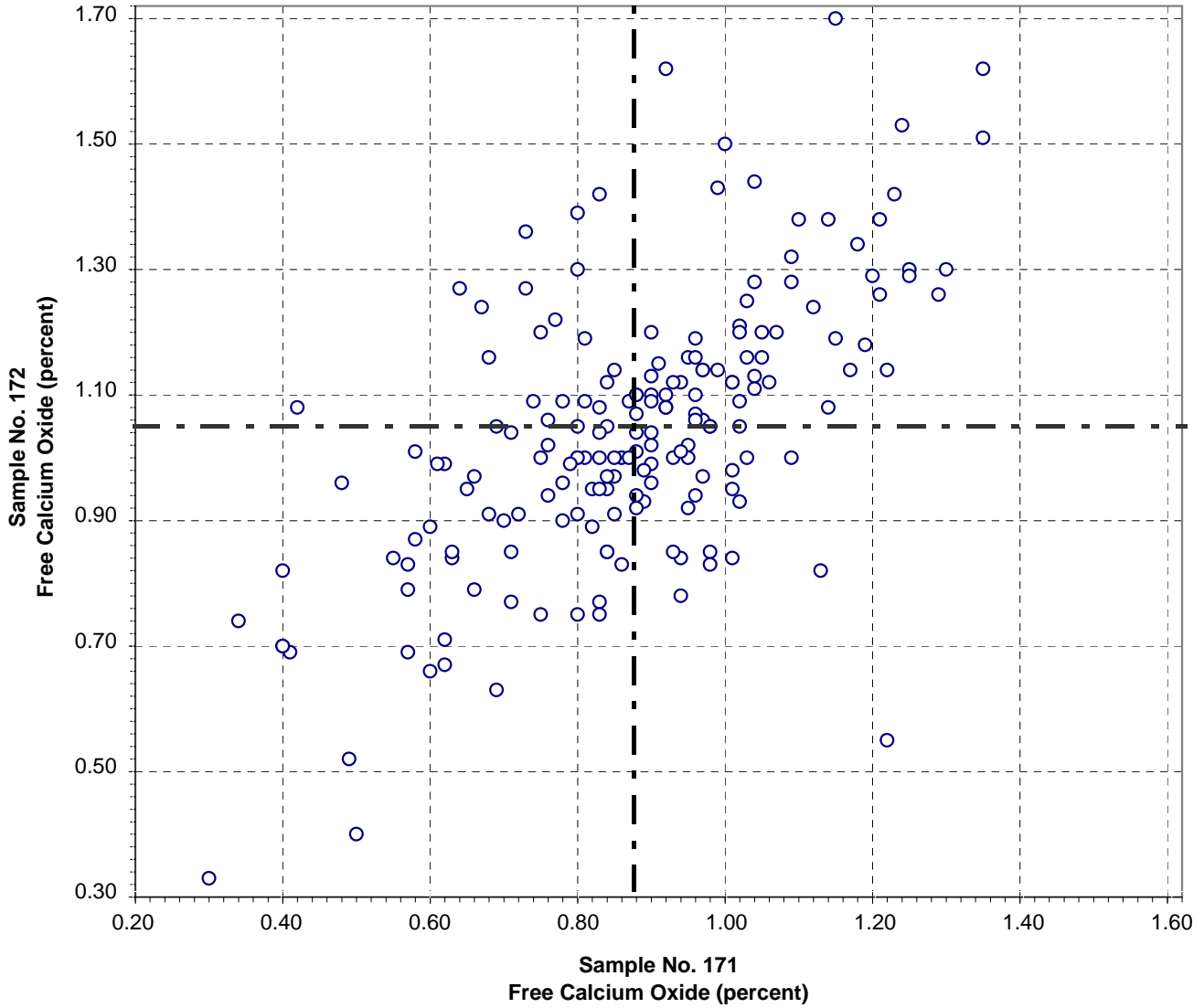


Test No. 80 Insoluble Residue 207 Points

Sample No. 171	Ave 0.21	S.D. 0.084	C.V. 39.4
Sample No. 172	Ave 0.44	S.D. 0.092	C.V. 20.9

Labs eliminated: 1251, 3297, 222, 694, 696, 1483, 2464, 2466, 2491, 3127, 3422

**CCRL Proficiency Sample Program
Free Calcium Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**



Test No. 41 Free Calcium Oxide 182 Points

Sample No. 171 Ave 0.88 S.D. 0.20 C.V. 23.4
 Sample No. 172 Ave 1.04 S.D. 0.22 C.V. 20.8

Labs eliminated: 74, 99, 129, 222, 2491

CCRL PROFICIENCY SAMPLE PROGRAM
Carbon Dioxide
PORTLAND CEMENT SAMPLES NO. 171 & NO. 172

No Diagram Printed for this Component

Sample No. 171 did not
Contain Limestone Additions.
Test Results Were Analyzed for
Sample No. 172 Only.

TEST NO. 97	Carbon Dioxide	179 labs
Sample No. 172	AVE 1.4	S.D. 0.16 C.V. 11.9

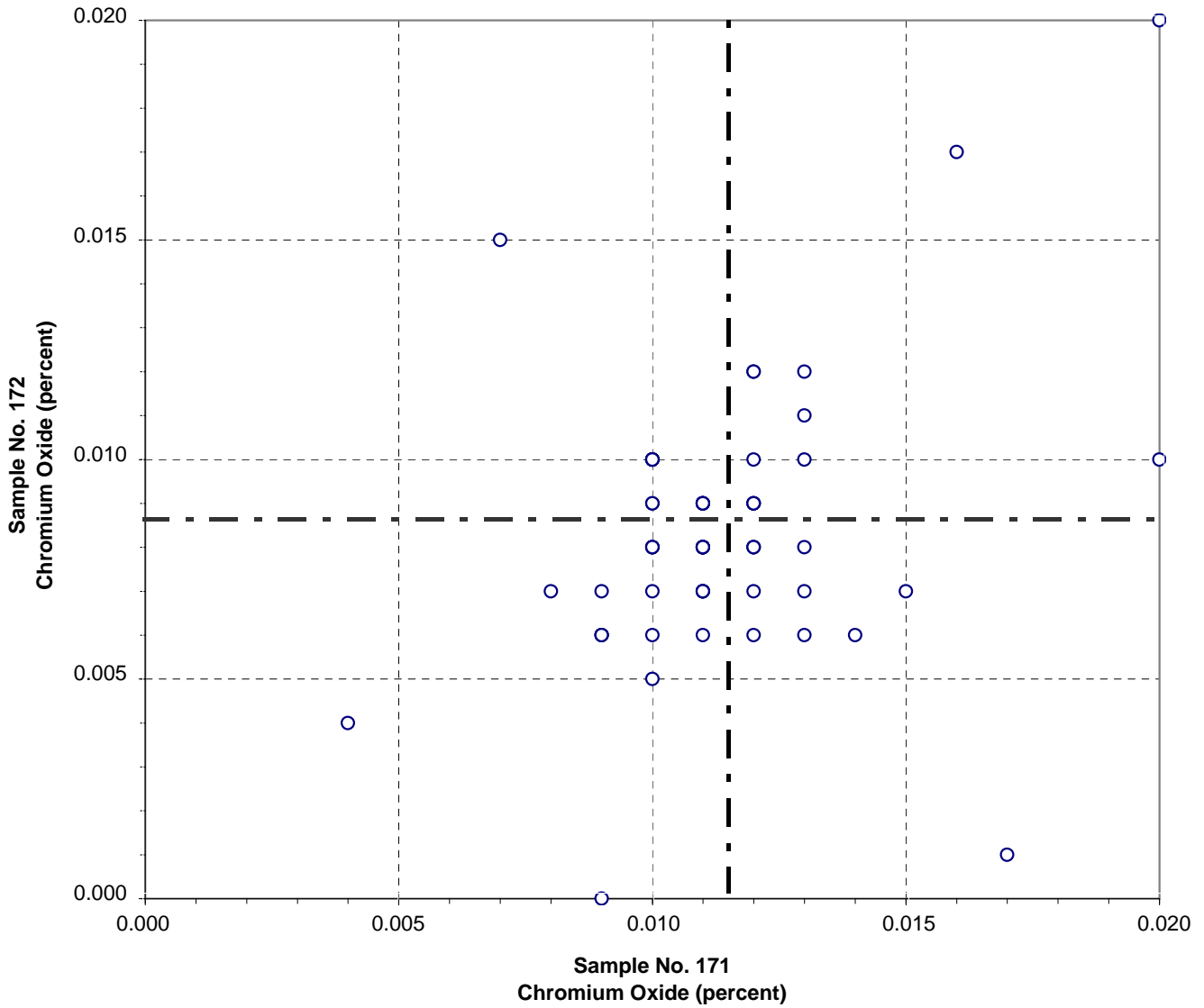
CCRL PROFICIENCY SAMPLE PROGRAM
Limestone Content
PORTLAND CEMENT SAMPLES NO. 171 & NO. 172

No Diagram Printed for this Component

Sample No. 171 did not
Contain Limestone Additions.
Test Results Were Analyzed for
Sample No. 172 Only.

TEST NO. 98	Limestone Content	176 labs
Sample No. 172	AVE 3.1	S.D. 0.26 C.V. 8.3

**CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 171 and No. 172**



Test No. 105

Chromium Oxide

65 Points

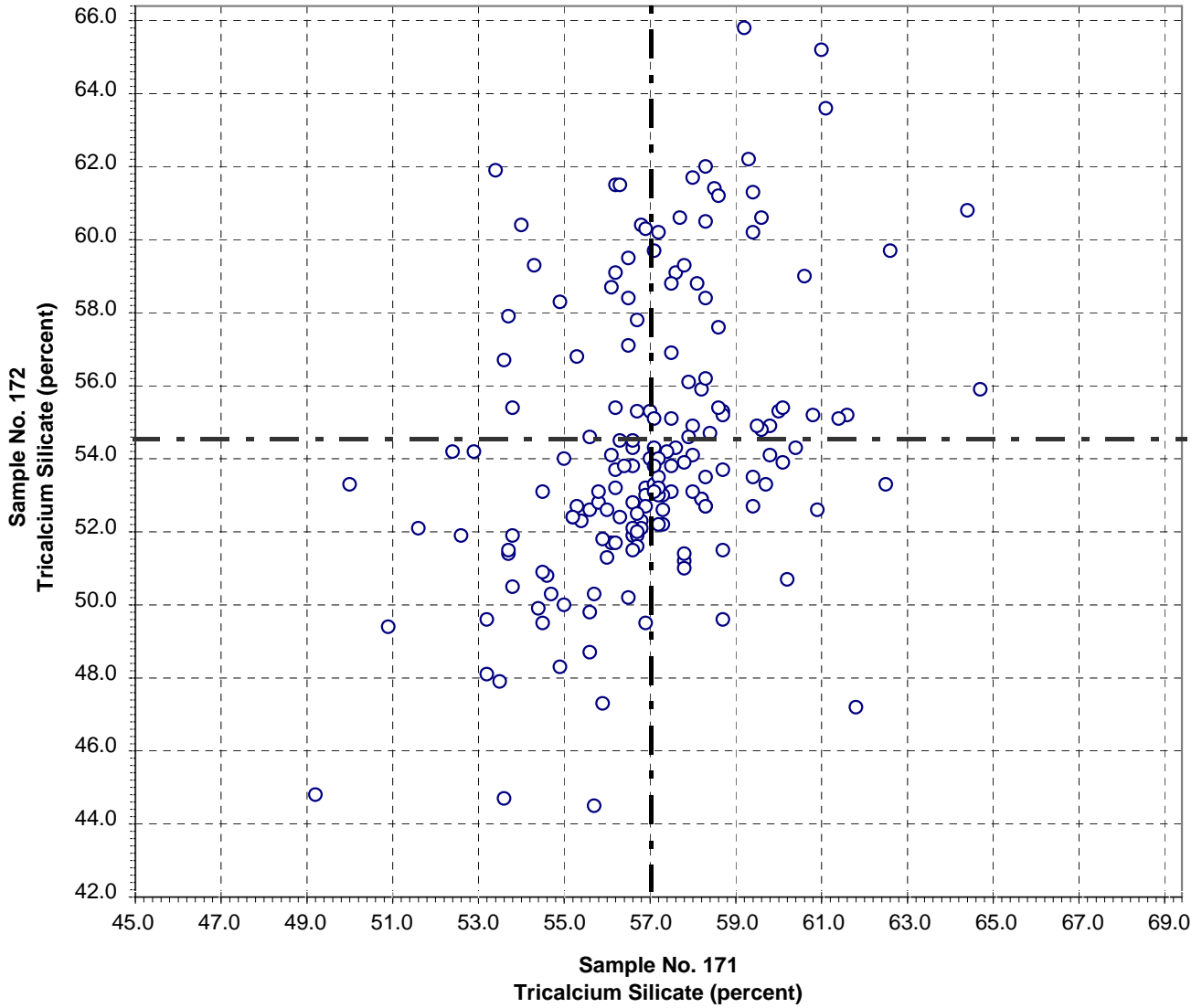
Sample No. 171 Ave 0.011 S.D. 0.0027 C.V. 23.6

Sample No. 172 Ave 0.009 S.D. 0.0031 C.V. 36.3

Labs eliminated: 95, 684, 15, 408, 1466

Labs off Diagram: 2462

**CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 171 and No. 172**

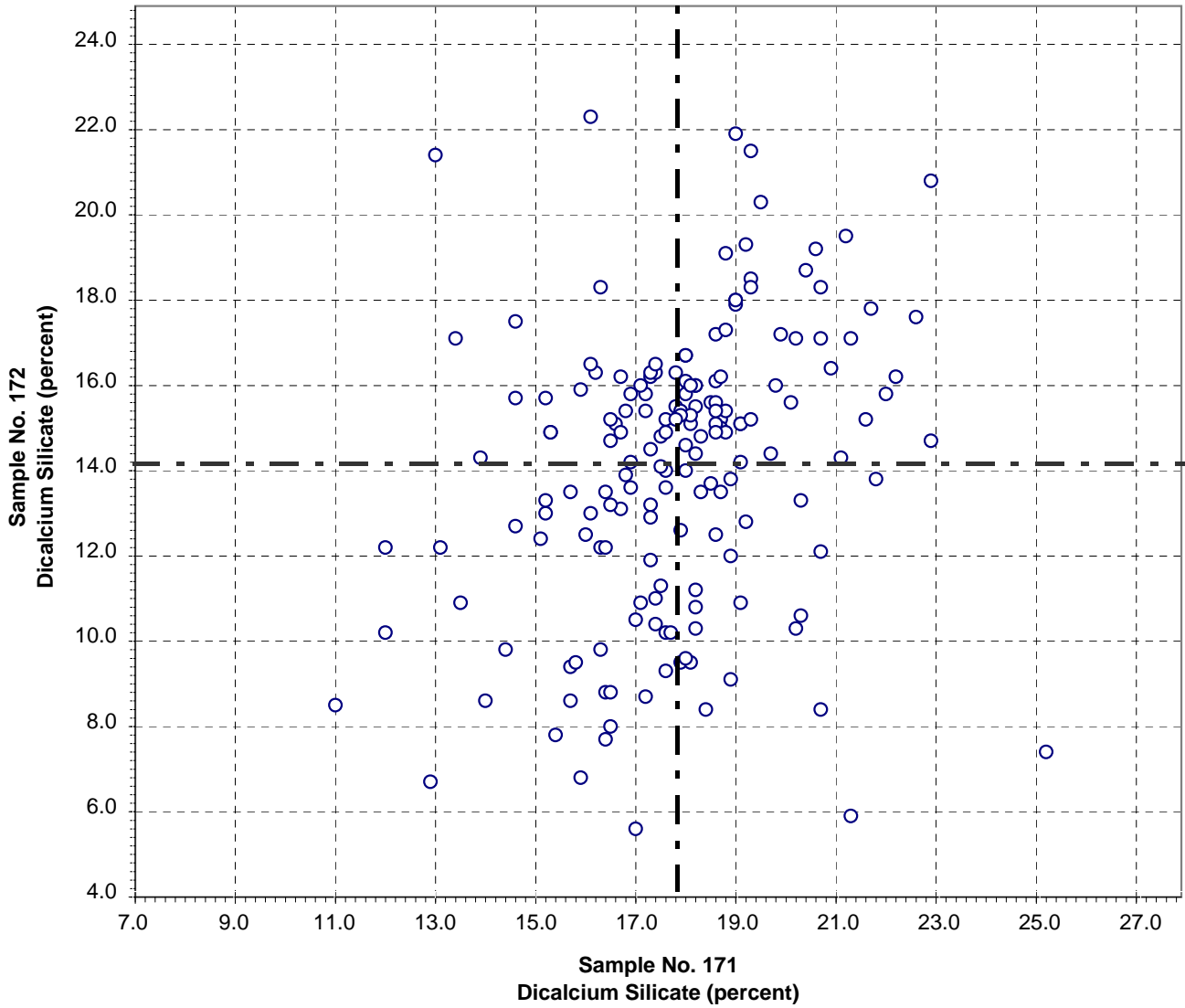


Test No. 106 Tricalcium Silicate 173 Points

Sample No. 171	Ave 57.0	S.D. 2.4	C.V. 4.2
Sample No. 172	Ave 54.4	S.D. 3.9	C.V. 7.1

Labs eliminated: 176, 270, 2464

**CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 171 and No. 172**

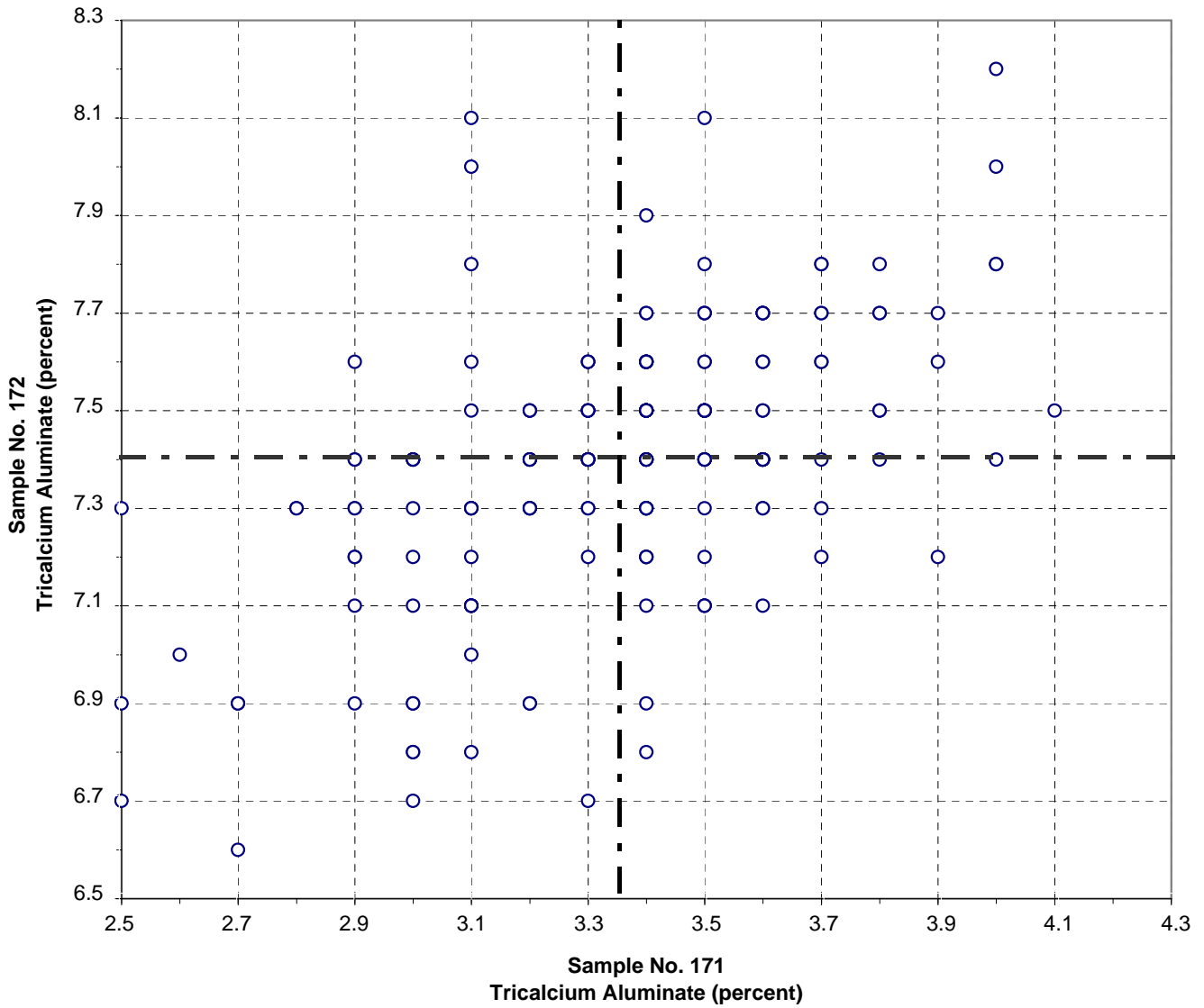


Test No. 107 Dicalcium Silicate 171 Points

Sample No. 171	Ave 17.8	S.D. 2.2	C.V. 12.3
Sample No. 172	Ave 14.1	S.D. 3.3	C.V. 23.8

Labs eliminated: 24, 93, 270, 407, 2464

**CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 171 and No. 172**

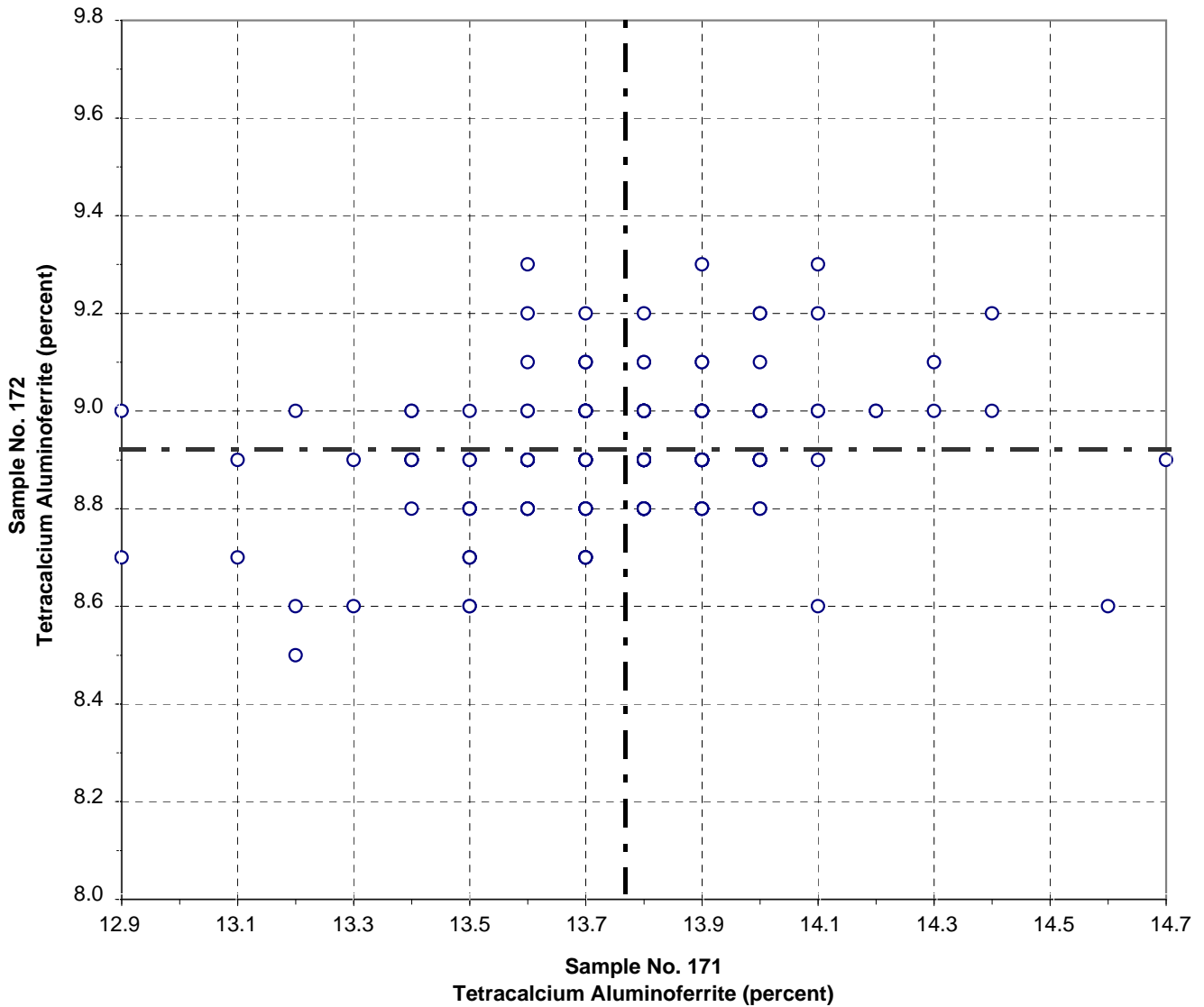


Test No. 108 Tricalcium Aluminate 191 Points

Sample No. 171 Ave 3.4 S.D. 0.30 C.V. 8.95
 Sample No. 172 Ave 7.4 S.D. 0.27 C.V. 3.67

Labs eliminated: 18, 78, 407, 870, 1251, 46, 47, 48, 134, 252, 2491

**CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 171 and No. 172**



Test No. 109 Tetracalcium Aluminoferrite 190 Points

Sample No. 171 Ave 13.8 S.D. 0.25 C.V. 1.82

Sample No. 172 Ave 8.9 S.D. 0.13 C.V. 1.50

Labs eliminated: 134, 157, 407, 870, 93, 218, 375, 605, 1251, 1715, 2491

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 171 and No. 172
 Final Report - Physical Results
 March 27, 2009

SUMMARY OF RESULTS

Test		#Labs	Sample No. 171			Sample No. 172		
			Average	S.D.	C.V.	Average	S.D.	C.V.
N.C. Water	prcnt	255	24.6	3.2	13.0	26.2	3.1	11.8
N.C. Water	prcnt	* 249	24.4	0.40	1.62	26.0	0.47	1.81
Vicat TS Initial	min	248	156	14.8	9.46	106	15.6	14.78
Vicat TS Initial	min	* 240	156	12.8	8.17	105	11.4	10.94
Vicat TS Final	min	239	250	32.3	12.9	207	32.2	15.5
Vicat TS Final	min	* 235	250	29.6	11.8	207	29.8	14.4
Gillmore TS Intial	min	159	180	23.8	13.2	140	22.9	16.4
Gillmore TS Intial	min	* 157	180	22.5	12.5	139	21.4	15.4
Gillmore TS Final	min	159	273	38.4	14.0	243	39.1	16.1
Gillmore TS Final	min	* 158	272	36.2	13.3	242	37.8	15.6
False Set	prent	197	48	21.4	44.4	77	8.6	11.3
False Set	prent	* 195	48	21.4	44.6	77	8.1	10.5
Autoclave Expan	prcnt	231	0.01	0.027	281.1	0.18	0.098	53.7
Autoclave Expan	prcnt	* 218	0.006	0.013	199.6	0.19	0.084	44.5

CONTINUED ON NEXT PAGE

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

Normal Consistency	2 5 51 416 1526 3287
Vicat TS Initial	2 9 47 52 93 1483 1526 2463
Vicat TS Final	47 116 1657 3394
Gillmore TS Initial	64 289
Gillmore TS Final	1054
False Set - Paste Method	154 2982
Autoclave Expansion	14 24 90 413 2254 2352 2464 5 10 126 130 2296 3255

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 171 and No. 172
 Final Report - Physical Results
 March 27, 2009

SUMMARY OF RESULTS

Test		#Labs	Sample No. 171			Sample No. 172		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Air Content	prcnt	226	7.6	1.2	15.8	7.2	1.3	18.3
Air Content	prcnt	* 224	7.6	1.1	15.0	7.2	1.2	17.4
AC Mix Water	prcnt	222	73.9	31.1	42.0	77.3	53.5	69.2
AC Mix Water	prcnt	* 207	69.0	2.2	3.26	69.5	2.3	3.30
AC Flow	prent	222	86	3.5	4.12	87	3.5	4.01
Comp Str, 3 day	psi	259	3037	246.4	8.11	4065	290.6	7.15
Comp Str, 3 day	psi	* 254	3025	219.6	7.26	4063	259.8	6.39
Comp Str, 7 day	psi	259	3795	302.8	7.98	4836	348.4	7.20
Comp Str, 7 day	psi	* 254	3791	277.0	7.31	4842	308.5	6.37
Comp Str, 28 day	psi	245	5344	401.3	7.51	5837	403.4	6.91
Comp Str, 28 day	psi	* 243	5344	387.9	7.26	5834	395.8	6.78
Com Str, Flow	prent	227	119	10.0	8.39	118	9.7	8.27
Com Str, Flow	prent	* 224	120	9.0	7.50	118	8.9	7.53

CONTINUED ON NEXT PAGE

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

Air Content	2021 3279
Air Content - % Water	5 129 177 221 222 551 667 105 246 1190 1323 354 1956 2938 3279
Comp Strength - 3 day	10 51 1526 3144 3320
Comp Strength - 7 day	5 10 51 1526 3144
Comp Strength - 28 day	52 3279
Comp Strength Flow	12 1956 2330

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 171 and No. 172
 Final Report - Physical Results
 March 27, 2009

SUMMARY OF RESULTS

Test	#Labs	Sample No. 171			Sample No. 172			
		Average	S.D.	C.V.	Average	S.D.	C.V.	
FINENESS								
Air Permeability	cm ² /g	253	3774	112.7	2.98	3916	187.9	4.80
Air Permeability	cm ² /g	* 241	3779	80.9	2.14	3912	91.2	2.33
Wagner Turbidim	cm ² /g	14	2224	447.7	20.1	2283	494.7	21.7
Wagner Turbidim	cm ² /g	* 13	2107	91.0	4.32	2153	98.6	4.58
45µm Sieve	prcnt	231	94.07	2.5	2.67	96.37	4.9	5.11
45µm Sieve	prcnt	* 222	94.18	0.98	1.04	96.74	0.62	0.64
C1038 MORTAR BAR EXPANSION								
Mortar Expansion	prcnt	142	0.007	0.0081	123	0.010	0.0139	146
Mortar Expansion	prcnt	* 134	0.006	0.0035	60.0	0.008	0.0045	56.2
Mortar Water	prcnt	134	234	14.4	6.14	235	17.0	7.24
Mortar Water	prcnt	* 128	235	5.5	2.34	237	5.2	2.20
Mortar Flow	prcnt	133	110	2.8	2.6	110	3.1	2.8
Mortar Flow	prcnt	* 129	110	2.6	2.4	110	2.7	2.4

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

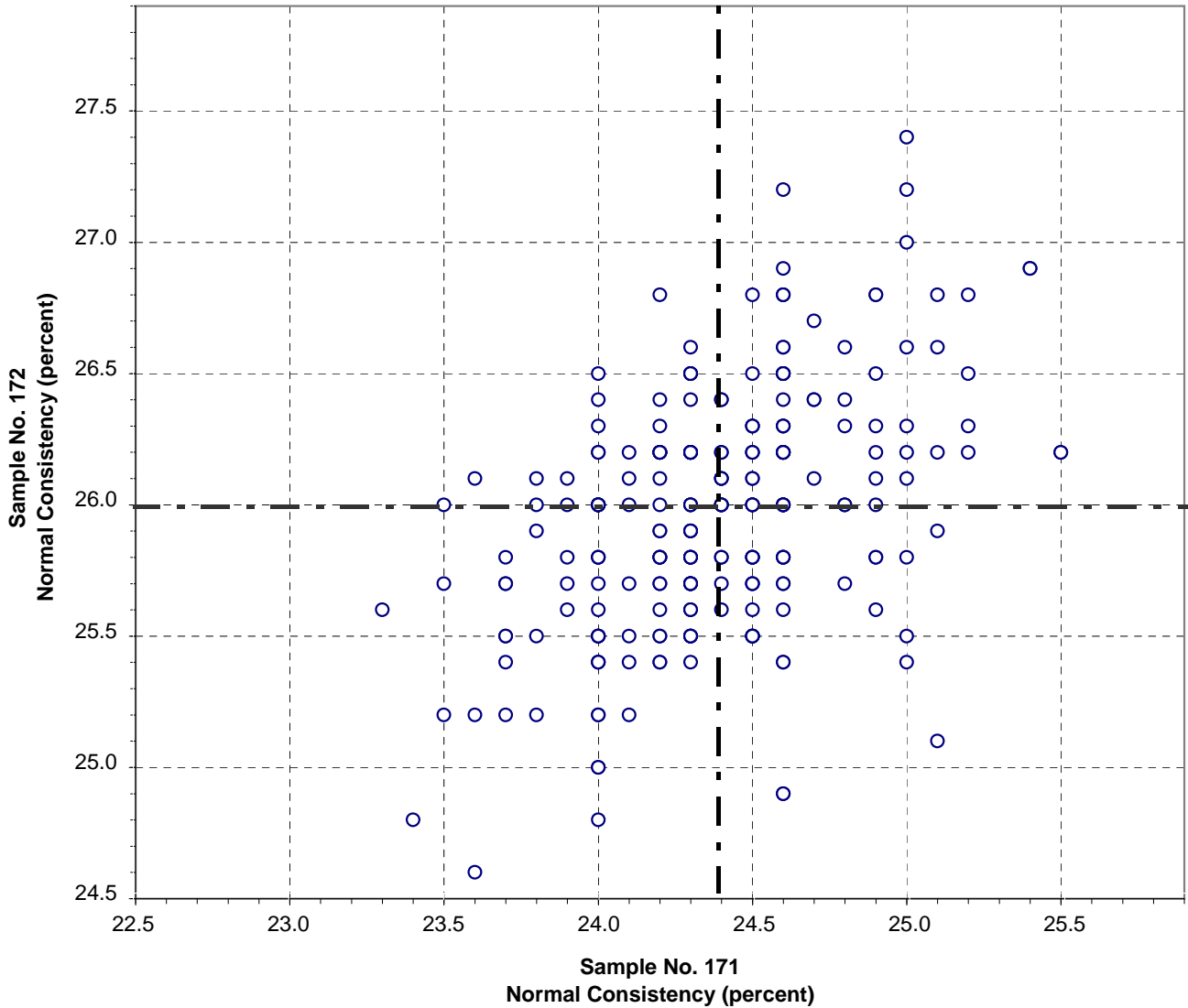
FINENESS

Air Permeability 42 46 52 2938 17 207 243 768 2491 2522 2982 3287
 Wagner Turbidimeter 19
 45µm Sieve 207 221 270 289 416 502 1435 2491 3316

C1038 MORTAR BAR EXPANSION

Mortar Expansion 90 768 34 438 691 692 1251 2296
 Mortar - Water 146 205 222 203 768 2296
 Mortar - Flow 14 46 90 1819

**CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 171 and No. 172**



Test No. 110 Normal Consistency - % Water 248 Points

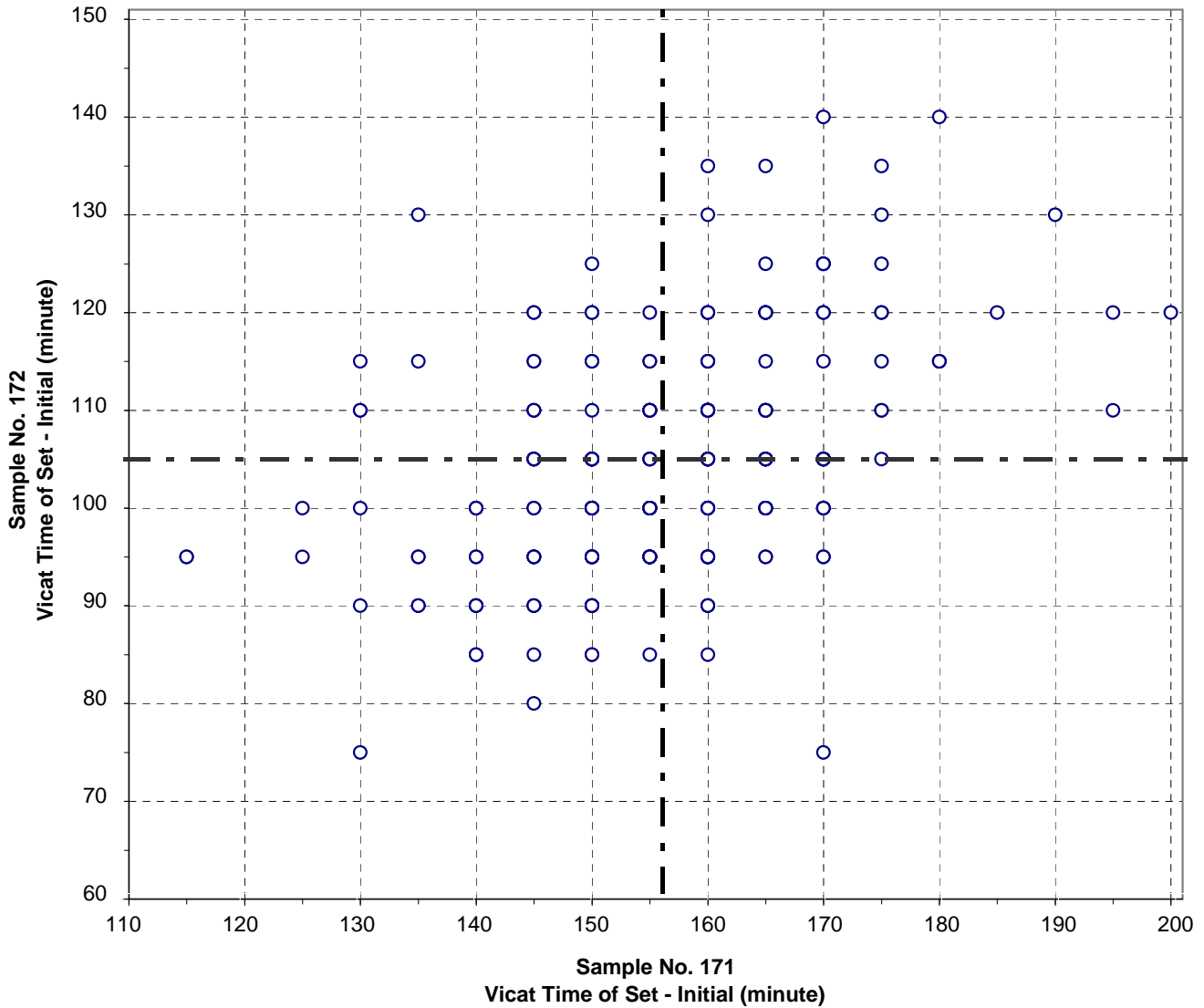
Sample No. 171 Ave 24.4 S.D. 0.40 C.V. 1.62

Sample No. 172 Ave 26.0 S.D. 0.47 C.V. 1.81

Labs eliminated: 2, 5, 51, 416, 1526, 3287

Labs off Diagram: 3236

CCRL Proficiency Sample Program
Vicat Time of Set - Initial
PORTLAND CEMENT Samples No. 171 and No. 172



Test No. 120

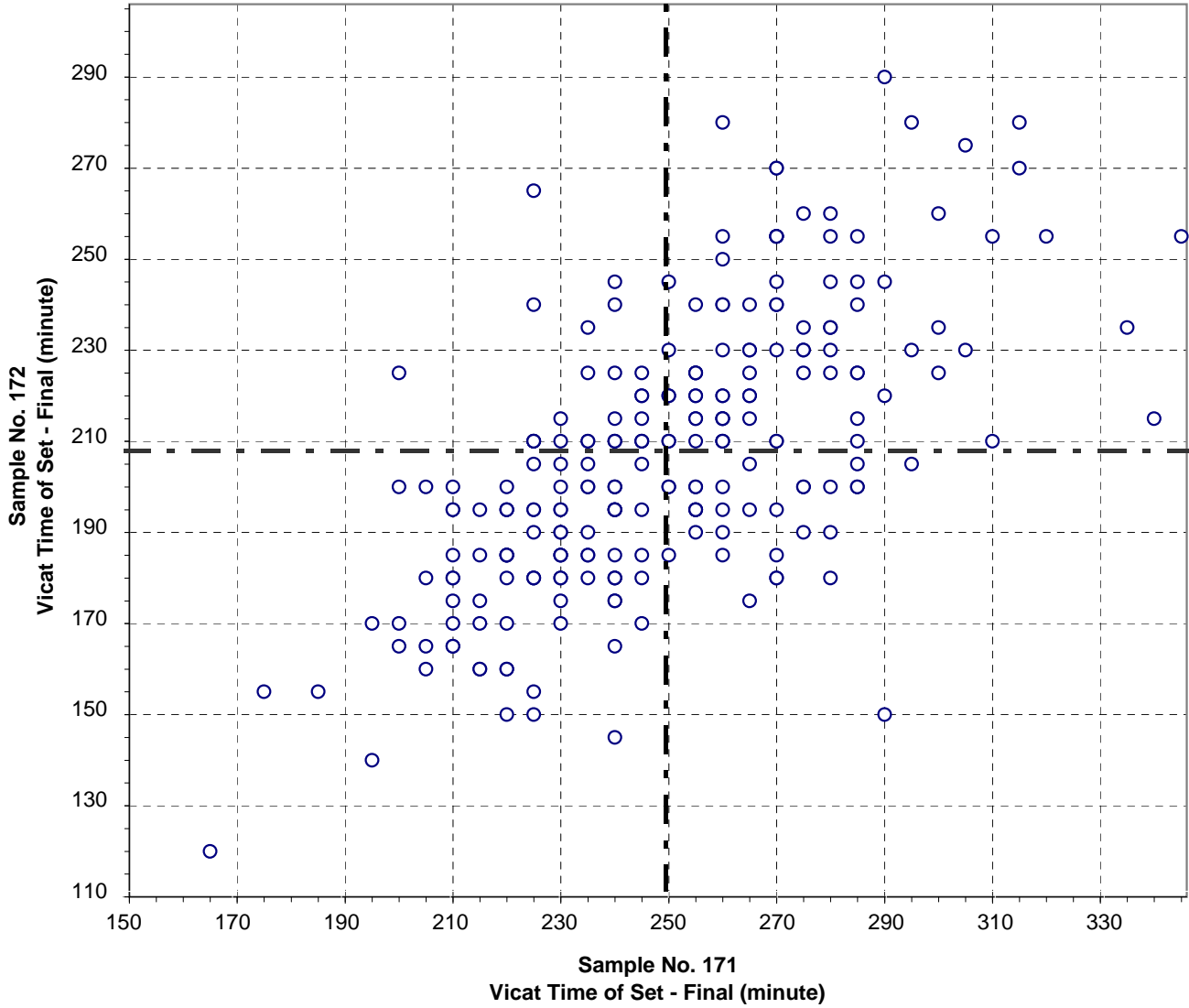
Vicat Time of Set - Initial

240 Points

Sample No. 171 Ave 156 S.D. 12.8 C.V. 8.17
 Sample No. 172 Ave 105 S.D. 11.4 C.V. 10.94

Labs eliminated: 2, 9, 47, 52, 93, 1483, 1526, 2463

CCRL Proficiency Sample Program
Vicat Time of Set - Final
PORTLAND CEMENT Samples No. 171 and No. 172

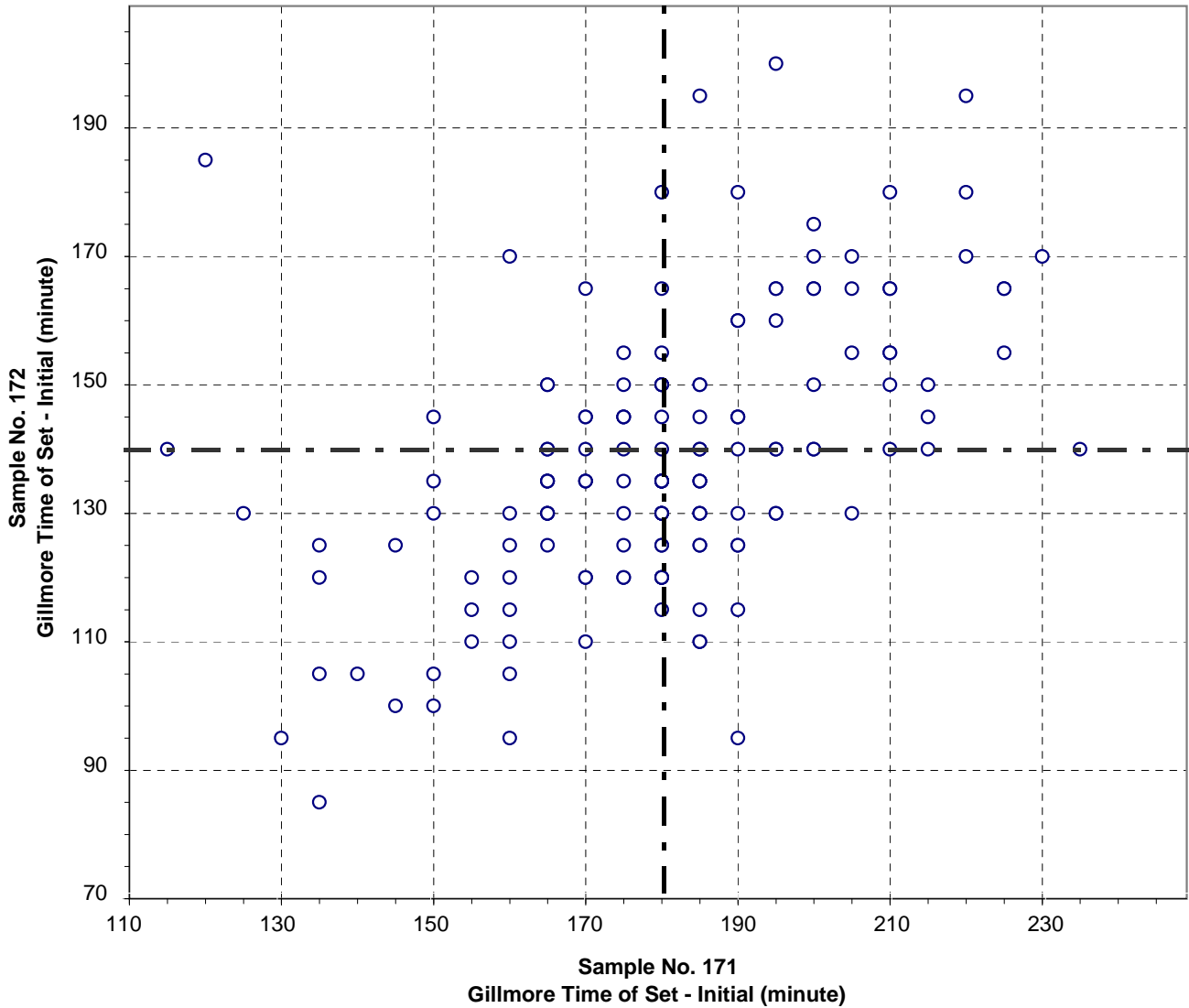


Test No. 121 Vicat Time of Set - Final 235 Points

Sample No. 171 Ave 250 S.D. 29.6 C.V. 11.8
 Sample No. 172 Ave 207 S.D. 29.8 C.V. 14.4

Labs eliminated: 47, 116, 1657, 3394

**CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 171 and No. 172**



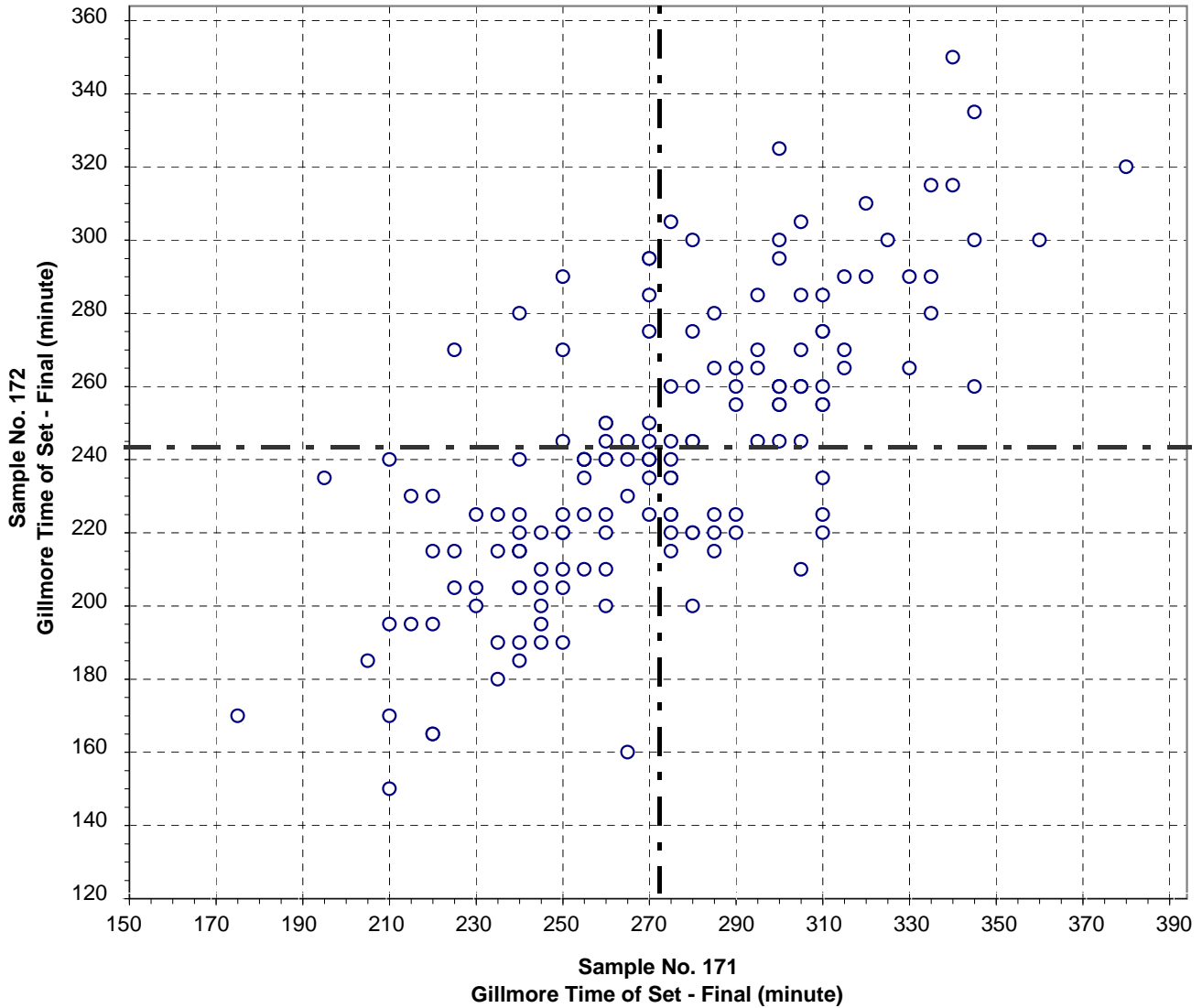
Test No. 130 Gillmore Time of Set - Initial 156 Points

Sample No. 171 Ave 180 S.D. 22.5 C.V. 12.5
 Sample No. 172 Ave 139 S.D. 21.4 C.V. 15.4

Labs eliminated: 64, 289

Labs off Diagram: 270

**CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 171 and No. 172**

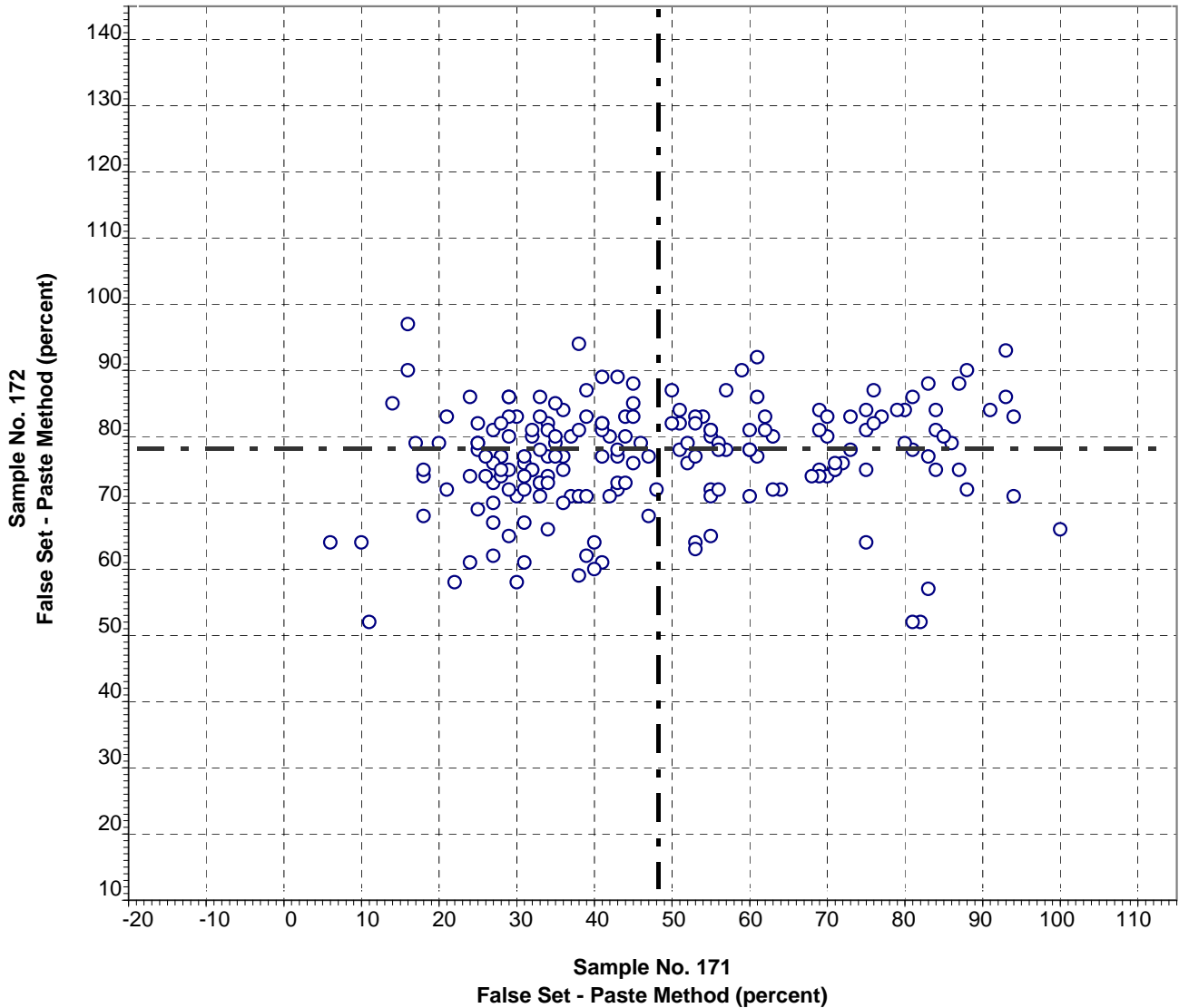


Test No. 140 Gillmore Time of Set - Final 158 Points

Sample No. 171 Ave 272 S.D. 36.2 C.V. 13.3
 Sample No. 172 Ave 242 S.D. 37.8 C.V. 15.6

Labs eliminated: 1054

**CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 171 and No. 172**

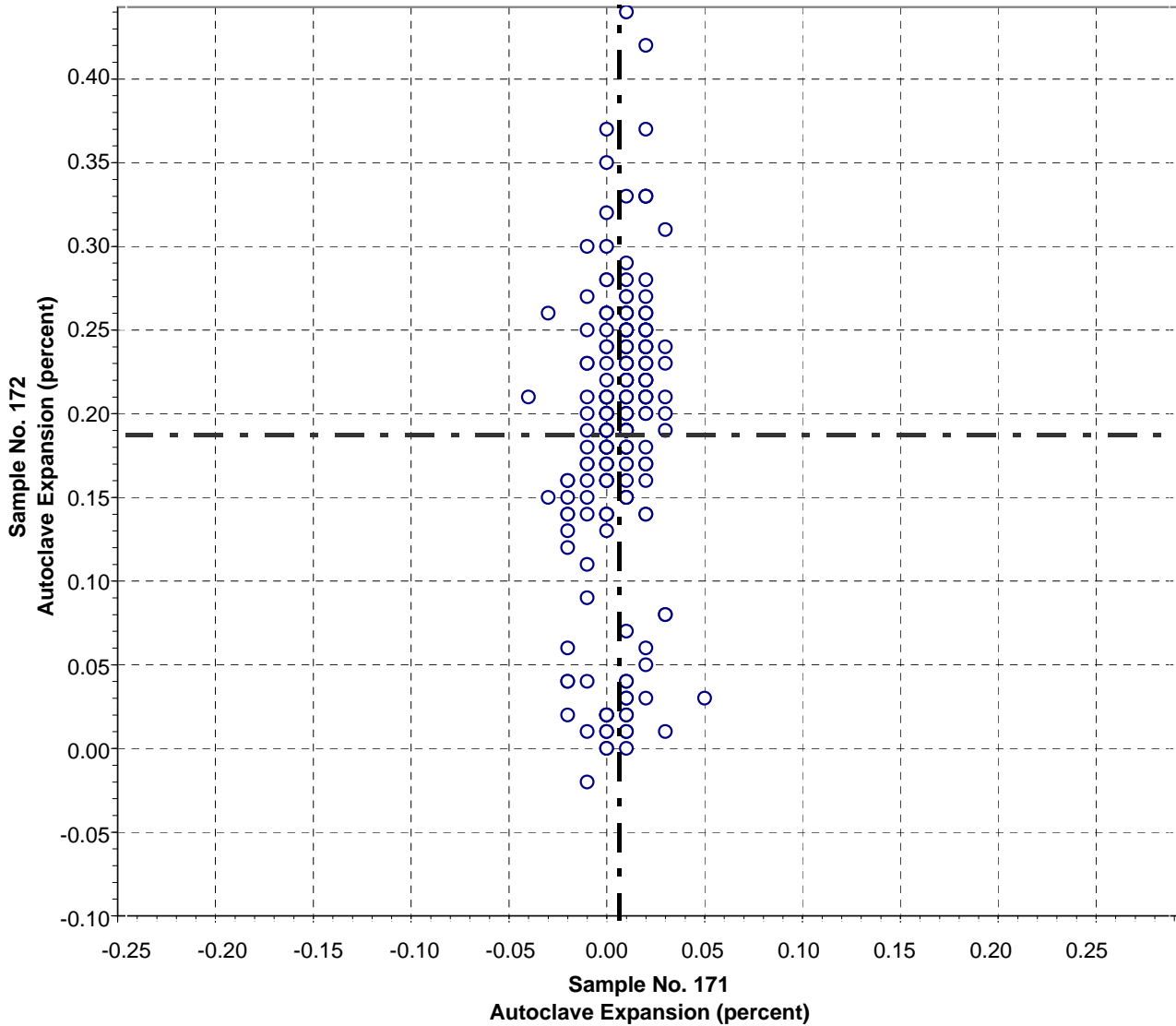


Test No. 150 False Set - Paste Method 195 Points

Sample No. 171 Ave 48 S.D. 21.4 C.V. 44.6
 Sample No. 172 Ave 77 S.D. 8.1 C.V. 10.5

Labs eliminated: 154, 2982

**CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 171 and No. 172**



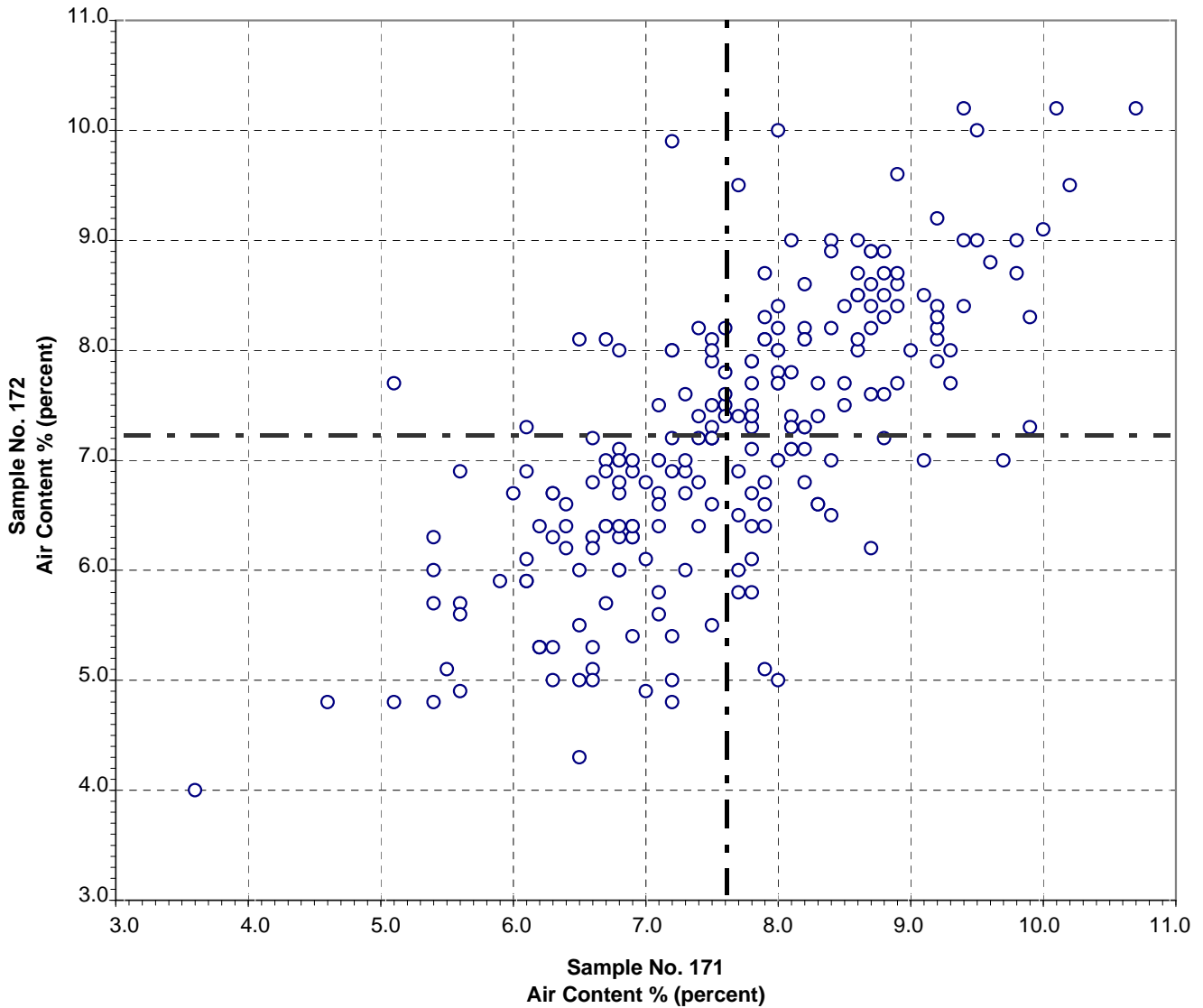
Test No. 160 Autoclave Expansion 218 Points

Sample No. 171 Ave 0.006 S.D. 0.013 C.V. 199.6

Sample No. 172 Ave 0.19 S.D. 0.084 C.V. 44.5

Labs eliminated: 14, 24, 90, 413, 2254, 2352, 2464, 5, 10, 126, 130, 2296, 3255

CCRL Proficiency Sample Program
Air Content %
PORTLAND CEMENT Samples No. 171 and No. 172

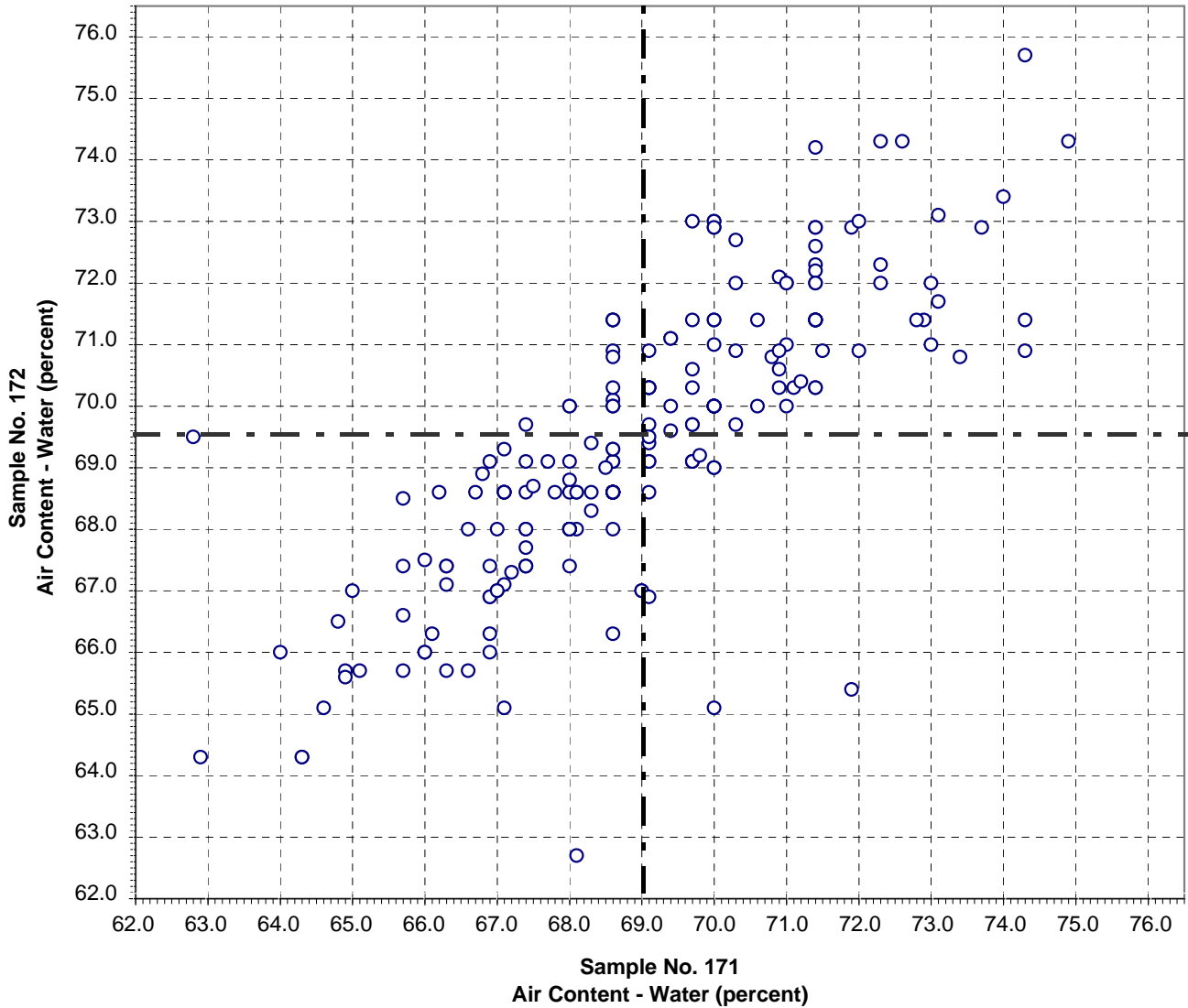


Test No. 170 Air Content % 224 Points

Sample No. 171 Ave 7.6 S.D. 1.1 C.V. 15.0
 Sample No. 172 Ave 7.2 S.D. 1.2 C.V. 17.4

Labs off Diagram: 3127, 3279

**CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 171 and No. 172**



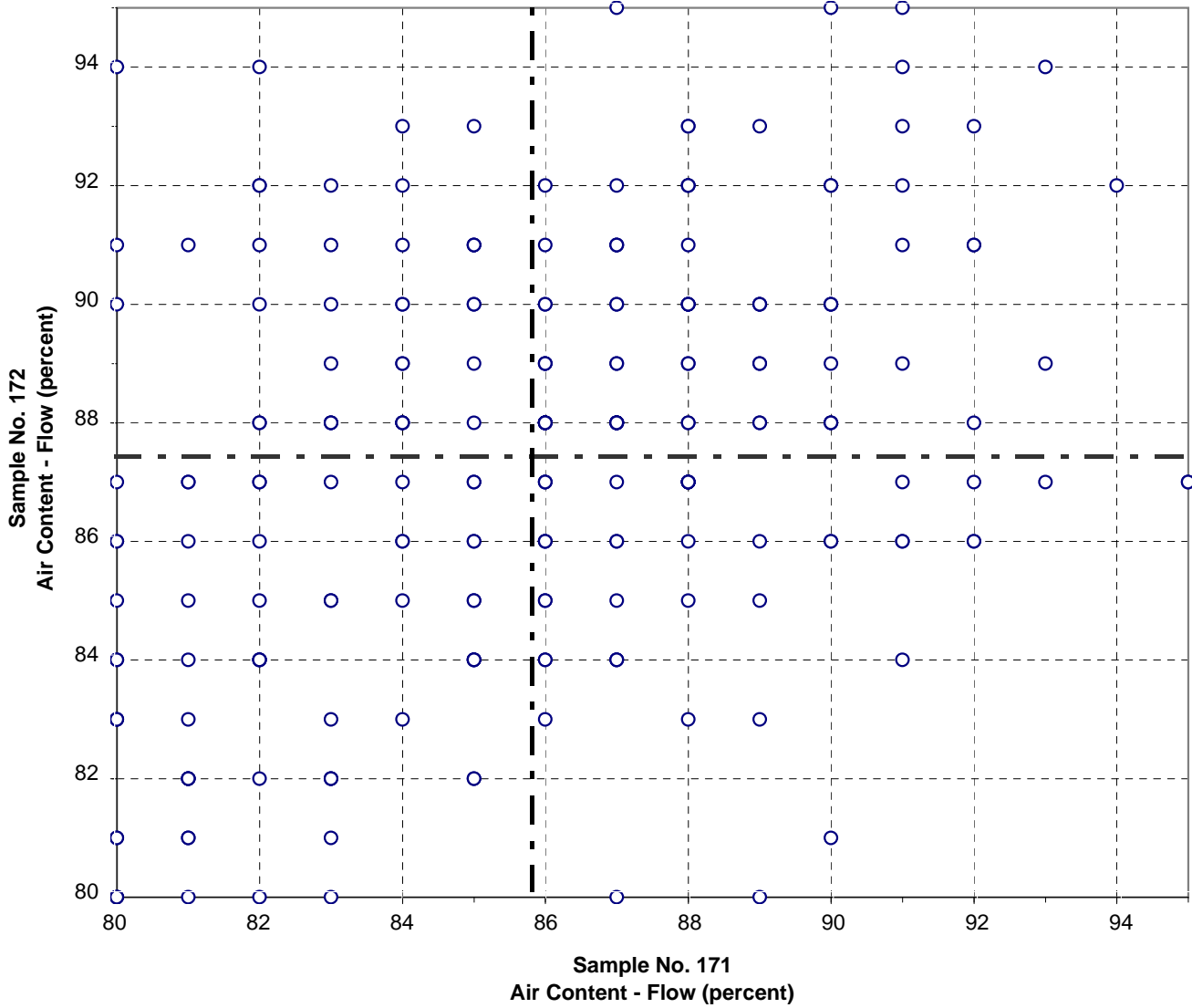
Test No. 180 Air Content - % Water 206 Points

Sample No. 171 Ave 69.0 S.D. 2.2 C.V. 3.26
 Sample No. 172 Ave 69.5 S.D. 2.3 C.V. 3.30

Labs eliminated: 5, 129, 177, 221, 222, 551, 667, 105, 246, 1190, 1323, 354, 1956, 2938, 3279

Labs off Diagram: 51

CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 171 and No. 172



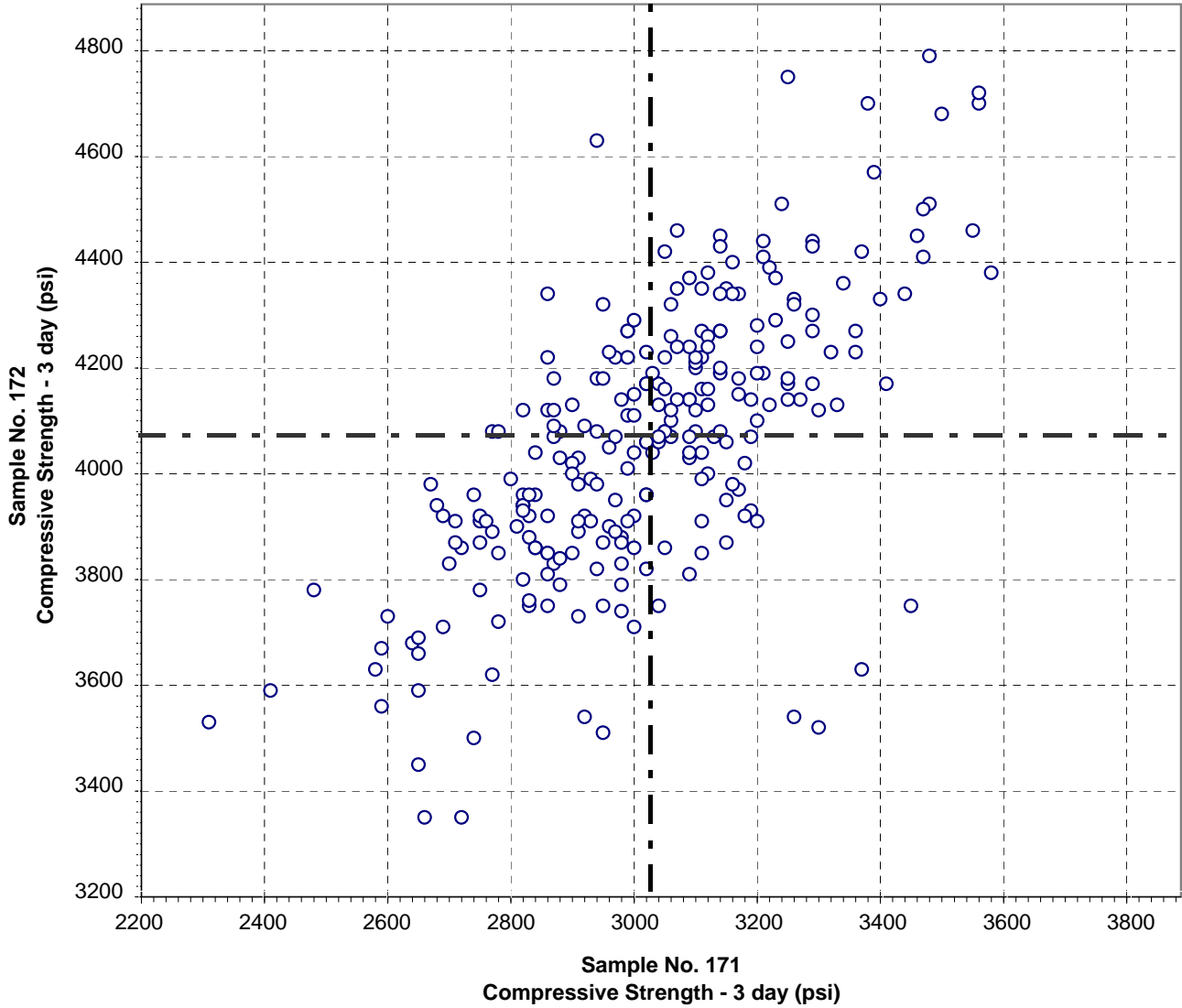
Test No. 190

Air Content - Flow

222 Points

Sample No. 171	Ave 86	S.D. 3.5	C.V. 4.12
Sample No. 172	Ave 87	S.D. 3.5	C.V. 4.01

**CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 171 and No. 172**



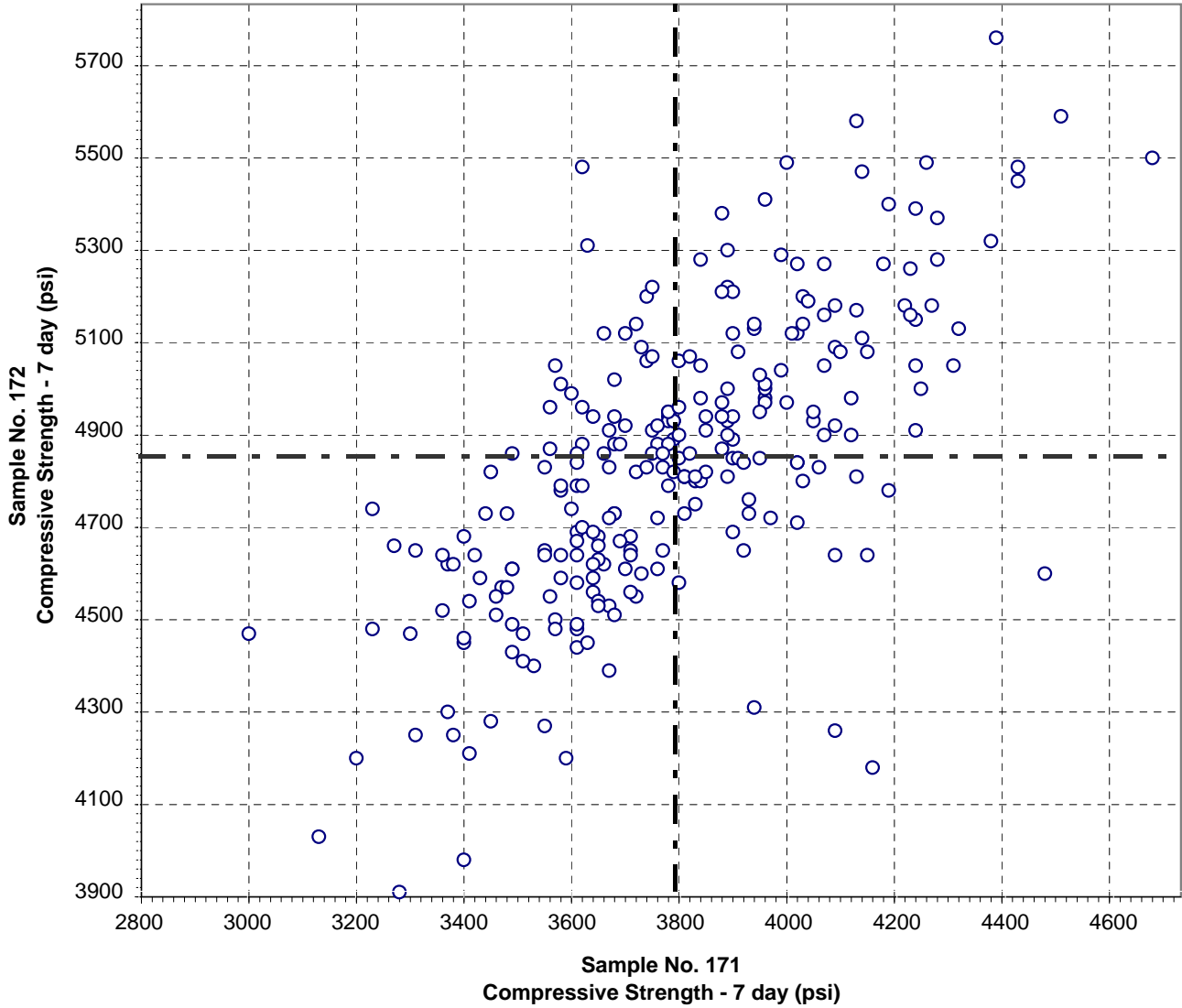
Test No. 200 Compressive Strength - 3 day 254 Points

Sample No. 171 Ave 3025 S.D. 219.6 C.V. 7.26

Sample No. 172 Ave 4063 S.D. 259.6 C.V. 6.39

Labs eliminated: 10, 51, 1526, 3144, 3320

**CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 171 and No. 172**



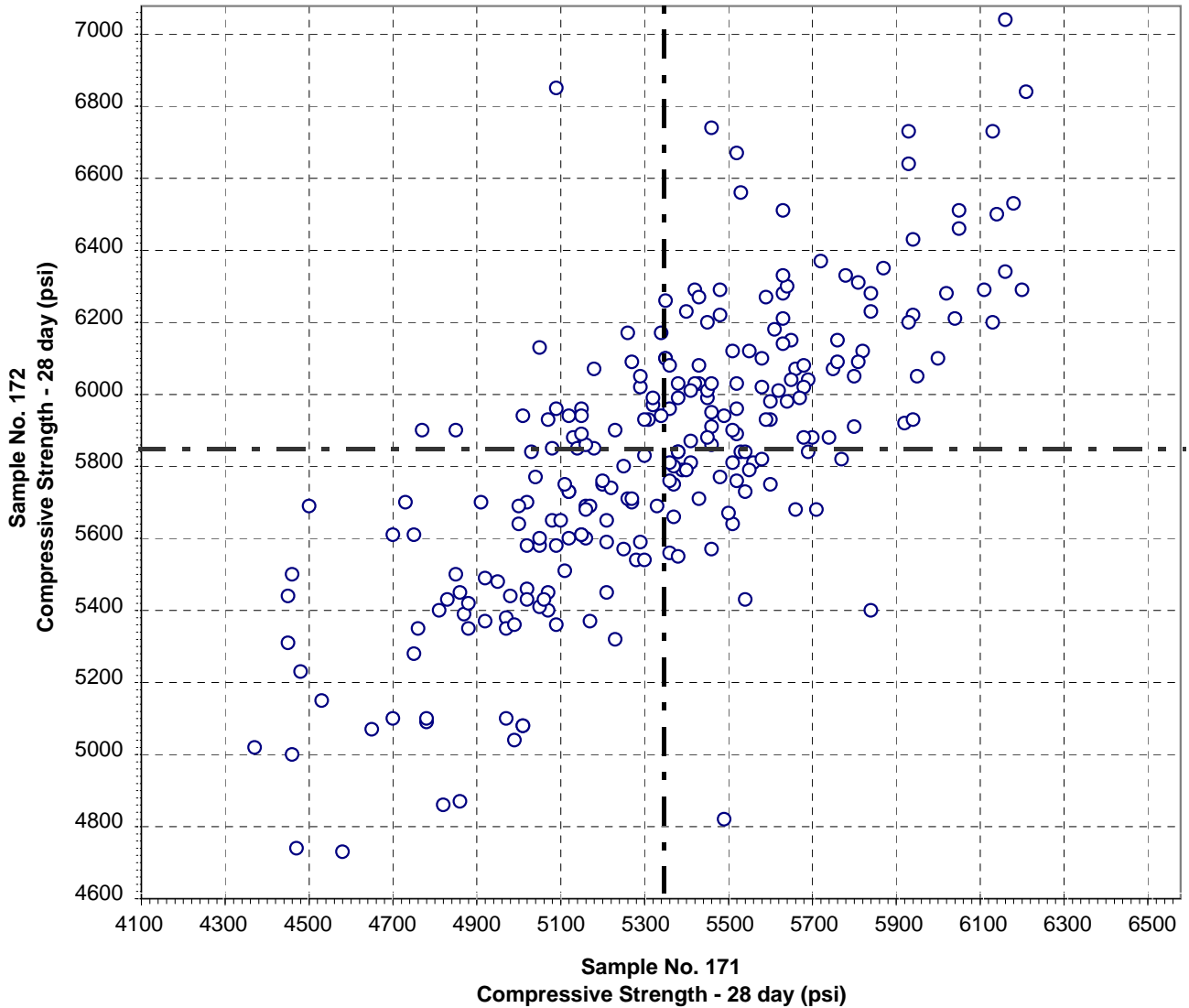
Test No. 210 Compressive Strength - 7 day 254 Points

Sample No. 171 Ave 3791 S.D. 277.0 C.V. 7.31

Sample No. 172 Ave 4842 S.D. 308.5 C.V. 6.37

Labs eliminated: 5, 10, 51, 1526, 3144

**CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 171 and No. 172**



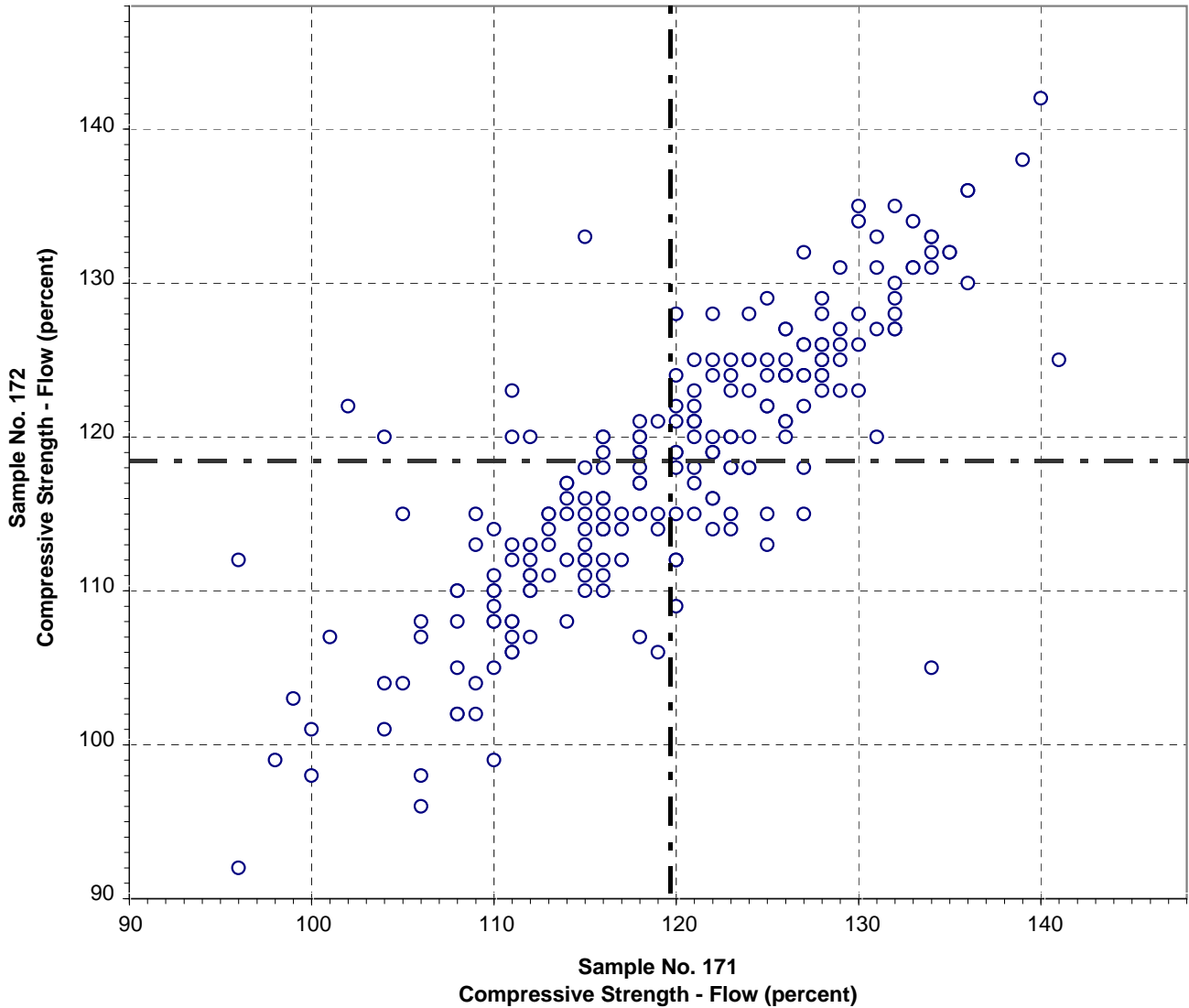
Test No. 211 Compressive Strength - 28 day 243 Points

Sample No. 171 Ave 5344 S.D. 387.9 C.V. 7.26

Sample No. 172 Ave 5834 S.D. 395.8 C.V. 6.78

Labs eliminated: 52, 3279

**CCRL Proficiency Sample Program
Compressive Strength - Flow
PORTLAND CEMENT Samples No. 171 and No. 172**

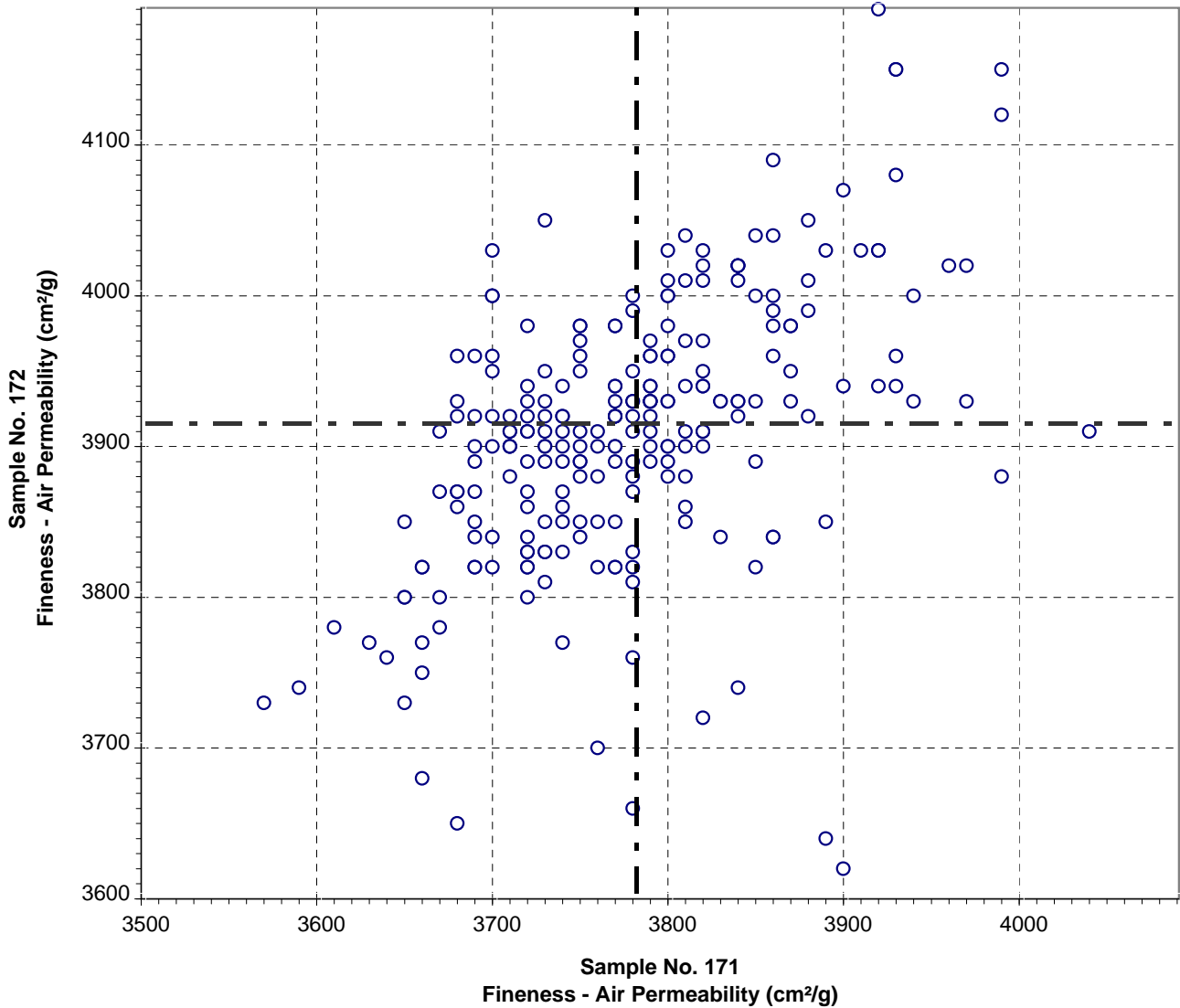


Test No. 230 Compressive Strength - Flow 224 Points

Sample No. 171 Ave 120 S.D. 9.0 C.V. 7.50
 Sample No. 172 Ave 118 S.D. 8.9 C.V. 7.53

Labs eliminated: 12, 1956, 2330

**CCRL Proficiency Sample Program
Fineness - Air Permeability
PORTLAND CEMENT Samples No. 171 and No. 172**



Test No. 270 Fineness - Air Permeability 240 Points

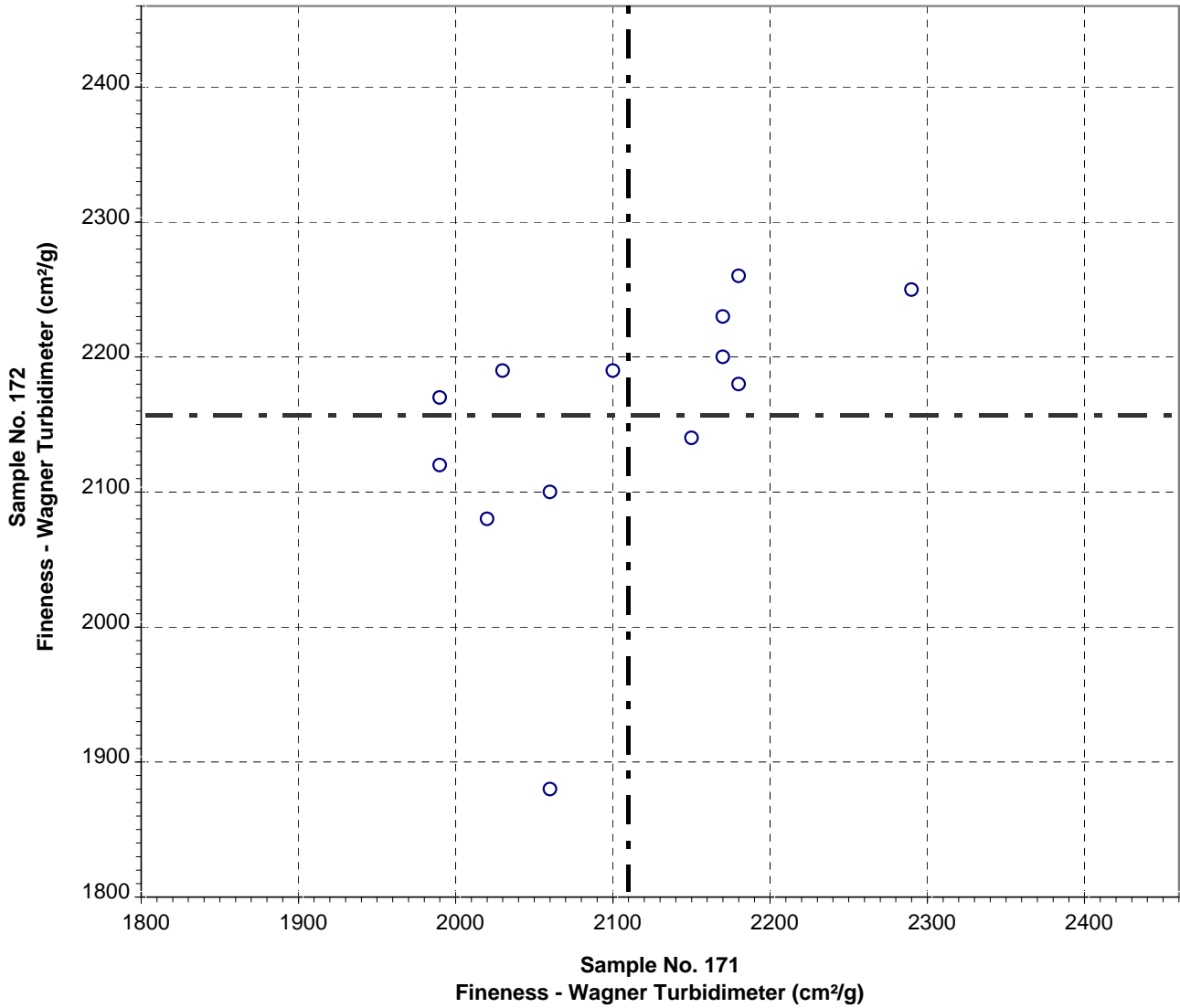
Sample No. 171 Ave 3779 S.D. 80.9 C.V. 2.14

Sample No. 172 Ave 3912 S.D. 91.2 C.V. 2.33

Labs eliminated: 42, 46, 52, 2938, 17, 207, 243, 768, 2491, 2522, 2982, 3287

Labs off Diagram: 1525

**CCRL Proficiency Sample Program
Fineness - Wagner Turbidimeter
PORTLAND CEMENT Samples No. 171 and No. 172**

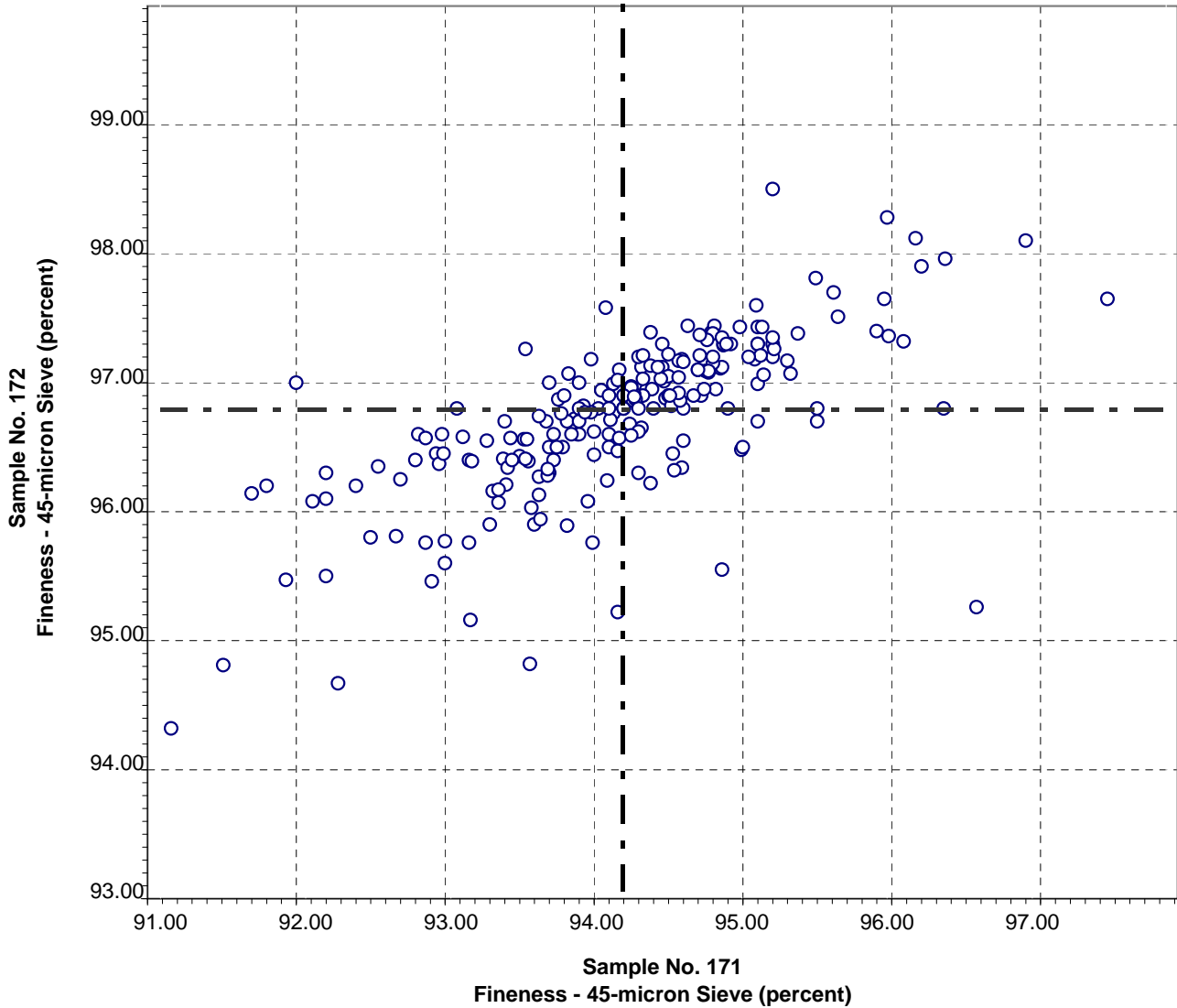


Test No. 280 Fineness - Wagner Turbidimeter 13 Points

Sample No. 171	Ave 2107	S.D. 91.0	C.V. 4.32
Sample No. 172	Ave 2153	S.D. 98.6	C.V. 4.58

Labs eliminated: 19

**CCRL Proficiency Sample Program
Fineness - 45-micron Sieve
PORTLAND CEMENT Samples No. 171 and No. 172**



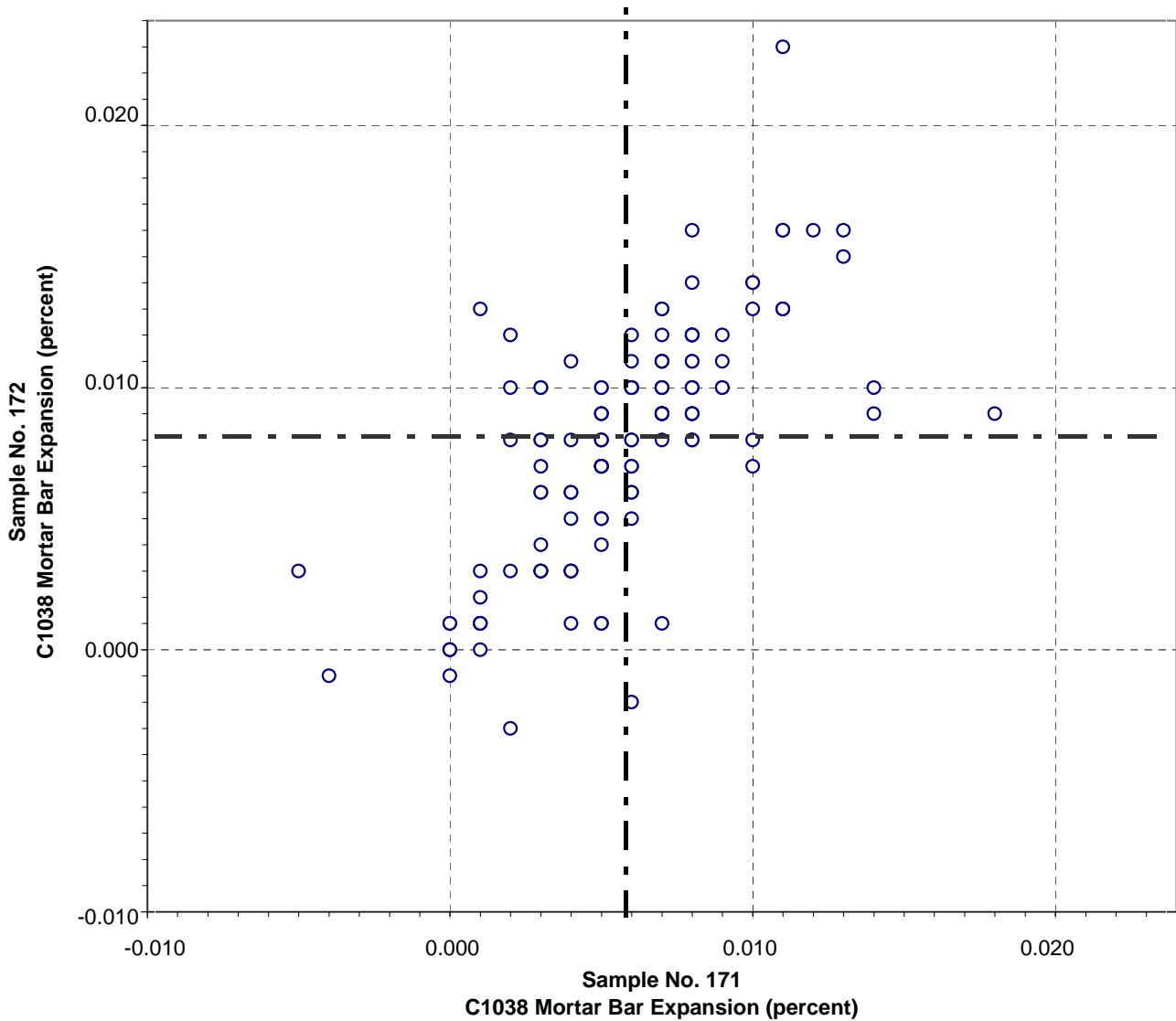
Test No. 281 Fineness - 45-micron Sieve 222 Points

Sample No. 171 Ave 94.18 S.D. 0.98 C.V. 1.04

Sample No. 172 Ave 96.74 S.D. 0.62 C.V. 0.64

Labs eliminated: 207, 221, 270, 289, 416, 502, 1435, 2491, 3316

**CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 171 and No. 172**



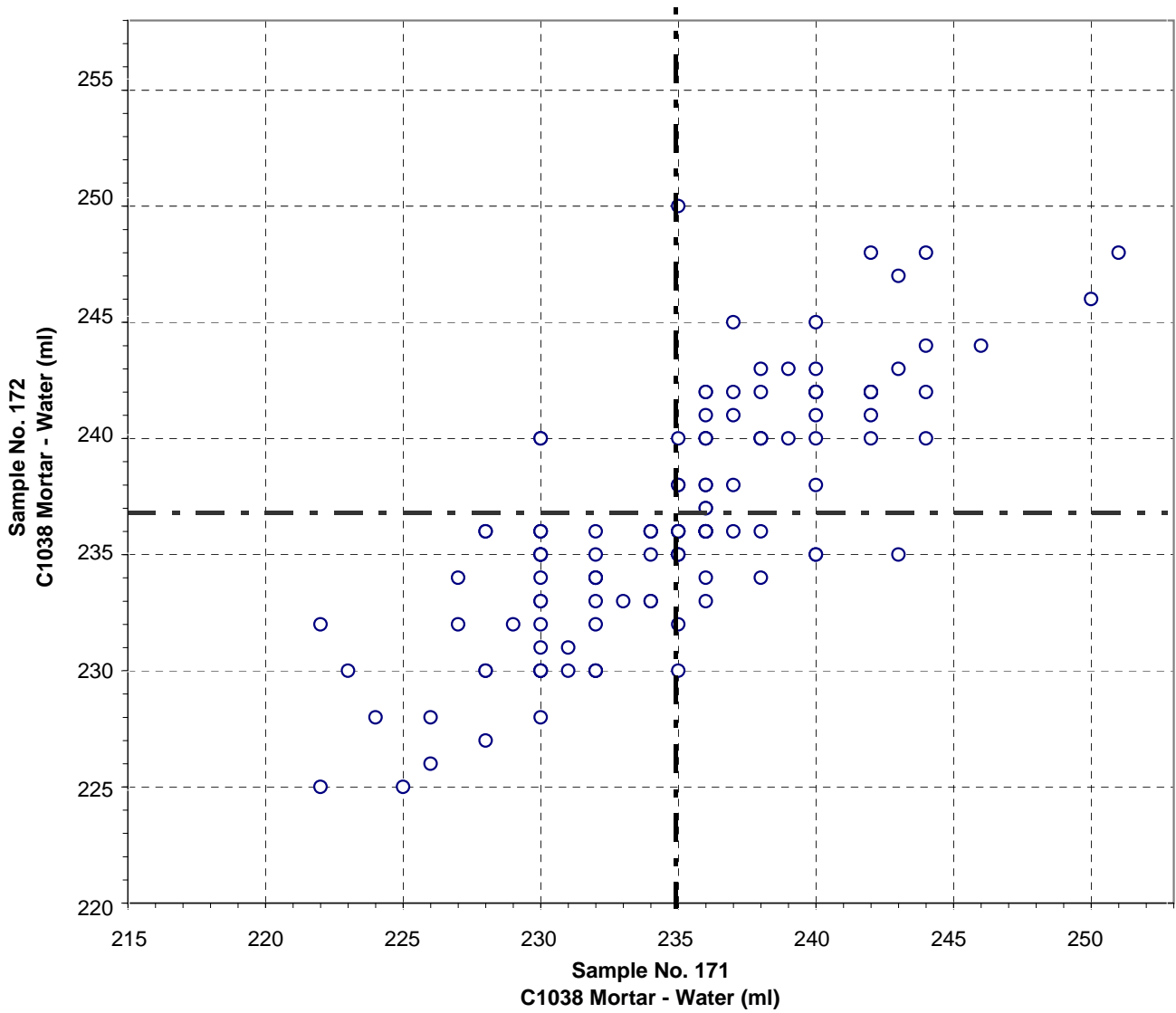
Test No. 400 C1038 Mortar Bar Expansion 134 Points

Sample No. 171 Ave 0.006 S.D. 0.0035 C.V. 60.0

Sample No. 172 Ave 0.008 S.D. 0.0045 C.V. 56.2

Labs eliminated: 90, 768, 34, 438, 691, 692, 1251, 2296

**CCRL Proficiency Sample Program
C1038 Mortar - Water
PORTLAND CEMENT Samples No. 171 and No. 172**

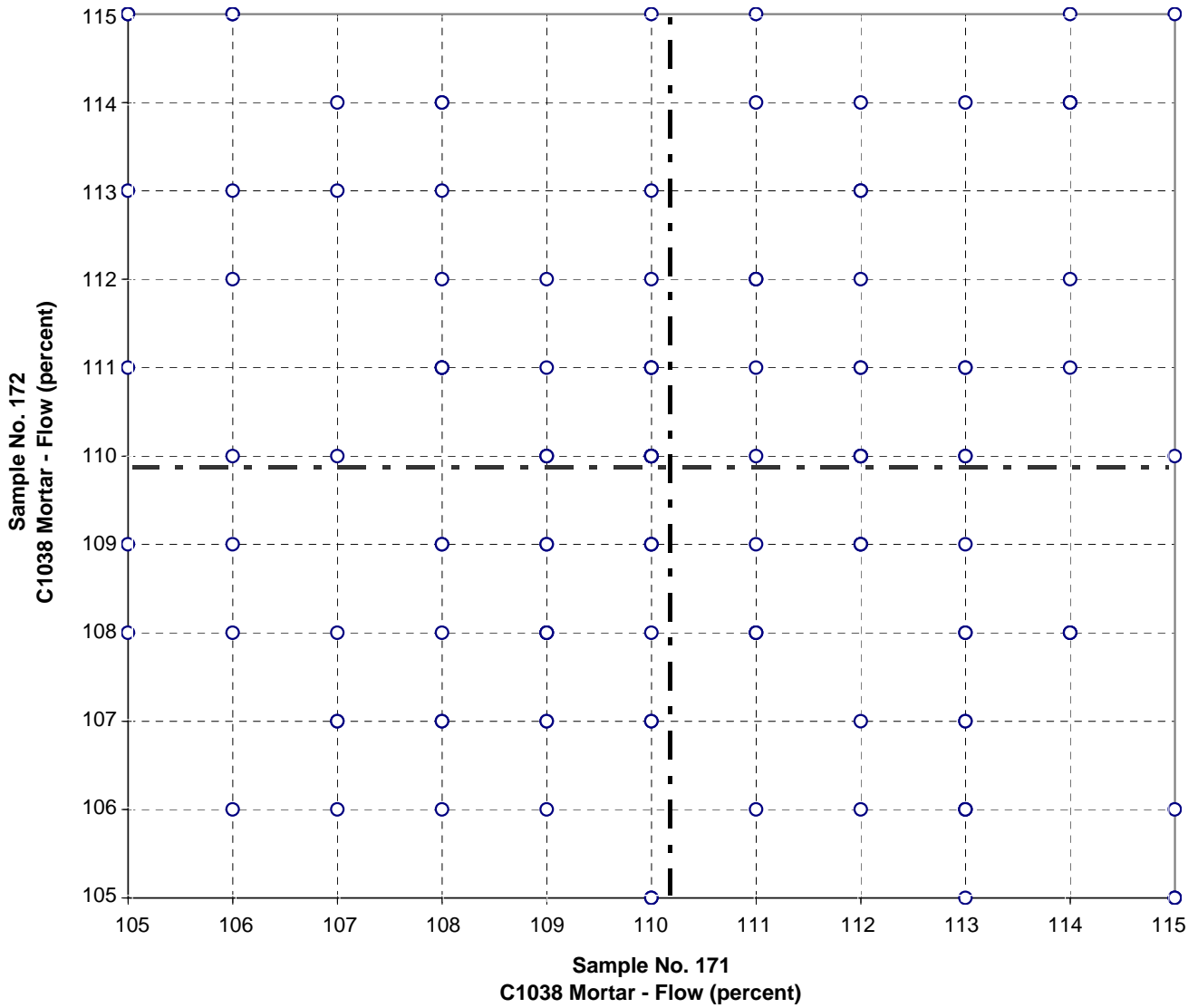


Test No. 401 C1038 Mortar - Water 128 Points

Sample No. 171 Ave 235 S.D. 5.5 C.V. 2.34
 Sample No. 172 Ave 237 S.D. 5.2 C.V. 2.20

Labs eliminated: 146, 205, 222, 203, 768, 2296

**CCRL Proficiency Sample Program
C1038 Mortar - Flow
PORTLAND CEMENT Samples No. 171 and No. 172**



Test No. 402

C1038 Mortar - Flow

129 Points

Sample No. 171 Ave 110 S.D. 2.6 C.V. 2.4

Sample No. 172 Ave 110 S.D. 2.7 C.V. 2.4

Labs eliminated: 14, 46, 90, 1819

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 171 and No. 172
 Final Report - Heat of Hydration Results
 March 27, 2009

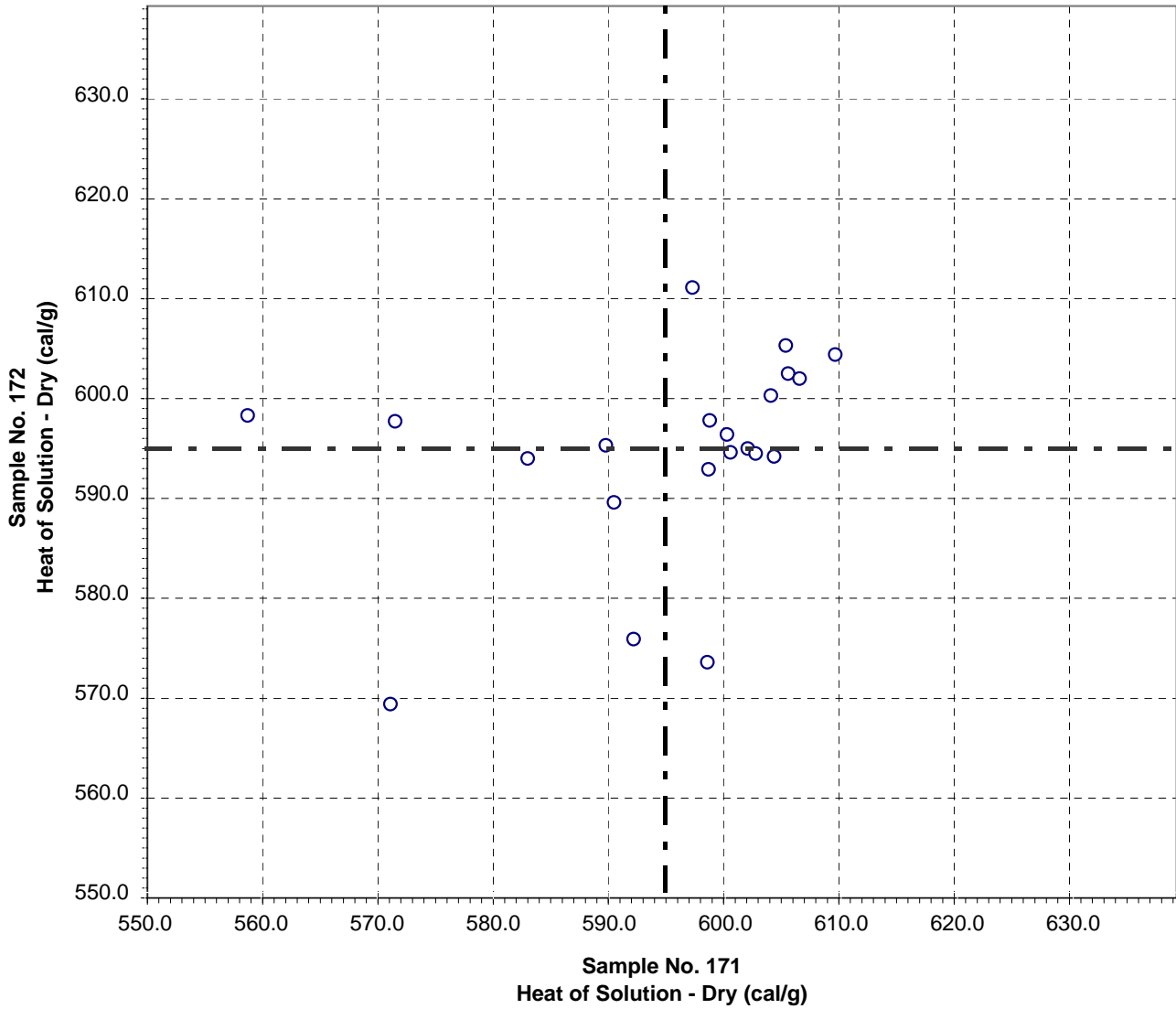
SUMMARY OF RESULTS

Test		#Labs	Sample No. 171			Sample No. 172		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Heat Solution, Dry	cal/g	22	589.8	27.0	4.59	588.2	31.0	5.28
Heat Solution, Dry	cal/g *	21	594.8	13.4	2.26	594.5	10.3	1.73
Heat Sol, 7 day	cal/g	22	520.5	28.1	5.39	507.3	34.0	6.70
Heat Sol, 7 day	cal/g *	21	525.7	13.8	2.63	514.4	7.8	1.52
Heat Sol, 28 day	cal/g	19	515.2	12.2	2.37	505.4	7.8	1.54
Heat Hyd, 7 day	cal/g	21	68.7	11.2	16.3	80.6	9.6	11.9
Heat Hyd, 7 day	cal/g *	20	70.8	5.6	7.97	81.2	9.4	11.63
Heat Hyd, 28 day	cal/g	20	80.2	7.3	9.12	89.4	9.8	10.98

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

Heat of Solution, Dry 1644
 Heat of Solution, 7 day 1644
 Heat of Hydration, 7 day 176

CCRL Proficiency Sample Program
Heat of Solution - Dry
PORTLAND CEMENT Samples No. 171 and No. 172

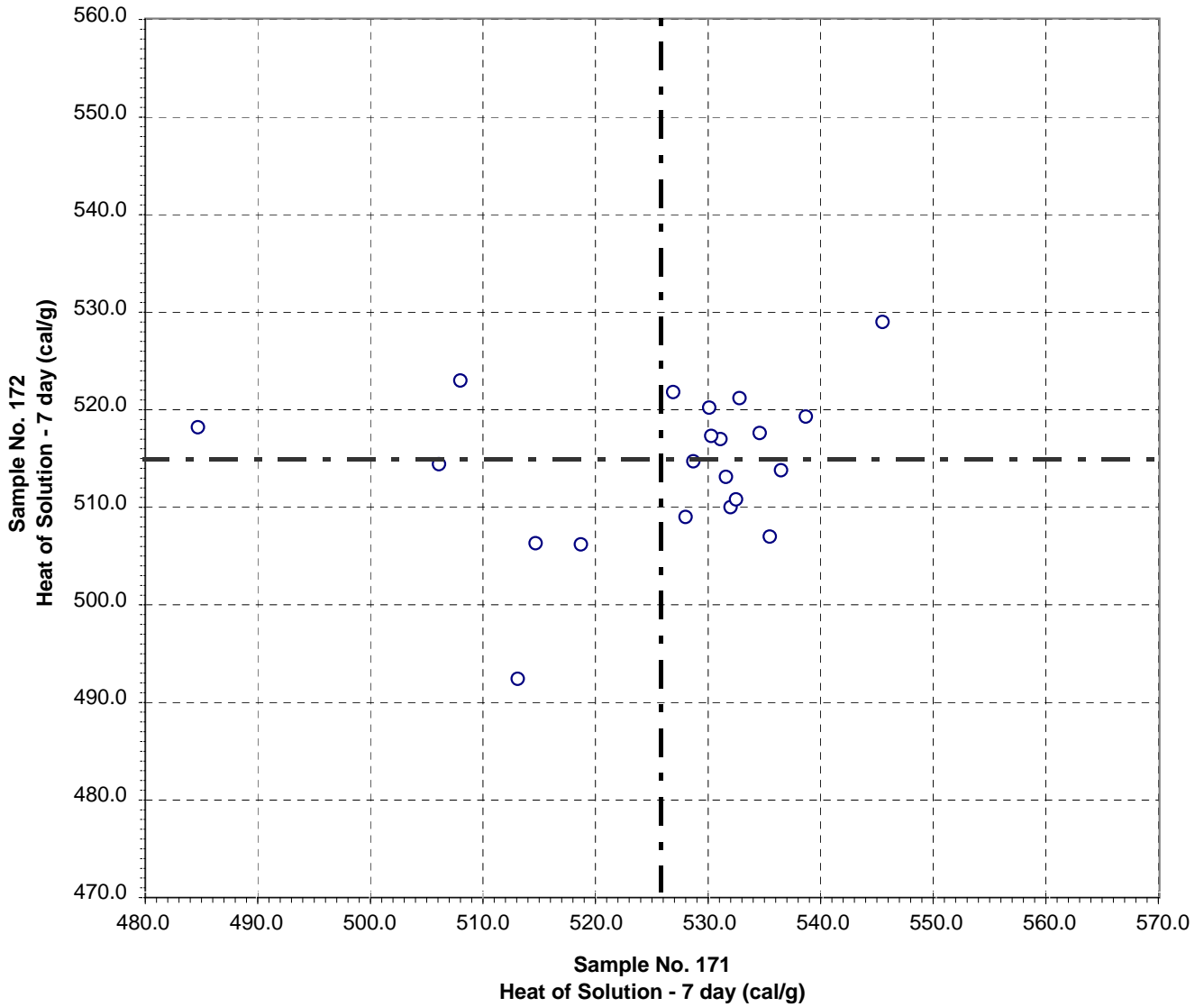


Test No. 291 Heat of Solution - Dry 21 Points

Sample No. 171	Ave 594.8	S.D. 13.4	C.V. 2.26
Sample No. 172	Ave 594.5	S.D. 10.3	C.V. 1.73

Labs eliminated: 1644

CCRL Proficiency Sample Program
Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 171 and No. 172

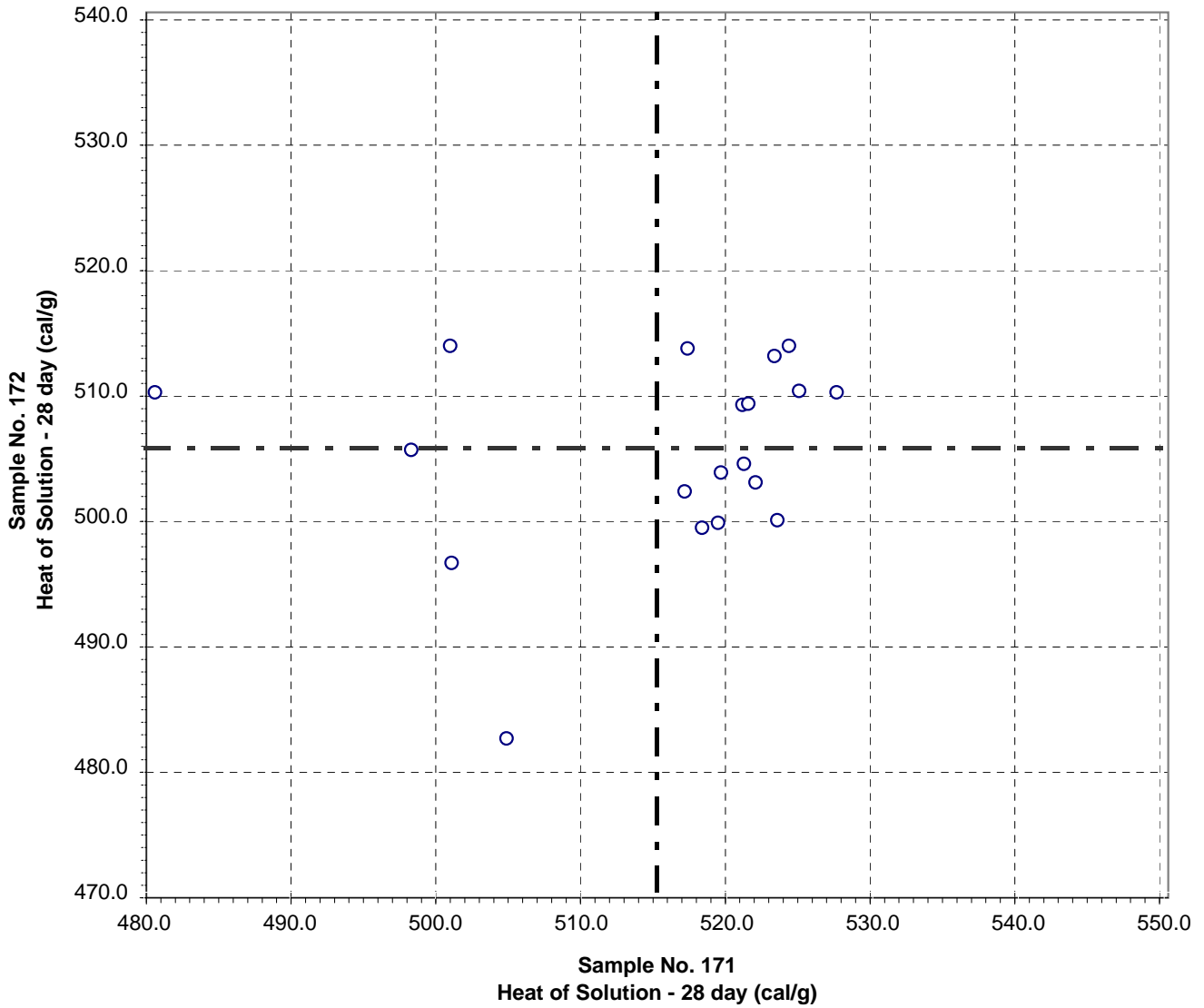


Test No. 292 Heat of Solution - 7 day 21 Points

Sample No. 171 Ave 525.7 S.D. 13.8 C.V. 2.63
 Sample No. 172 Ave 514.4 S.D. 7.8 C.V. 1.52

Labs eliminated: 1644

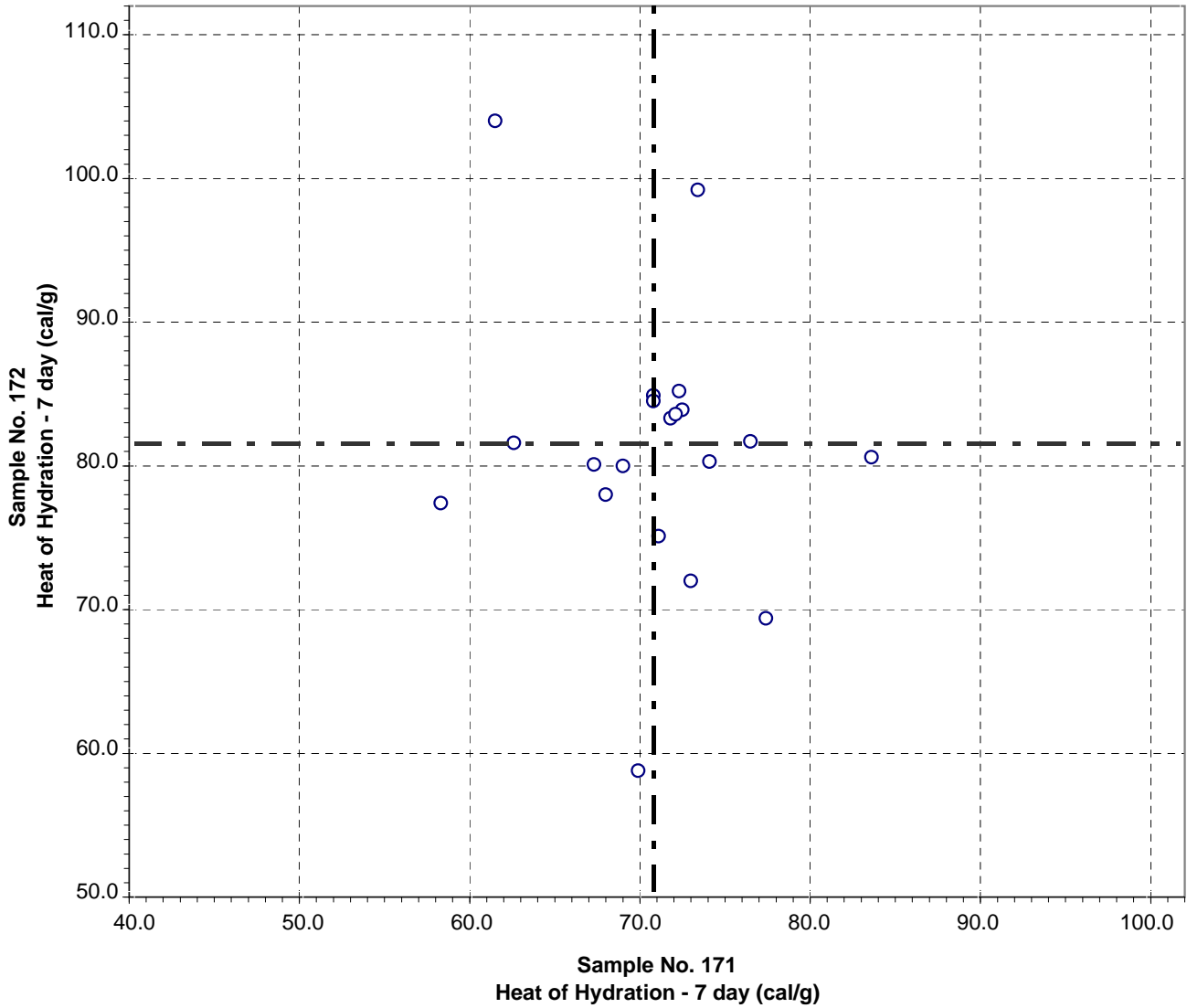
CCRL Proficiency Sample Program
Heat of Solution - 28 day
PORTLAND CEMENT Samples No. 171 and No. 172



Test No. 301 Heat of Solution - 28 day 19 Points

Sample No. 171	Ave 515.2	S.D. 12.2	C.V. 2.37
Sample No. 172	Ave 505.4	S.D. 7.8	C.V. 1.54

CCRL Proficiency Sample Program
Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 171 and No. 172

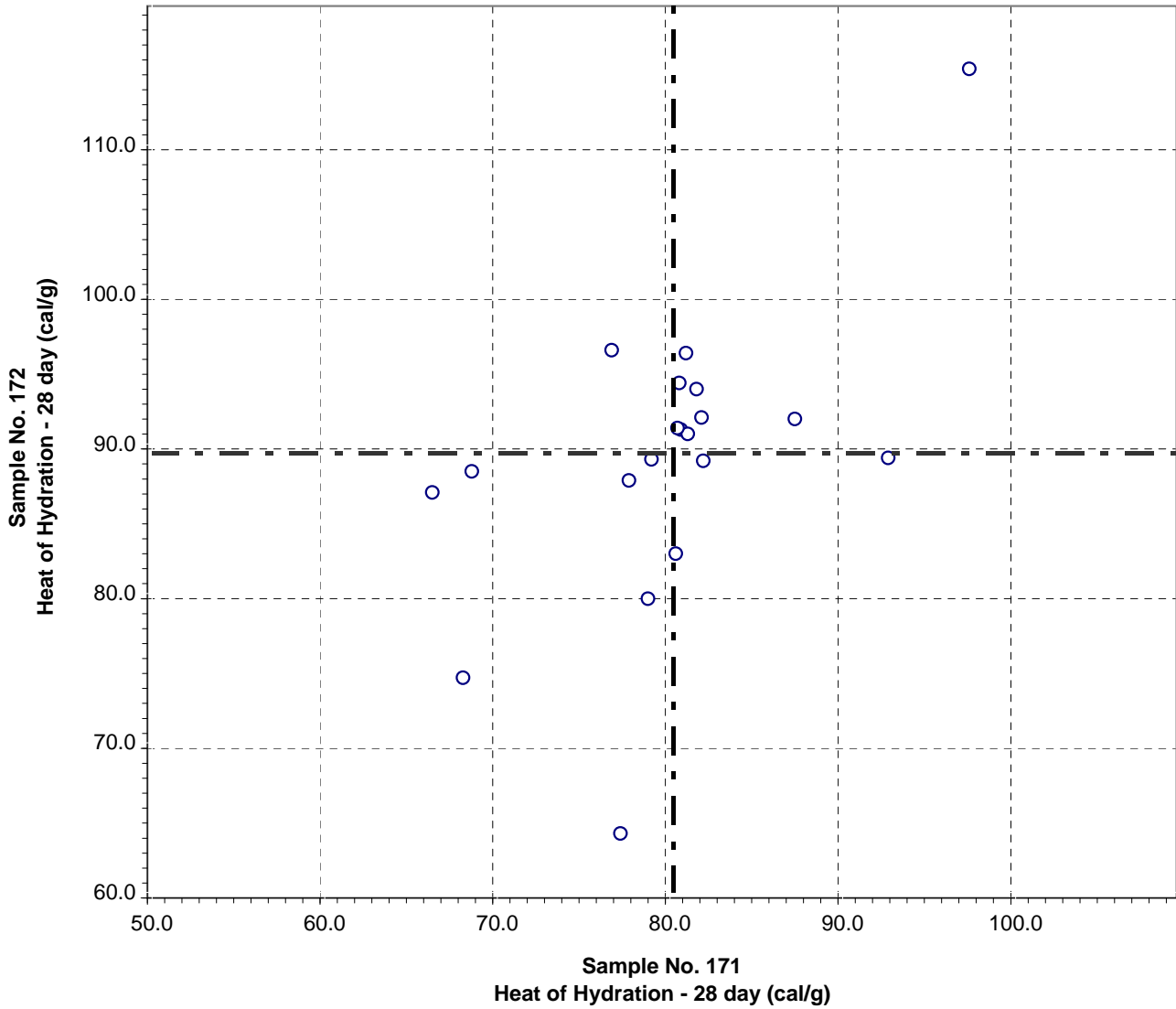


Test No. 290 Heat of Hydration - 7 day 20 Points

Sample No. 171 Ave 70.8 S.D. 5.6 C.V. 7.97
 Sample No. 172 Ave 81.2 S.D. 9.4 C.V. 11.63

Labs eliminated: 176

CCRL Proficiency Sample Program
Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 171 and No. 172



Test No. 300 Heat of Hydration - 28 day 20 Points

Sample No. 171	Ave 80.2	S.D. 7.3	C.V. 9.12
Sample No. 172	Ave 89.4	S.D. 9.8	C.V. 10.98