

CEMENT AND CONCRETE REFERENCE LABORATORY
PROFICIENCY SAMPLE PROGRAM

Final Report
Portland Cement Proficiency Samples
Number 169 and Number 170

October 2008



October 8, 2008

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 169 and No. 170

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in June 2008. Portland Cement Sample No. 169 was an ASTM C150 Type I and No. 170 was an ASTM C150 Type I. Both cements contained 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 June 2008.

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. 169 and No. 170

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 2008. 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,

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.*

labs with flow values outside this range will be flagged as a “Labs Eliminated” or “Labs Off Diagram” on the scatter diagram. Averages, standard deviations, and a scatter diagram are provided for your information. This information may be a helpful indicator of a problem with flow table apparatus or mortar mixing 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. 169 and No. 170
 Final Report - Primary Chemical Results
 October 3, 2008

SUMMARY OF RESULTS

Test	#Labs	Sample No. 169				Sample No. 170		
		Average	S.D.	C.V.	Average	S.D.	C.V.	
Silicon Dioxide	prent 233	22.04	0.40	1.83	21.69	0.34	1.56	
Silicon Dioxide	prent *226	22.07	0.30	1.36	21.71	0.28	1.31	
Aluminum Oxide	prent 225	3.18	0.16	5.16	3.77	0.12	3.33	
Aluminum Oxide	prent *219	3.17	0.14	4.37	3.77	0.11	2.89	
Ferric Oxide	prent 230	3.69	0.112	3.05	2.49	0.086	3.44	
Ferric Oxide	prent *223	3.70	0.068	1.85	2.48	0.049	1.99	
Calcium Oxide	prent 228	63.41	0.72	1.136	64.32	0.48	0.747	
Calcium Oxide	prent *224	63.47	0.46	0.729	64.32	0.45	0.697	
Magnesium Oxide	prent 228	2.01	0.15	7.60	1.44	0.09	6.07	
Magnesium Oxide	prent *212	2.00	0.07	3.74	1.44	0.05	3.75	
Sulfur Trioxide	prent 234	2.17	0.28	12.8	2.778	0.35	12.7	
Sulfur Trioxide	prent *224	2.15	0.08	3.74	2.75	0.10	3.68	
Loss on Ignition	prent 235	2.30	0.20	8.85	2.78	0.19	6.86	
Loss on Ignition	prent *225	2.30	0.12	5.38	2.78	0.12	4.23	
Sodium Oxide	prent 214	0.201	0.061	30.2	0.095	0.061	64.7	
Sodium Oxide	prent *199	0.201	0.032	16.2	0.092	0.026	28.3	

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

Silicon Dioxide	20 26 43 107 557 3009 3297
Aluminum Oxide	11 107 1251 2463 2491 3297
Ferric Oxide	8 52 107 305 458 2463 2484
Calcium Oxide	107 222 695 2305
Magnesium Oxide	1 201 305 2463 3009 3127 20 289 1251 2251 2360 2491 3235 3250 3297 3320
Sulfur Trioxide	4 47 51 94 161 690 768 1053 1940 3297
Loss on Ignition	95 169 51 132 207 289 695 1466 2464 3379
Sodium Oxide	54 161 201 1196 1483 2463 94 98 157 375 2462 2466 2621 3234 3279

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 169 and No. 170
 Final Report - Primary Chemical Results
 October 3, 2008

SUMMARY OF RESULTS

Test		#Labs	Sample No. 169			Sample No. 170		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Potassium Oxide	prent	223	0.429	0.041	9.53	0.622	0.071	11.39
Potassium Oxide	prent	*210	0.429	0.015	3.48	0.628	0.020	3.21
Titanium Dioxide	prent	176	0.23	0.020	8.61	0.17	0.013	7.84
Titanium Dioxide	prent	*159	0.23	0.0087	3.80	0.17	0.0072	4.27
Phosphorous Pent	prent	162	0.136	0.026	19.2	0.074	0.021	28.9
Phosphorous Pent	prent	*145	0.135	0.0080	5.90	0.074	0.0072	9.73
Zinc Oxide	prent	74	0.108	0.0229	21.2	0.009	0.0098	112.2
Zinc Oxide	prent	* 69	0.110	0.0048	4.34	0.008	0.0022	29.47
Manganic Oxide	prent	131	0.107	0.024	22.5	0.043	0.016	37.0
Manganic Oxide	prent	*120	0.111	0.0046	4.14	0.045	0.0043	9.67
Chloride	prent	99	0.009	0.017	199	0.006	0.013	223
Chloride	prent	* 91	0.005	0.0040	84.2	0.003	0.0030	98.5
Insoluble Residue	prent	221	0.38	1.23	321	0.64	0.92	144
Insoluble Residue	prent	*205	0.28	0.076	26.9	0.56	0.097	17.3
Free Calcium Oxid	prent	184	1.36	0.36	26.5	1.36	0.37	26.9
Free Calcium Oxid	prent	*179	1.36	0.32	23.6	1.36	0.32	23.5

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

Potassium Oxide	413 698 1483 2 137 206 1940 2463 3009 3126 3144 3233 3234
Titan Dioxide	40 45 48 125 494 2254 2296 2621 168 175 491 1196 2463 2477 3015 3185 3297
Phosphorous Pentoxide	94 98 201 684 687 1054 1196 54 66 101 178 289 1940 2463 2466 2483 3279
Zinc Oxide	125 493 206 611 2305
Manganic Oxide	161 1053 1251 2305 3 201 768 1054 1196 2462 2463
Chloride	158 1940 3057 84 98 692 1379 3144
Insoluble Residue	29 66 154 289 695 2477 3255 3279 43 47 48 64 96 243 1379 3297
Free Calcium Oxide	107 148 494 1644 2491

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 169 and No. 170
 Final Report - Primary Chemical Results
 October 3, 2008

SUMMARY OF RESULTS

Test		#Labs	Sample No. 169			Sample No. 170		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Carbon Dioxide	prent	177	1.64	0.33	20.1	1.86	0.41	22.2
Carbon Dioxide	prent	*170	1.66	0.26	15.6	1.88	0.30	15.8
Limestone Content	prent	171	3.8	0.81	21.5	4.8	1.11	23.1
Limestone Content	prent	*165	3.8	0.60	15.8	4.8	0.77	16.0
Chromium Oxide	prent	77	0.015	0.0135	91.9	0.009	0.0094	103.2
Chromium Oxide	prent	*73	0.013	0.0040	31.3	0.008	0.0038	50.7
⁽¹⁾ Tricalcium Silicate	prent	167	51.4	5.0	9.75	52.6	5.2	9.85
⁽¹⁾ Tricalcium Silicate	prent	*163	51.1	4.4	8.52	52.4	4.7	8.97
⁽¹⁾ Dicalcium Silicate	prent	167	24.2	4.5	18.7	22.3	4.4	19.9
⁽¹⁾ Dicalcium Silicate	prent	*163	24.5	4.0	16.3	22.4	4.0	17.9
Tricalc Aluminate	prent	194	2.2	0.56	25.41	5.8	0.38	6.61
Tricalc Aluminate	prent	*187	2.1	0.37	17.59	5.8	0.30	5.18
Tetracalc Alumino	prent	192	11.2	0.35	3.13	7.6	0.17	2.23
Tetracalc Alumino	prent	*184	11.3	0.19	1.66	7.6	0.15	1.99

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

Carbon Dioxide	26 54 94 95 162 222 1196
Limestone Content	26 41 54 162 1196 3379
Chromium Oxide	438 5 684 2463
Tricalcium Silicate	15 43 883 2116
Dicalcium Silicate	15 43 883 2116
Tricalcium Aluminate	46 131 305 2463 2484 2491 3297
Tetracalcium Aluminoferrite	46 107 305 870 2463 2484 2491 3320

NOTES:

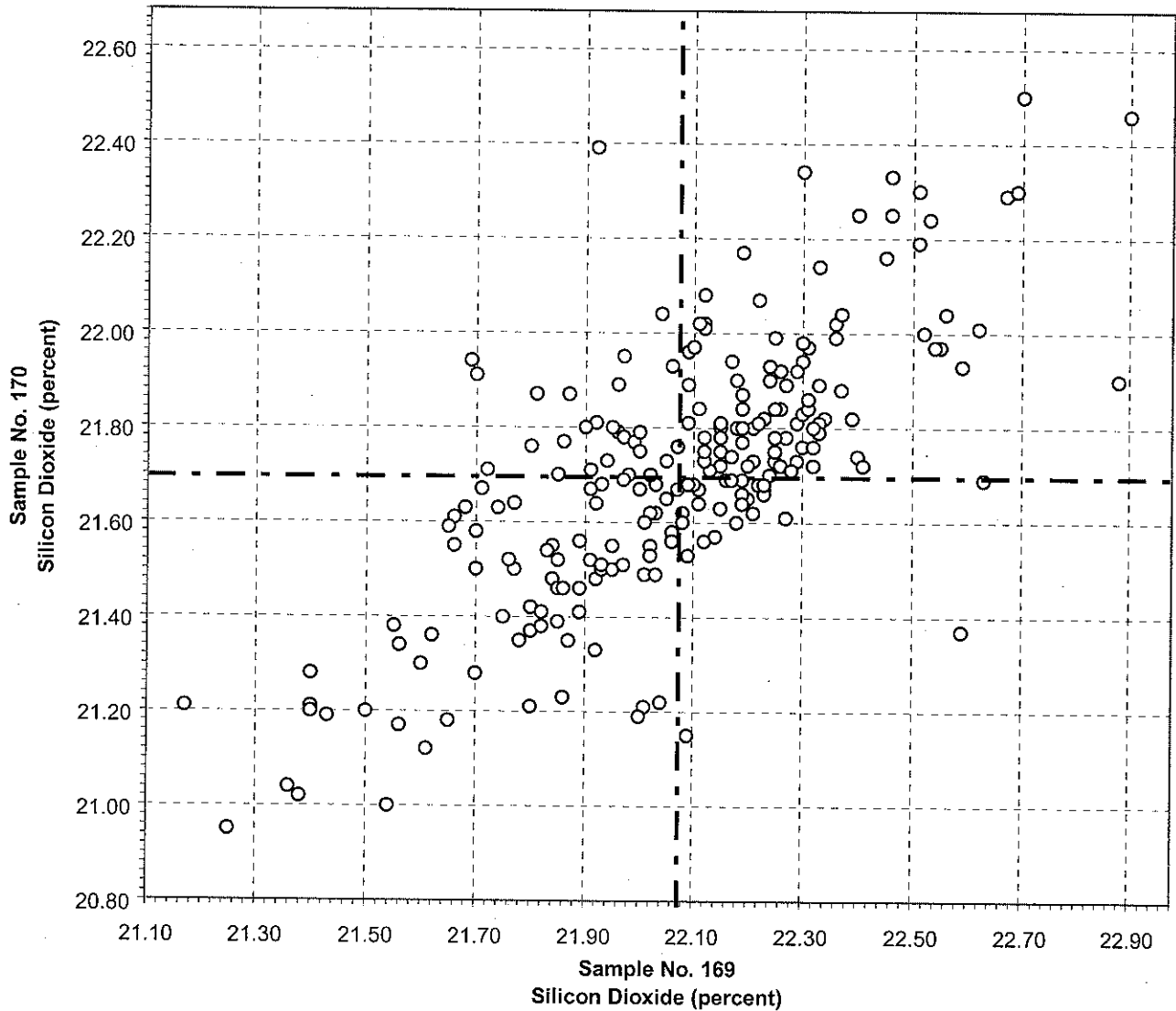
(1) Tricalcium silicate and Dicalcium silicate - ASTM C150 requires that cements containing limestone additions use CO₂ in the calculation of these two phases. Both Sample No. 169 and No. 170 contain limestone additions, therefore test results of 26 laboratories not determining CO₂ were not used in calculating 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 .

34	696
78	787
80	870
86	2251
98	2435
106	2477
137	2483
161	2484
181	2621
209	3127
289	3235
557	3279
611	3297

CCRL Proficiency Sample Program
Silicon Dioxide
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 10 Silicon Dioxide 224 Points

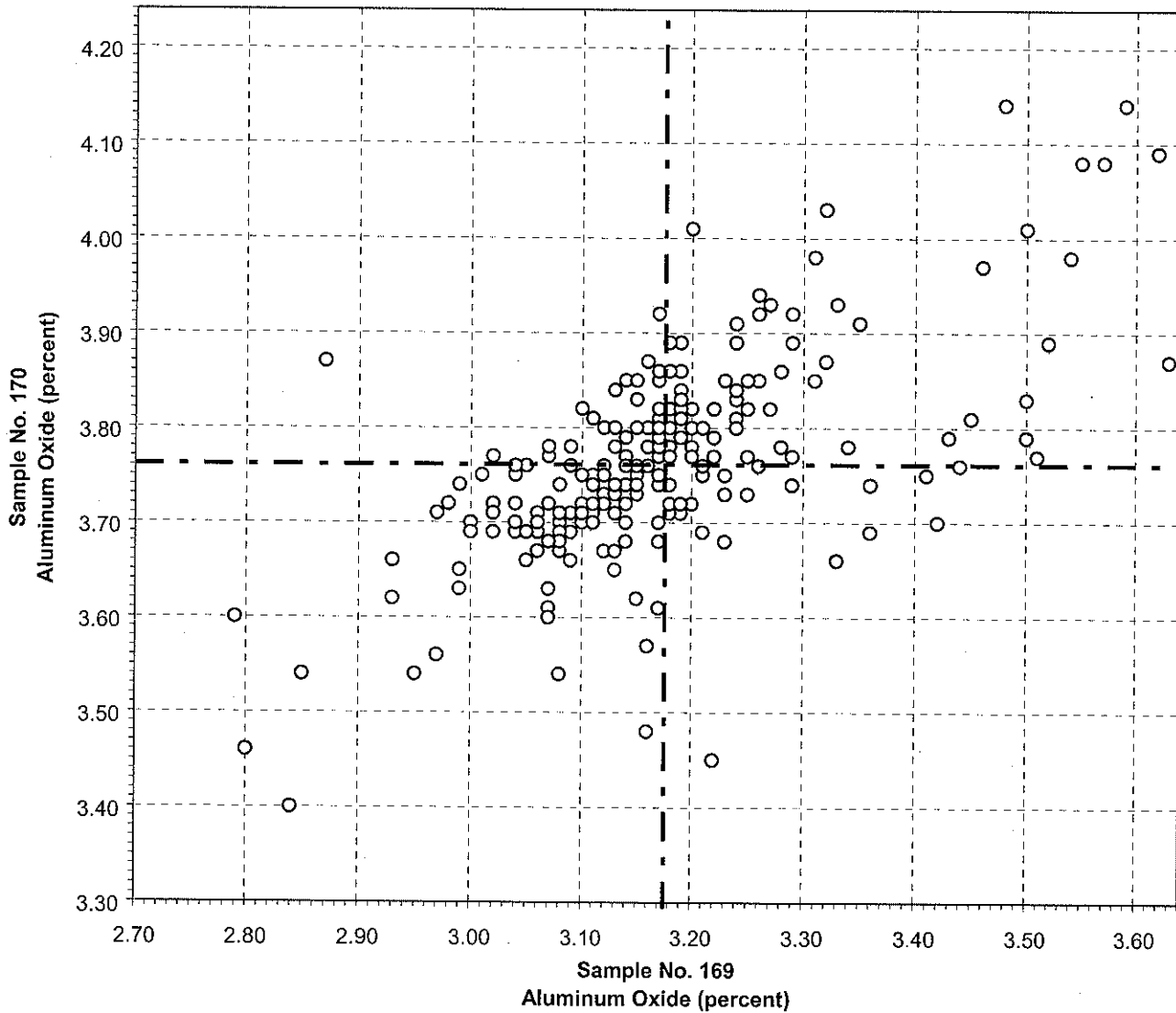
Sample No. 169 Ave 22.07 S.D. 0.30 C.V. 1.36

Sample No. 170 Ave 21.71 S.D. 0.28 C.V. 1.31

Labs eliminated: 20, 26, 43, 107, 557, 3009, 3297

Labs off Diagram: 2, 779

CCRL Proficiency Sample Program
Aluminum Oxide
PORTLAND CEMENT Samples No. 169 and No. 170



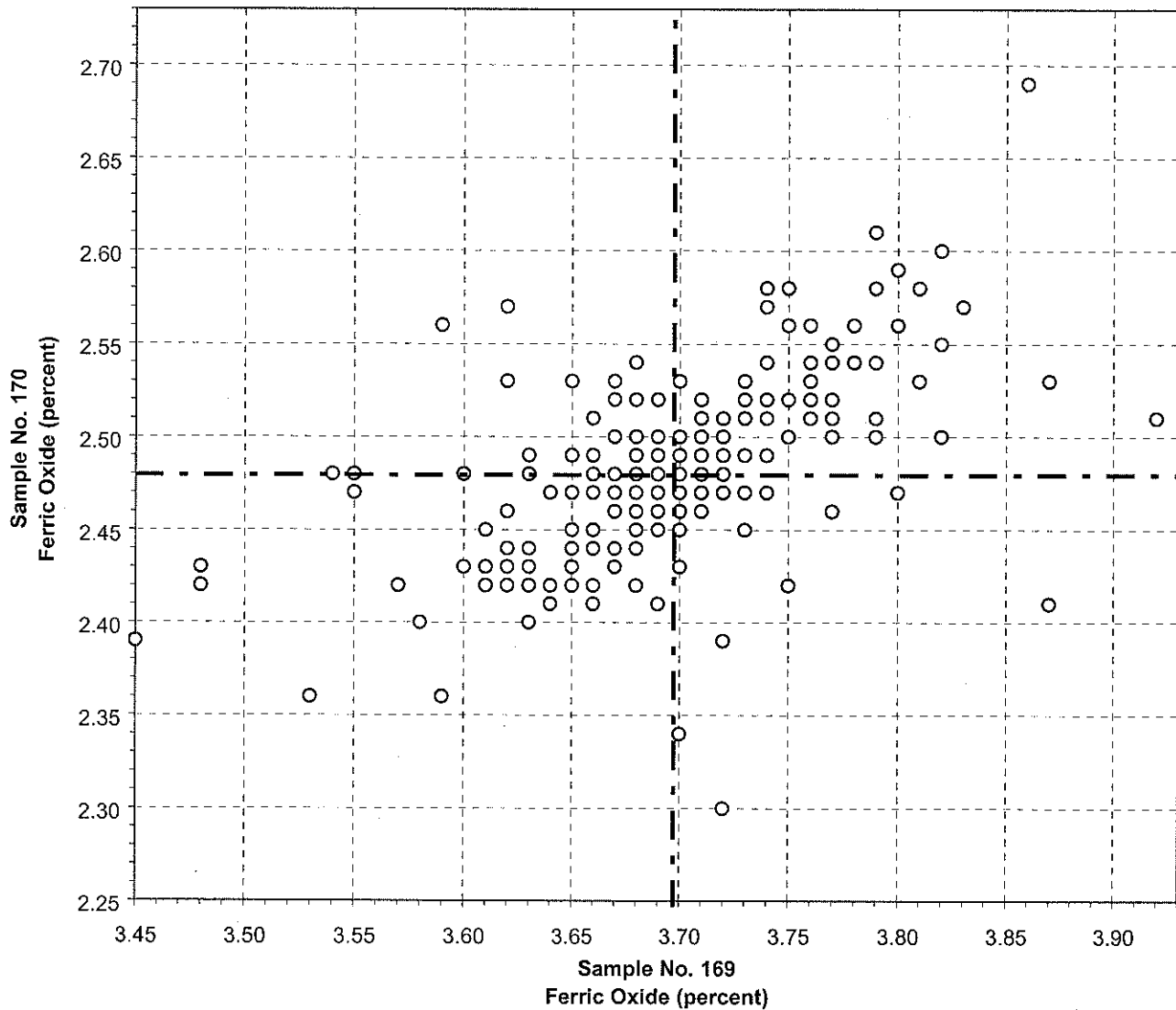
Test No. 21 Aluminum Oxide 219 Points

Sample No. 169 Ave 3.17 S.D. 0.14 C.V. 4.37

Sample No. 170 Ave 3.77 S.D. 0.11 C.V. 2.89

Labs eliminated: 11, 107, 1251, 2463, 2491, 3297

CCRL Proficiency Sample Program
Ferric Oxide
PORTLAND CEMENT Samples No. 169 and No. 170



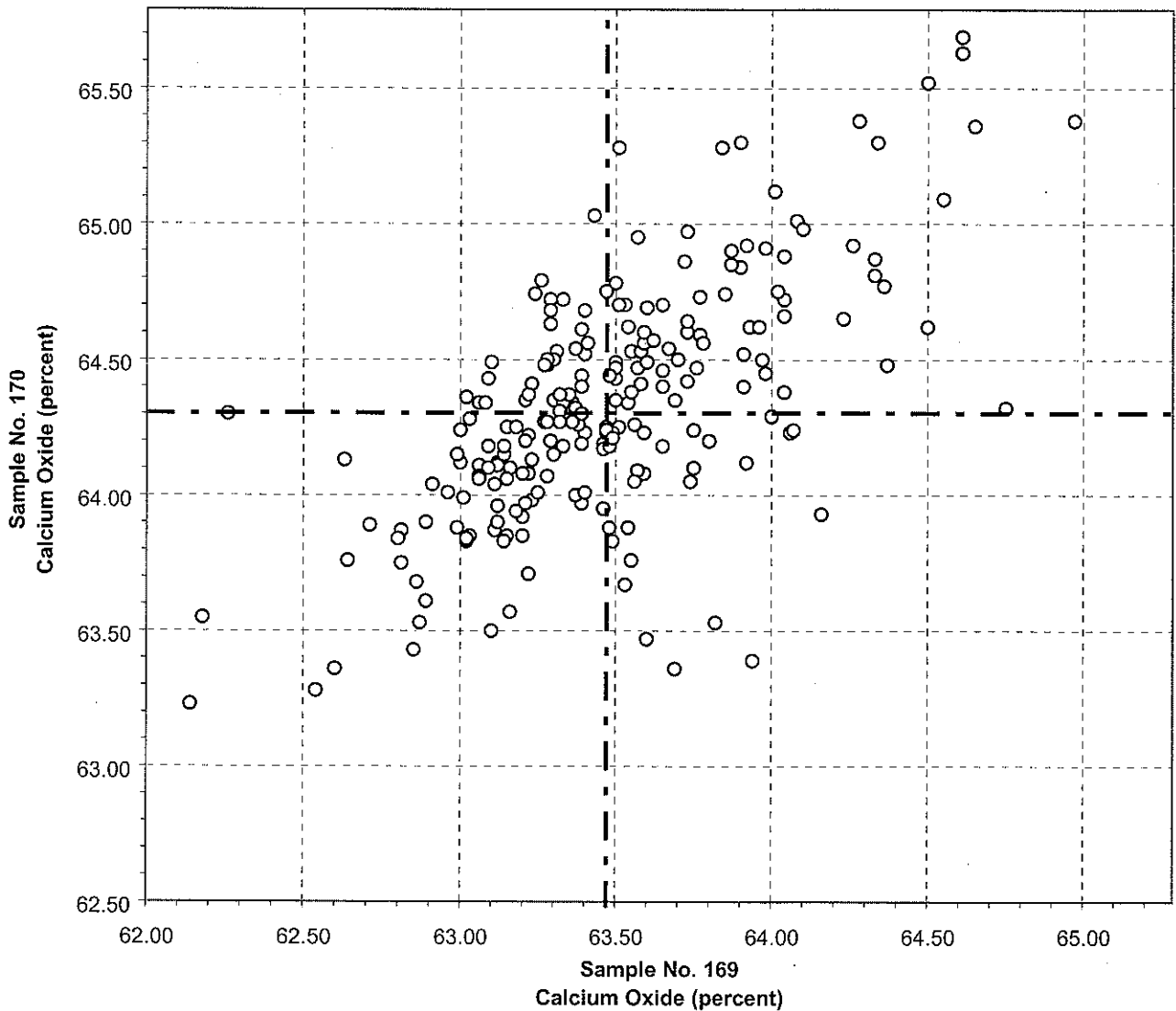
Test No. 30 Ferric Oxide 222 Points

Sample No. 169 Ave 3.70 S.D. 0.068 C.V. 1.85
 Sample No. 170 Ave 2.48 S.D. 0.049 C.V. 1.99

Labs eliminated: 8, 52, 107, 305, 458, 2463, 2484

Labs off Diagram: 2491

**CCRL Proficiency Sample Program
 Calcium Oxide
 PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 40 Calcium Oxide 223 Points

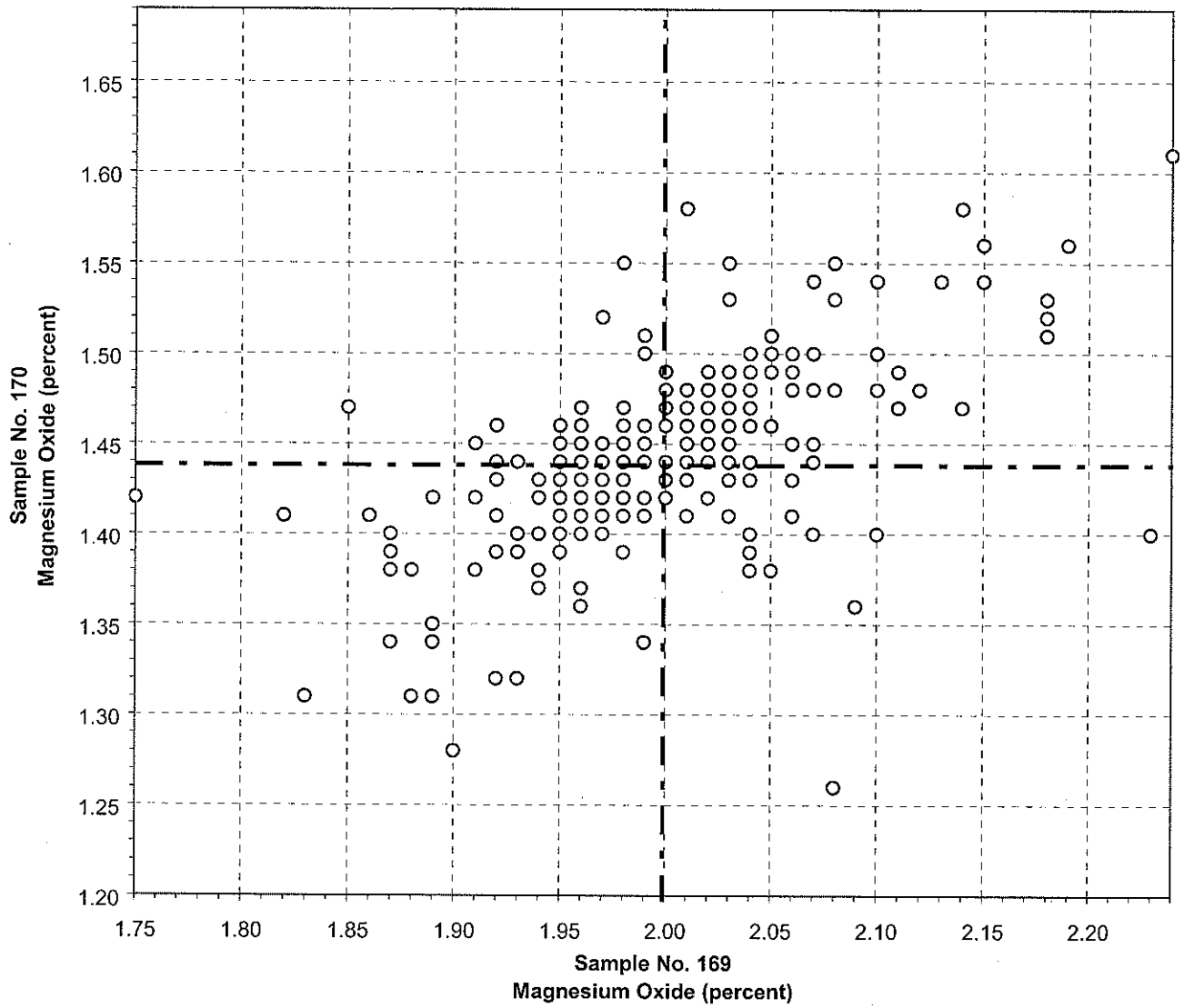
Sample No. 169 Ave 63.47 S.D. 0.46 C.V. 0.729

Sample No. 170 Ave 64.32 S.D. 0.45 C.V. 0.697

Labs eliminated: 107, 222, 695, 2305

Labs off Diagram: 8

**CCRL Proficiency Sample Program
Magnesium Oxide
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 50 Magnesium Oxide 211 Points

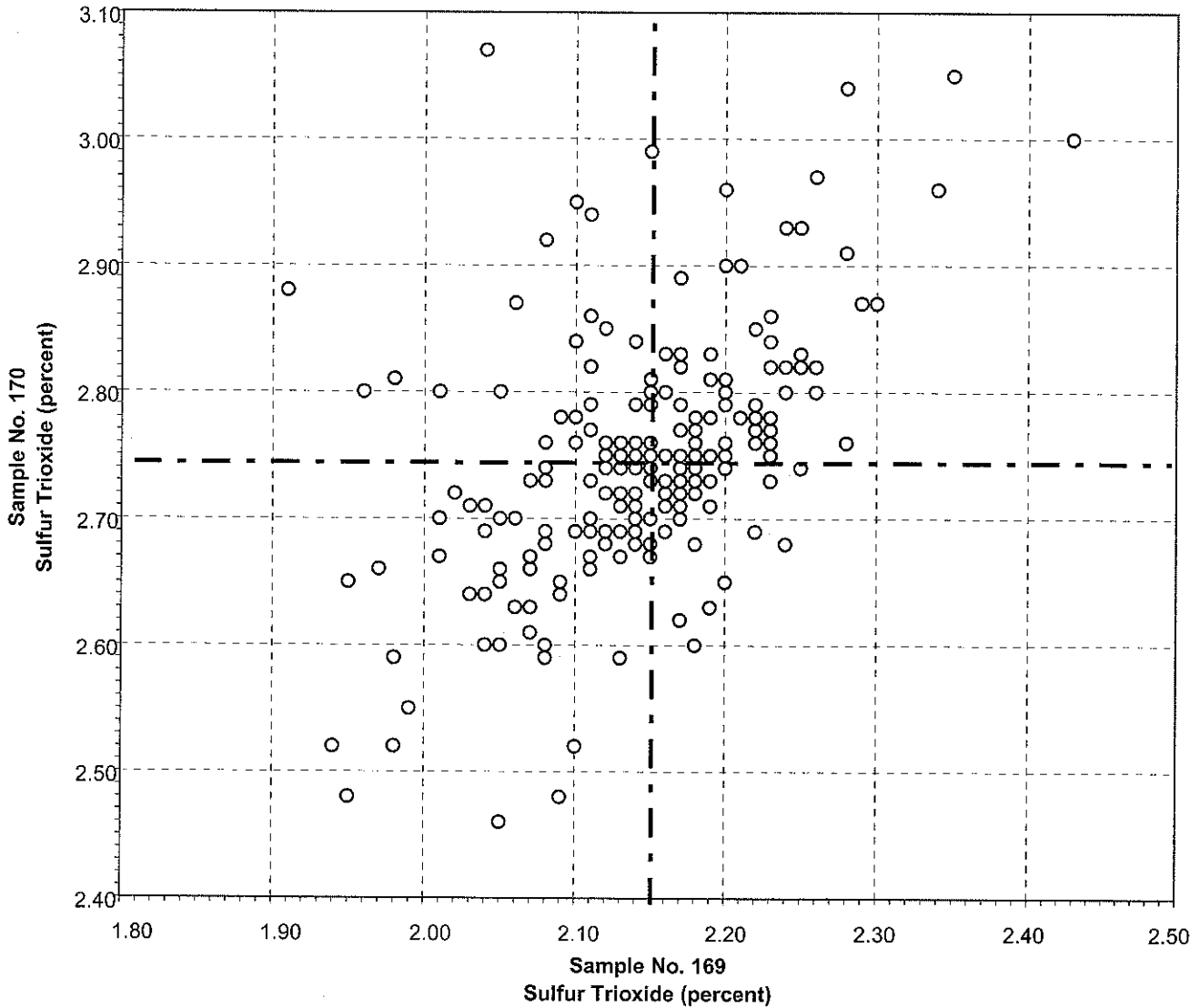
Sample No. 169 Ave 2.01 S.D. 0.07 C.V. 3.74

Sample No. 170 Ave 1.44 S.D. 0.05 C.V. 3.75

Labs eliminated: 1, 201, 305, 2463, 3009, 3127, 20, 289, 1251, 2251, 2360, 2491, 3235, 3250, 3297, 3320

Labs off Diagram: 694

**CCRL Proficiency Sample Program
Sulfur Trioxide
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 60 Sulfur Trioxide 222 Points

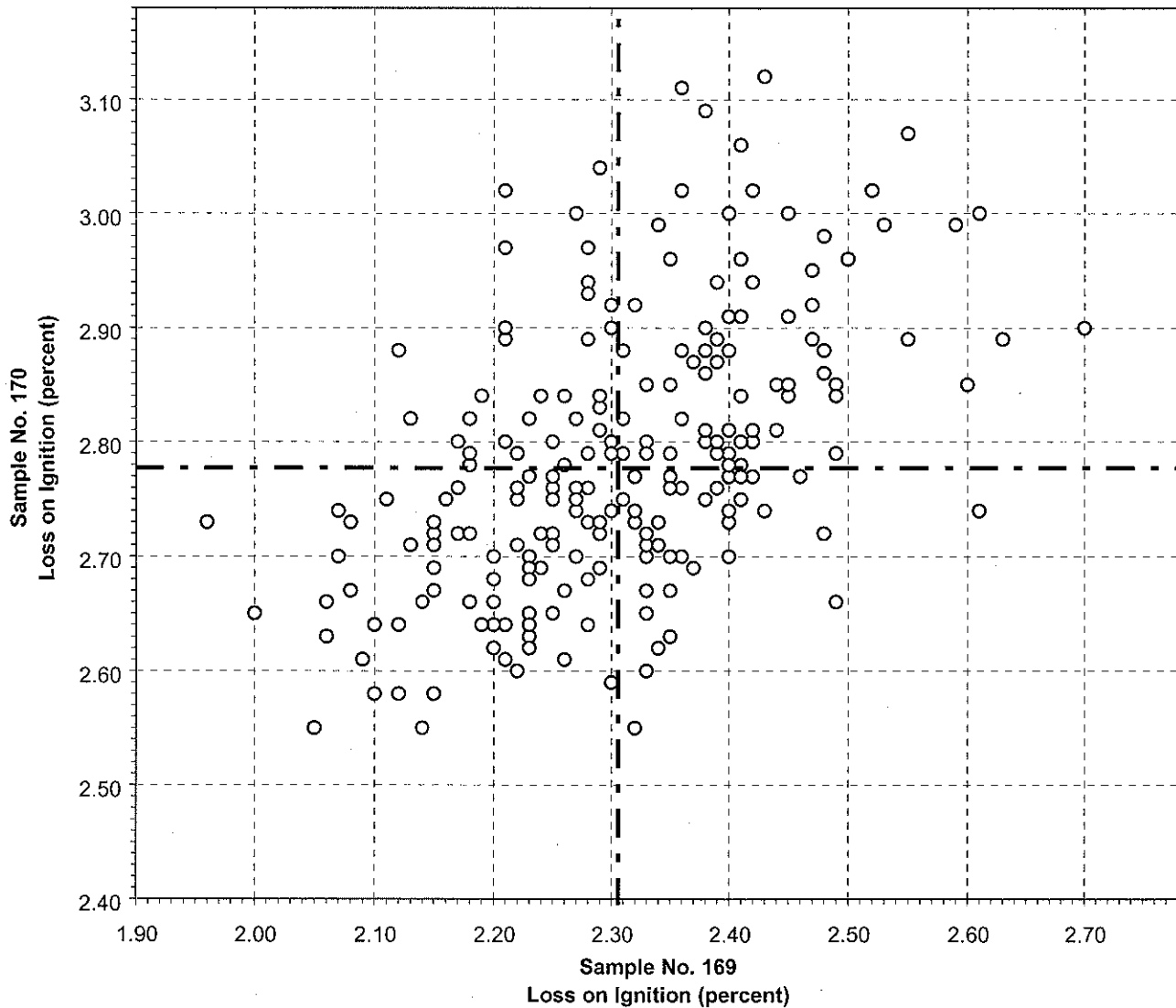
Sample No. 169 Ave 2.15 S.D. 0.08 C.V. 3.74

Sample No. 170 Ave 2.75 S.D. 0.10 C.V. 3.68

Labs eliminated: 4, 47, 51, 94, 161, 690, 768, 1053, 1940, 3297

Labs off Diagram: 1196, 1483

CCRL Proficiency Sample Program
Loss on Ignition
PORTLAND CEMENT Samples No. 169 and No. 170



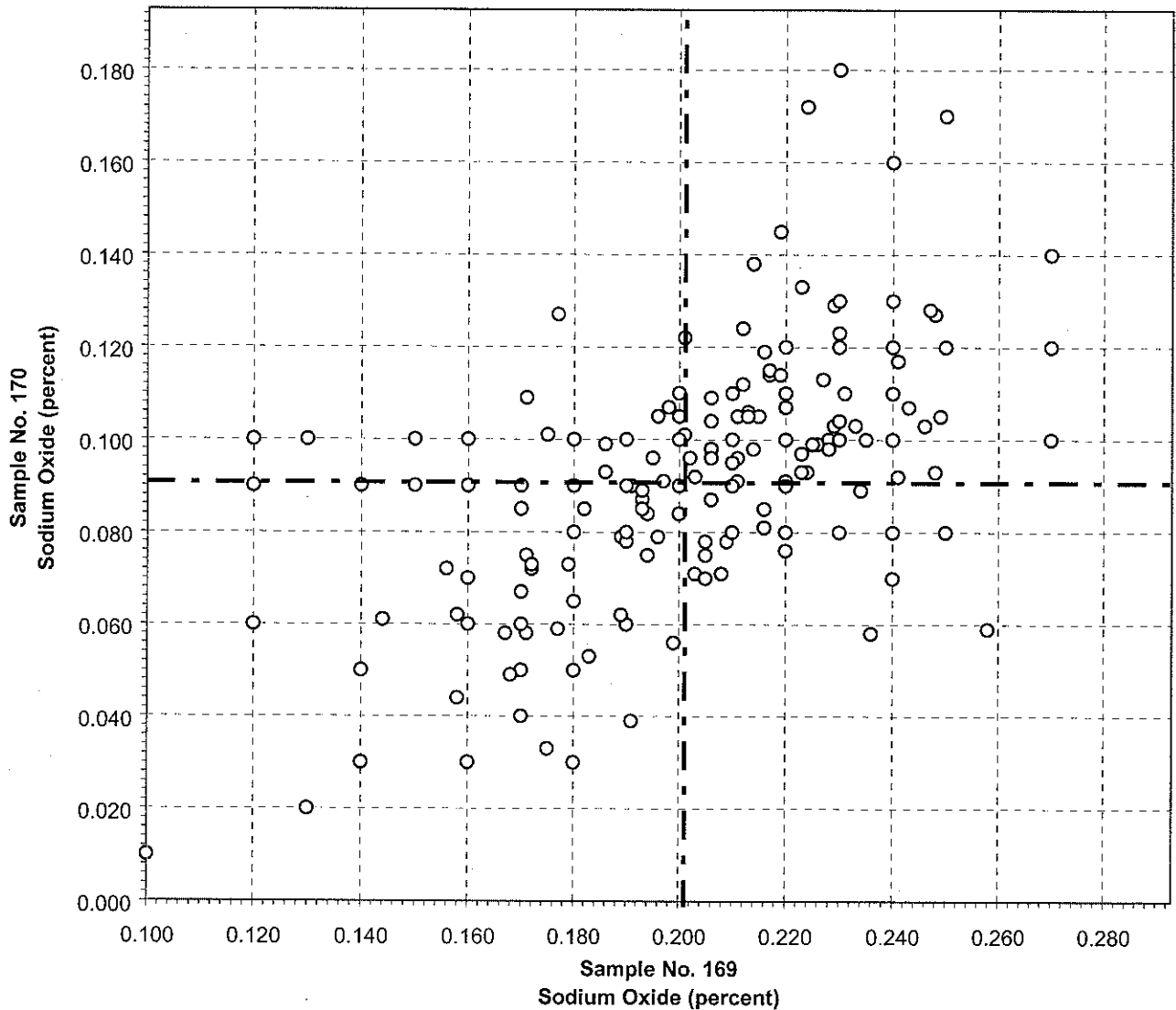
Test No. 70 Loss on Ignition 225 Points

Sample No. 169 Ave 2.30 S.D. 0.12 C.V. 5.38

Sample No. 170 Ave 2.78 S.D. 0.12 C.V. 4.23

Labs eliminated: 95, 169, 51, 132, 207, 289, 695, 1466, 2464, 3379

CCRL Proficiency Sample Program
Sodium Oxide
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 90 Sodium Oxide 198 Points

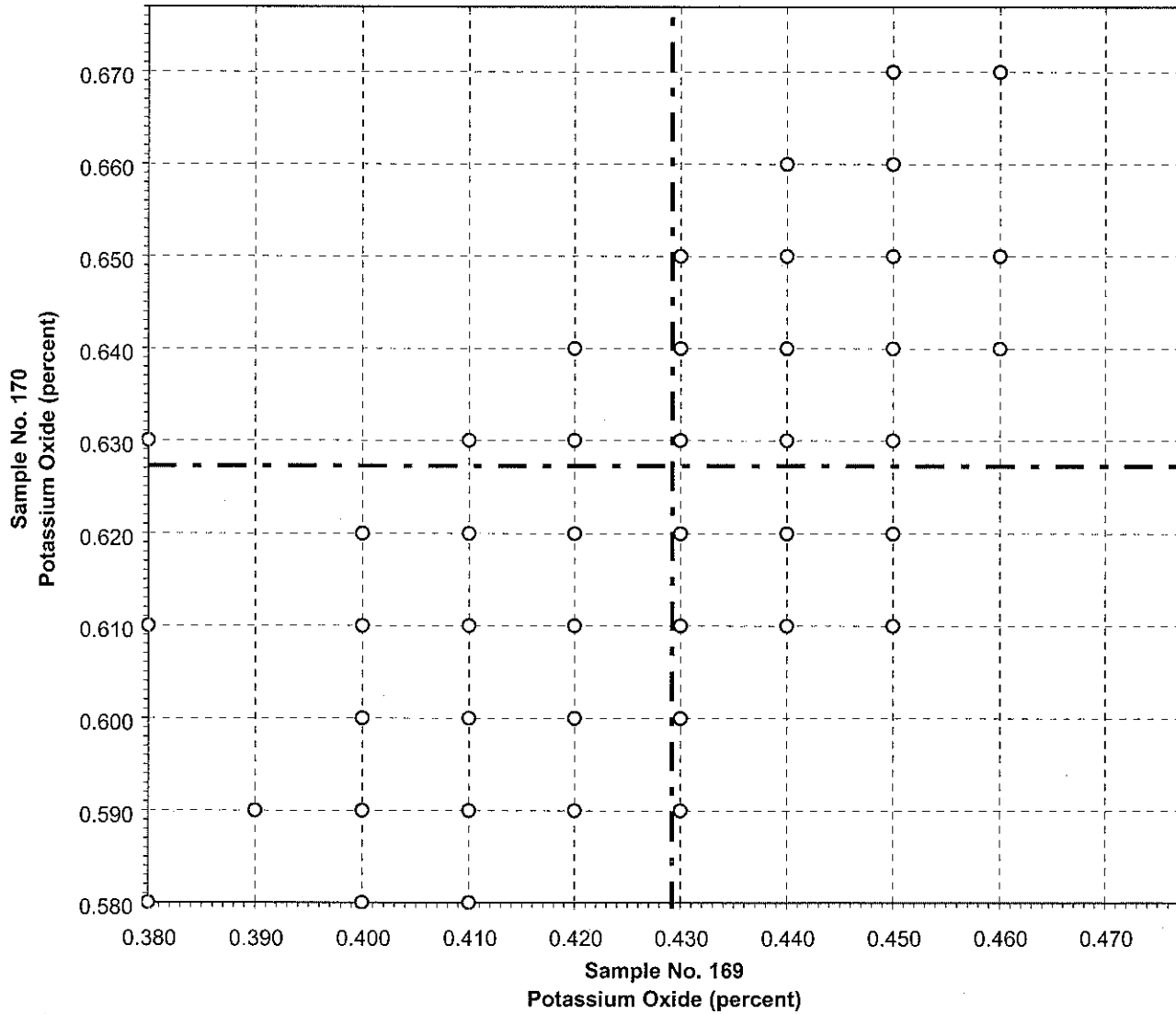
Sample No. 169 Ave 0.201 S.D. 0.032 C.V. 16.2

Sample No. 170 Ave 0.092 S.D. 0.026 C.V. 28.3

Labs eliminated: 54, 161, 201, 1196, 1483, 2463, 94, 98, 157, 375, 2462, 2466, 2621, 3234, 3279

Labs off Diagram: 3320

**CCRL Proficiency Sample Program
Potassium Oxide
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 100 Potassium Oxide 205 Points

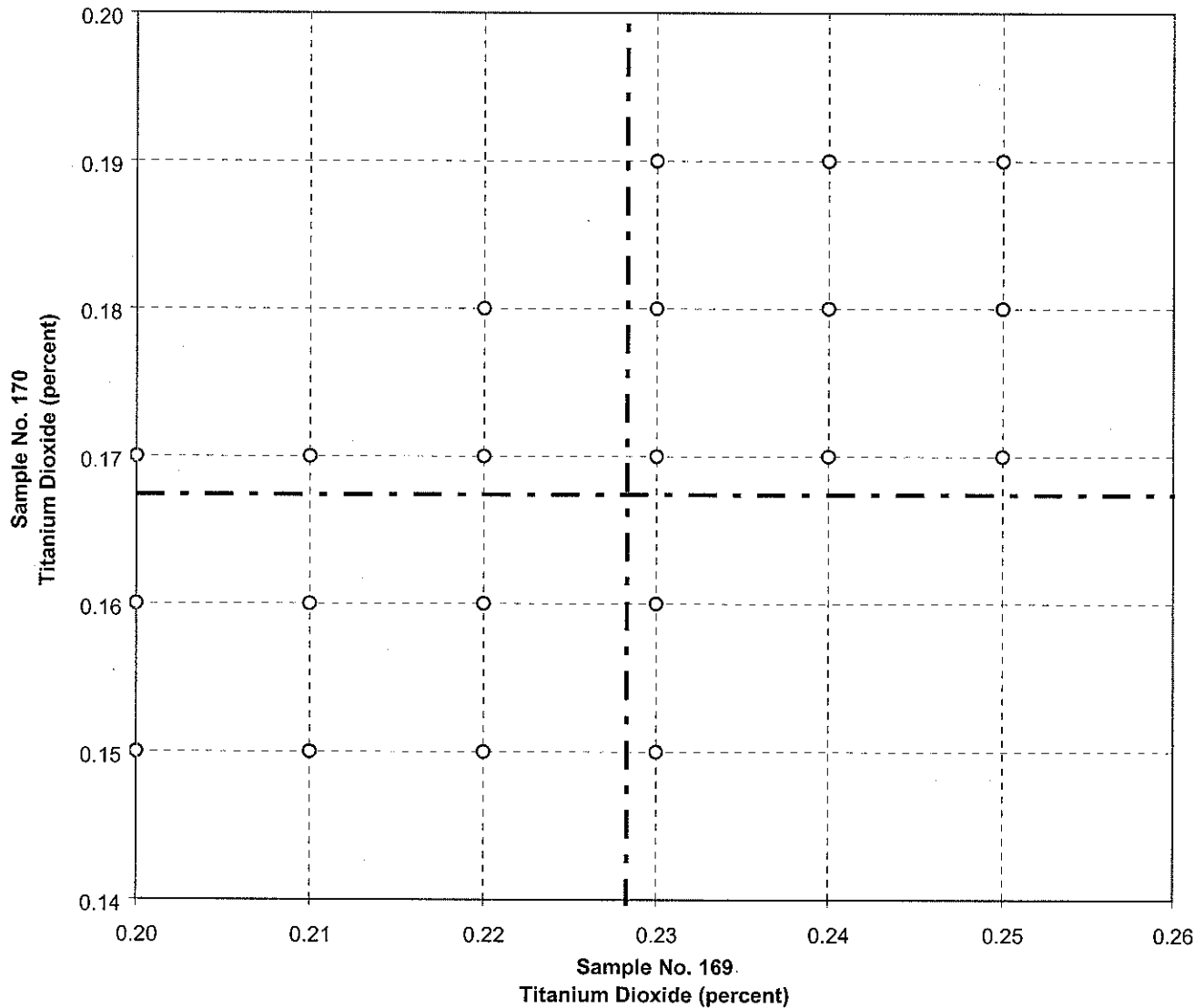
Sample No. 169 Ave 0.429 S.D. 0.015 C.V. 3.48

Sample No. 170 Ave 0.628 S.D. 0.020 C.V. 3.21

Labs eliminated: 413, 698, 1483, 2, 137, 206, 1940, 2463, 3009, 3126, 3144, 3233, 3234

Labs off Diagram: 168, 501, 1054, 2621, 2934

**CCRL Proficiency Sample Program
Titanium Dioxide
PORTLAND CEMENT Samples No. 169 and No. 170**



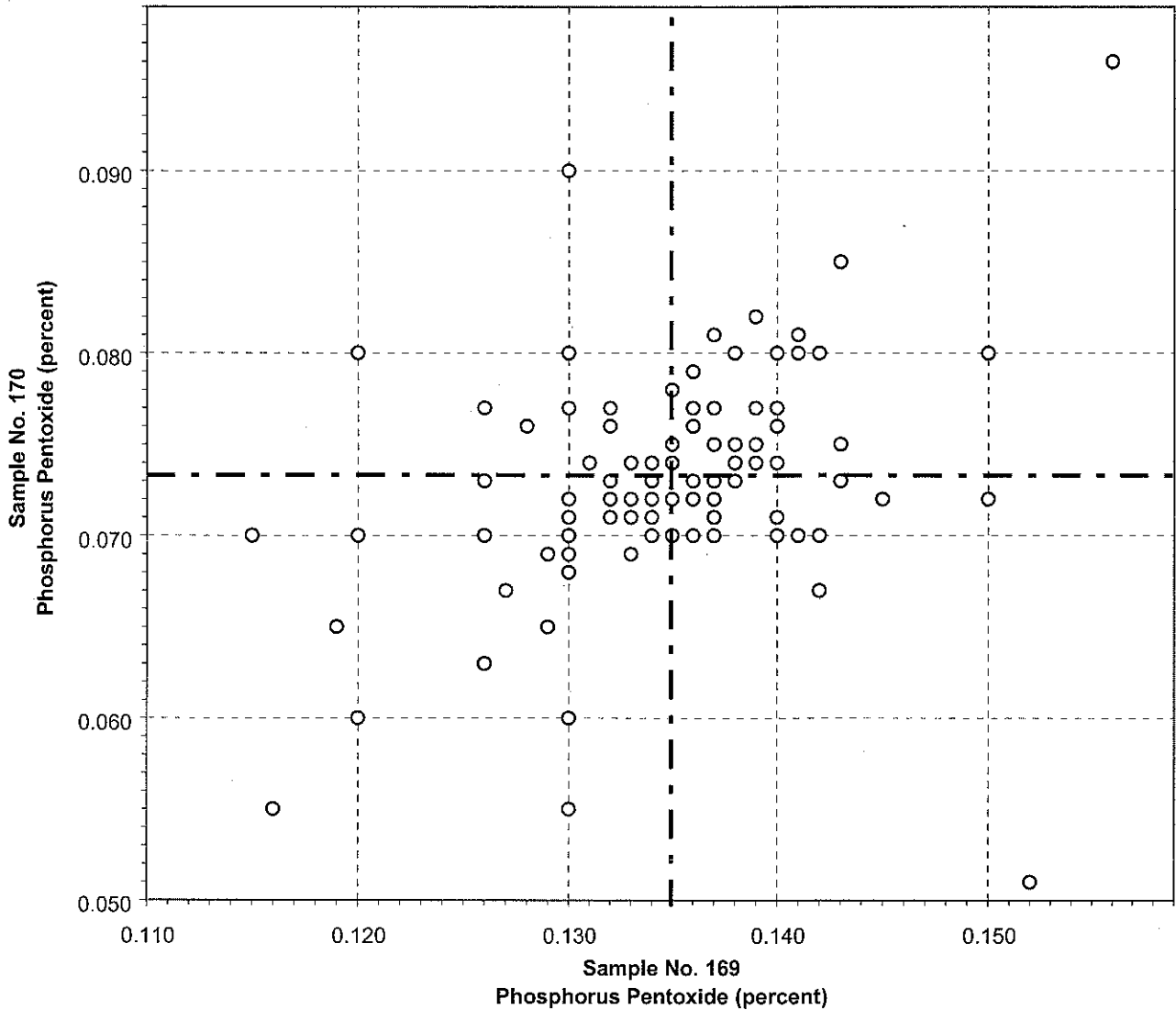
Test No. 103 Titanium Dioxide 159 Points

Sample No. 169 Ave 0.23 S.D. 0.0087 C.V. 3.80

Sample No. 170 Ave 0.17 S.D. 0.0072 C.V. 4.27

Labs eliminated: 40, 45, 48, 125, 494, 2254, 2296, 2621, 168, 175, 491, 1196, 2463, 2477, 3015, 3185, 3297

**CCRL Proficiency Sample Program
Phosphorus Pentoxide
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 102 Phosphorus Pentoxide 139 Points

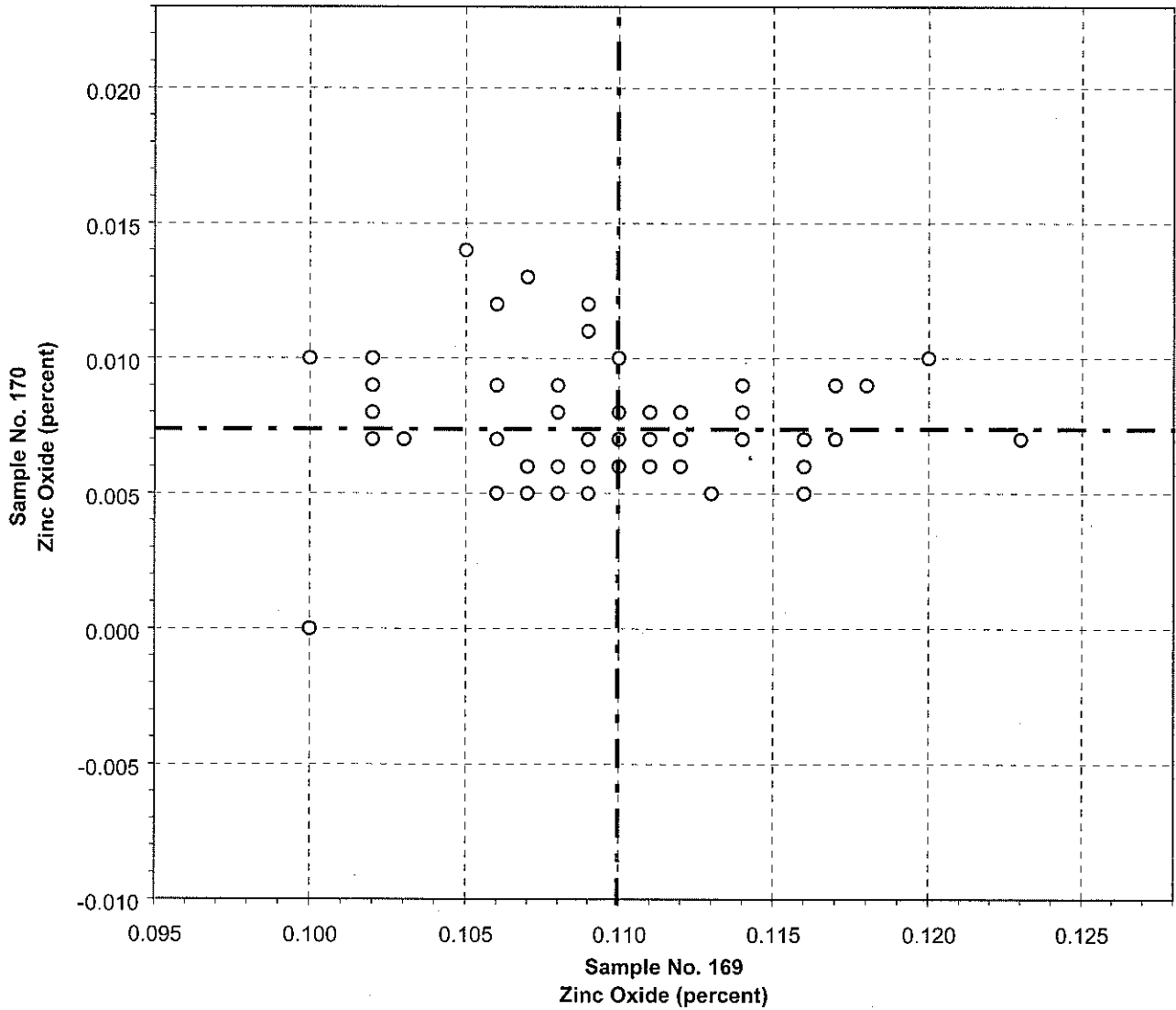
Sample No. 169 Ave 0.135 S.D. 0.008 C.V. 5.90

Sample No. 170 Ave 0.074 S.D. 0.0072 C.V. 9.73

Labs eliminated: 94, 98, 201, 684, 687, 1054, 1196, 54, 66, 101, 178, 289, 1940, 2463, 2466, 2483, 3279

Labs off Diagram: 137, 493, 1053, 1251, 2490, 3233

**CCRL Proficiency Sample Program
Zinc Oxide
PORTLAND CEMENT Samples No. 169 and No. 170**

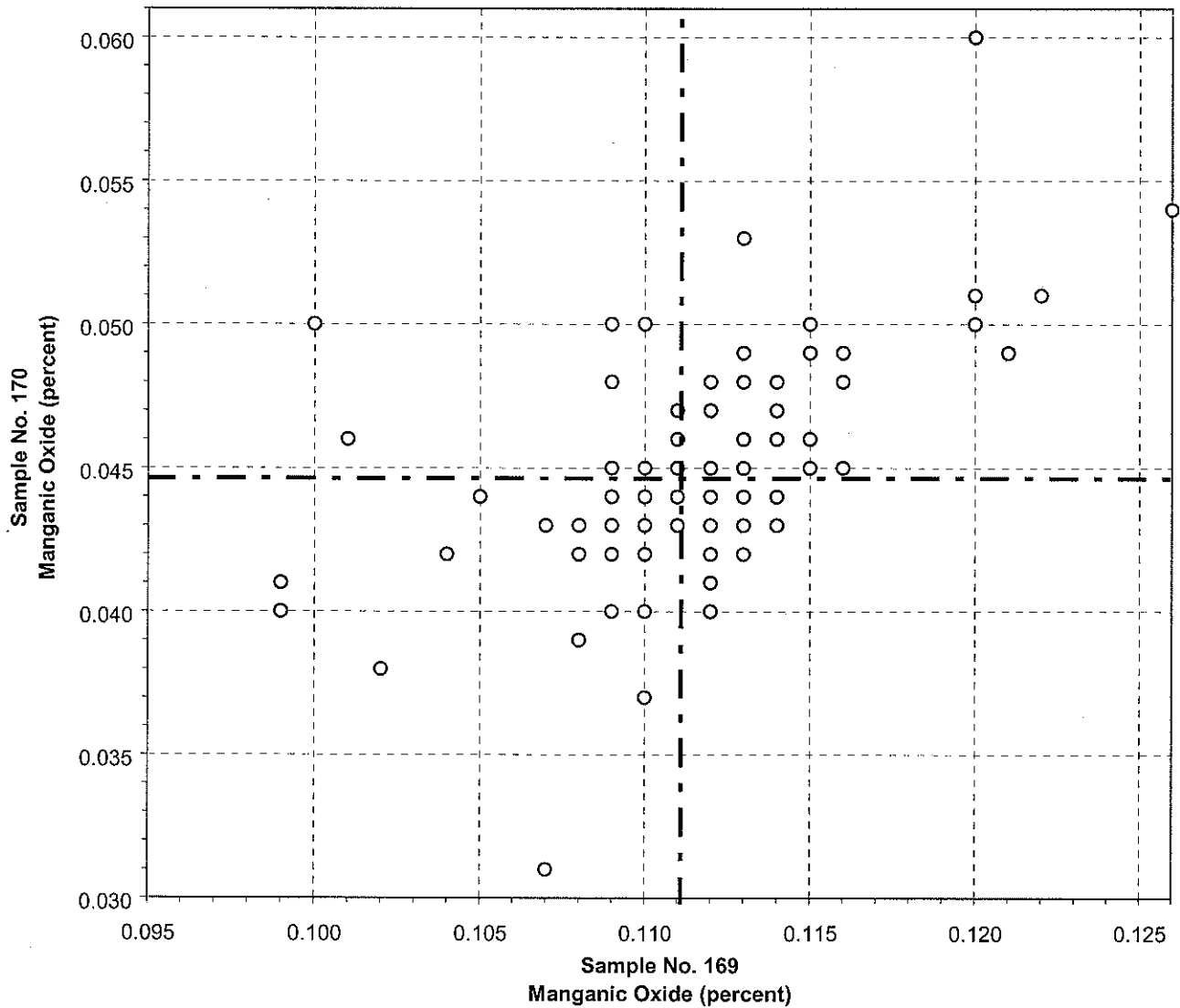


Test No. 99 Zinc Oxide 69 Points

Sample No. 169	Ave 0.110	S.D. 0.0048	C.V. 4.34
Sample No. 170	Ave 0.008	S.D. 0.0022	C.V. 29.47

Labs eliminated: 125, 493, 206, 611, 2305

CCRL Proficiency Sample Program
Manganic Oxide
PORTLAND CEMENT Samples No. 169 and No. 170



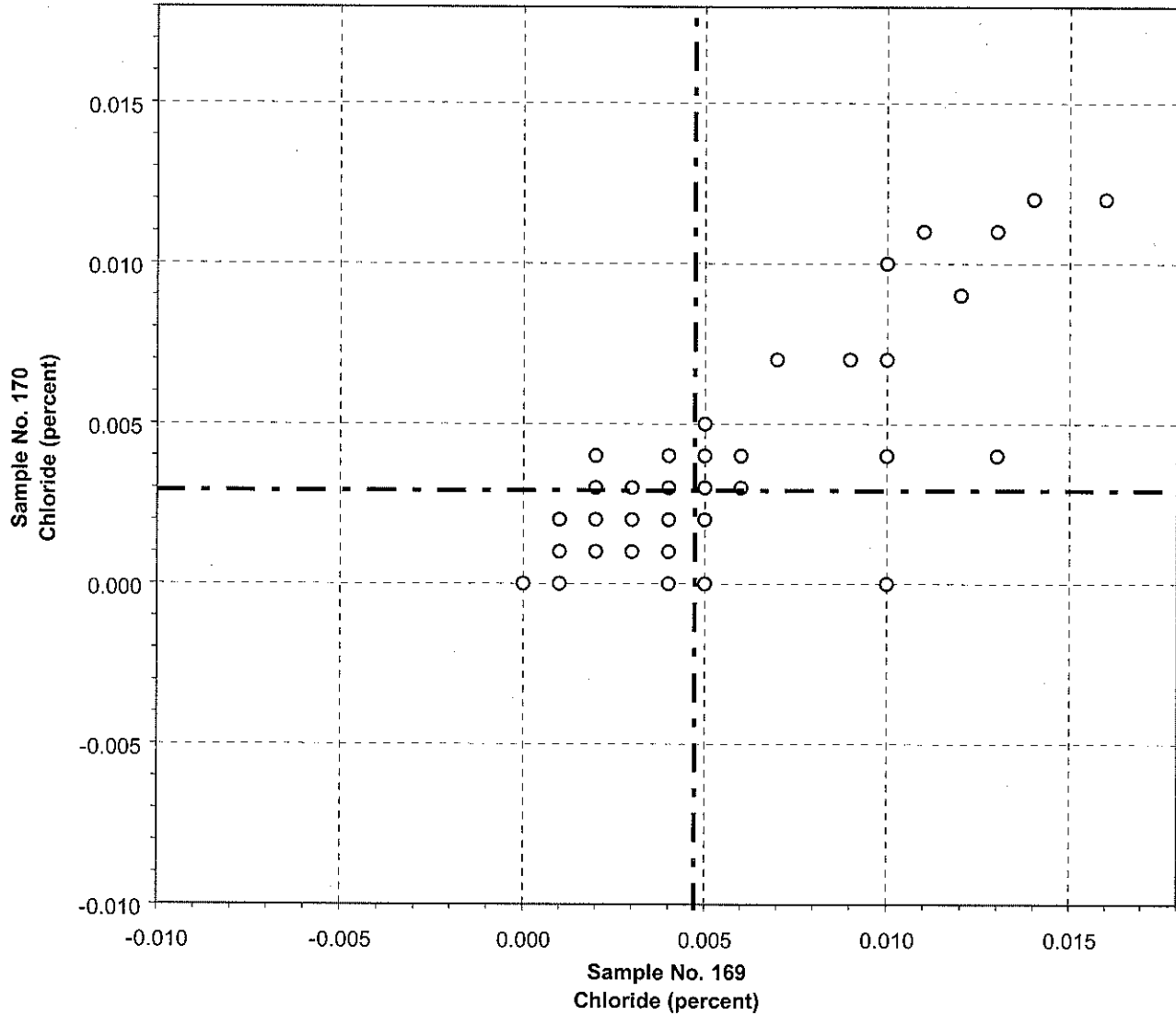
Test No. 101 Manganic Oxide 119 Points

Sample No. 169 Ave 0.111 S.D. 0.0046 C.V. 4.14
 Sample No. 170 Ave 0.0445 S.D. 0.0043 C.V. 9.67

Labs eliminated: 161, 1053, 1251, 2305, 3, 201, 768, 1054, 1196, 2462, 2463

Labs off Diagram: 48

CCRL Proficiency Sample Program
Chloride
PORTLAND CEMENT Samples No. 169 and No. 170



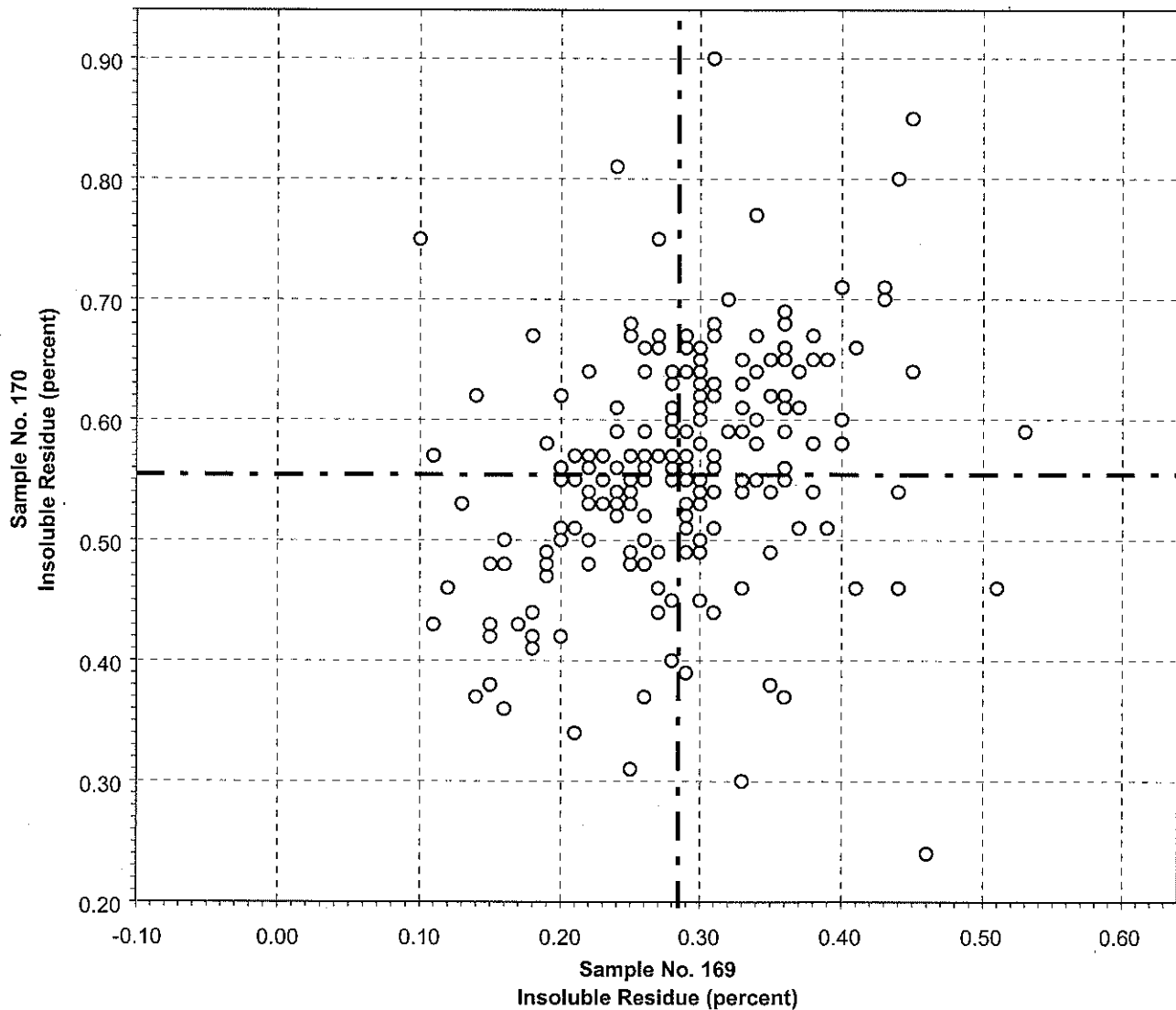
Test No. 104 Chloride 90 Points

Sample No. 169 Ave 0.005 S.D. 0.0040 C.V. 84.2
 Sample No. 170 Ave 0.003 S.D. 0.0030 C.V. 98.5

Labs eliminated: 158, 1940, 3057, 84, 98, 692, 1379, 3144

Labs off Diagram: 243

**CCRL Proficiency Sample Program
Insoluble Residue
PORTLAND CEMENT Samples No. 169 and No. 170**



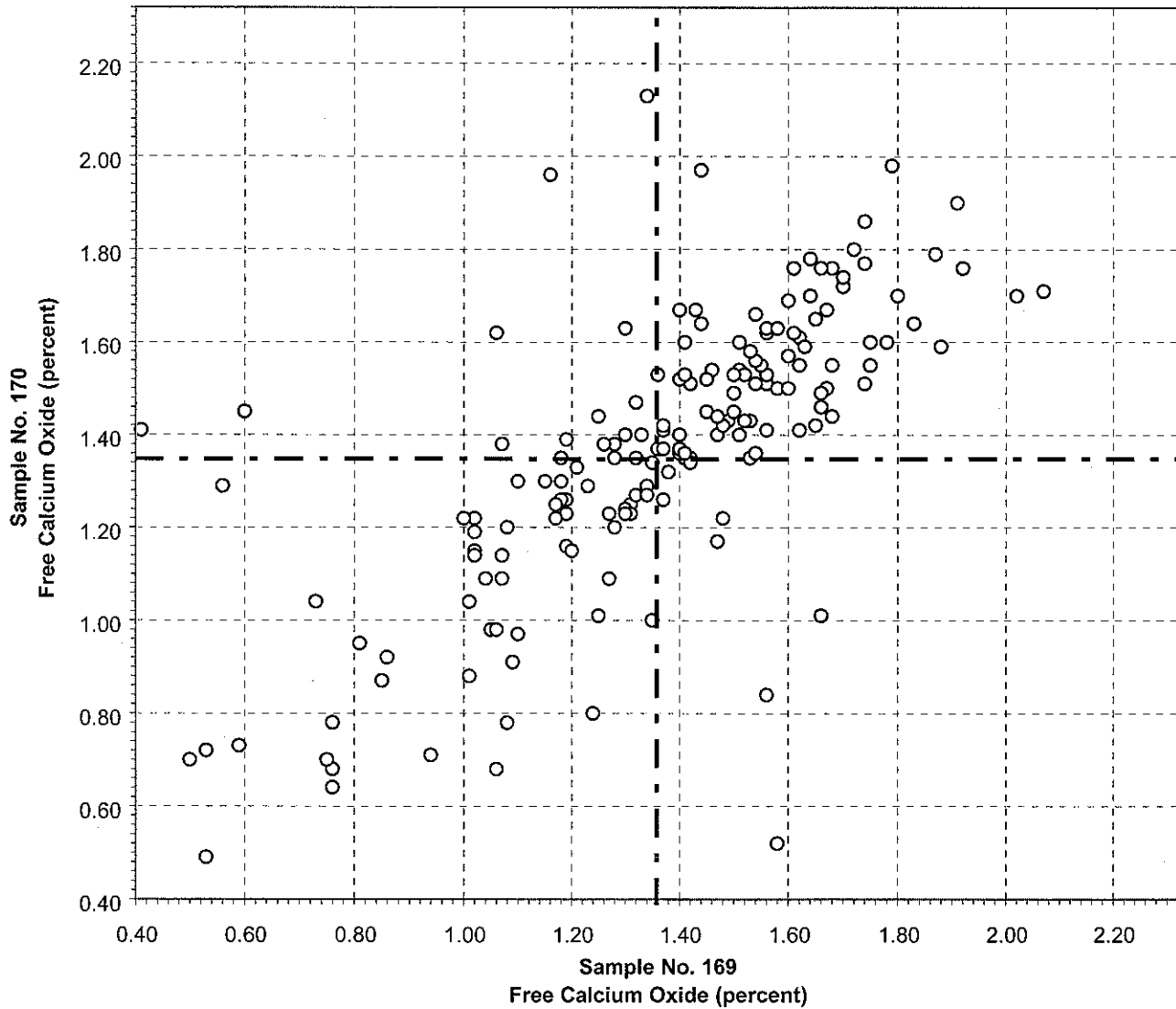
Test No. 80 Insoluble Residue 205 Points

Sample No. 169 Ave 0.28 S.D. 0.076 C.V. 26.9

Sample No. 170 Ave 0.56 S.D. 0.097 C.V. 17.3

Labs eliminated: 29, 66, 154, 289, 695, 2477, 3255, 3279, 43, 47, 48, 64, 96, 243, 1379, 3297

CCRL Proficiency Sample Program
Free Calcium Oxide
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 41 Free Calcium Oxide 177 Points

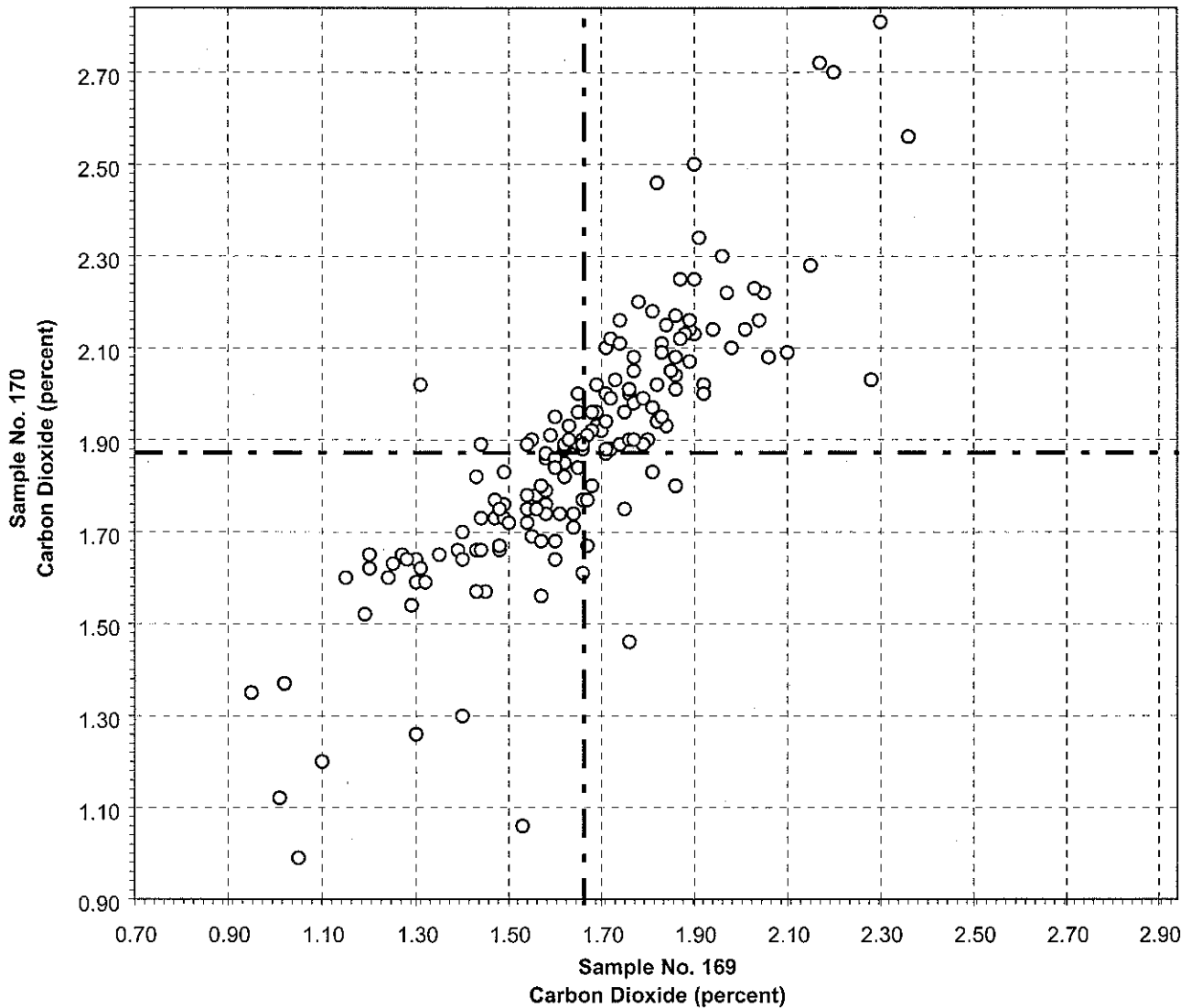
Sample No. 169 Ave 1.36 S.D. 0.32 C.V. 23.6

Sample No. 170 Ave 1.36 S.D. 0.32 C.V. 23.5

Labs eliminated: 107, 148, 494, 1644, 2491

Labs off Diagram: 66, 1940

**CCRL Proficiency Sample Program
Carbon Dioxide
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 97 Carbon Dioxide 168 Points

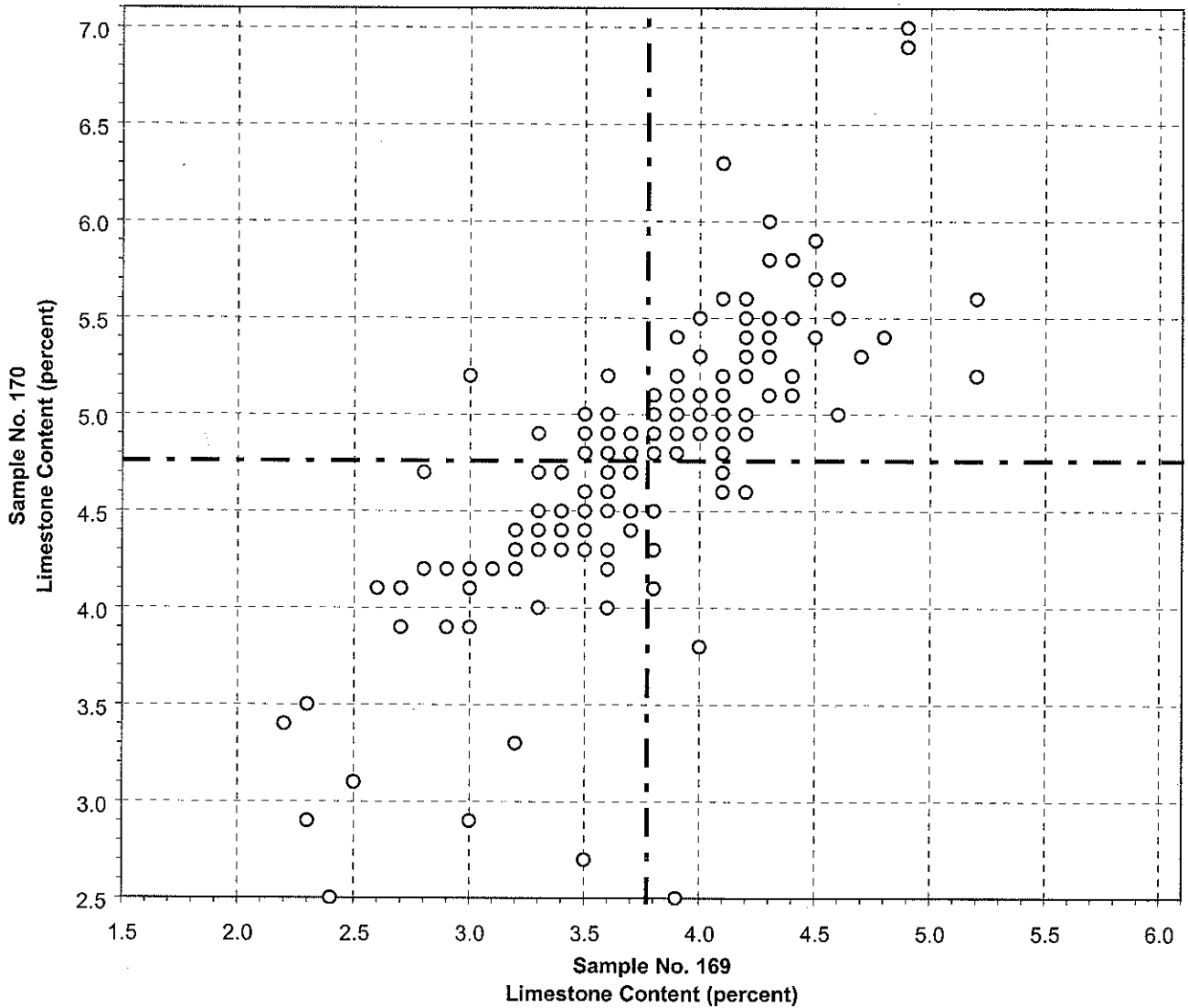
Sample No. 169 Ave 1.66 S.D. 0.26 C.V. 15.6

Sample No. 170 Ave 1.88 S.D. 0.30 C.V. 15.8

Labs eliminated: 26, 54, 94, 95, 162, 222, 1196

Labs off Diagram: 413, 2296

**CCRL Proficiency Sample Program
Limestone Content
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 98 Limestone Content 162 Points

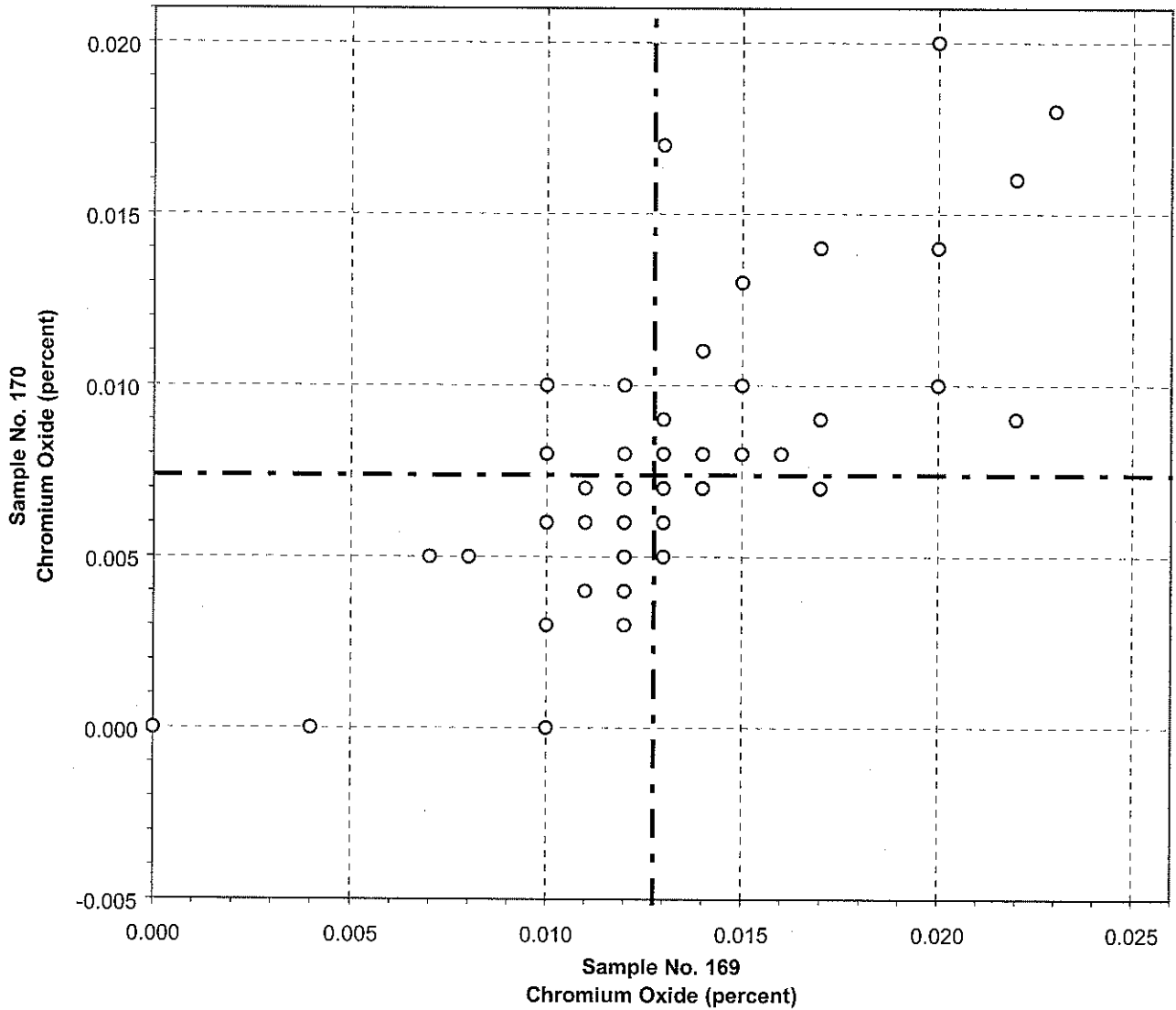
Sample No. 169 Ave 3.8 S.D. 0.60 C.V. 15.8

Sample No. 170 Ave 4.8 S.D. 0.77 C.V. 16.0

Labs eliminated: 26, 41, 54, 162, 1196, 3379

Labs off Diagram: 222, 246, 2296

**CCRL Proficiency Sample Program
Chromium Oxide
PORTLAND CEMENT Samples No. 169 and No. 170**

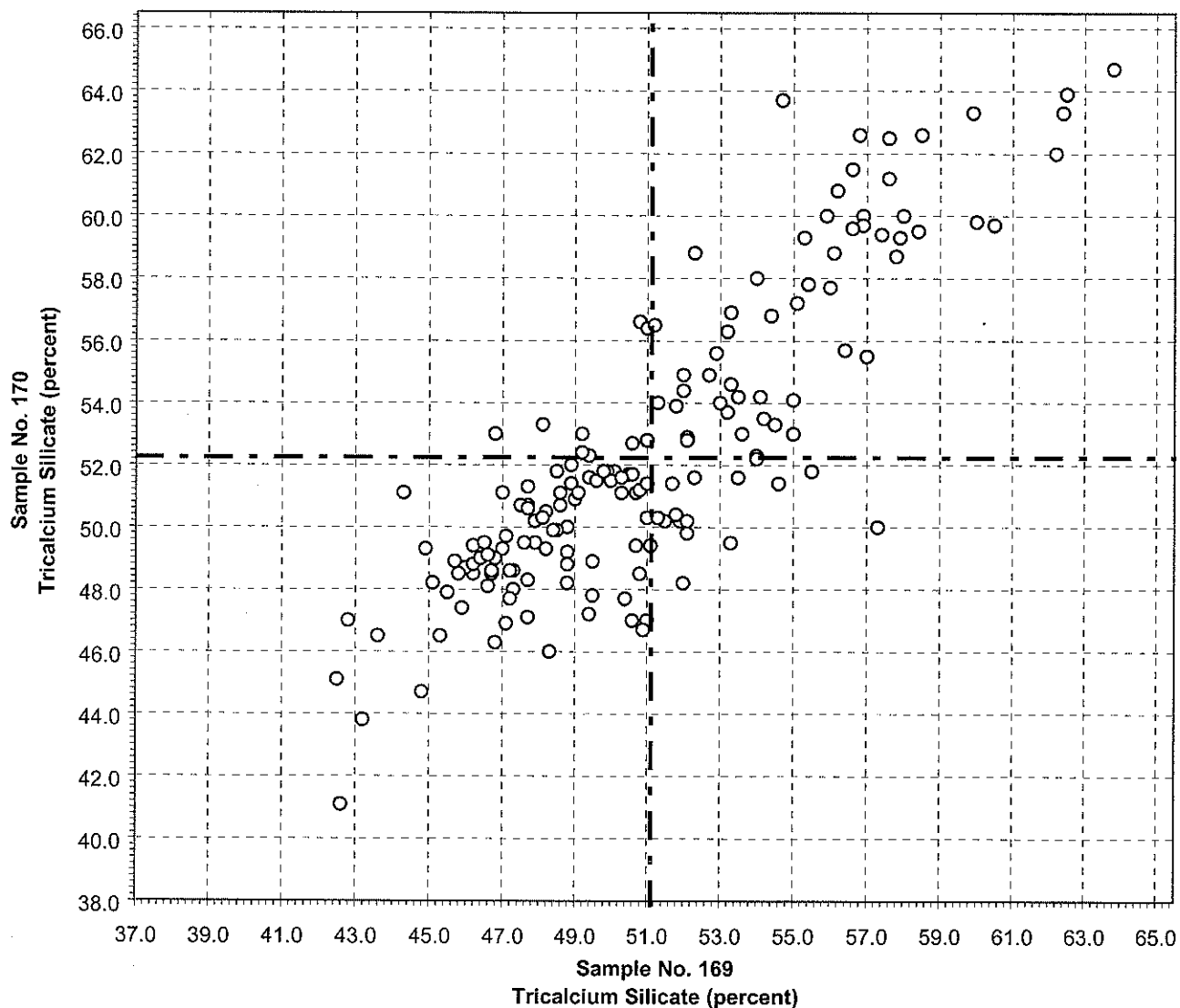


Test No. 105 Chromium Oxide 73 Points

Sample No. 169	Ave 0.013	S.D. 0.0040	C.V. 31.3
Sample No. 170	Ave 0.008	S.D. 0.0038	C.V. 50.7

Labs eliminated: 438, 5, 684, 2463

**CCRL Proficiency Sample Program
Tricalcium Silicate
PORTLAND CEMENT Samples No. 169 and No. 170**



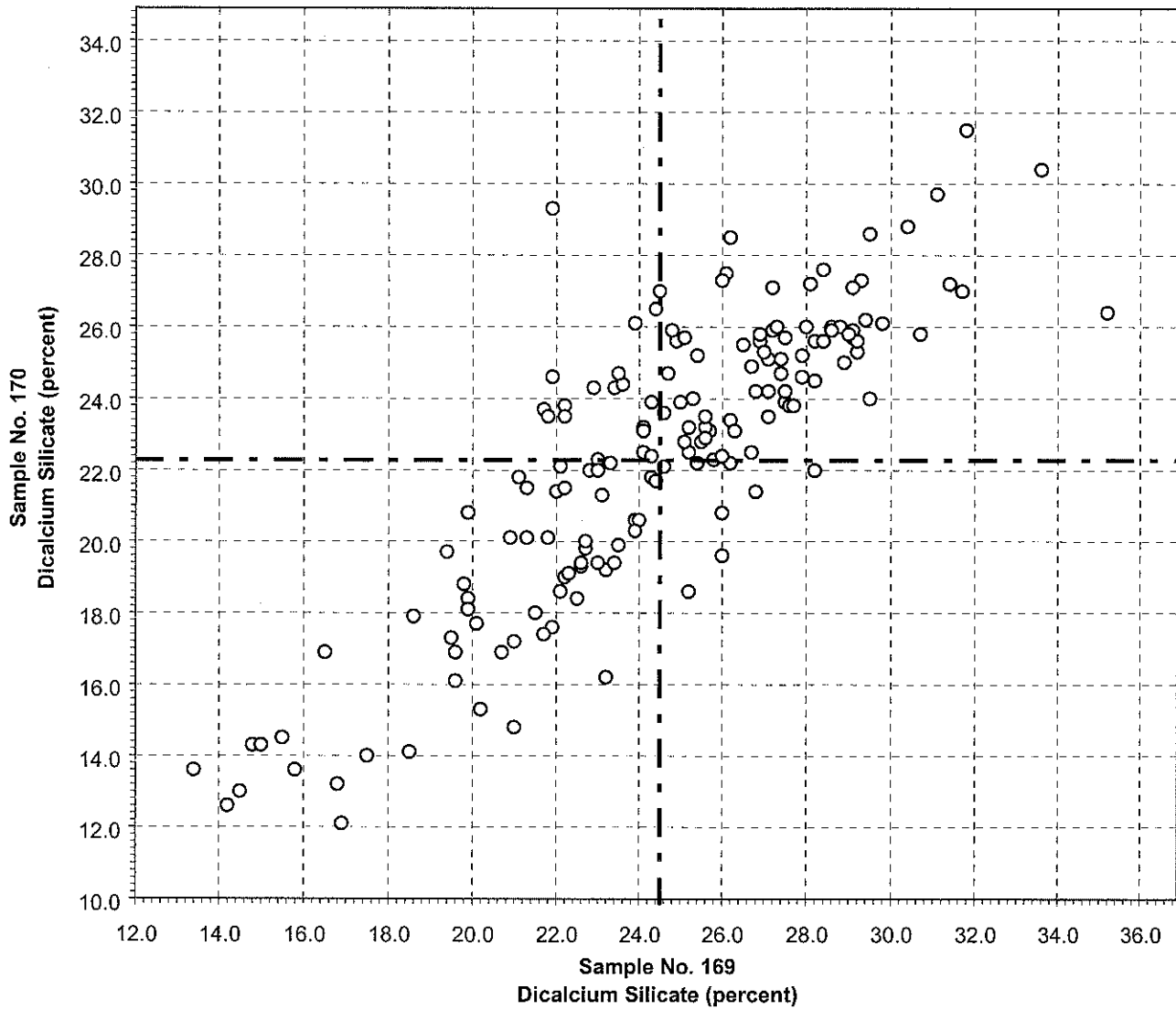
Test No. 106 Tricalcium Silicate 163 Points

Sample No. 169 Ave 51.1 S.D. 4.4 C.V. 8.52

Sample No. 170 Ave 52.4 S.D. 4.7 C.V. 8.97

Labs eliminated: 15, 43, 883, 2116

**CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 169 and No. 170**



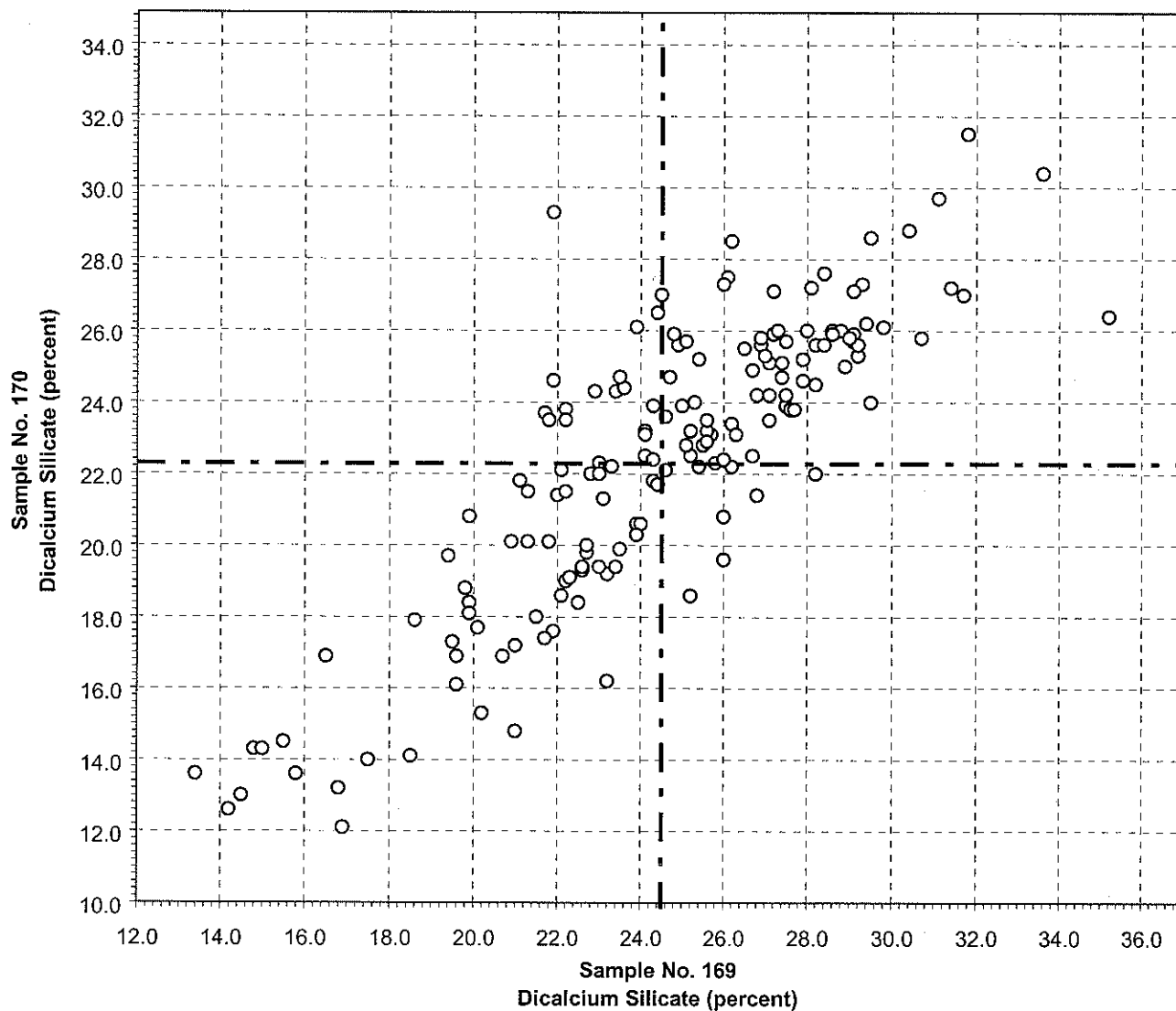
Test No. 107 Dicalcium Silicate 163 Points

Sample No. 169 Ave 24.5 S.D. 4.0 C.V. 16.3

Sample No. 170 Ave 22.4 S.D. 4.0 C.V. 17.9

Labs eliminated: 15, 43, 883, 2116

**CCRL Proficiency Sample Program
Dicalcium Silicate
PORTLAND CEMENT Samples No. 169 and No. 170**



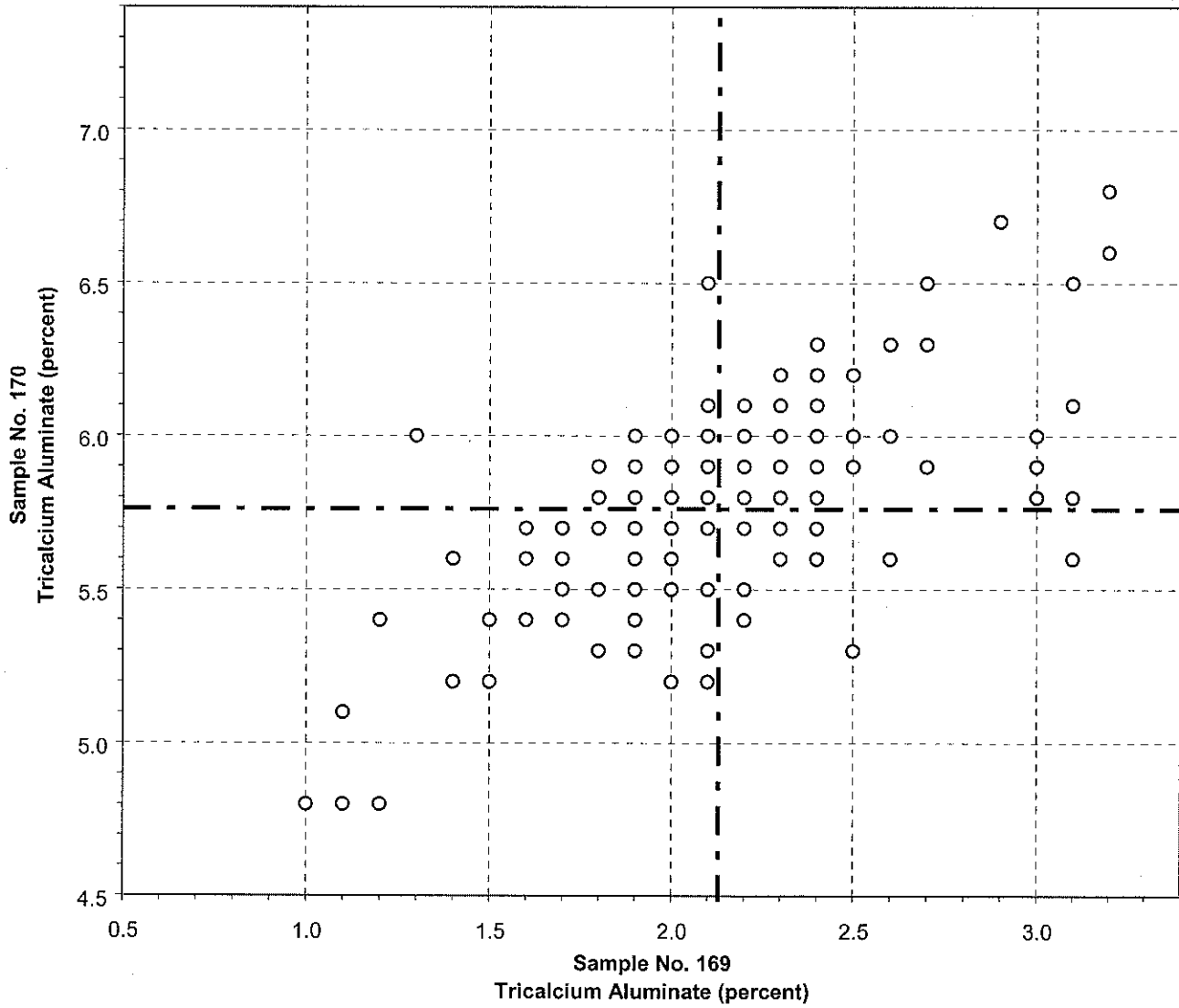
Test No. 107 Dicalcium Silicate 163 Points

Sample No. 169 Ave 24.5 S.D. 4.0 C.V. 16.3

Sample No. 170 Ave 22.4 S.D. 4.0 C.V. 17.9

Labs eliminated: 15, 43, 883, 2116

CCRL Proficiency Sample Program
Tricalcium Aluminate
PORTLAND CEMENT Samples No. 169 and No. 170



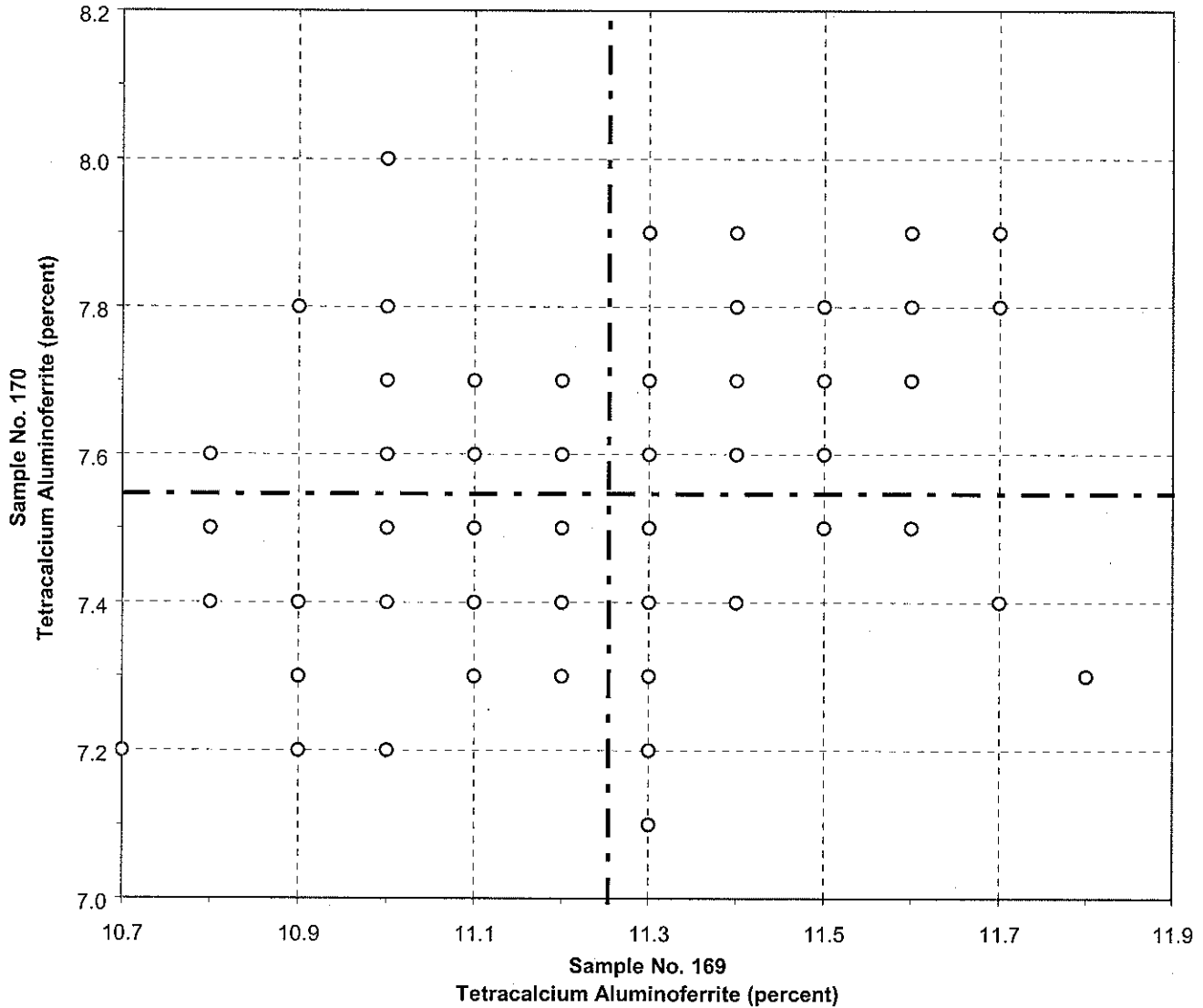
Test No. 108 Tricalcium Aluminate 187 Points

Sample No. 169 Ave 2.1 S.D. 0.37 C.V. 17.59

Sample No. 170 Ave 5.8 S.D. 0.30 C.V. 5.18

Labs eliminated: 46, 131, 305, 2463, 2484, 2491, 3297

**CCRL Proficiency Sample Program
Tetracalcium Aluminoferrite
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 109 Tetracalcium Aluminoferrite 184 Points

Sample No. 169 Ave 11.3 S.D. 0.19 C.V. 1.66

Sample No. 170 Ave 7.6 S.D. 0.15 C.V. 1.99

Labs eliminated: 46, 107, 305, 870, 2463, 2484, 2491, 3320

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 169 and No. 170
 Final Report - Physical Results
 October 8, 2008

SUMMARY OF RESULTS

Test		#Labs	Sample No. 169			Sample No. 170		
			Average	S.D.	C.V.	Average	S.D.	C.V.
N.C. Water	prcnt	245	27.2	9.4	34.6	25.2	8.9	35.4
N.C. Water	prcnt	* 236	26.6	0.47	1.78	24.6	0.46	1.89
Vicat TS Initial	min	240	148	17.7	12.0	91	15.4	17.0
Vicat TS Initial	min	* 232	1482	15.6	10.5	89	12.3	13.8
Vicat TS Final	min	235	265	43.1	16.3	186	33.6	18.1
Vicat TS Final	min	* 233	264	40.9	15.5	185	32.1	17.4
Gillmore TS Initial	min	148	190	28.8	15.2	126	24.4	19.4
Gillmore TS Initial	min	* 146	190	28.0	14.8	124	22.4	18.0
Gillmore TS Final	min	147	301	44.8	14.9	220	36.8	16.7
Gillmore TS Final	min	* 143	298	41.6	13.9	217	31.6	14.6
False Set	prcnt	190	82	7.9	9.61	75	11.7	15.62
False Set	prcnt	* 186	82	7.2	8.73	75	11.1	14.82
Autoclave Expan	prcnt	227	0.02	0.062	280	0.03	0.068	267
Autoclave Expan	prcnt	* 218	0.02	0.015	80.2	0.02	0.016	81.6

CONTINUED ON NEXT PAGE

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

Normal Consistency	5 10 51 169 289 408 557 768 3379
Vicat TS Initial	37 39 169 360 1715 2308 3144 3185
Vicat TS Final	1956 3379
Gillmore TS Initial	126 289
Gillmore TS Final	18 99 375 1054
False Set - Paste Method	154 205 565 605
Autoclave Expansion	2 4 93 162 1435 1773 2308 2463 2482

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 169 and No. 170
 Final Report - Physical Results
 October 8, 2008

SUMMARY OF RESULTS

Test	#Labs	Sample No. 169			Sample No. 170		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Air Content	prcnt 219	8.7	1.2	13.8	9.4	1.2	12.4
Air Content	prcnt * 216	8.7	1.16	13.3	9.4	0.98	10.5
AC Mix Water	prcnt 214	74.9	35.4	47.3	76.8	35.9	46.7
AC Mix Water	prcnt * 201	67.9	2.8	4.11	69.7	2.6	3.74
AC Flow	prcnt 216	88	6.2	7.02	85	5.8	6.79
AC Flow	prcnt * 212	88	3.6	4.12	85	3.3	3.89
Comp Str, 3 day	psi 250	2997	334.3	11.2	3097	387.2	12.5
Comp Str, 3 day	psi * 242	2976	216.1	7.26	3064	208.1	6.79
Comp Str, 7 day	psi 250	3957	361.3	9.13	4285	447.7	10.45
Comp Str, 7 day	psi * 247	3945	272.2	6.90	4266	279.2	6.54
Comp Str, 28 day	psi 231	6391	439.8	6.88	6084	396.7	6.52
Comp Str, 28 day	psi * 227	6399	397.1	6.20	6091	365.0	5.99
Com Str, Flow	prcnt 218	120	13.4	11.2	100	11.5	11.6
Com Str Flow	prcnt * 210	121	9.9	8.17	101	9.9	9.81

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

Air Content	289 1916 3279
Air Content - % Water	5 66 95 157 167 222 415 691 201 1379 1956 2251 3379
Air Content - Flow	1379 2296 1956 3379
Comp Strength - 3 day	103 10 126 289 354 1196 2352 3320
Comp Strength - 7 day	14 103 3320
Comp Strength - 28 day	21 1019 2938 3320
Comp Strength - Flow	1196 2491 3249 289 413 557 1483 3316

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 169 and No. 170
 Final Report - Physical Results
 October 8, 2008

SUMMARY OF RESULTS

Test	#Labs	Sample No. 169			Sample No. 170			
		Average	S.D.	C.V.	Average	S.D.	C.V.	
FINENESS								
Air Permeability	cm ² /g	240	4164	148.4	3.56	4131	162.9	3.94
Air Permeability	cm ² /g *	228	4161	99.8	2.40	4124	98.2	2.38
Wagner Turbidim	cm ² /g	12	2345	201.6	8.60	1950	103.4	5.30
45µm Sieve	prcnt	223	98.56	3.7	3.72	86.24	2.8	3.28
45µm Sieve	prcnt *	203	99.08	0.18	0.181	86.02	1.73	2.017
C1038 MORTAR BAR EXPANSION								
Mortar Expansion	prcnt	133	0.009	0.018	192	0.009	0.019	217
Mortar Expansion	prcnt *	122	0.008	0.0046	57.8	0.007	0.0036	54.4
Mortar Water	ml	127	236	7.5	3.19	248	8.0	3.26
Mortar Water	ml *	125	236	7.0	2.96	247	7.2	2.90
Mortar Flow	prcnt	124	111	3.4	3.03	108	3.8	3.56
Mortar Flow	prcnt *	119	111	2.8	2.55	109	2.6	2.43

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

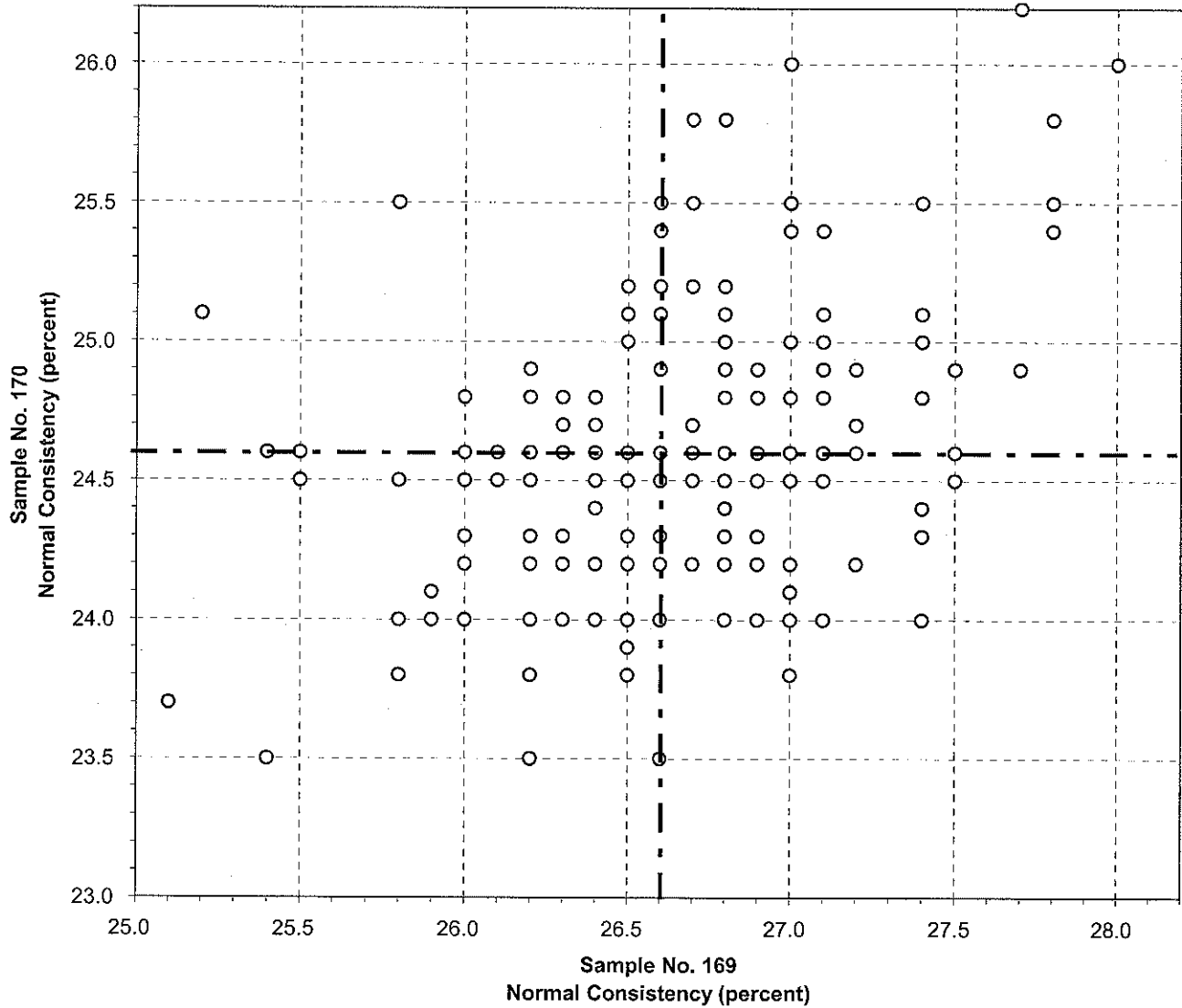
Fineness

Air Permeability 43 47 265 787 1196 94 270 1251 1657 2251 2491 3297
 45µm Sieve 47 49 360 932 1435 2482 3185 51 180 1079 1196 2938 34 101 270 1025
 2491 156 343 3379

C1038 Mortar Bar Expansion

Mortar Expansion 8 10 94 1799 151 201 883 1196 2296 3255 3316
 Mortar - Water 96 3316
 Mortar - Flow 14 46 1379 3126 3297

**CCRL Proficiency Sample Program
Normal Consistency - % Water
PORTLAND CEMENT Samples No. 169 and No. 170**

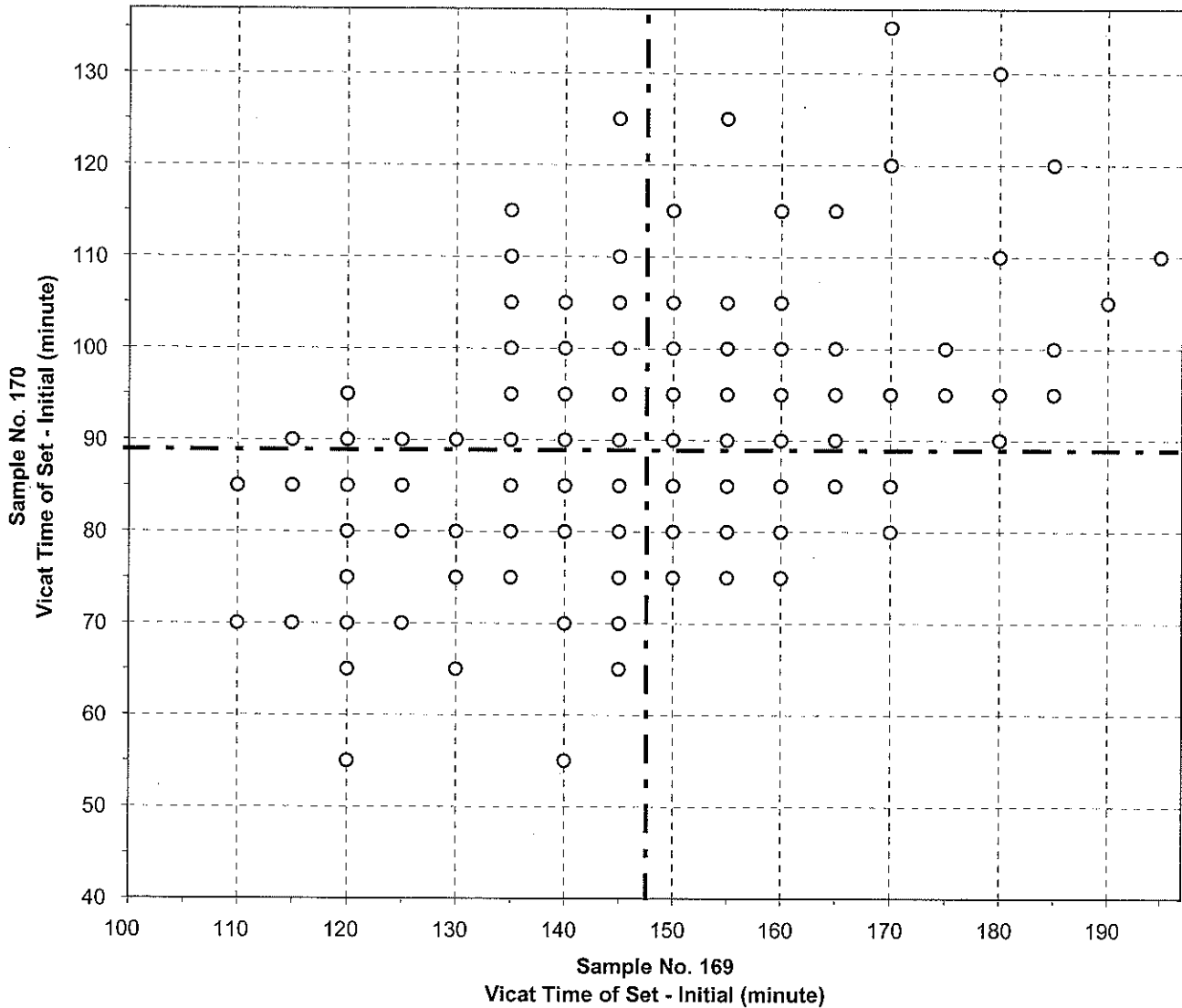


Test No. 110 Normal Consistency - % Water 236 Points

Sample No. 169 Ave 26.6 S.D. 0.47 C.V. 1.78
 Sample No. 170 Ave 24.6 S.D. 0.46 C.V. 1.89

Labs eliminated: 5, 10, 51, 169, 289, 408, 557, 768, 3379

**CCRL Proficiency Sample Program
 Vicat Time of Set - Initial
 PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 120 Vicat Time of Set - Initial 231 Points

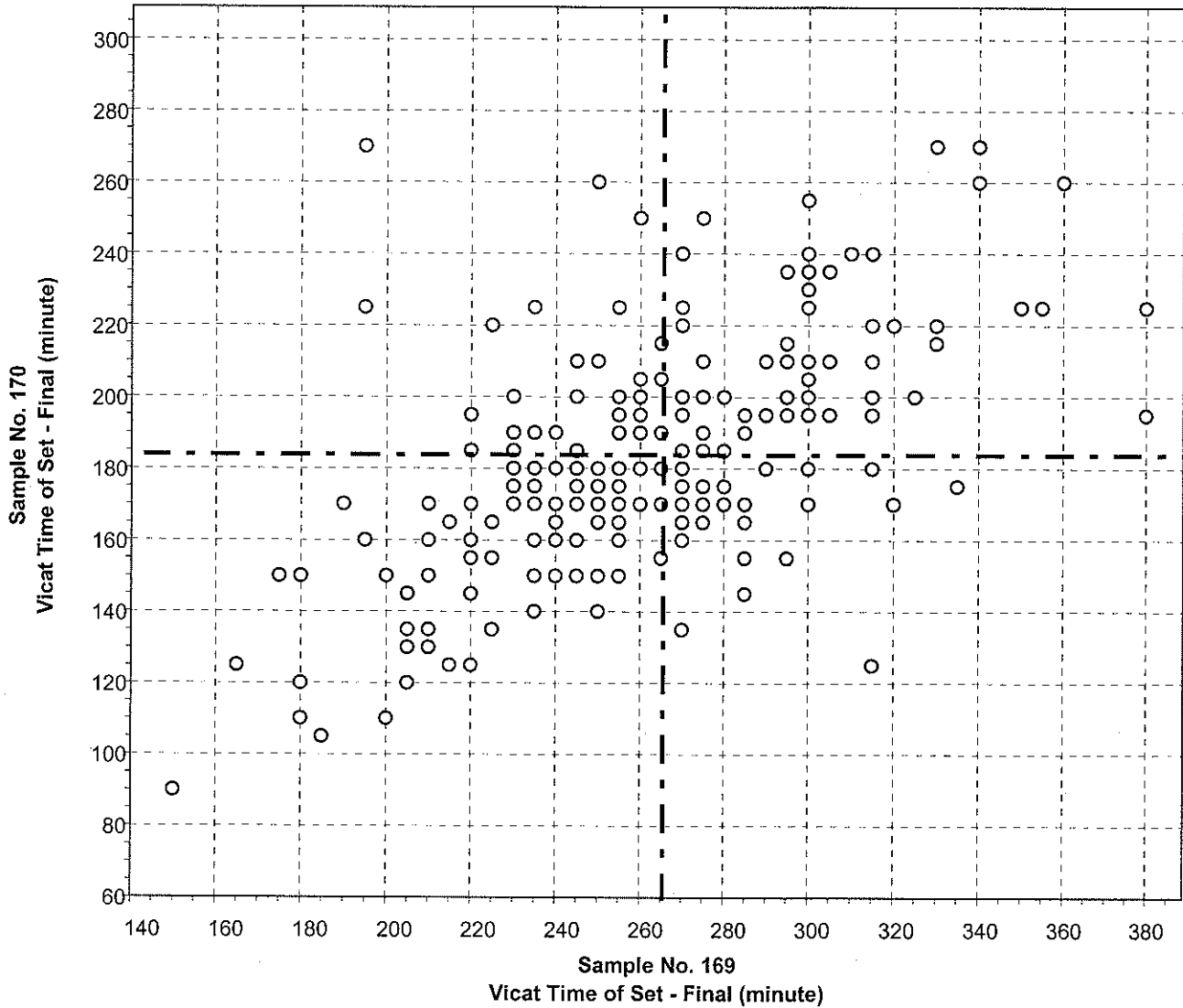
Sample No. 169 Ave 148 S.D. 15.6 C.V. 10.5

Sample No. 170 Ave 89.1 S.D. 12.3 C.V. 13.8

Labs eliminated: 37, 39, 169, 360, 1715, 2308, 3144, 3185

Labs off Diagram: 619

**CCRL Proficiency Sample Program
 Vicat Time of Set - Final
 PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 121 Vicat Time of Set - Final 231 Points

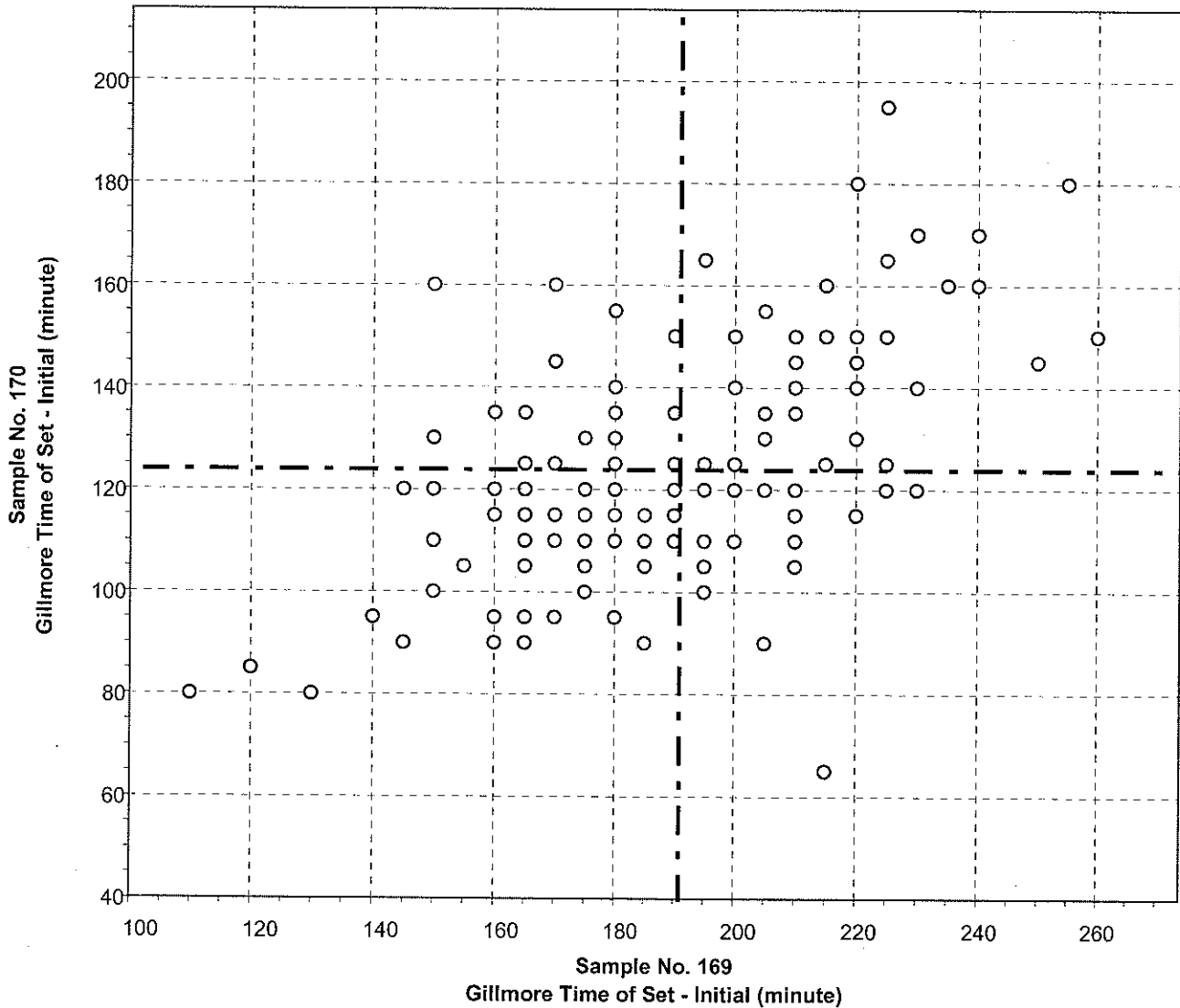
Sample No. 169 Ave 264 S.D. 40.9 C.V. 15.5

Sample No. 170 Ave 185 S.D. 32.1 C.V. 17.4

Labs eliminated: 1956, 3379

Labs off Diagram: 305, 3249

**CCRL Proficiency Sample Program
Gillmore Time of Set - Initial
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 130 Gillmore Time of Set - Initial 145 Points

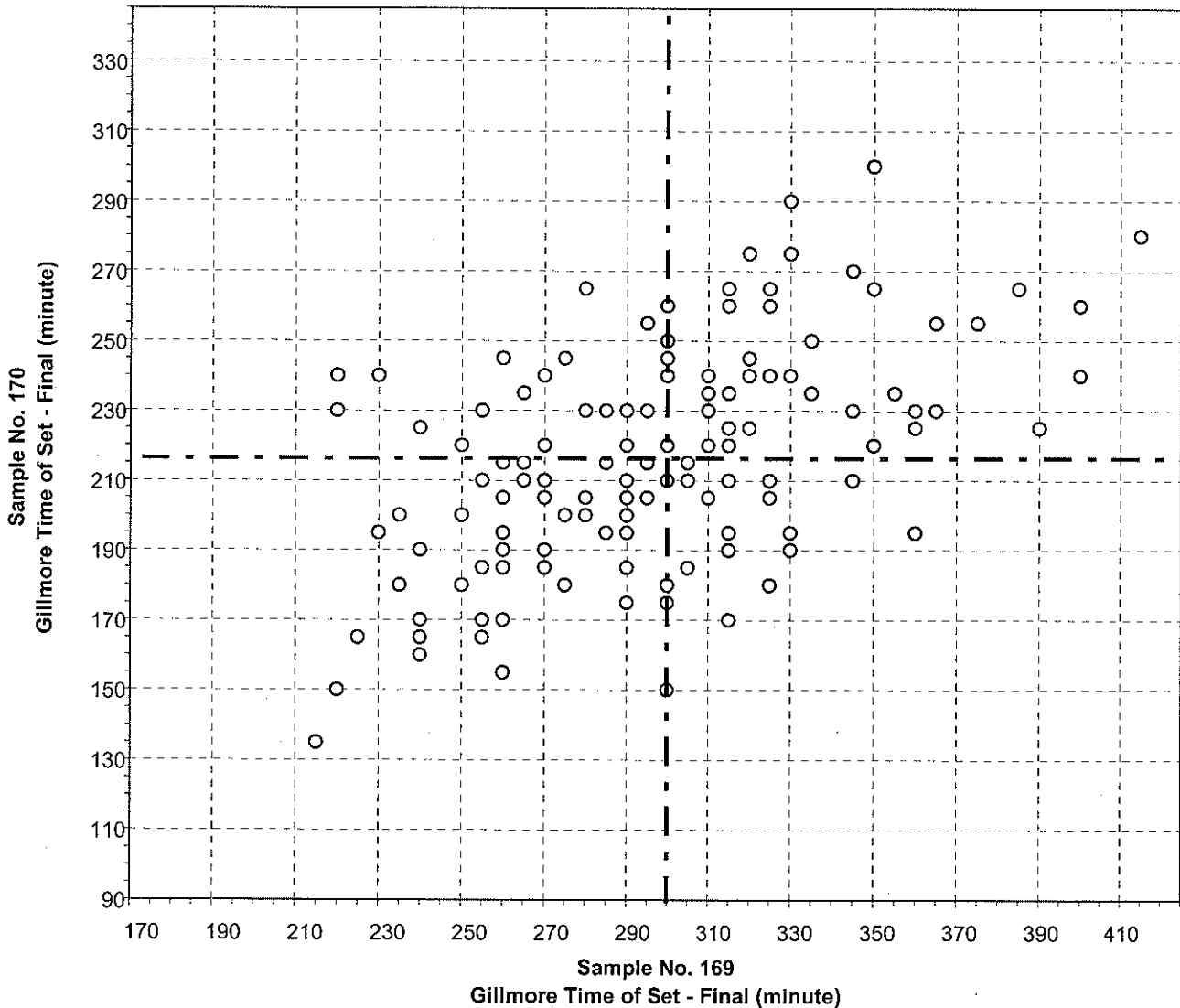
Sample No. 169 Ave 190 S.D. 28.0 C.V. 14.8

Sample No. 170 Ave 124 S.D. 22.4 C.V. 18.0

Labs eliminated: 126, 289

Labs off Diagram: 375

**CCRL Proficiency Sample Program
Gillmore Time of Set - Final
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 140 Gillmore Time of Set - Final 142 Points

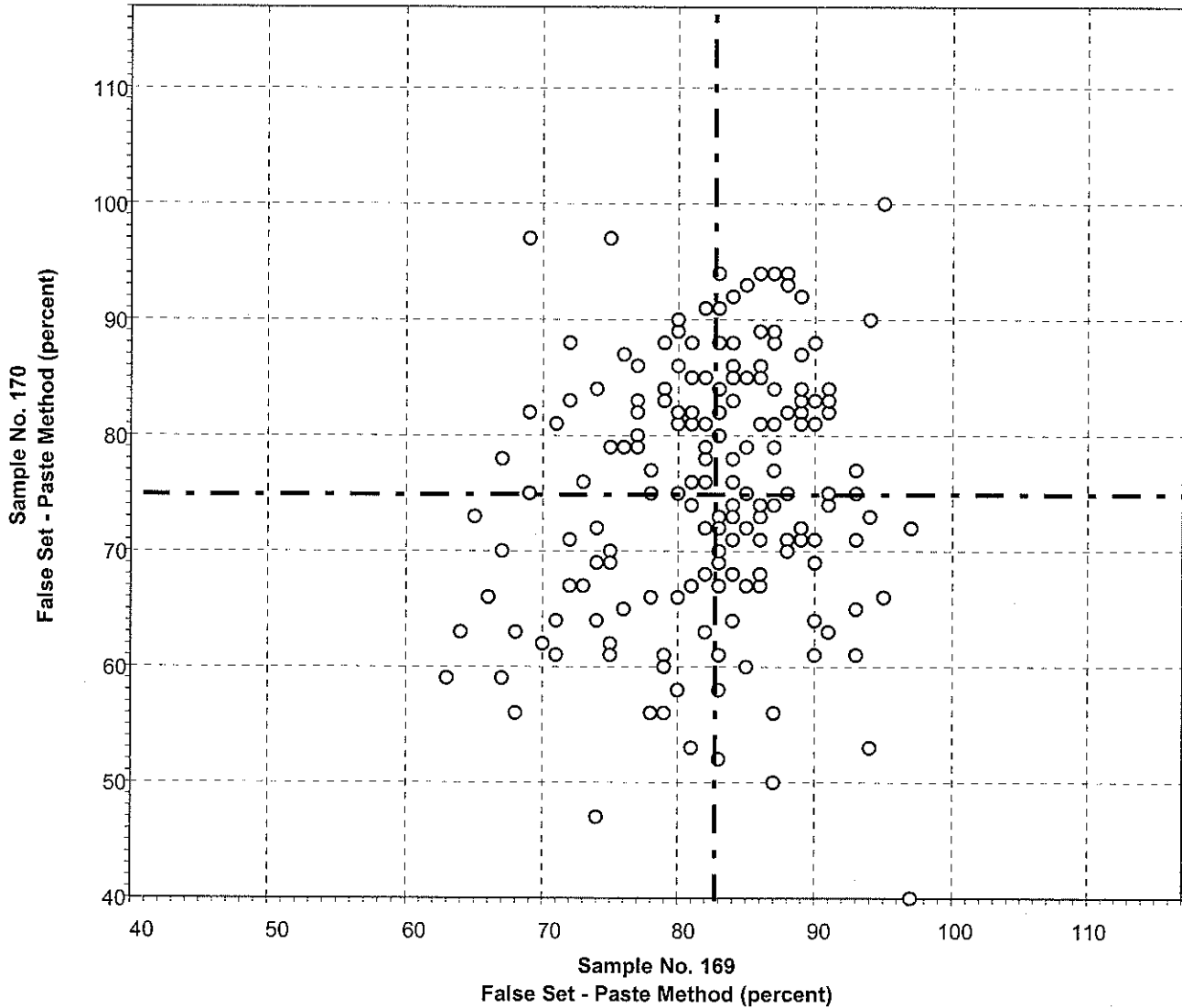
Sample No. 169 Ave 298 S.D. 41.6 C.V. 13.9

Sample No. 170 Ave 217 S.D. 31.6 C.V. 14.6

Labs eliminated: 18, 99, 375, 1054

Labs off Diagram: 2484

**CCRL Proficiency Sample Program
False Set - Paste Method
PORTLAND CEMENT Samples No. 169 and No. 170**

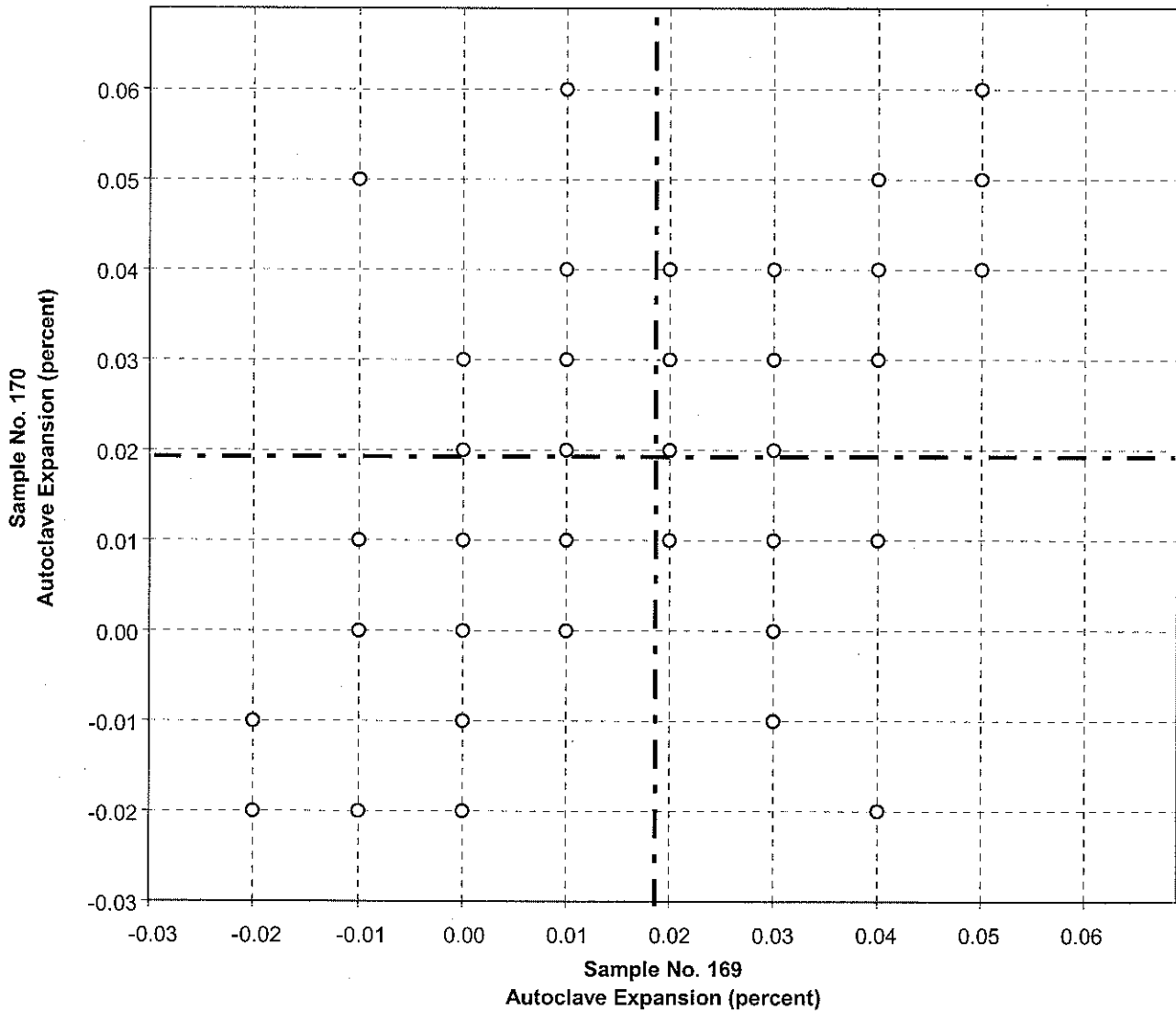


Test No. 150 False Set - Paste Method 186 Points

Sample No. 169 Ave 82 S.D. 7.2 C.V. 8.73
 Sample No. 170 Ave 75 S.D. 11.1 C.V. 14.82

Labs eliminated: 154, 205, 565, 605

**CCRL Proficiency Sample Program
Autoclave Expansion
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 160 Autoclave Expansion 214 Points

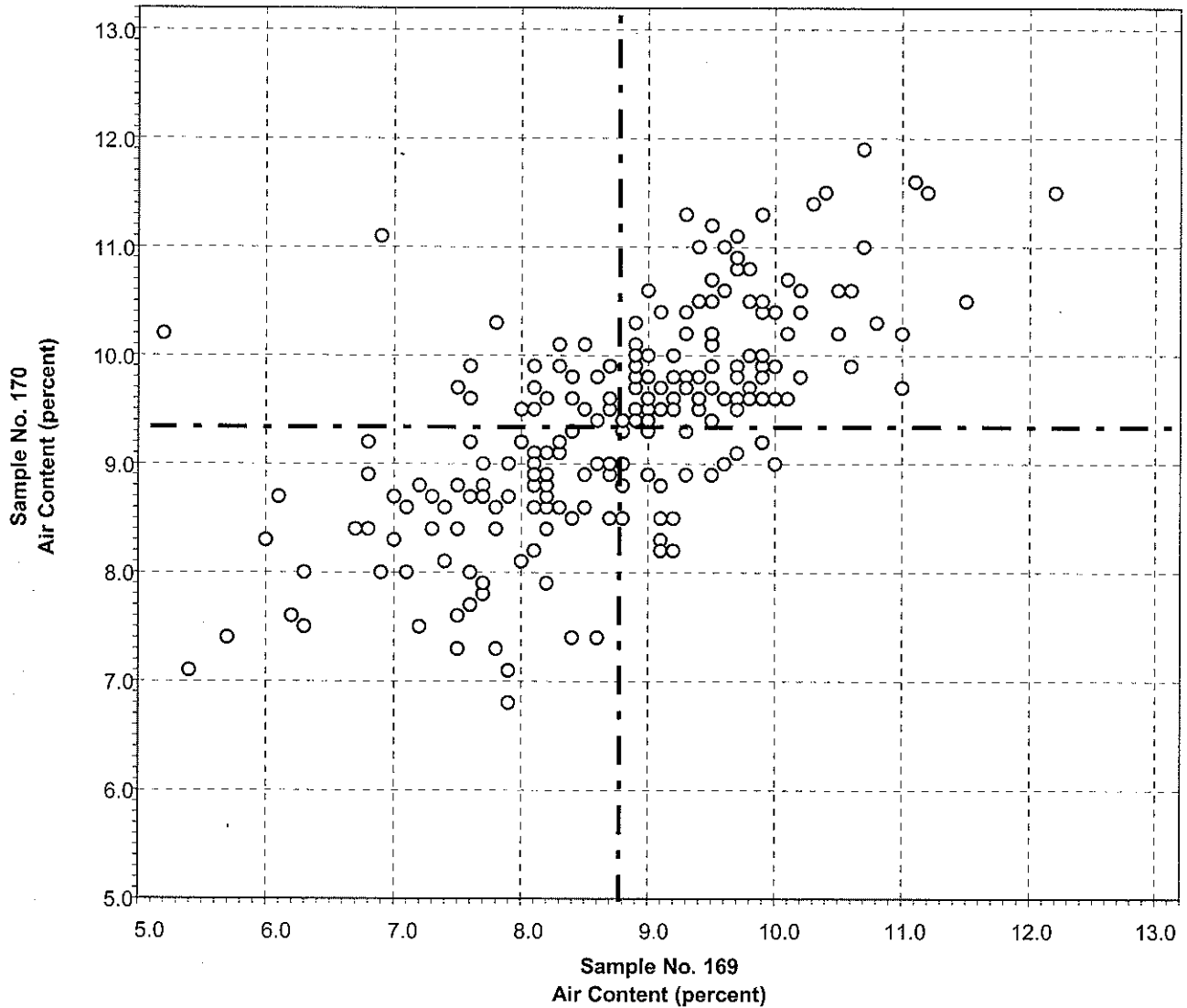
Sample No. 169 Ave 0.02 S.D. 0.015 C.V. 80.2

Sample No. 170 Ave 0.02 S.D. 0.016 C.V. 81.6

Labs eliminated: 2, 4, 93, 162, 1435, 1773, 2308, 2463, 2482

Labs off Diagram: 42, 1379, 1940, 3255

**CCRL Proficiency Sample Program
Air Content
PORTLAND CEMENT Samples No. 169 and No. 170**



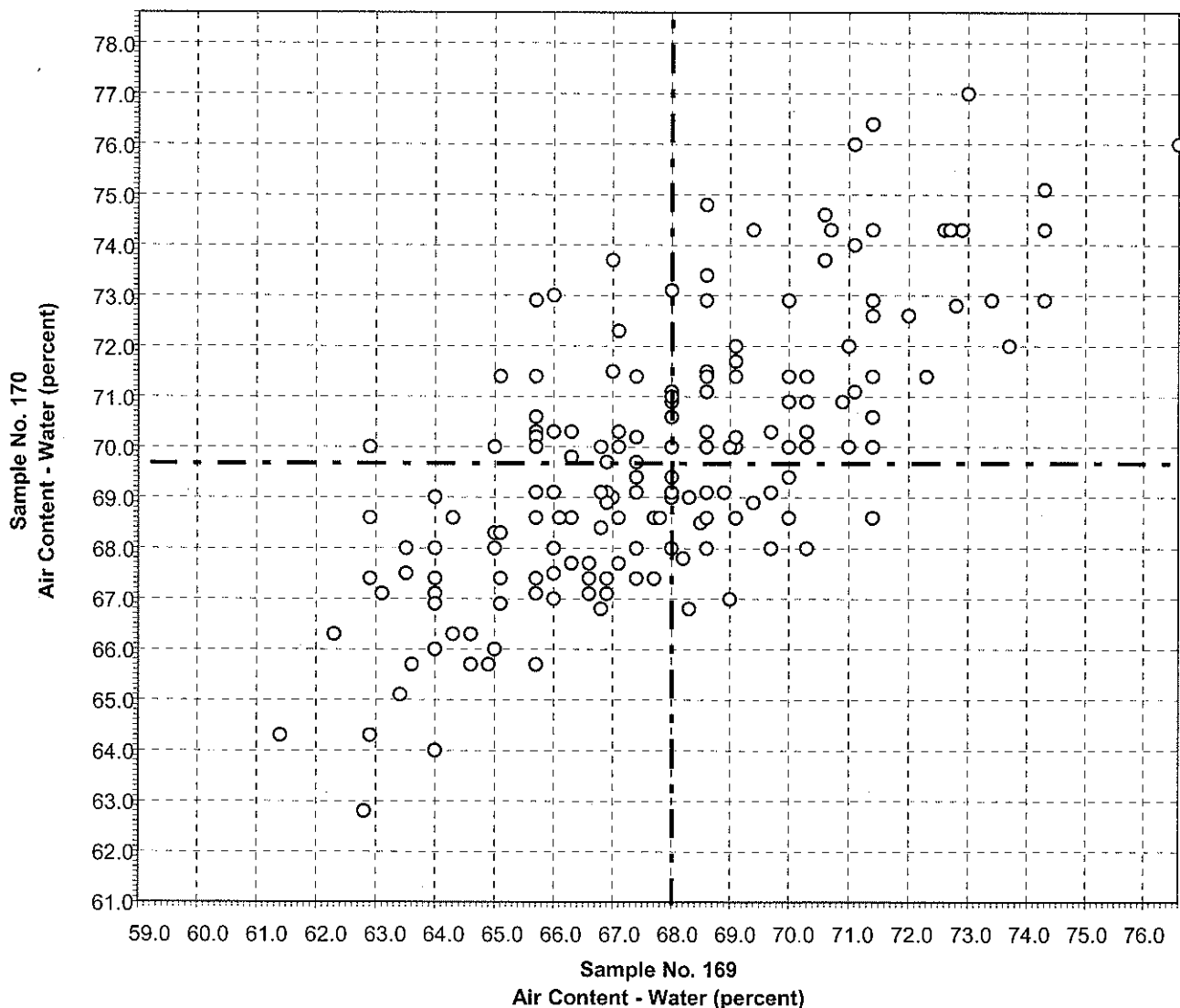
Test No. 170 Air Content 216 Points

Sample No. 169 Ave 8.7 S.D. 1.16 C.V. 13.3

Sample No. 170 Ave 9.4 S.D. 0.98 C.V. 10.5

Labs eliminated: 289, 1916, 3279

**CCRL Proficiency Sample Program
Air Content - % Water
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 180 Air Content - % Water 200 Points

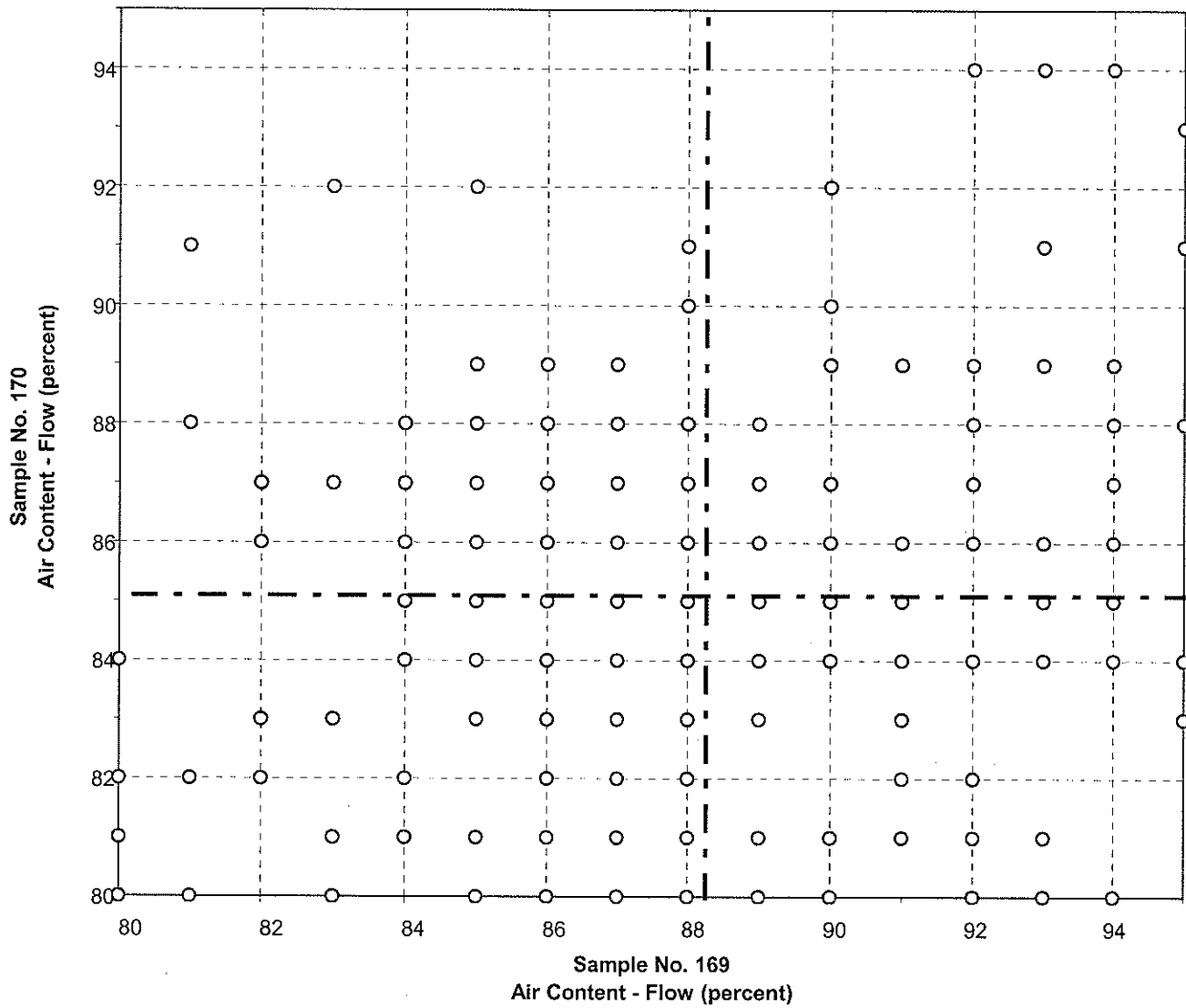
Sample No. 169 Ave 67.9 S.D. 2.8 C.V. 4.11

Sample No. 170 Ave 69.7 S.D. 2.6 C.V. 3.74

Labs eliminated: 5, 66, 95, 157, 167, 222, 415, 691, 201, 1379, 1956, 2251, 3379

Labs off Diagram: 3279

**CCRL Proficiency Sample Program
Air Content - Flow
PORTLAND CEMENT Samples No. 169 and No. 170**

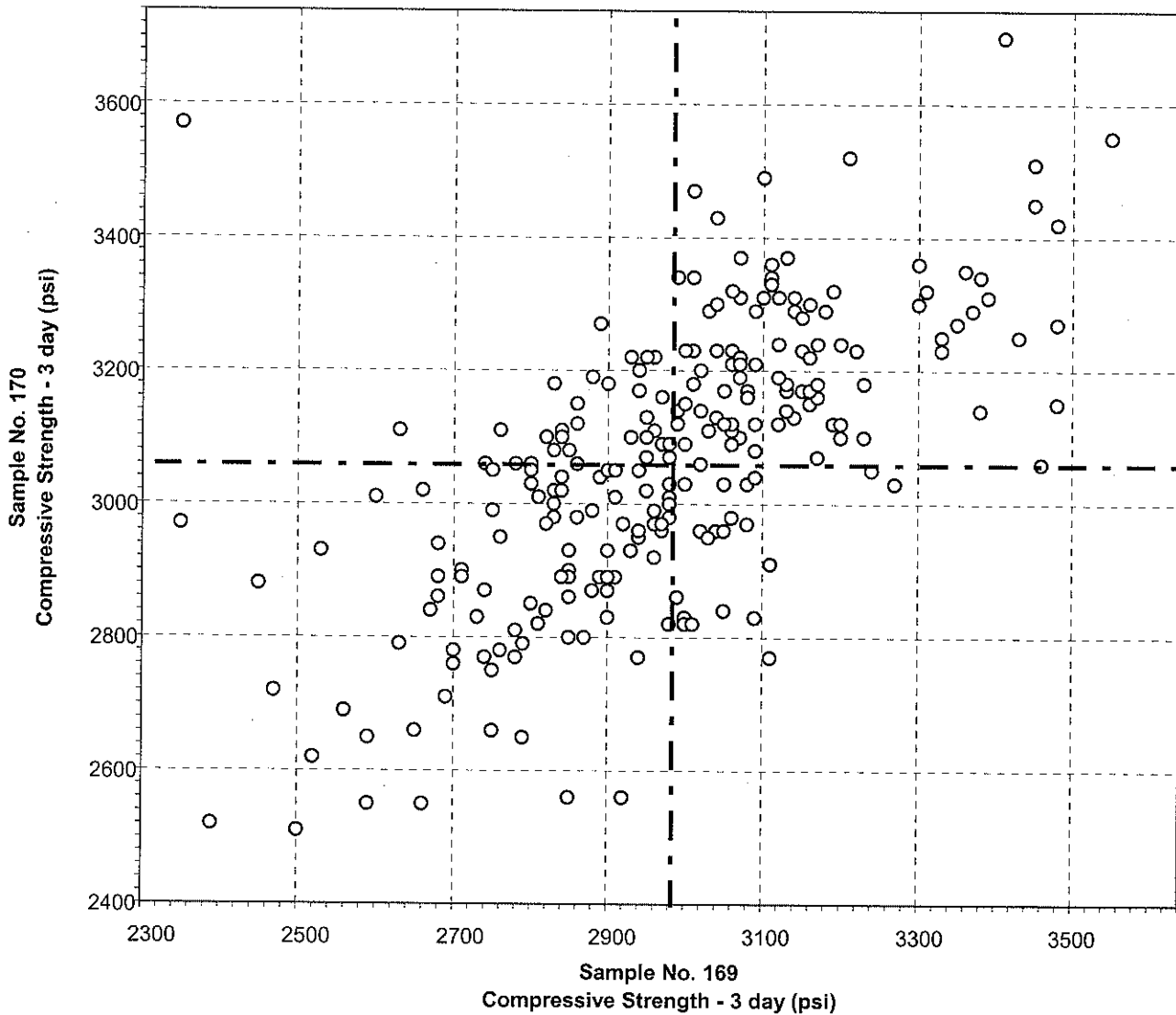


Test No. 190 Air Content - Flow 212 Points

Sample No. 169 Ave 88 S.D. 3.6 C.V. 4.12
 Sample No. 170 Ave 85 S.D. 3.3 C.V. 3.89

Labs eliminated: 1379, 2296, 1956, 3379

**CCRL Proficiency Sample Program
Compressive Strength - 3 day
PORTLAND CEMENT Samples No. 169 and No. 170**



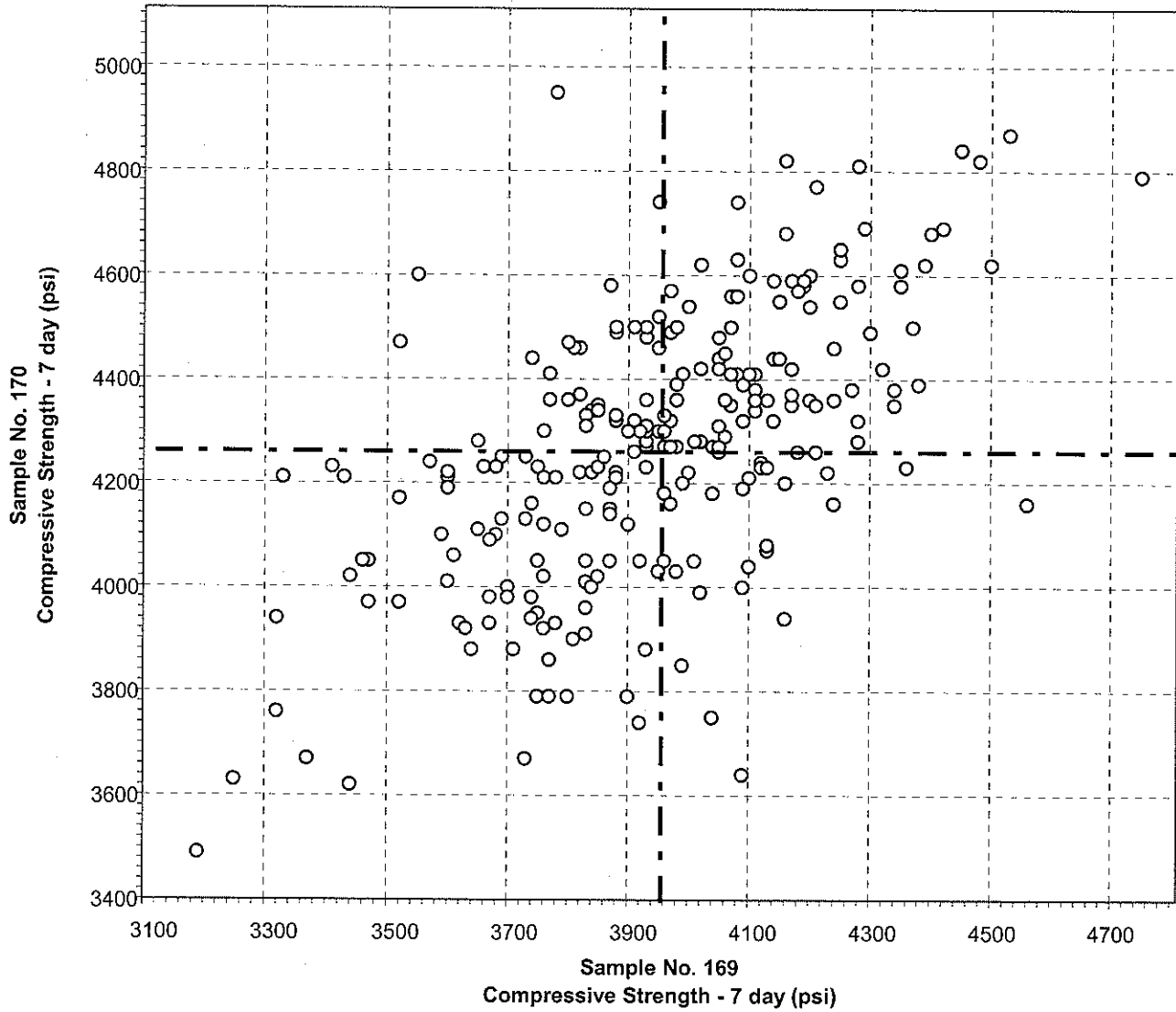
Test No. 200 Compressive Strength - 3 day 242 Points

Sample No. 169 Ave 2976 S.D. 216.1 C.V. 7.26

Sample No. 170 Ave 3064 S.D. 208.1 C.V. 6.79

Labs eliminated: 103, 10, 126, 289, 354, 1196, 2352, 3320

**CCRL Proficiency Sample Program
Compressive Strength - 7 day
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 210 Compressive Strength - 7 day 243 Points

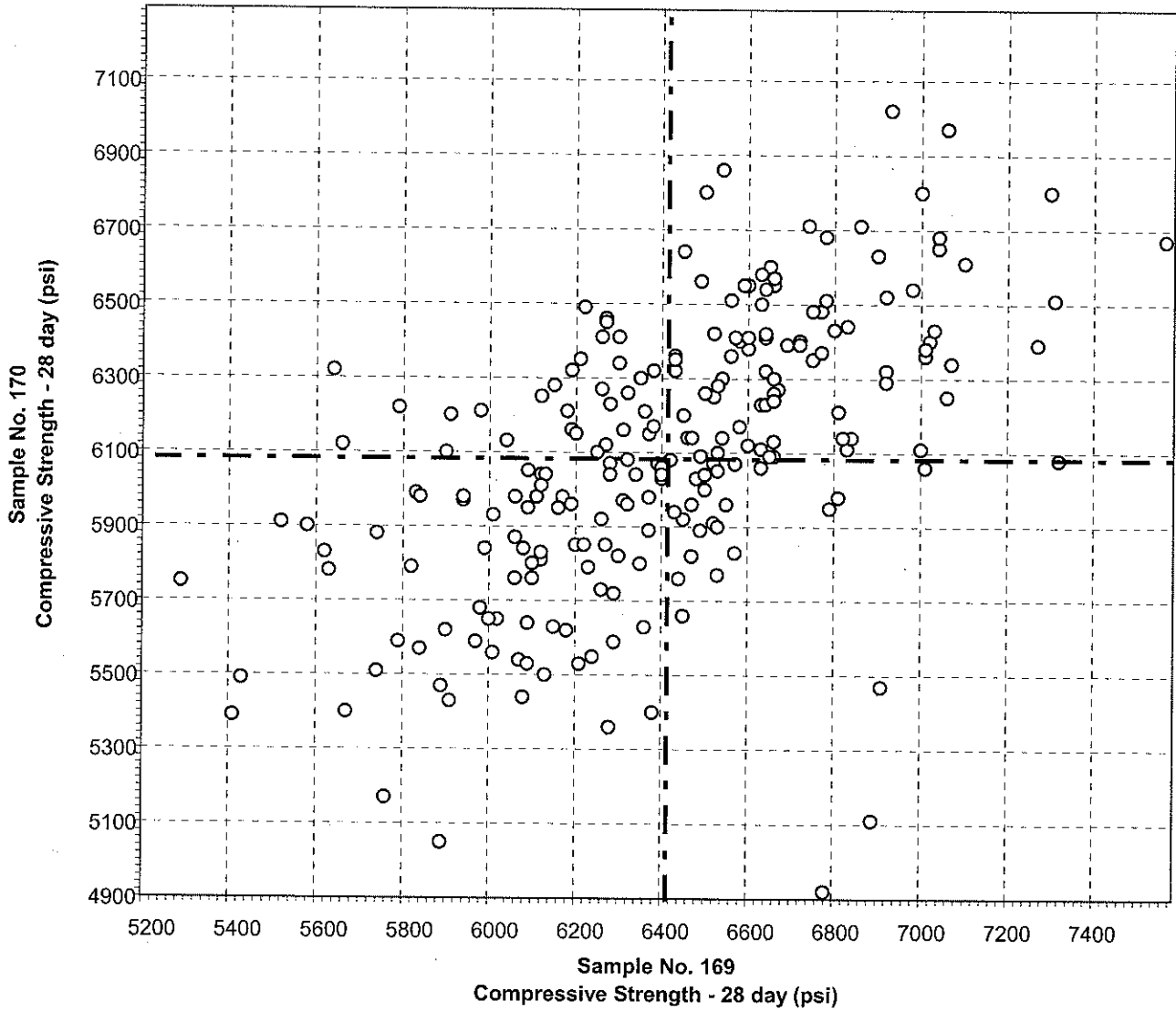
Sample No. 169 Ave 3945 S.D. 272 C.V. 6.90

Sample No. 170 Ave 4266 S.D. 279 C.V. 6.54

Labs eliminated: 14, 103, 3320

Labs off Diagram: 47, 265, 1196, 2491

**CCRL Proficiency Sample Program
Compressive Strength - 28 day
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 211 Compressive Strength - 28 day 226 Points

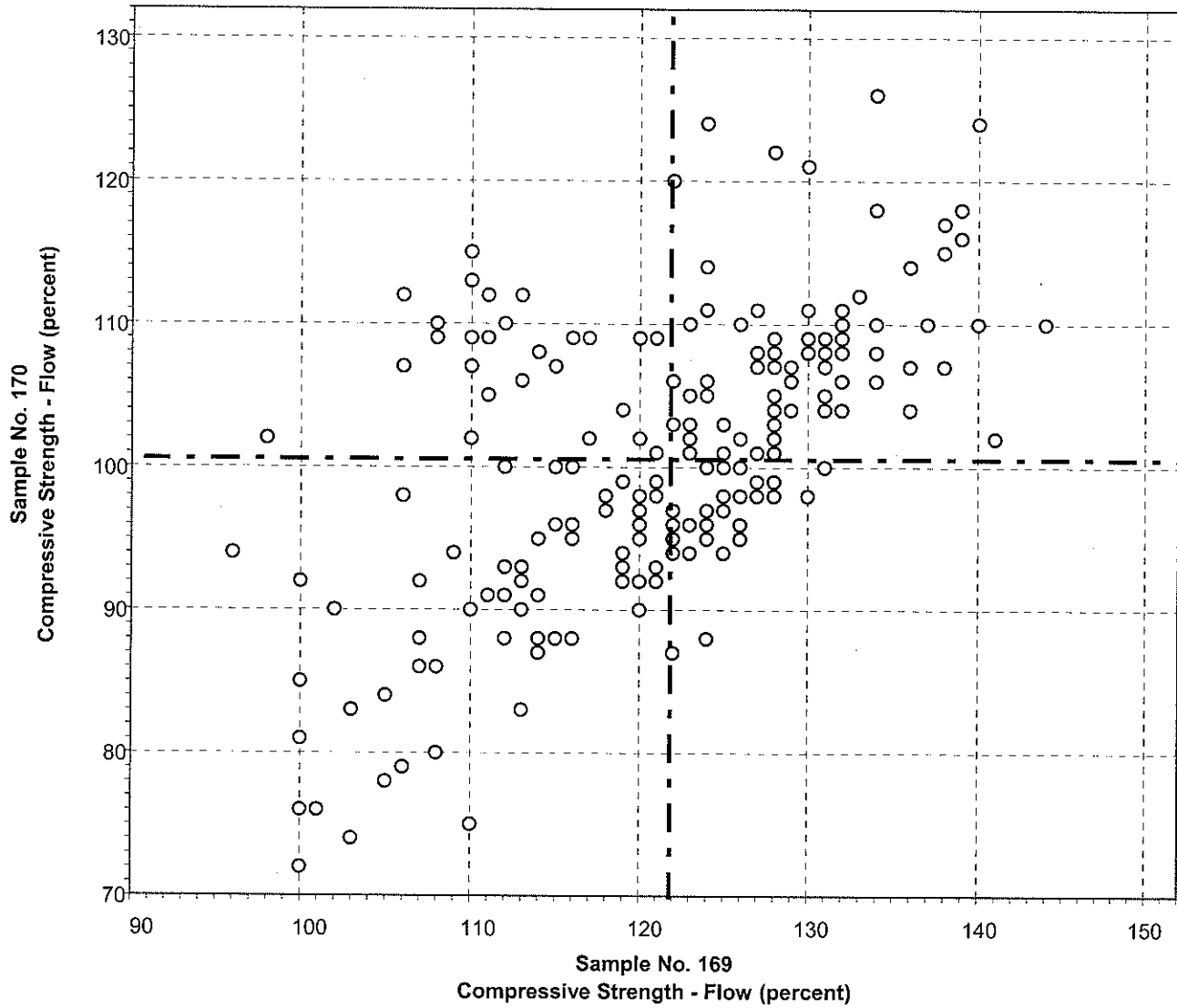
Sample No. 169 Ave 6399 S.D. 397 C.V. 6.20

Sample No. 170 Ave 6091 S.D. 365 C.V. 5.99

Labs eliminated: 21, 1019, 2938, 3320

Labs off Diagram: 3059

**CCRL Proficiency Sample Program
Compressive Strength - Flow
PORTLAND CEMENT Samples No. 169 and No. 170**



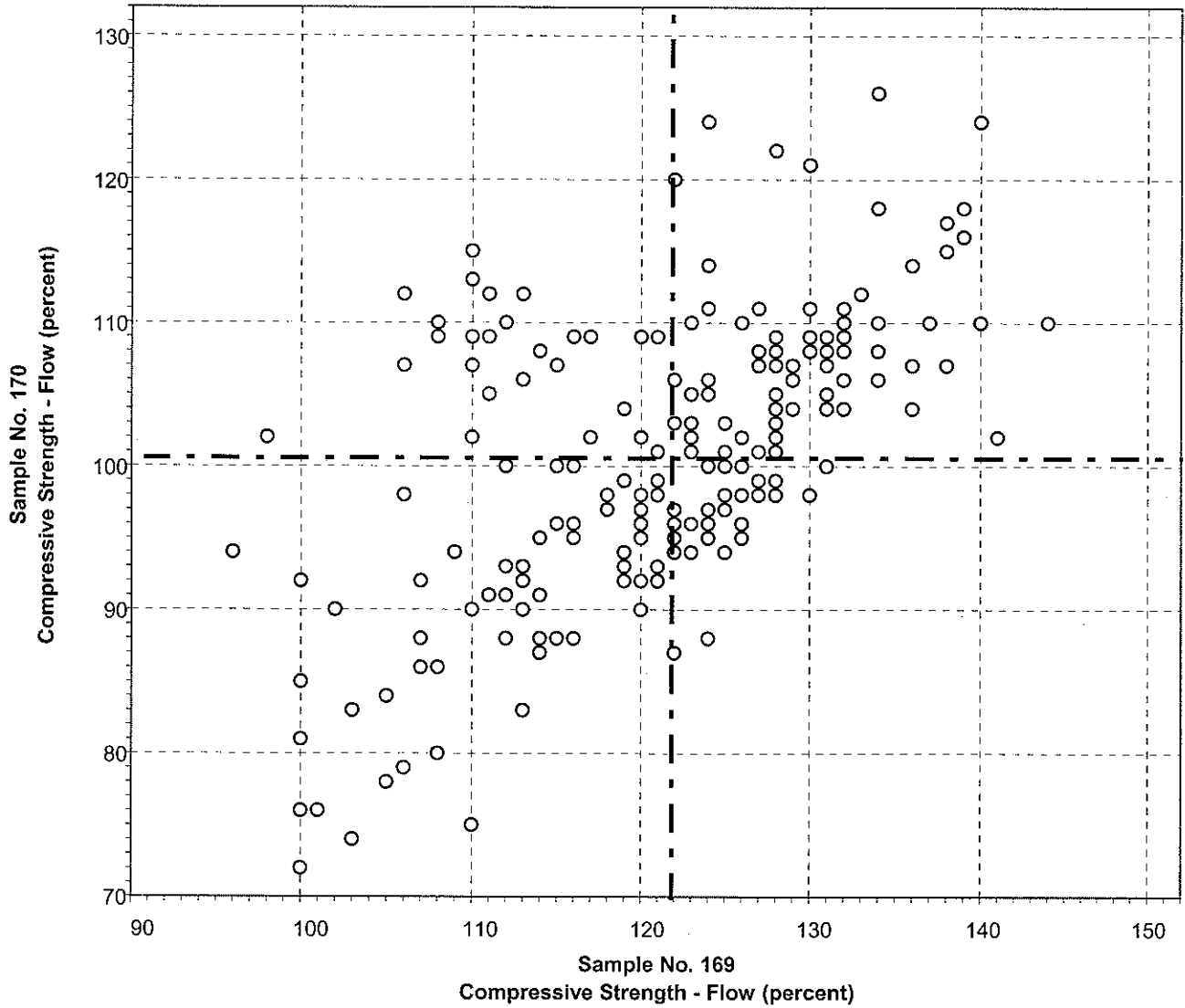
Test No. 230 Compressive Strength - Flow 210 Points

Sample No. 169 Ave 121 S.D. 9.9 C.V. 8.17

Sample No. 170 Ave 101 S.D. 9.9 C.V. 9.81

Labs eliminated: 1196, 2491, 3249, 289, 413, 557, 1483, 3316

**CCRL Proficiency Sample Program
Compressive Strength - Flow
PORTLAND CEMENT Samples No. 169 and No. 170**



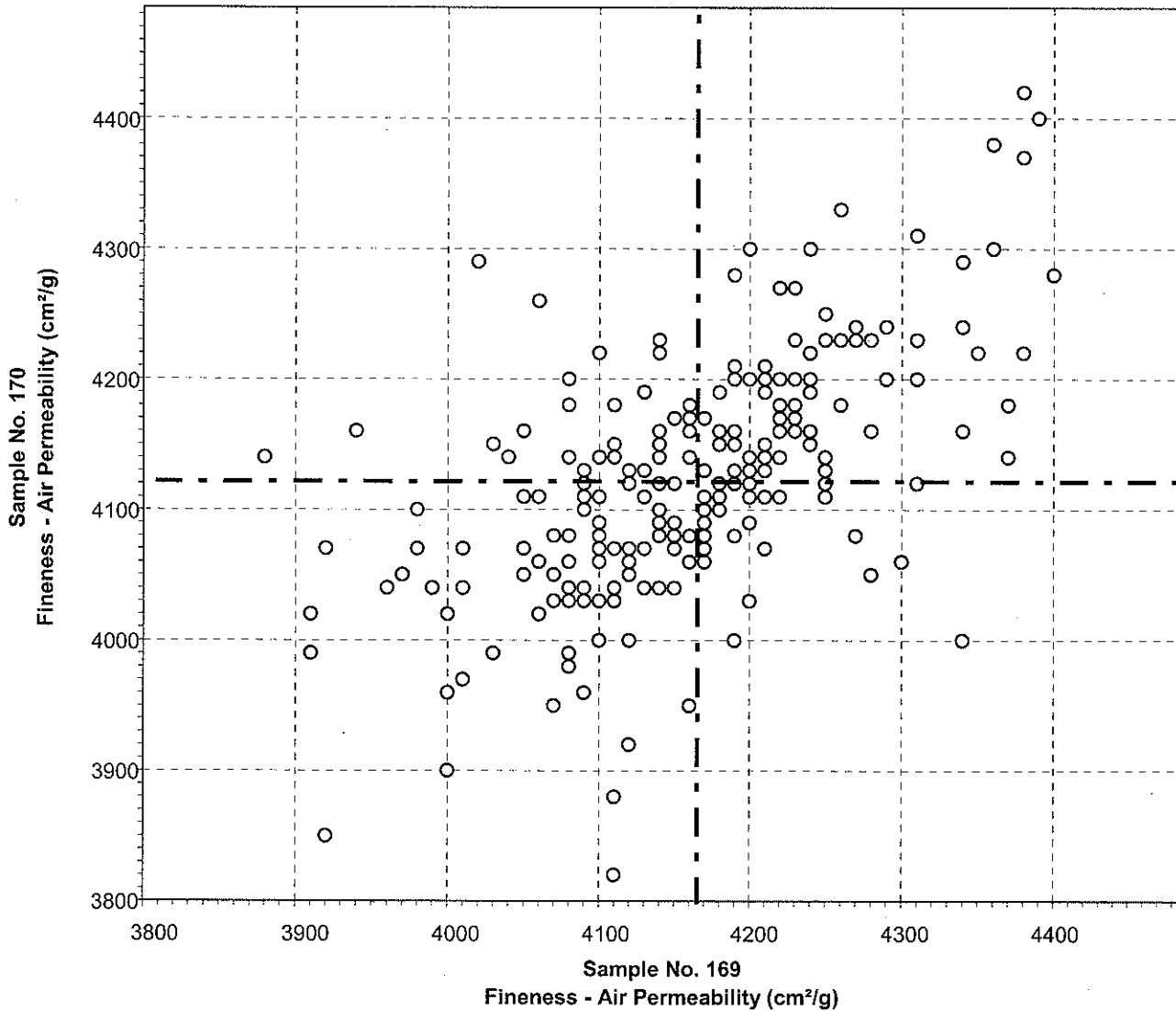
Test No. 230 Compressive Strength - Flow 210 Points

Sample No. 169 Ave 121 S.D. 9.9 C.V. 8.17

Sample No. 170 Ave 101 S.D. 9.9 C.V. 9.81

Labs eliminated: 1196, 2491, 3249, 289, 413, 557, 1483, 3316

**CCRL Proficiency Sample Program
 Fineness - Air Permeability
 PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 270 Fineness - Air Permeability 226 Points

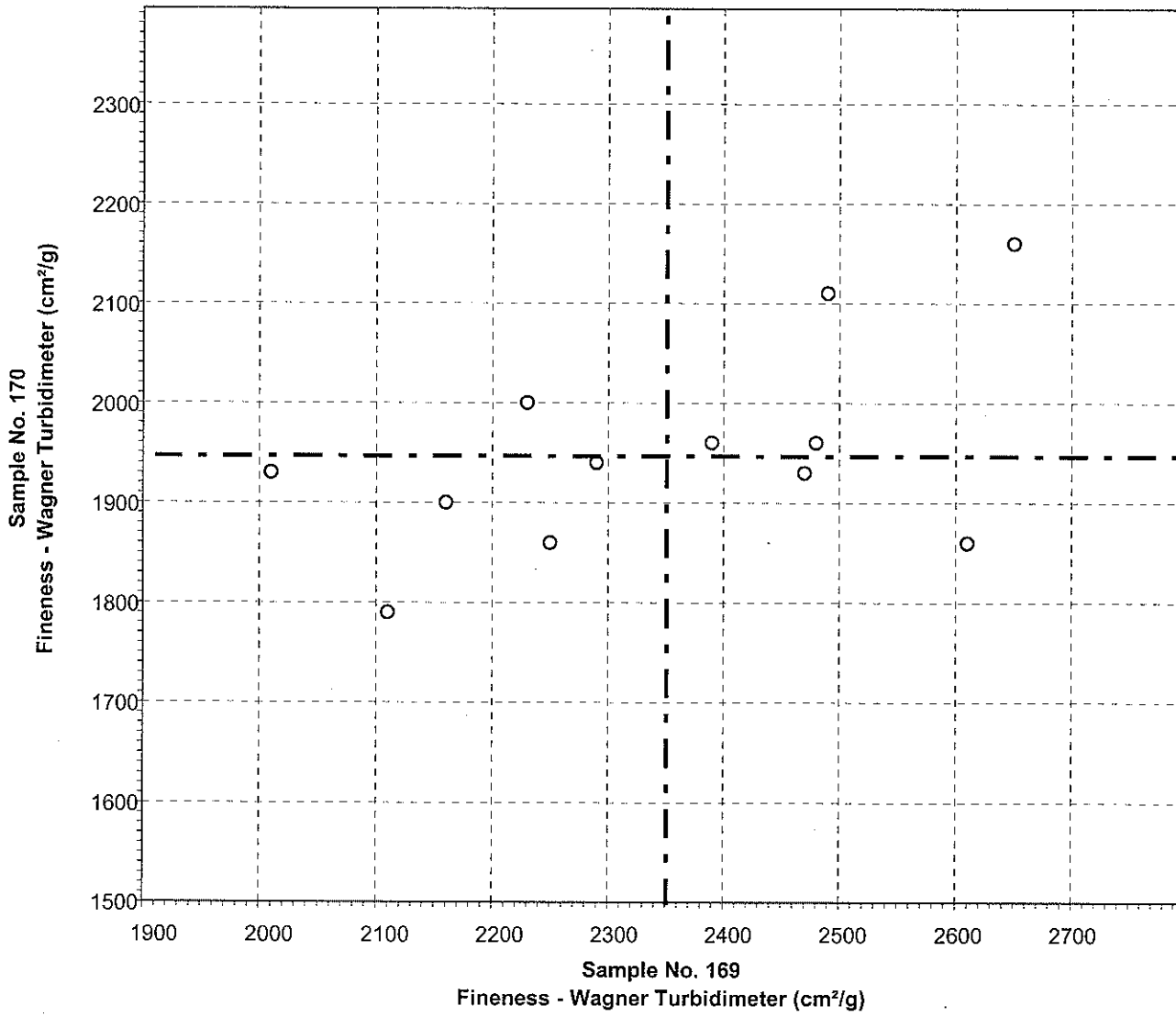
Sample No. 169 Ave 4164 S.D. 99.8 C.V. 2.40

Sample No. 170 Ave 4124 S.D. 98.2 C.V. 2.38

Labs eliminated: 43, 47, 265, 787, 1196, 94, 270, 1251, 1657, 2251, 2491, 3297

Labs off Diagram: 10, 2308

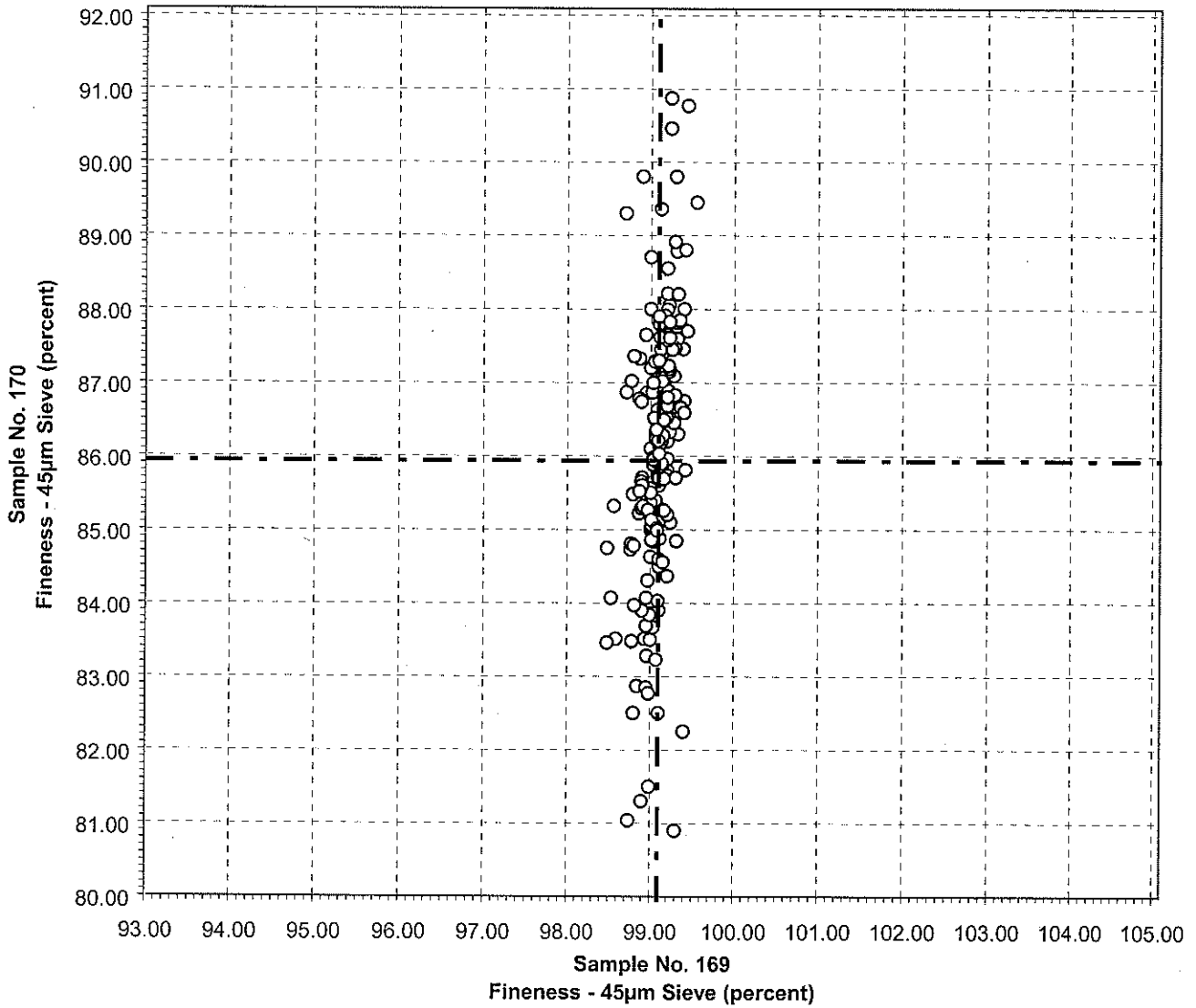
**CCRL Proficiency Sample Program
 Fineness - Wagner Turbidimeter
 PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 280 Fineness - Wagner Turbidimeter 12 Points

Sample No. 169	Ave 2345	S.D. 201.6	C.V. 8.60
Sample No. 170	Ave 1950	S.D. 103.4	C.V. 5.30

CCRL Proficiency Sample Program
Fineness - 45-micron Sieve
PORTLAND CEMENT Samples No. 169 and No. 170



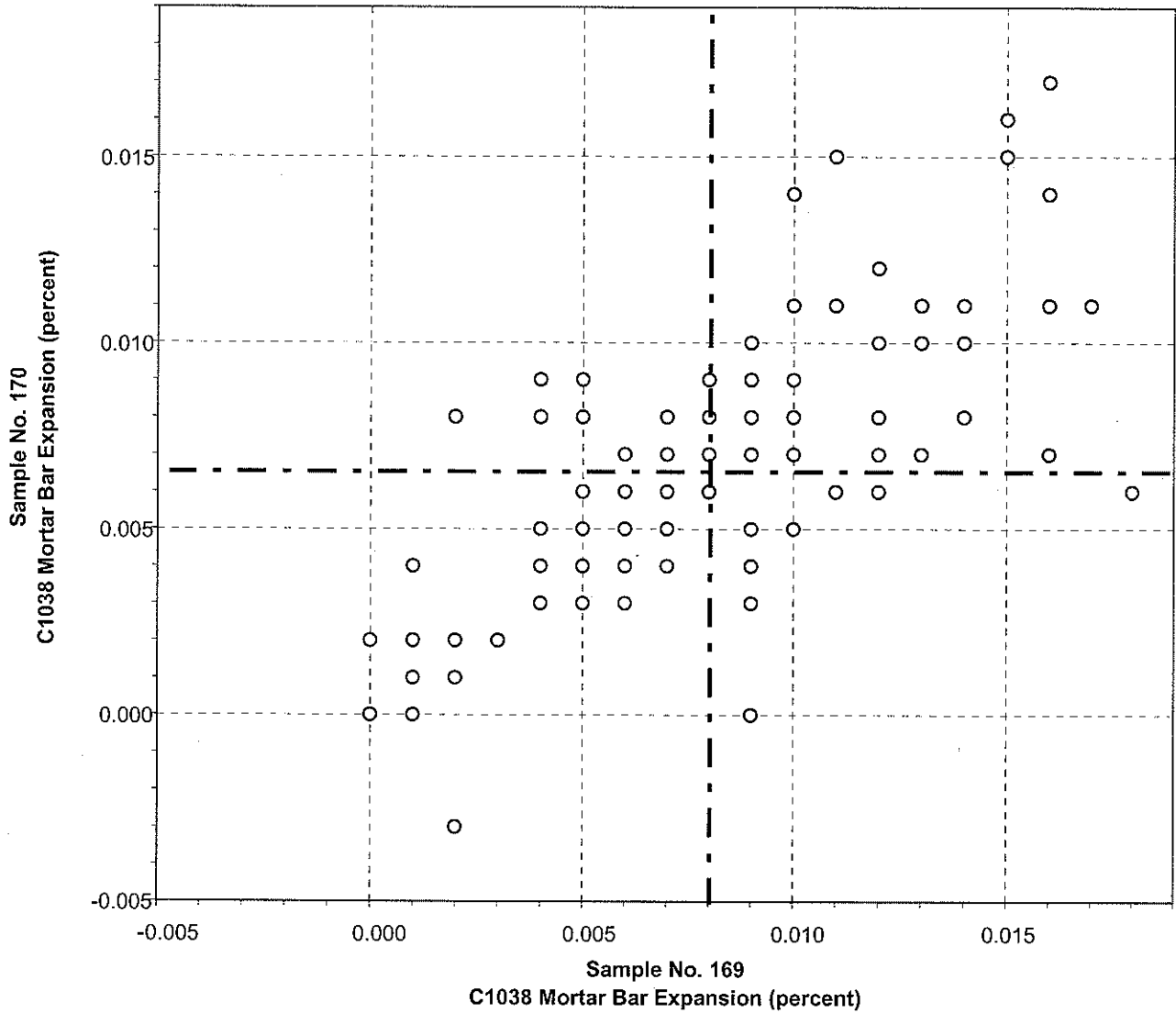
Test No. 281 Fineness - 45-micron Sieve 203 Points

Sample No. 169 Ave 99.08 S.D. 0.18 C.V. 0.181

Sample No. 170 Ave 86.02 S.D. 1.73 C.V. 2.017

Labs eliminated: 47, 49, 180, 360, 932, 1079, 1435, 2482, 3185, 51, 101, 270, 1025, 1196, 2491, 2938, 34, 156, 343, 3379

**CCRL Proficiency Sample Program
C1038 Mortar Bar Expansion
PORTLAND CEMENT Samples No. 169 and No. 170**



Test No. 400 C1038 Mortar Bar Expansion 120 Points

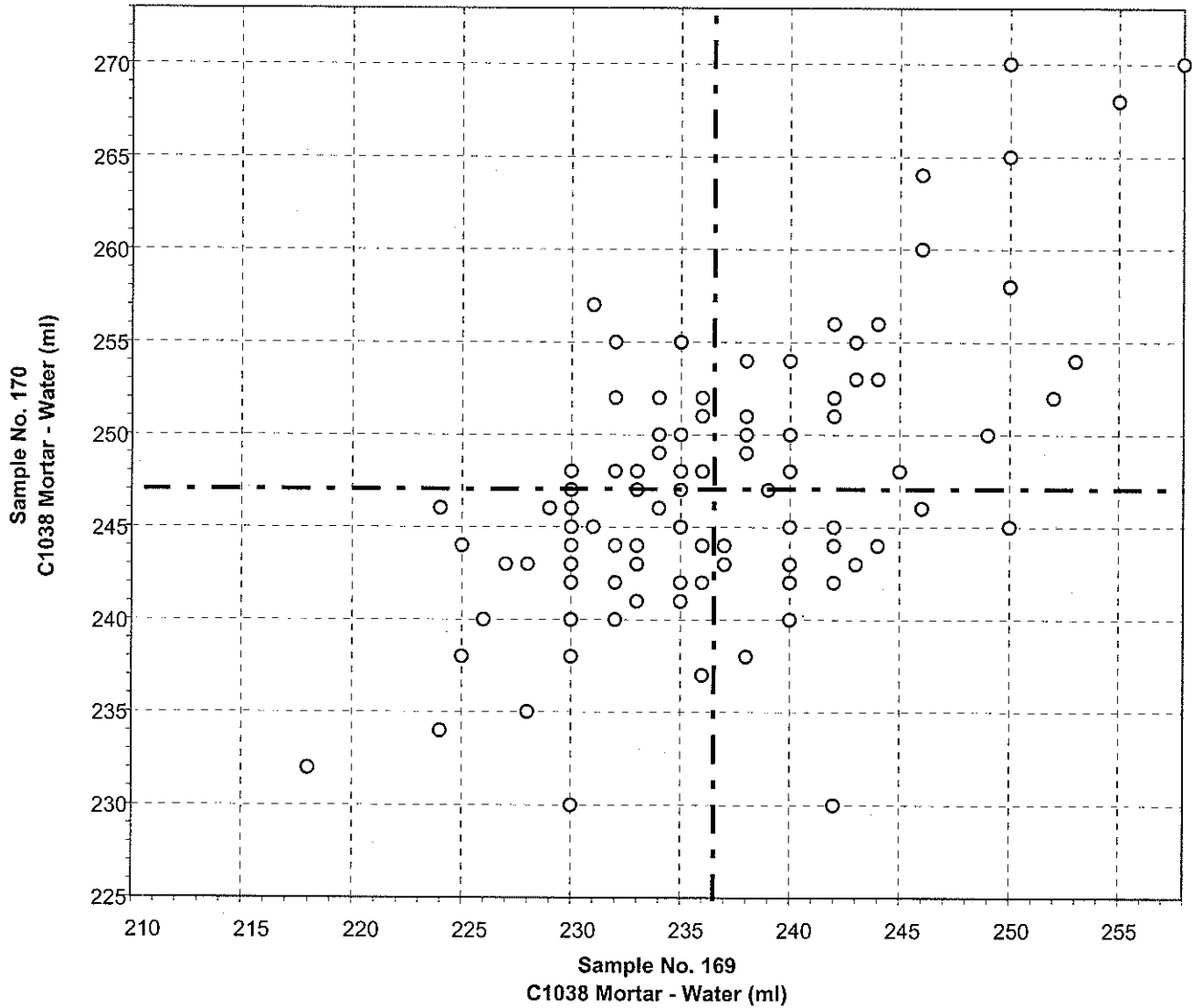
Sample No. 169 Ave 0.008 S.D. 0.0046 C.V. 57.8

Sample No. 170 Ave 0.007 S.D. 0.0036 C.V. 54.4

Labs eliminated: 8, 10, 94, 1799, 151, 201, 883, 1196, 2296, 3255, 3316

Labs off Diagram: 99, 413

CCRL Proficiency Sample Program
C1038 Mortar - Water
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 401

C1038 Mortar - Water

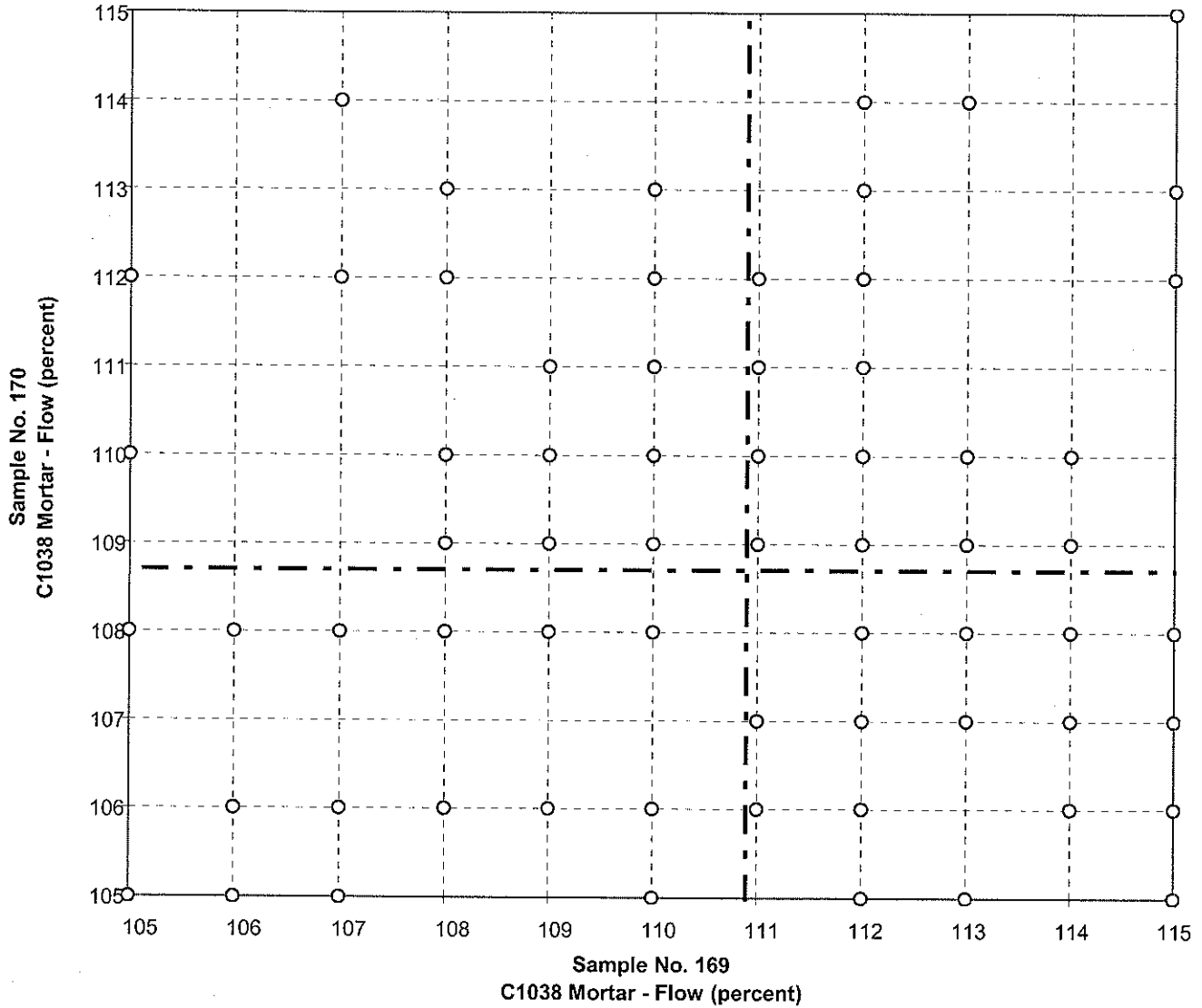
125 Points

Sample No. 169 Ave 236 S.D. 7.0 C.V. 2.96

Sample No. 170 Ave 247 S.D. 7.2 C.V. 2.90

Labs eliminated: 96, 3316

CCRL Proficiency Sample Program
C1038 Mortar - Flow
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 402 C1038 Mortar - Flow 119 Points

Sample No. 169 Ave 111 S.D. 2.8 C.V. 2.55

Sample No. 170 Ave 109 S.D. 2.6 C.V. 2.43

Labs eliminated: 14, 46, 1379, 3126, 3279

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 169 and No. 170
 Final Report - Heat of Hydration Results
 October 8, 2008

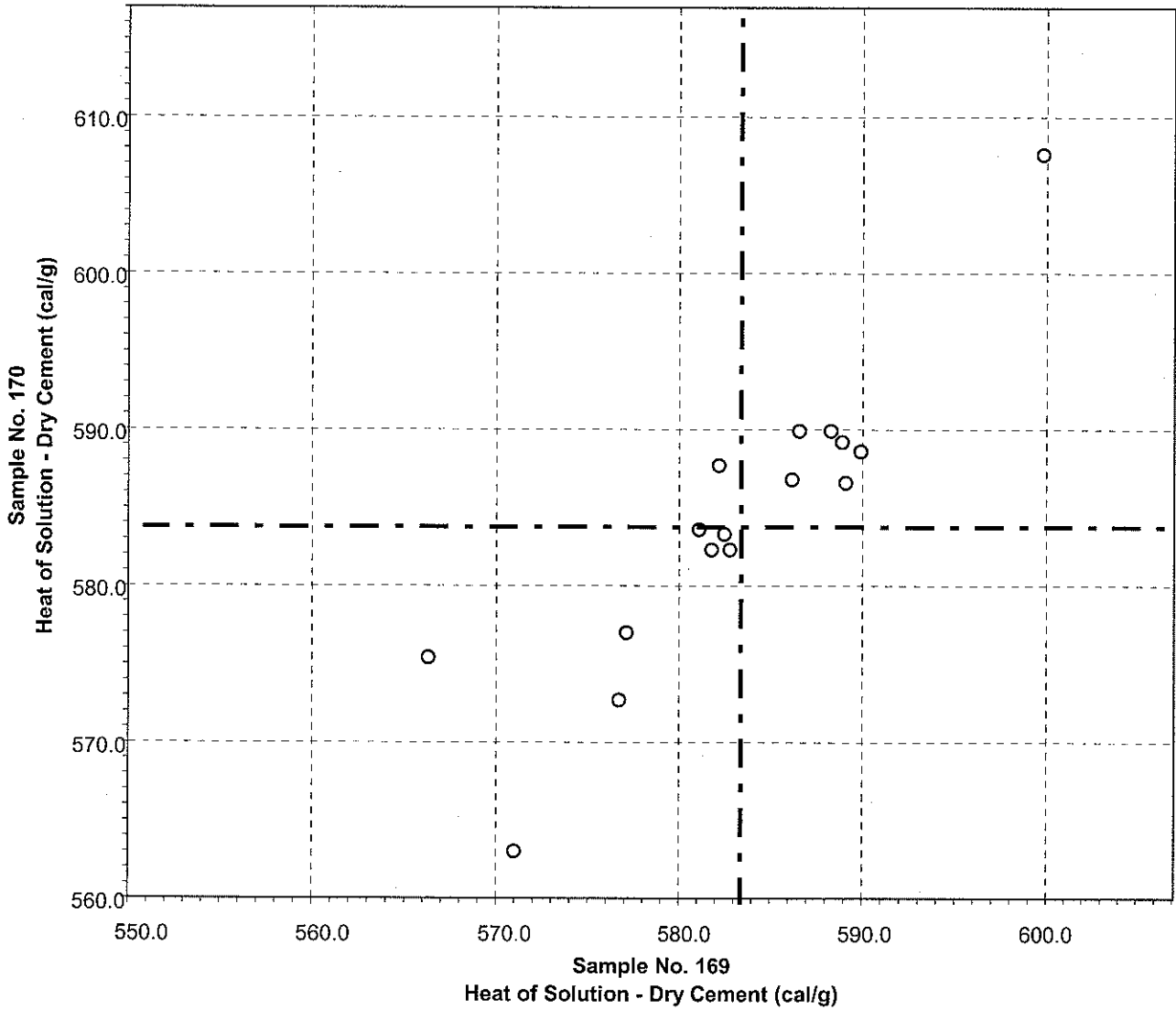
SUMMARY OF RESULTS

Test		#Labs	Sample No. 169			Sample No. 170		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Heat Solution, Dry	cal/g	18	572.2	34.4	6.01	576.5	31.3	5.43
Heat Solution, Dry	cal/g *	16	583.1	8.0	1.37	584.1	9.7	1.65
Heat Sol, 7 day	cal/g	18	502.7	31.9	6.34	499.8	33.9	6.79
Heat Sol, 7 day	cal/g *	17	509.9	10.0	1.95	507.0	14.3	2.82
Heat Sol, 28 day	cal/g	14	499.9	8.4	1.68	496.9	9.7	1.96
Heat Hyd, 7 day	cal/g	19	73.2	4.1	5.66	77.1	8.2	10.66
Heat Hyd, 7 day	cal/g *	18	72.8	3.9	5.37	75.4	4.0	5.30
Heat Hyd, 28 day	cal/g	14	83.7	5.2	6.18	88.0	4.6	5.24

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

Heat of Solution, Dry 92 1644
 Heat of Solution, 7 day 1644
 Heat of Hydration, 7 day 3057

CCRL Proficiency Sample Program
Heat of Solution - Dry
PORTLAND CEMENT Samples No. 169 and No. 170

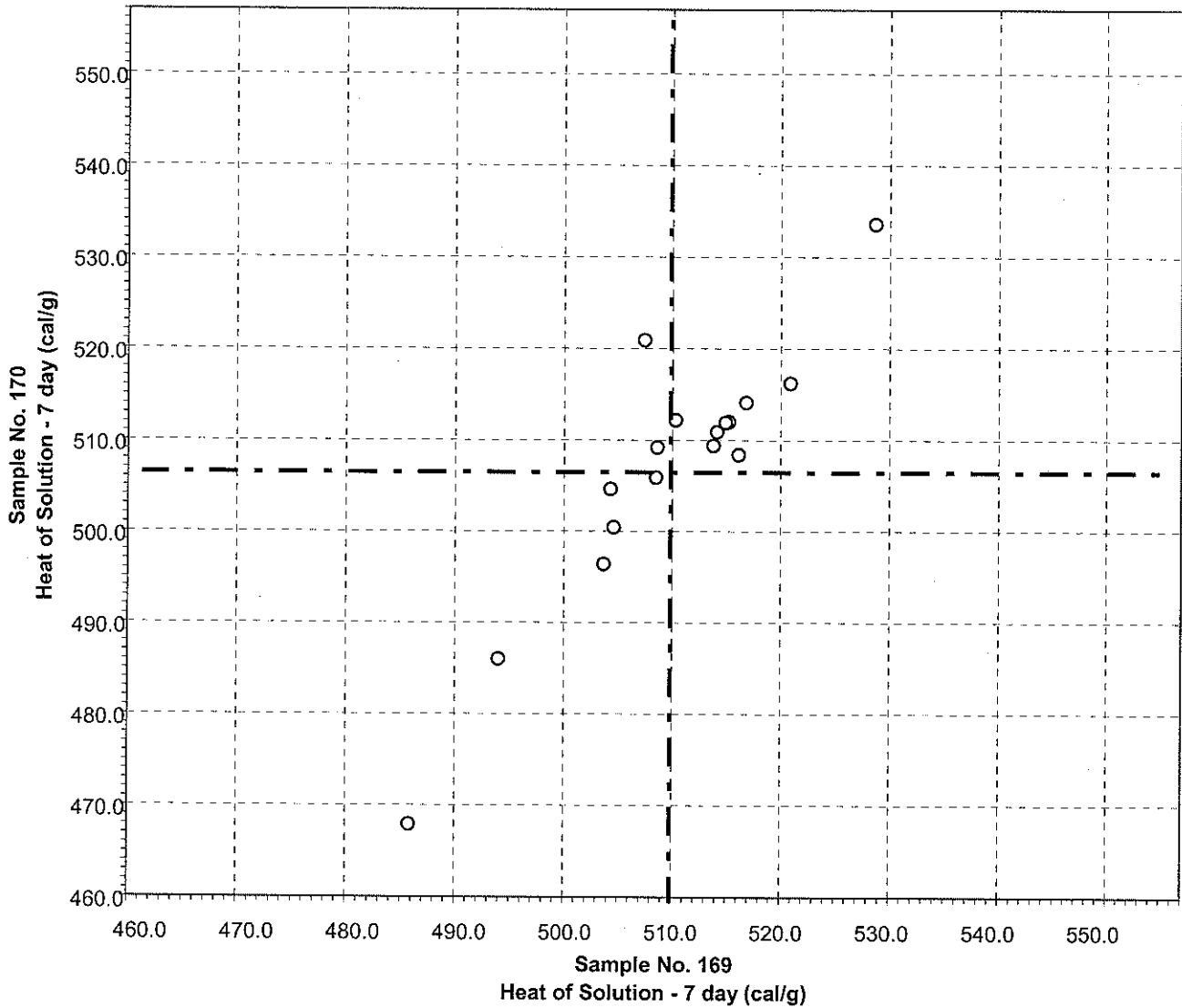


Test No. 291 Heat of Solution - Dry 16 Points

Sample No. 169	Ave 583.1	S.D. 8.0	C.V. 1.37
Sample No. 170	Ave 584.1	S.D. 9.7	C.V. 1.65

Labs eliminated: 92, 1644

CCRL Proficiency Sample Program
Heat of Solution - 7 day
PORTLAND CEMENT Samples No. 169 and No. 170



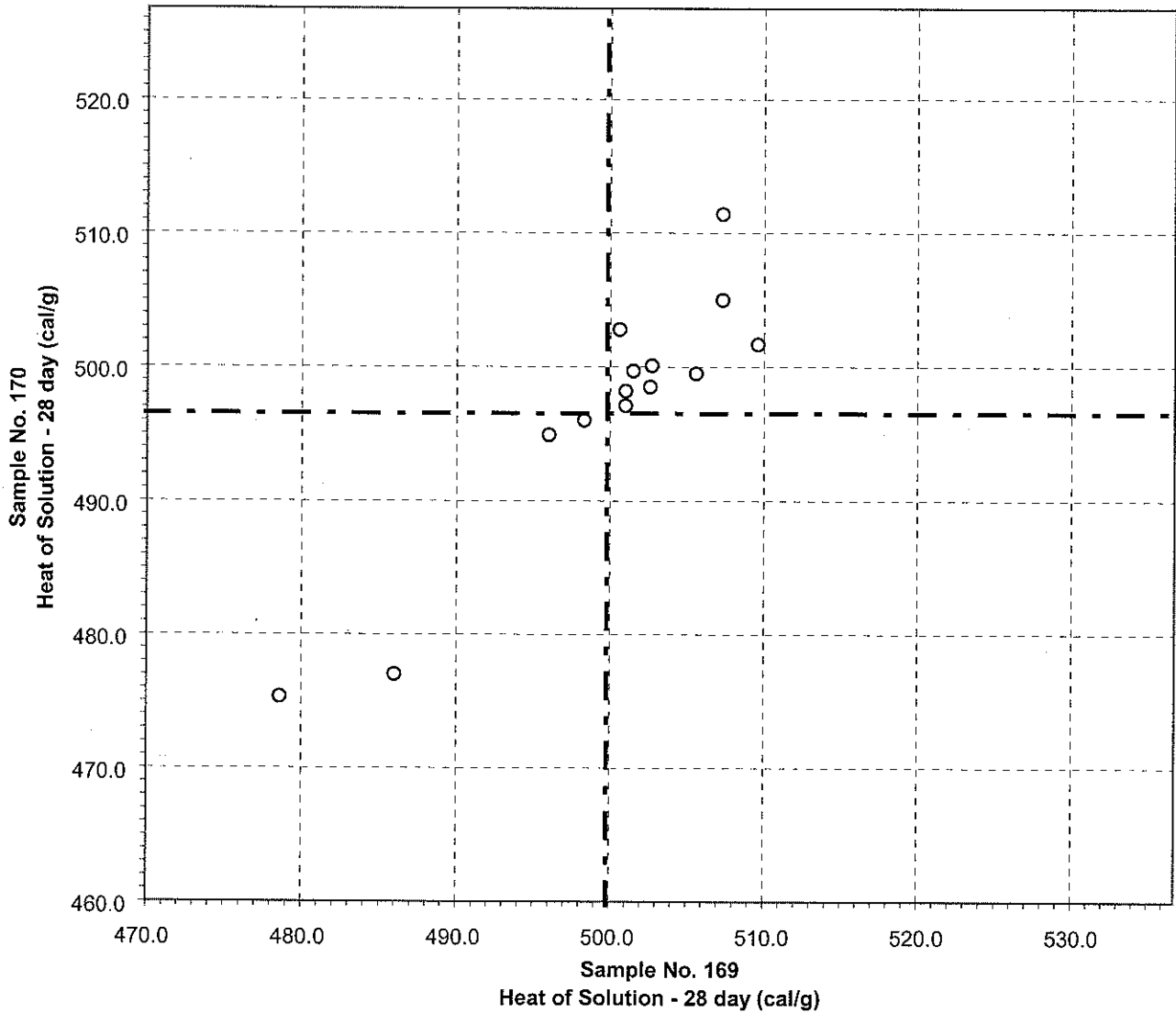
Test No. 292 Heat of Solution - 7 day 17 Points

Sample No. 169 Ave 509.9 S.D. 10.0 C.V. 1.95

Sample No. 170 Ave 507.0 S.D. 14.3 C.V. 2.82

Labs eliminated: 1644

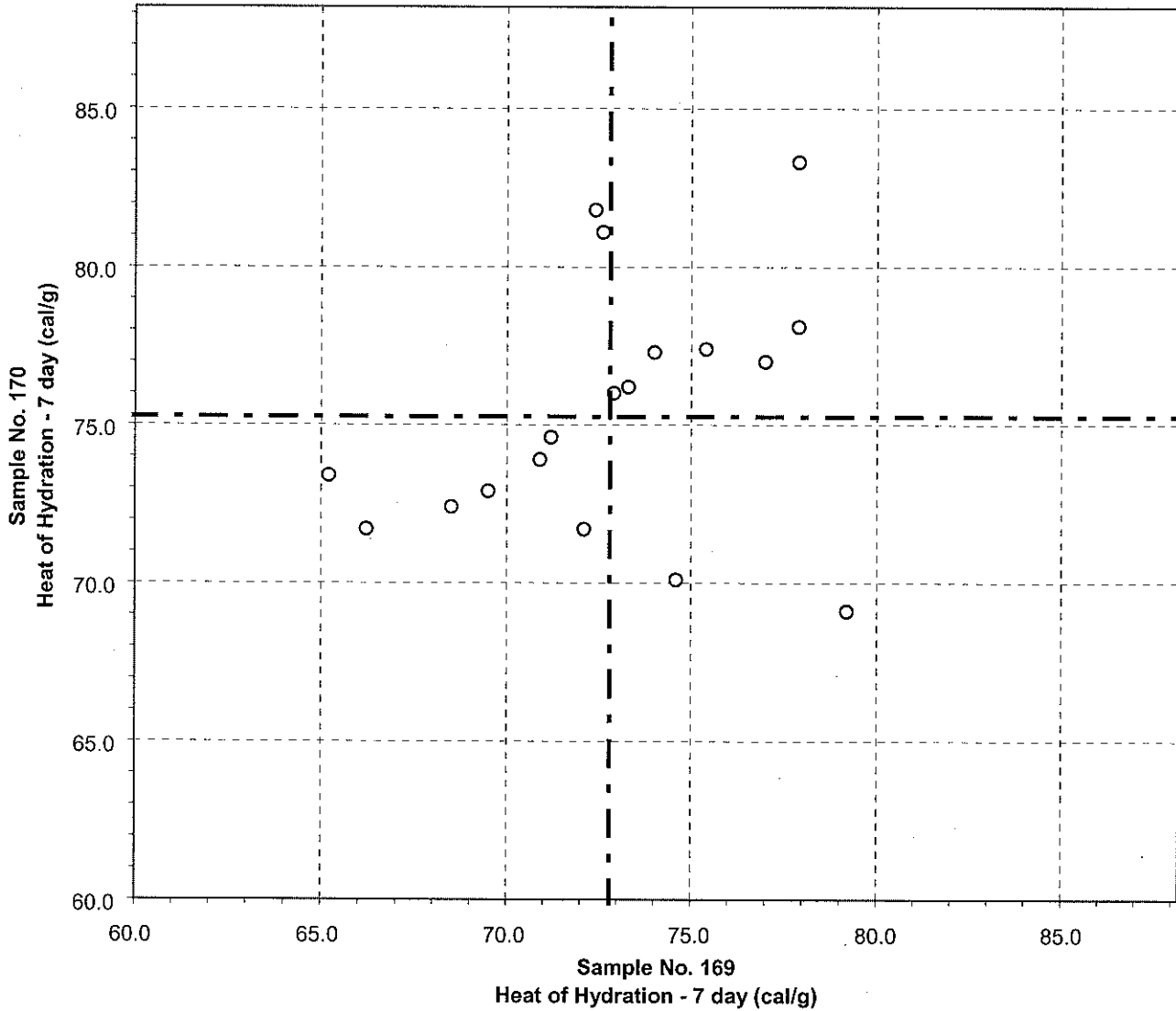
CCRL Proficiency Sample Program
Heat of Solution - 28 day
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 301 Heat of Solution - 28 day 14 Points

Sample No. 169	Ave 499.9	S.D. 8.4	C.V. 1.68
Sample No. 170	Ave 496.9	S.D. 9.7	C.V. 1.96

**CCRL Proficiency Sample Program
Heat of Hydration - 7 day
PORTLAND CEMENT Samples No. 169 and No. 170**



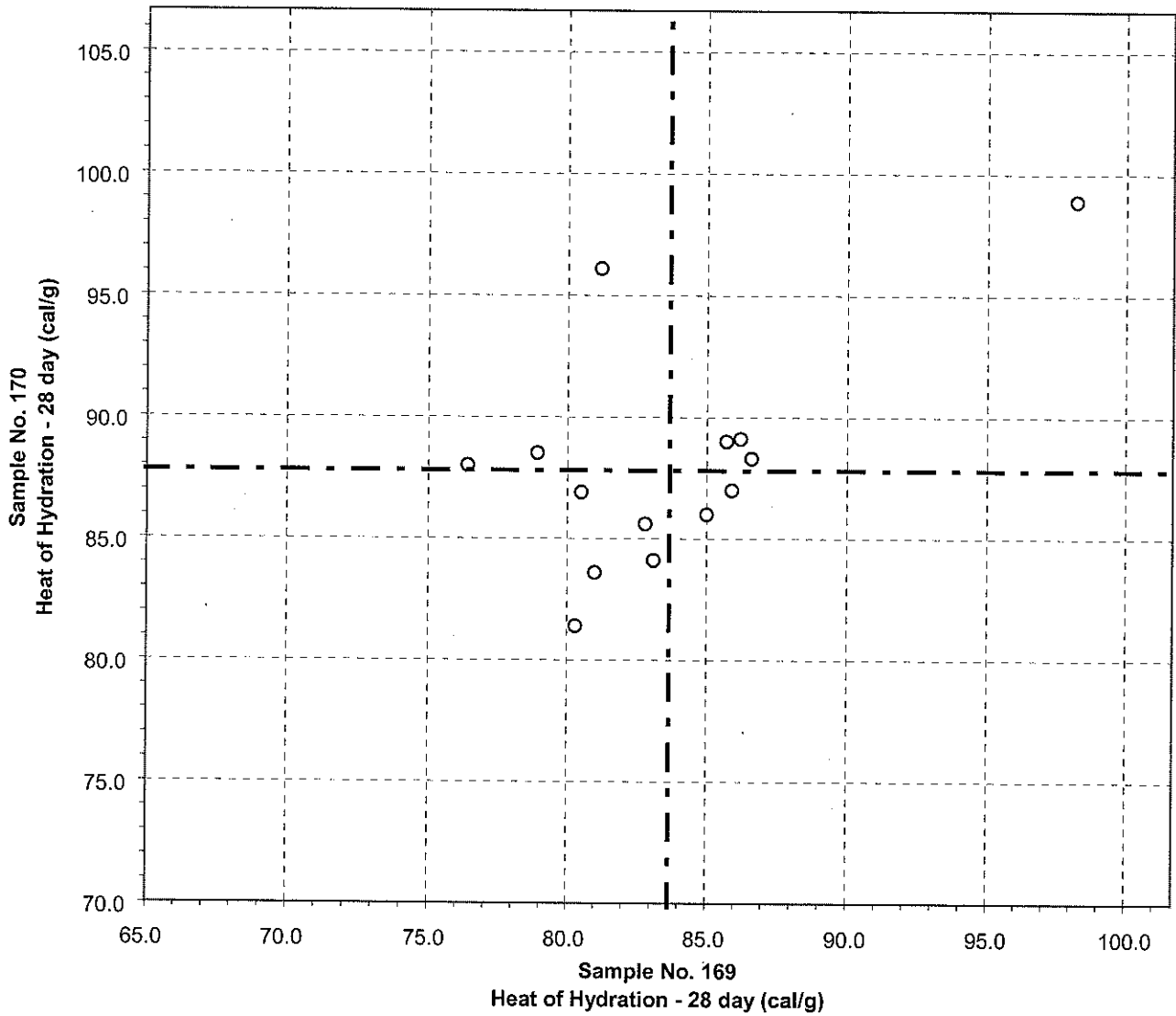
Test No. 290 Heat of Hydration - 7 day 18 Points

Sample No. 169 Ave 72.8 S.D. 3.9 C.V. 5.37

Sample No. 170 Ave 75.4 S.D. 4.0 C.V. 5.3

Labs eliminated: 3057

CCRL Proficiency Sample Program
Heat of Hydration - 28 day
PORTLAND CEMENT Samples No. 169 and No. 170



Test No. 300 Heat of Hydration - 28 day 14 Points

Sample No. 169	Ave 83.7	S.D. 5.2	C.V. 6.18
Sample No. 170	Ave 88.0	S.D. 4.6	C.V. 5.24