# CEMENT AND CONCRETE REFERENCE LABORATORY

# PROFICIENCY SAMPLE PROGRAM

**Final Report**
**Portland Cement Proficiency Samples**
**Number 179 and Number 180**

March 2011

CCRL CEMENT AND CONCRETE REFERENCE LABORATORY

CCRL
Cement and Concrete Reference Laboratory

www.ccrl.us

March 25, 2011

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

**SUBJECT: Final Report on Portland Cement Proficiency Samples No. 179 and No. 180**

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in January 2011. Portland Cement Samples No. 179 and No. 180 were ASTM C150 cements meeting the specifications of Type I and Type II.

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.

A special report is available for Chemical Analysis by XRF Fused Glass and Pressed Powder sample preparation; and 45µm Sieve Fineness using cement from the chemical sample. This report is for information only and laboratory test results were not assigned ratings.

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 2011.

Sincerely,

Robin K. Haupt

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. 179 and No. 180**

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 2011. 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,

[1]Youden, 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.

## 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. 179 and No. 180
Final Report - Chemical Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| Silicon Dioxide | % | 234 | 21.14 | 0.22 | 1.1 | 20.37 | 0.24 | 1.2 |
| Silicon Dioxide | % | * 227 | 21.14 | 0.17 | 0.83 | 20.36 | 0.17 | 0.84 |
| Aluminum Oxide | % | 231 | 4.86 | 0.11 | 2.3 | 5.21 | 0.12 | 2.3 |
| Aluminum Oxide | % | * 223 | 4.85 | 0.09 | 1.9 | 5.21 | 0.09 | 1.8 |
| Ferric Oxide | % | 232 | 3.36 | 0.06 | 1.8 | 3.83 | 0.08 | 2.1 |
| Ferric Oxide | % | * 222 | 3.36 | 0.05 | 1.4 | 3.84 | 0.06 | 1.4 |
| Calcium Oxide | % | 232 | 64.35 | 0.42 | 0.65 | 64.58 | 0.49 | 0.77 |
| Calcium Oxide | % | * 226 | 64.36 | 0.35 | 0.55 | 64.57 | 0.38 | 0.58 |
| Magnesium Oxide | % | 233 | 0.97 | 0.09 | 9.7 | 0.89 | 0.09 | 9.8 |
| Magnesium Oxide | % | * 211 | 0.97 | 0.05 | 5.5 | 0.89 | 0.05 | 6.0 |
| Sulfur Trioxide | % | 236 | 3.11 | 0.16 | 5.2 | 2.99 | 0.15 | 4.9 |
| Sulfur Trioxide | % | * 228 | 3.10 | 0.08 | 2.6 | 2.98 | 0.07 | 2.5 |
| Loss on Ignition | % | 237 | 1.14 | 0.10 | 8.3 | 1.18 | 0.11 | 9.0 |
| Loss on Ignition | % | * 221 | 1.14 | 0.07 | 5.8 | 1.17 | 0.06 | 5.5 |
| Sodium Oxide | % | 220 | 0.108 | 0.088 | 81 | 0.061 | 0.076 | 123 |
| Sodium Oxide | % | * 198 | 0.094 | 0.023 | 25 | 0.046 | 0.021 | 46 |

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

Silicon Dioxide 50 124 502 2464 3422 3454 3577

Aluminum Oxide 4 151 687 3454 3606 3135 3422 3607

Ferric Oxide 157 159 407 1 14 124 698 1251 3135 3454

Calcium Oxide 123 222 1676 2464 3422 3577

Magnesium Oxide 53 502 557 736 1676 95 413 1251 1715 2464 2491 3233 3249 25 169 457 2352 2490 3135 3422 3428 3606

Sulfur Trioxide 20 43 53 84 203 690 2982 3454

Loss on Ignition 95 131 205 244 996 1799 2464 2763 137 156 252 2352 3127 3249 3428 3454 3577

Sodium Oxide 14 116 130 1466 2360 53 98 1251 2464 2490 3238 3249 56 157 494 557 736 1657 2296 2463 2477 3577

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Chemical Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| Potassium Oxide | % | 227 | 0.454 | 0.030 | 6.6 | 0.367 | 0.019 | 5.3 |
| Potassium Oxide | % | * 217 | 0.457 | 0.015 | 3.4 | 0.367 | 0.013 | 3.6 |
| Titanium Dioxide | % | 187 | 0.26 | 0.014 | 5.4 | 0.35 | 0.016 | 4.6 |
| Titanium Dioxide | % | * 180 | 0.26 | 0.009 | 3.3 | 0.35 | 0.012 | 3.6 |
| Phosphorus Pent | % | 181 | 0.129 | 0.051 | 40 | 0.106 | 0.077 | 73 |
| Phosphorus Pent | % | * 169 | 0.126 | 0.008 | 6.0 | 0.101 | 0.007 | 7.0 |
| Zinc Oxide | % | 82 | 0.015 | 0.008 | 48 | 0.060 | 0.010 | 18 |
| Zinc Oxide | % | * 70 | 0.014 | 0.002 | 15 | 0.060 | 0.002 | 4.1 |
| Manganic Oxide | % | 138 | 0.027 | 0.022 | 82 | 0.068 | 0.009 | 13 |
| Manganic Oxide | % | * 125 | 0.024 | 0.004 | 17 | 0.069 | 0.004 | 5.9 |
| Chloride | % | 115 | 0.012 | 0.010 | 84 | 0.005 | 0.008 | 151 |
| Chloride | % | * 104 | 0.010 | 0.005 | 48 | 0.004 | 0.003 | 90 |
| Insoluble Residue | % | 219 | 0.32 | 0.11 | 35 | 0.18 | 0.13 | 71 |
| Insoluble Residue | % | * 205 | 0.31 | 0.08 | 26 | 0.16 | 0.08 | 49 |
| Free Lime | % | 181 | 0.72 | 0.20 | 27 | 0.55 | 0.35 | 65 |
| Free Lime | % | * 177 | 0.72 | 0.19 | 26 | 0.52 | 0.22 | 42 |

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

Potassium Oxide 557 736 975 124 206 1053 2412 3422 3454 3606

Titanium Dioxide 736 2296 162 494 3057 3368 3454

Phosphorus Pentoxide 695 66 139 696 736 3057 4 53 493 2484 3454 3577

Zinc Oxide 95 408 2483 19 206 219 407 493 54 932 3454 3605

Manganic Oxide 142 247 736 2491 11 124 162 203 205 354 457 2462 3454

Chloride 130 142 206 1466 158 309 768 1594 2482 3057 3422

Insoluble Residue 413 491 695 696 996 2466 56 354 450 557 1676 2477 2491 3422

Free Lime 221 413 557 1676 3249

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Chemical Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| Chromium Oxide | % | 83 | 0.011 | 0.004 | 41 | 0.027 | 0.006 | 22 |
| Chromium Oxide | % | * 80 | 0.011 | 0.004 | 36 | 0.027 | 0.005 | 20 |
| Tricalcium Silicate | % | 205 | 55.0 | 2.7 | 4.8 | 59.0 | 3.1 | 5.3 |
| Tricalcium Silicate | % | * 200 | 55.1 | 2.0 | 3.6 | 59.1 | 2.2 | 3.7 |
| Dicalcium Silicate | % | 206 | 19.1 | 2.6 | 14 | 13.9 | 2.9 | 21 |
| Dicalcium Silicate | % | * 196 | 19.1 | 1.6 | 8.6 | 13.8 | 1.8 | 13 |
| Tricalc Aluminate | % | 209 | 7.2 | 0.7 | 10.2 | 7.4 | 0.5 | 7.1 |
| Tricalc Aluminate | % | * 201 | 7.2 | 0.3 | 3.5 | 7.3 | 0.3 | 3.5 |
| Tetracalc Alumino | % | 208 | 10.2 | 0.2 | 1.8 | 11.7 | 0.4 | 3.6 |
| Tetracalc Alumino | % | * 203 | 10.2 | 0.2 | 1.5 | 11.7 | 0.2 | 1.6 |

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

Chromium Oxide 1676 3233 3454

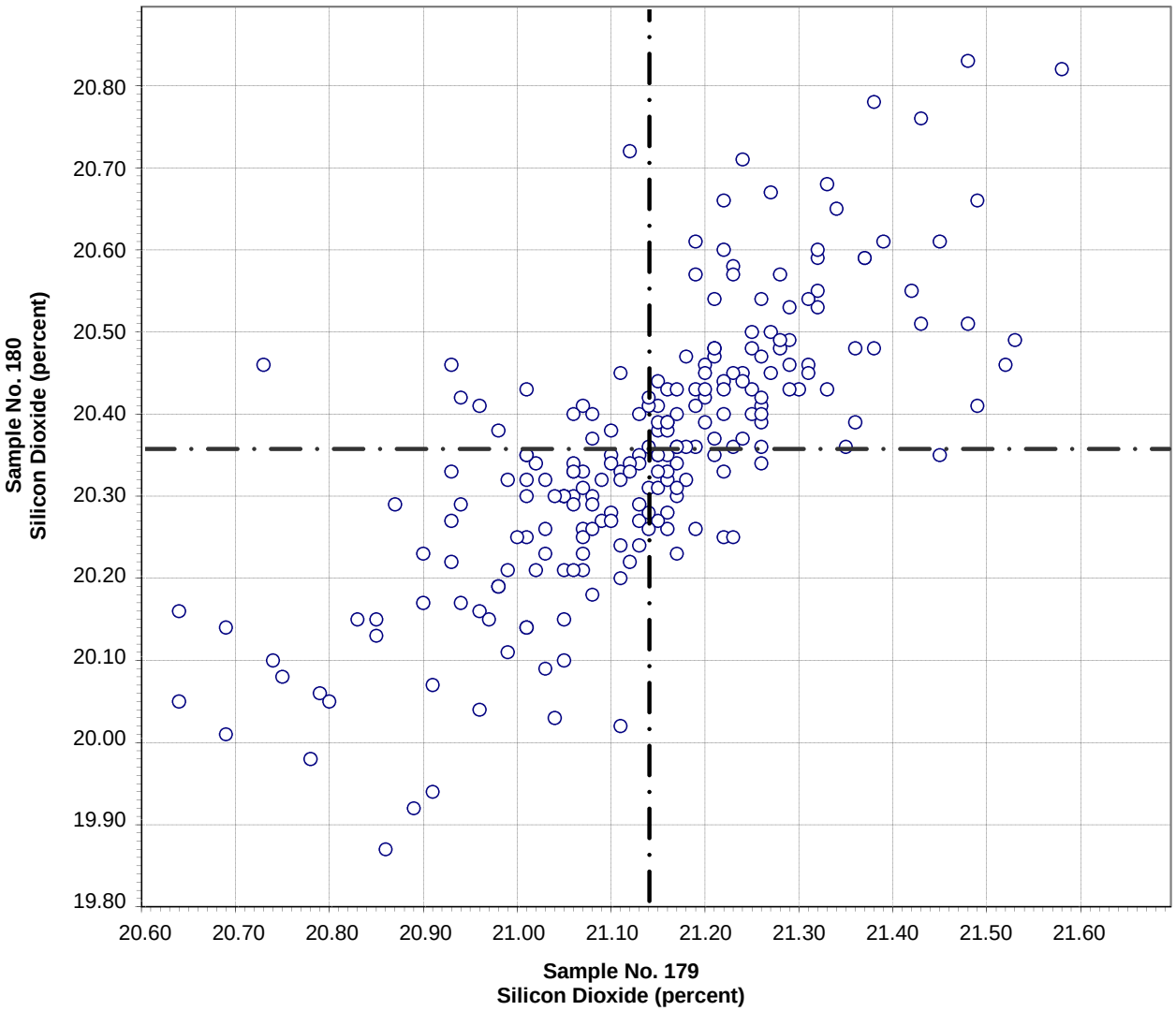
Tricalcium Silicate 50 695 2296 3454 3577

Dicalcium Silicate 50 502 1799 2296 3454 53 284 354 695 3577

Tricalcium Aluminate 206 1799 24 151 687 736 3606 3607

Tetracalcium Aluminoferrite 159 206 407 2463 3454

**CCRL Proficiency Sample Program**
**Silicon Dioxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**



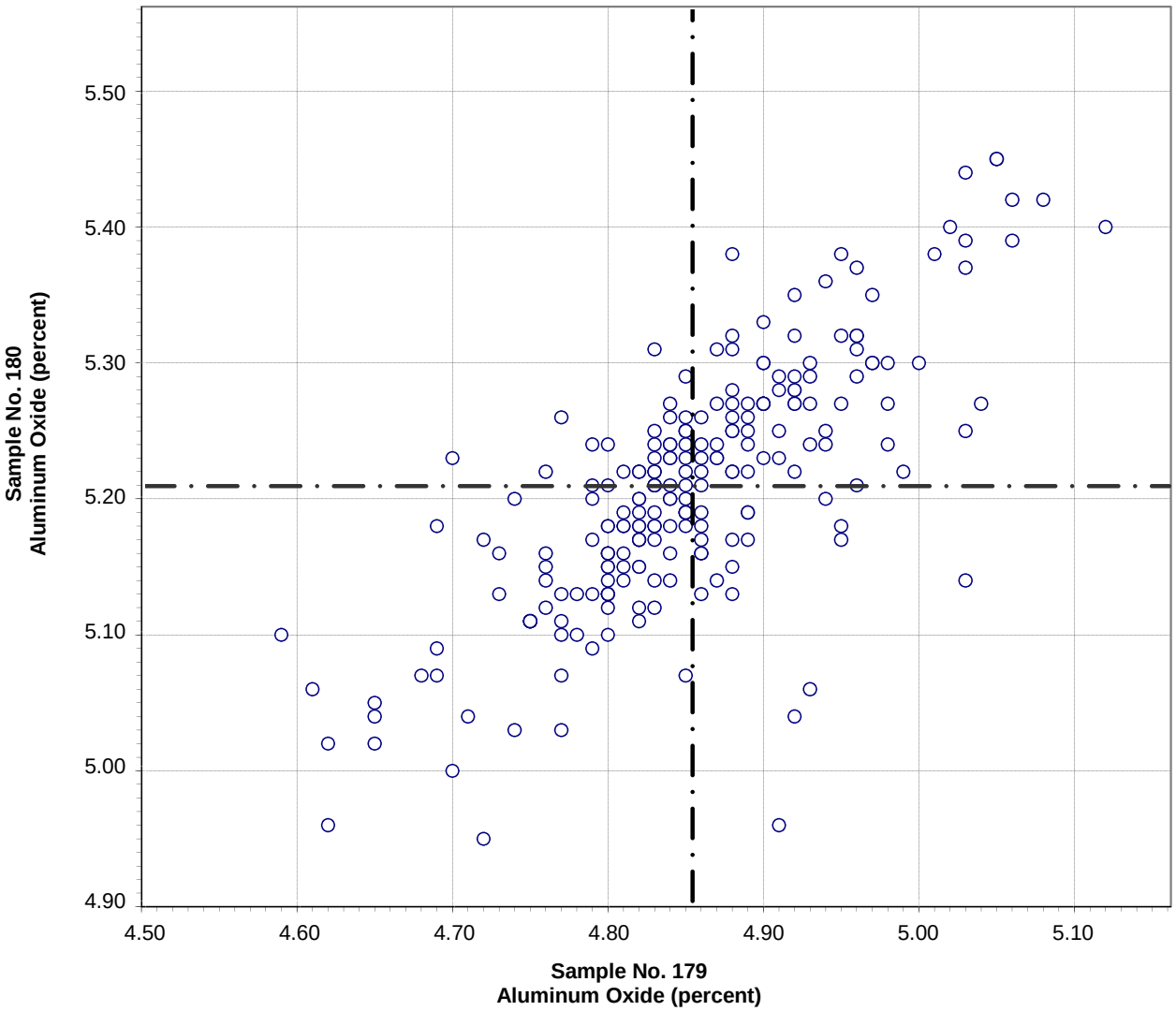

Test No. 10 Silicon Dioxide 224 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 21.14 | S.D. | 0.17 | C.V. 0.83 |
| Sample No. 180 | Ave | 20.36 | S.D. | 0.17 | C.V. 0.84 |

Labs eliminated: 50, 124, 502, 2464, 3422, 3454, 3577

Labs off Diagram: 4, 93, 3428

**CCRL Proficiency Sample Program**
**Aluminum Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

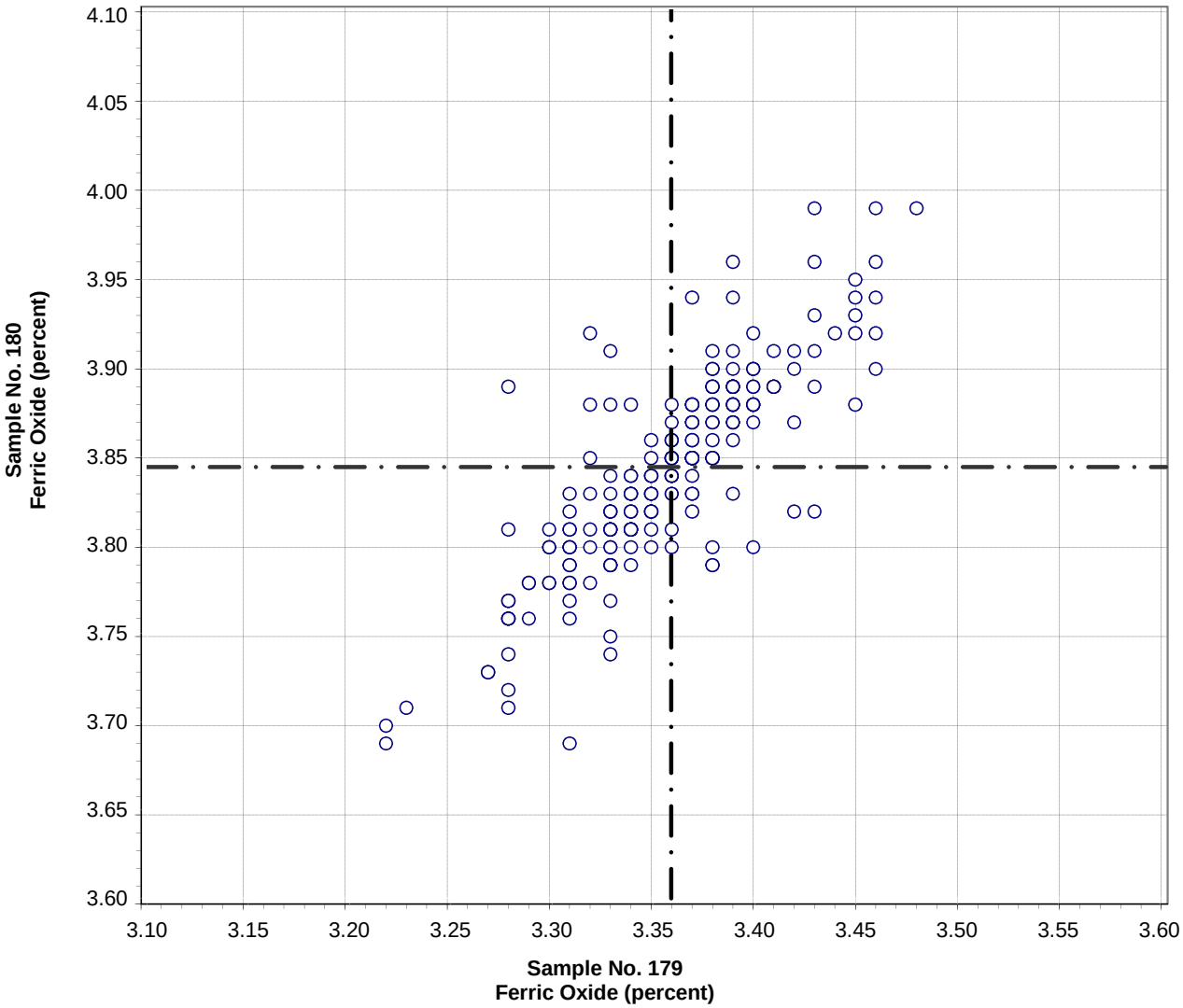



Test No. 21 Aluminum Oxide 223 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 4.85 | S.D. | 0.09 | C.V. | 1.9 |
| Sample No. 180 | Ave | 5.21 | S.D. | 0.09 | C.V. | 1.8 |

Labs eliminated: 4, 151, 687, 3454, 3606, 3135, 3422, 3607

**CCRL Proficiency Sample Program**
**Ferric Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

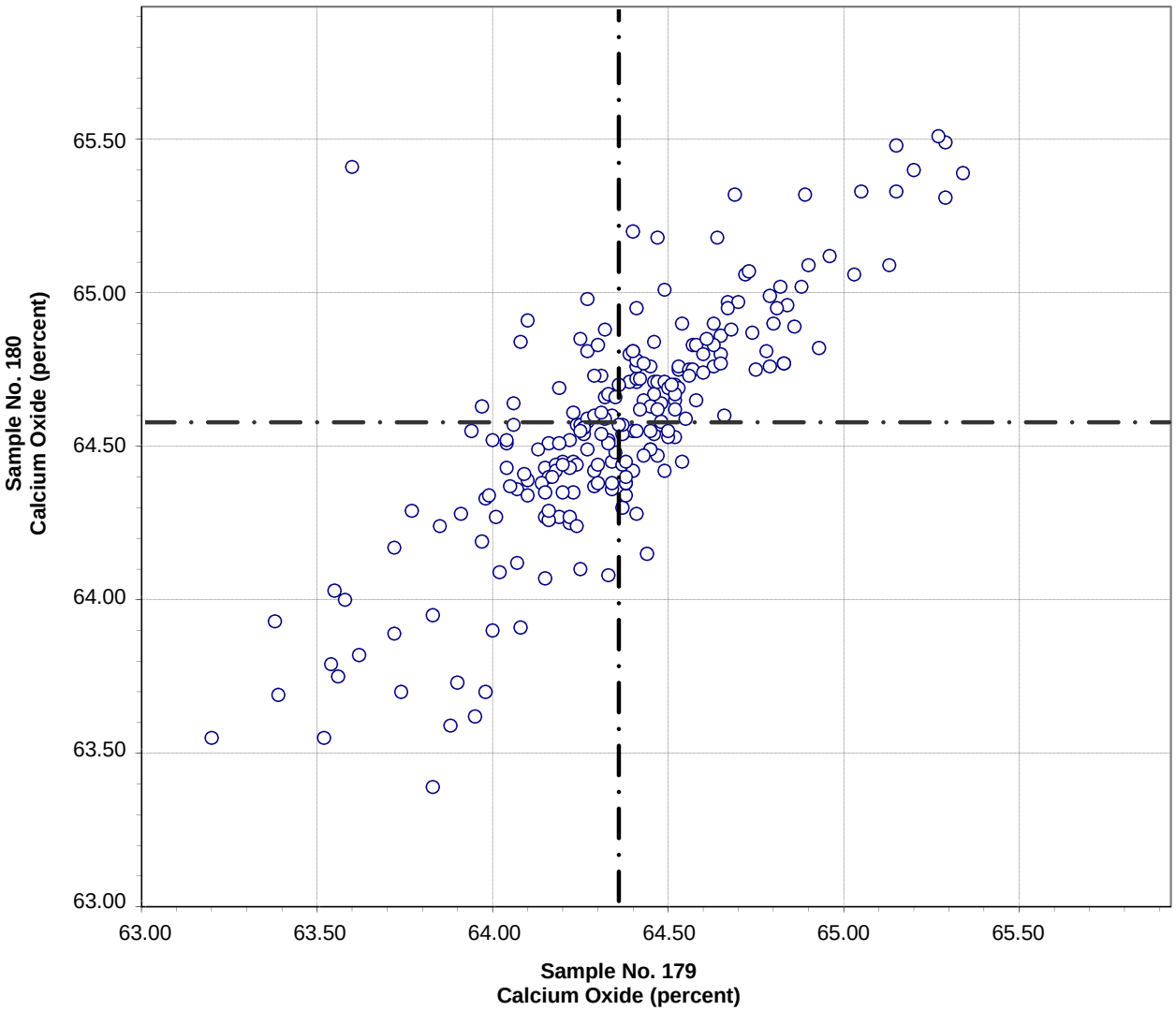



Test No. 30 Ferric Oxide 222 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 3.36 | S.D. | 0.05 | C.V. | 1.4 |
| Sample No. 180 | Ave | 3.84 | S.D. | 0.06 | C.V. | 1.4 |

Labs eliminated: 157, 159, 407, 1, 14, 124, 698, 1251, 3135, 3454

**CCRL Proficiency Sample Program**
**Calcium Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

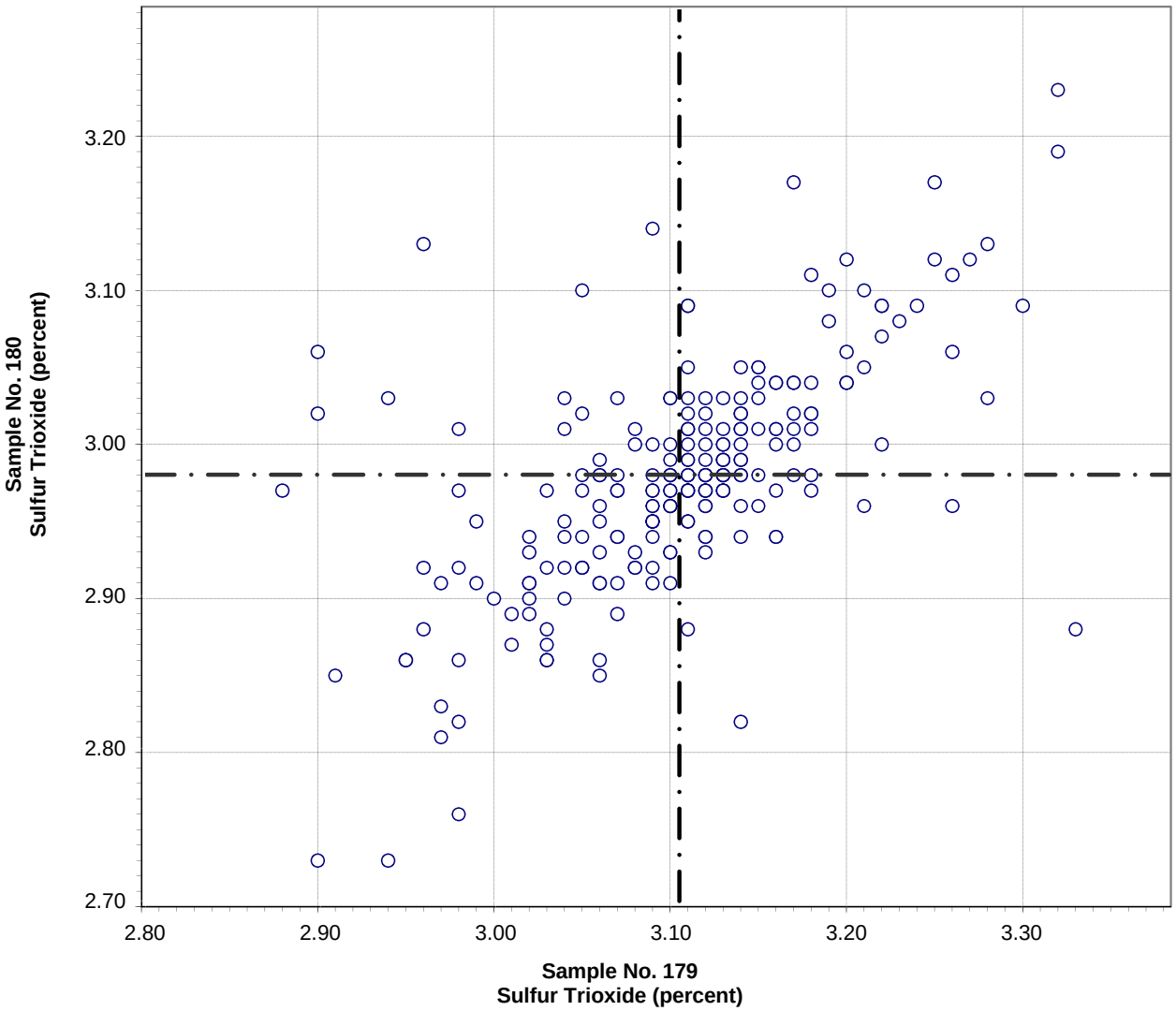



Test No. 40 Calcium Oxide 226 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 64.36 | S.D. | 0.35 | C.V. | 0.55 |
| Sample No. 180 | Ave | 64.57 | S.D. | 0.38 | C.V. | 0.58 |

Labs eliminated: 123, 222, 1676, 2464, 3422, 3577

**CCRL Proficiency Sample Program**
**Sulfur Trioxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

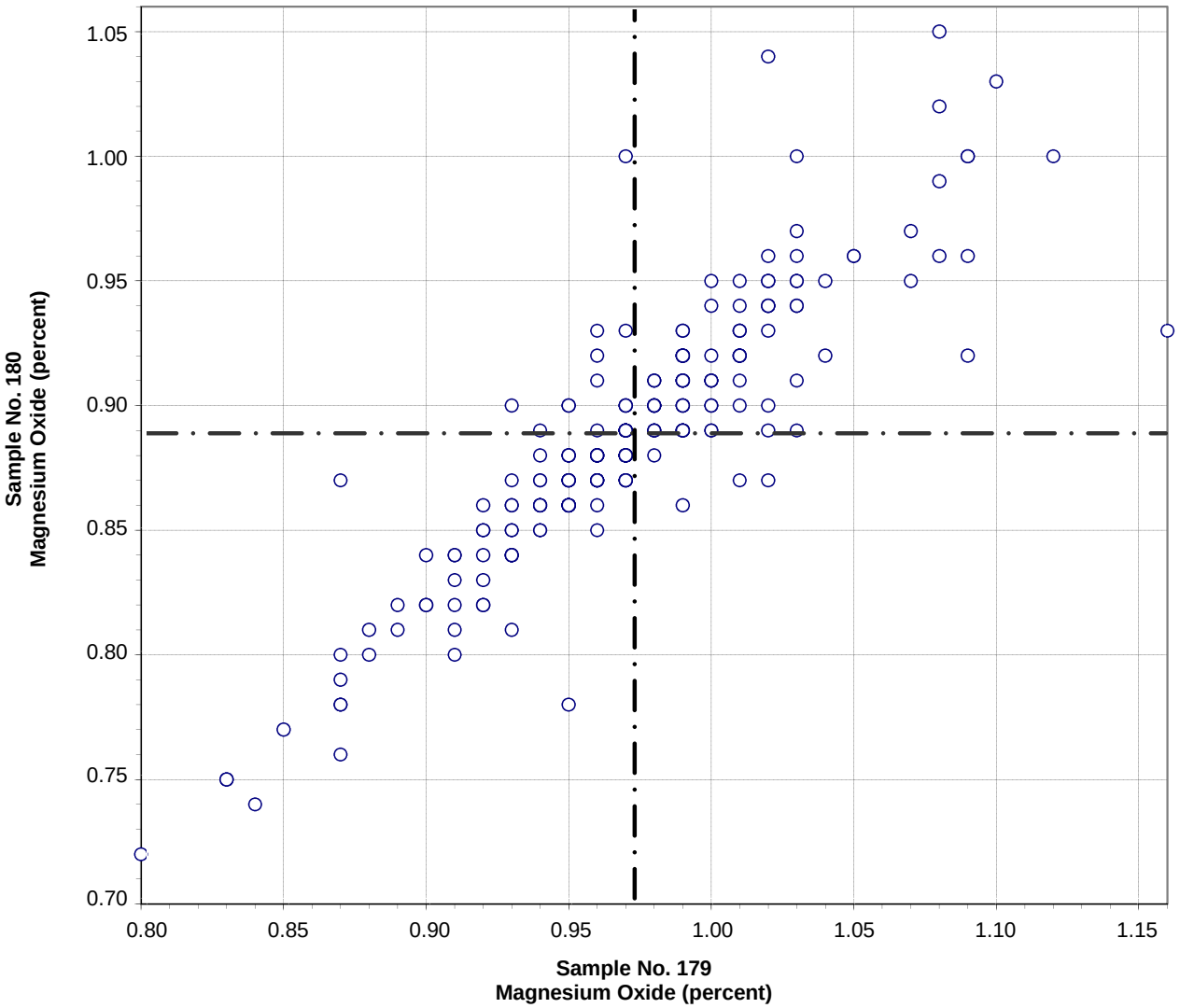



Test No. 60 Sulfur Trioxide 228 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 3.10 | S.D. | 0.08 | C.V. | 2.6 |
| Sample No. 180 | Ave | 2.98 | S.D. | 0.07 | C.V. | 2.5 |

Labs eliminated: 20, 43, 53, 84, 203, 690, 2982, 3454

**CCRL Proficiency Sample Program**
**Magnesium Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

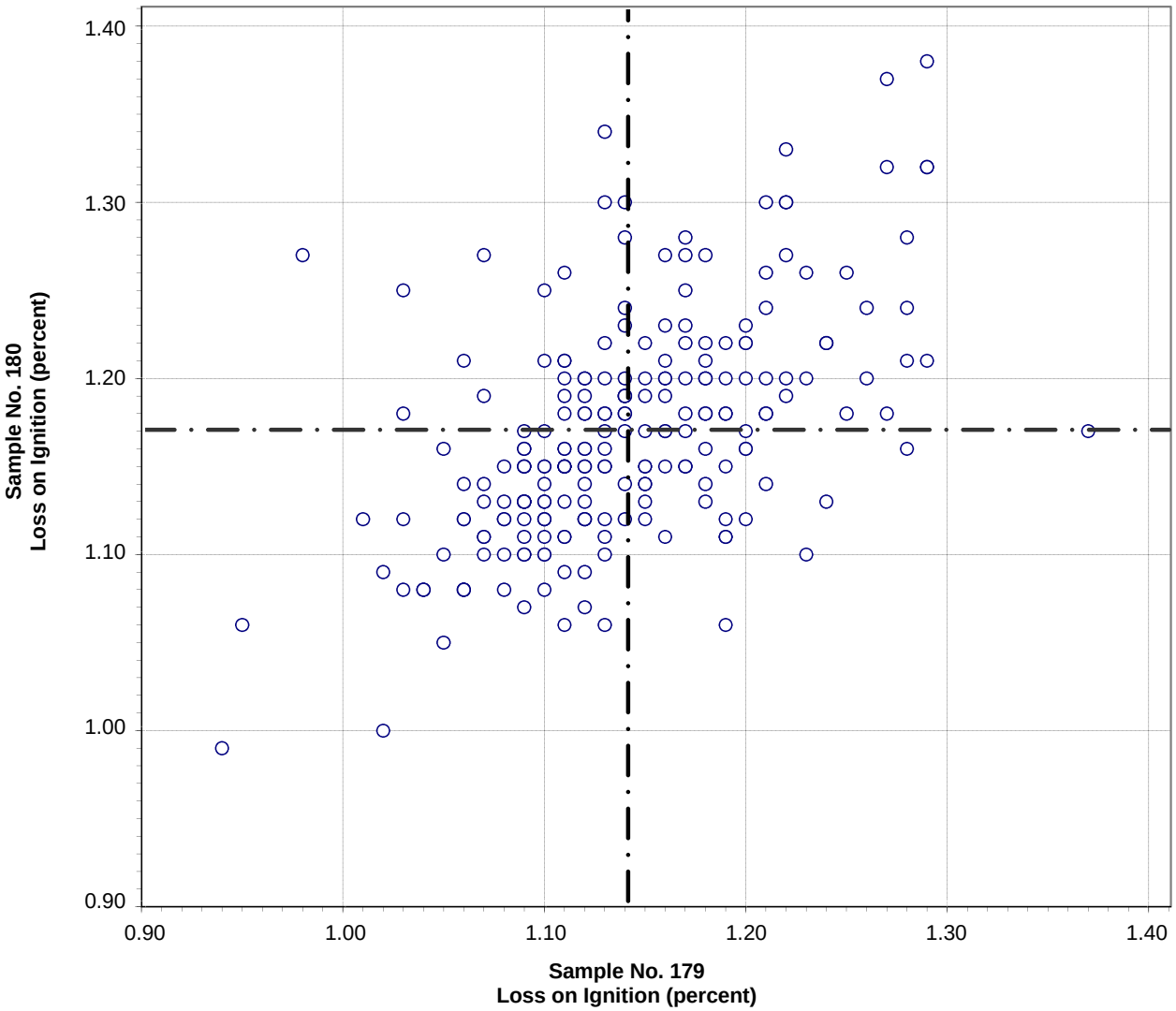



Test No. 50 Magnesium Oxide 211 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.97 | S.D. | 0.05 | C.V. | 5.5 |
| Sample No. 180 | Ave | 0.89 | S.D. | 0.05 | C.V. | 6.0 |

Labs eliminated: 53, 502, 557, 736, 1676, 95, 413, 1251, 1715, 2464, 2491, 3233, 3249, 25, 169, 457, 2352, 2490, 3135, 3422, 3428, 3606

**CCRL Proficiency Sample Program**
**Loss on Ignition**
**PORTLAND CEMENT Samples No. 179 and No. 180**

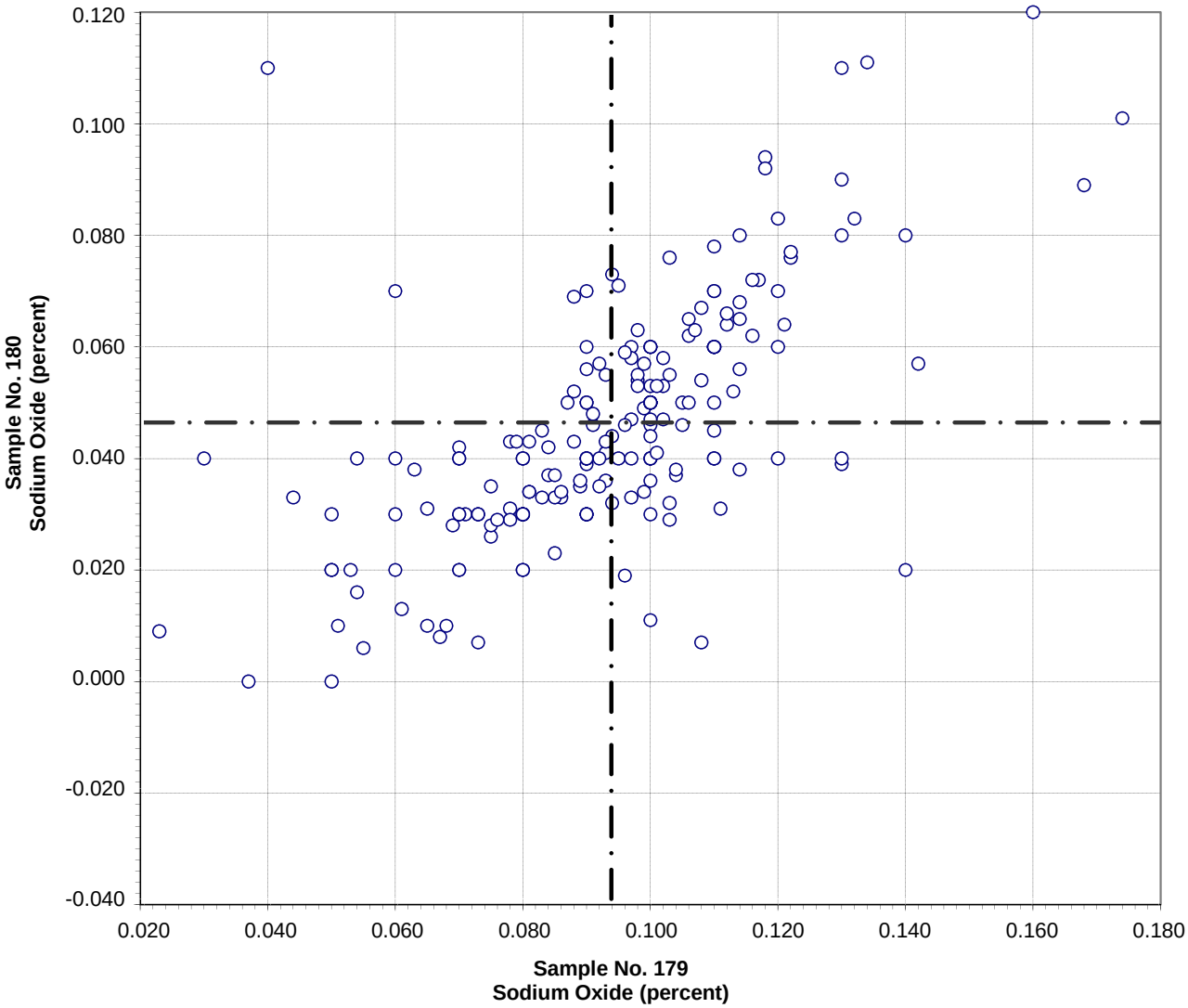



Test No. 70 Loss on Ignition 221 Points

Sample No. 179 Ave 1.14 S.D. 0.07 C.V. 5.8
Sample No. 180 Ave 1.17 S.D. 0.06 C.V. 5.5

Labs eliminated: 95, 131, 205, 244, 996, 1799, 2464, 2763, 137, 156, 252, 2352, 3127, 3249, 3428, 3454, 3577

**CCRL Proficiency Sample Program**
**Sodium Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

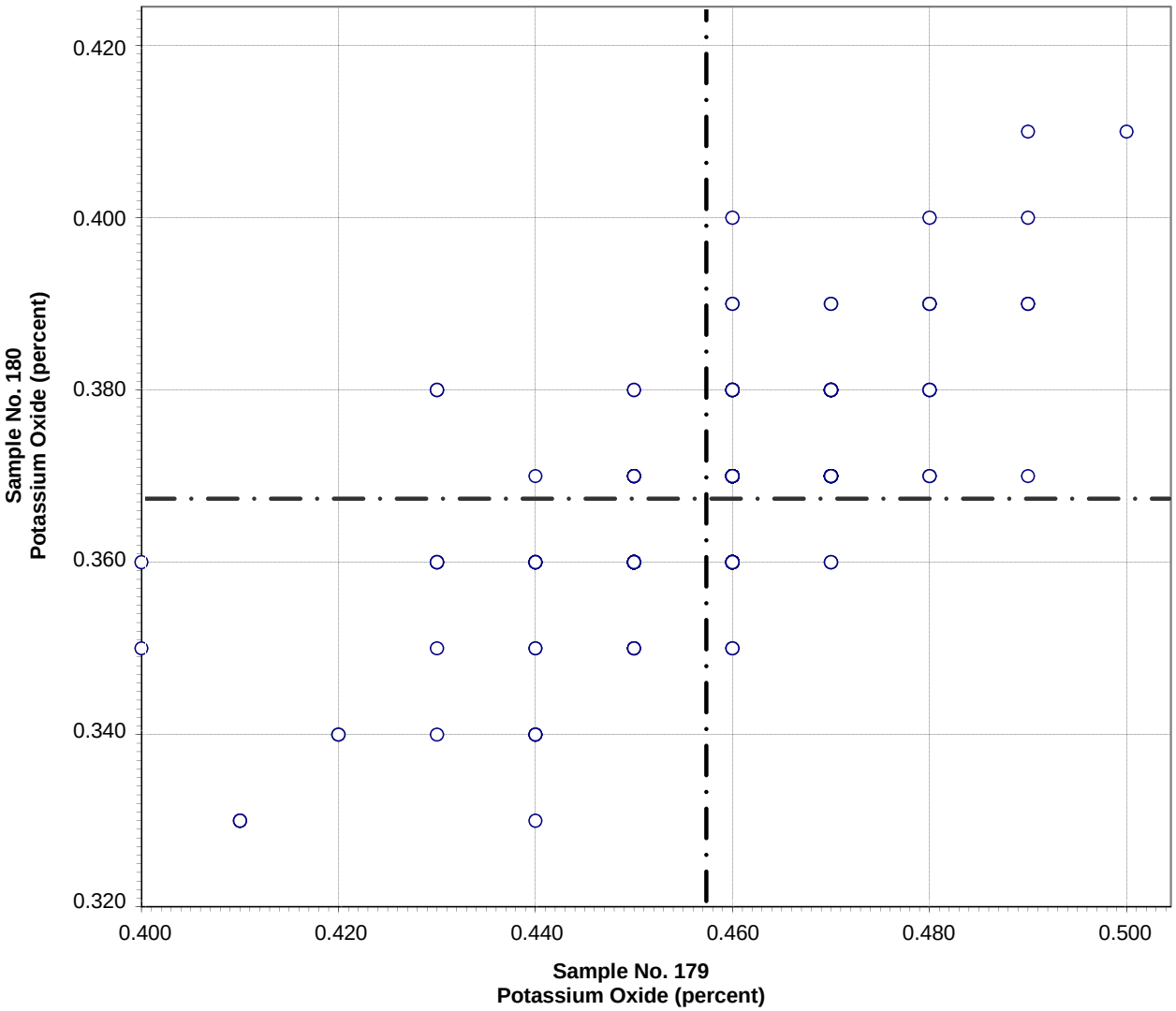



Test No. 90 Sodium Oxide 198 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.094 | S.D. | 0.023 | C.V. | 25 |
| Sample No. 180 | Ave | 0.046 | S.D. | 0.021 | C.V. | 46 |

Labs eliminated: 14, 116, 130, 1466, 2360, 53, 98, 1251, 2464, 2490, 3238, 3249, 56, 157, 494, 557, 736, 1657, 2296, 2463, 2477, 3577

**CCRL Proficiency Sample Program**
**Potassium Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**



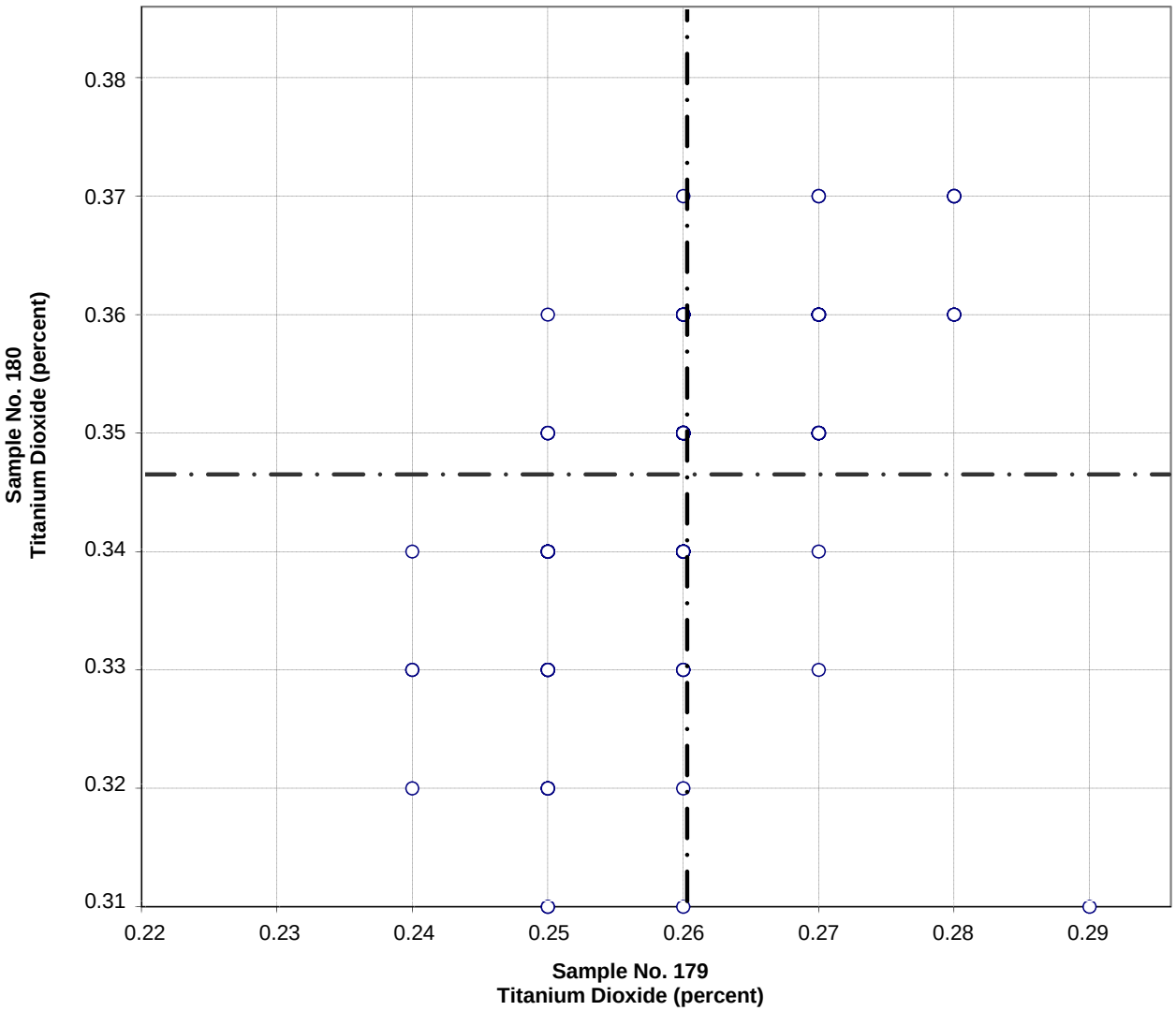

Test No. 100 Potassium Oxide 216 Points

Sample No. 179 Ave 0.457 S.D. 0.015 C.V. 3.4
Sample No. 180 Ave 0.367 S.D. 0.013 C.V. 3.6

Labs eliminated: 557, 736, 975, 124, 206, 1053, 2412, 3422, 3454, 3606

Labs off Diagram: 3607

**CCRL Proficiency Sample Program**
**Titanium Dioxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

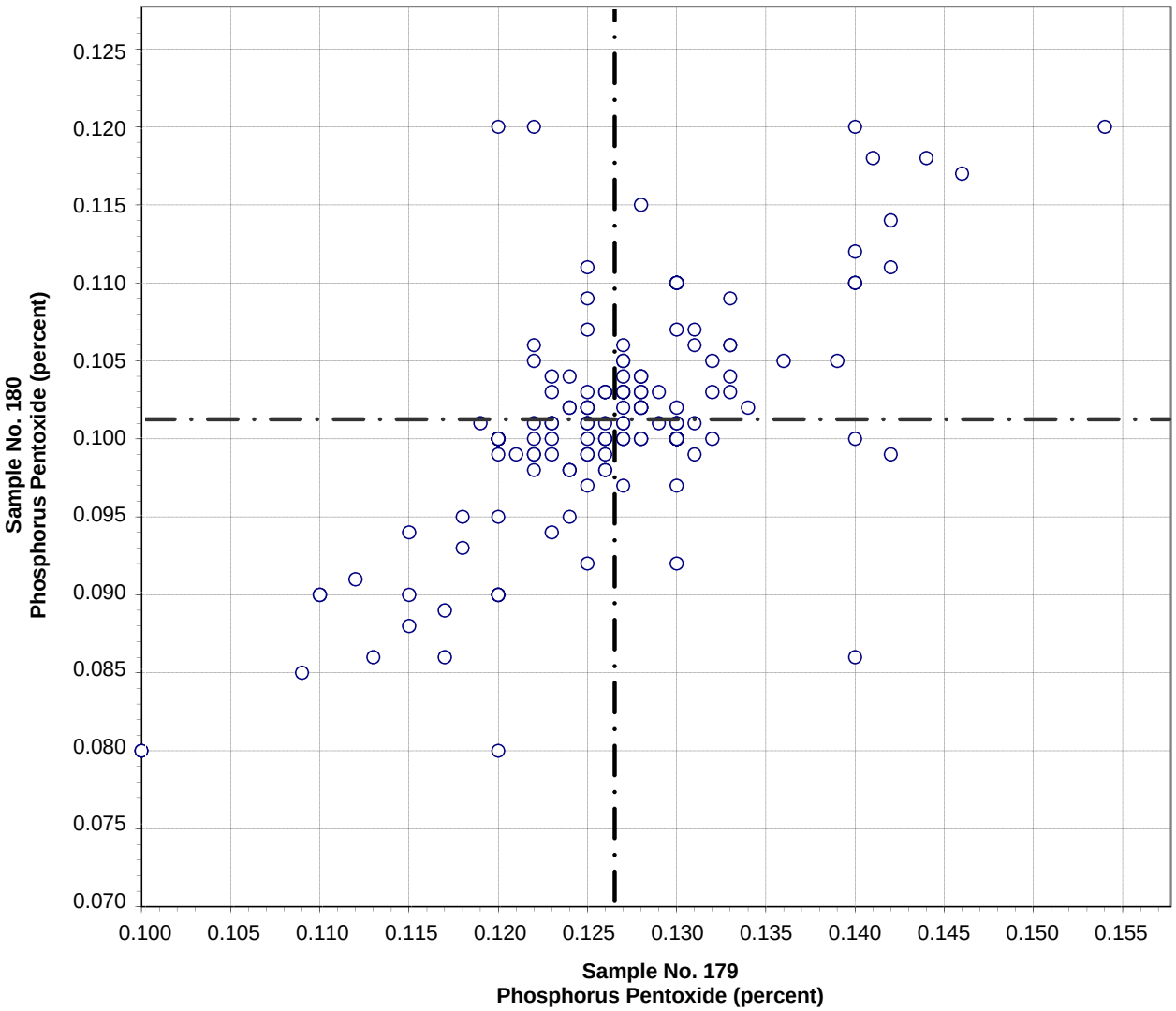



Test No. 103 Titanium Dioxide 180 Points

Sample No. 179 Ave 0.26 S.D. 0.009 C.V. 3.3
Sample No. 180 Ave 0.35 S.D. 0.012 C.V. 3.6

Labs eliminated: 736, 2296, 162, 494, 3057, 3368, 3454

**CCRL Proficiency Sample Program**
**Phosphorus Pentoxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

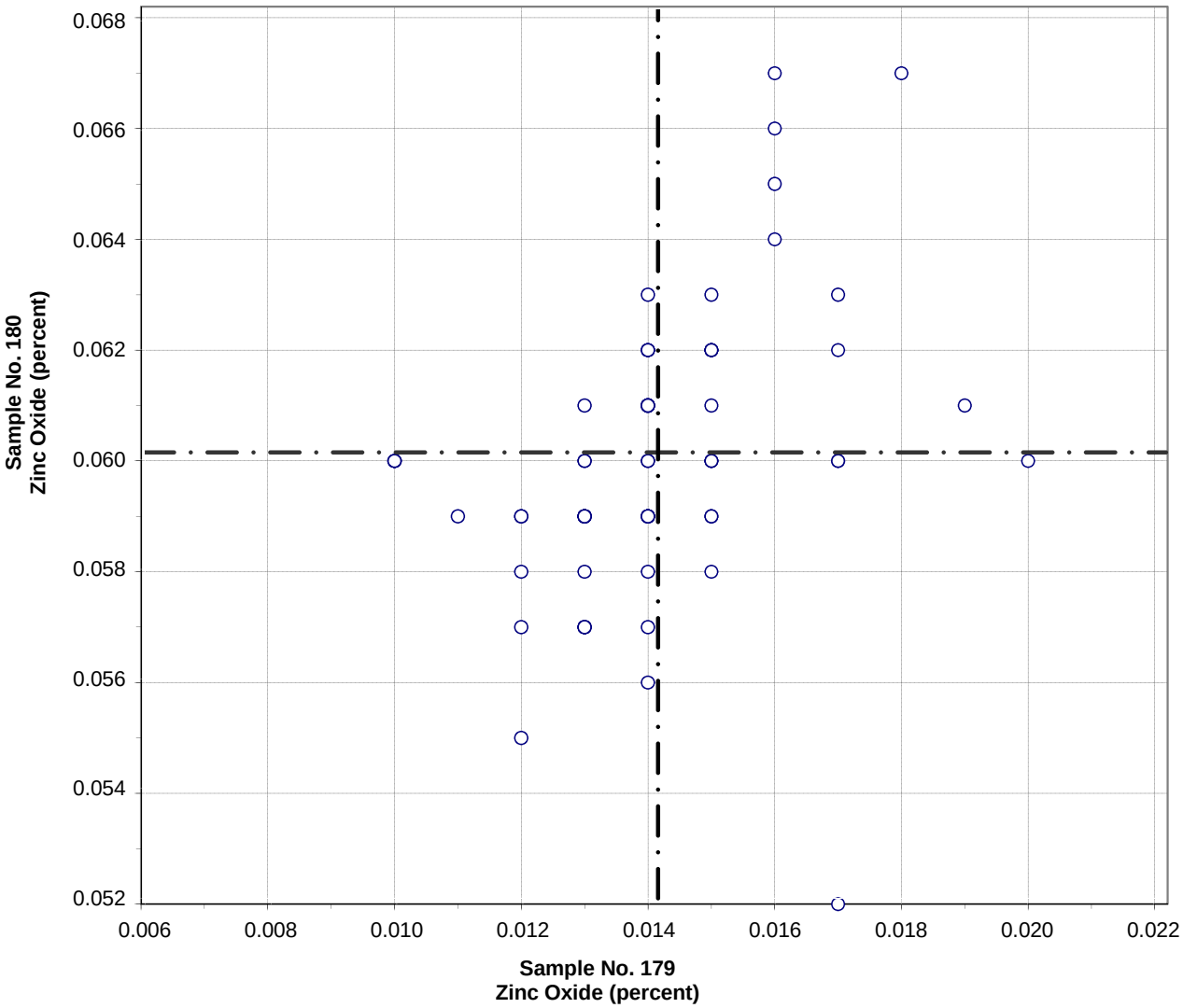



Test No. 102 Phosphorus Pentoxide 169 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.126 | S.D. | 0.008 | C.V. | 6.0 |
| Sample No. 180 | Ave | 0.101 | S.D. | 0.007 | C.V. | 7.0 |

Labs eliminated: 695, 66, 139, 696, 736, 3057, 4, 53, 493, 2484, 3454, 3577

**CCRL Proficiency Sample Program**
**Zinc Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

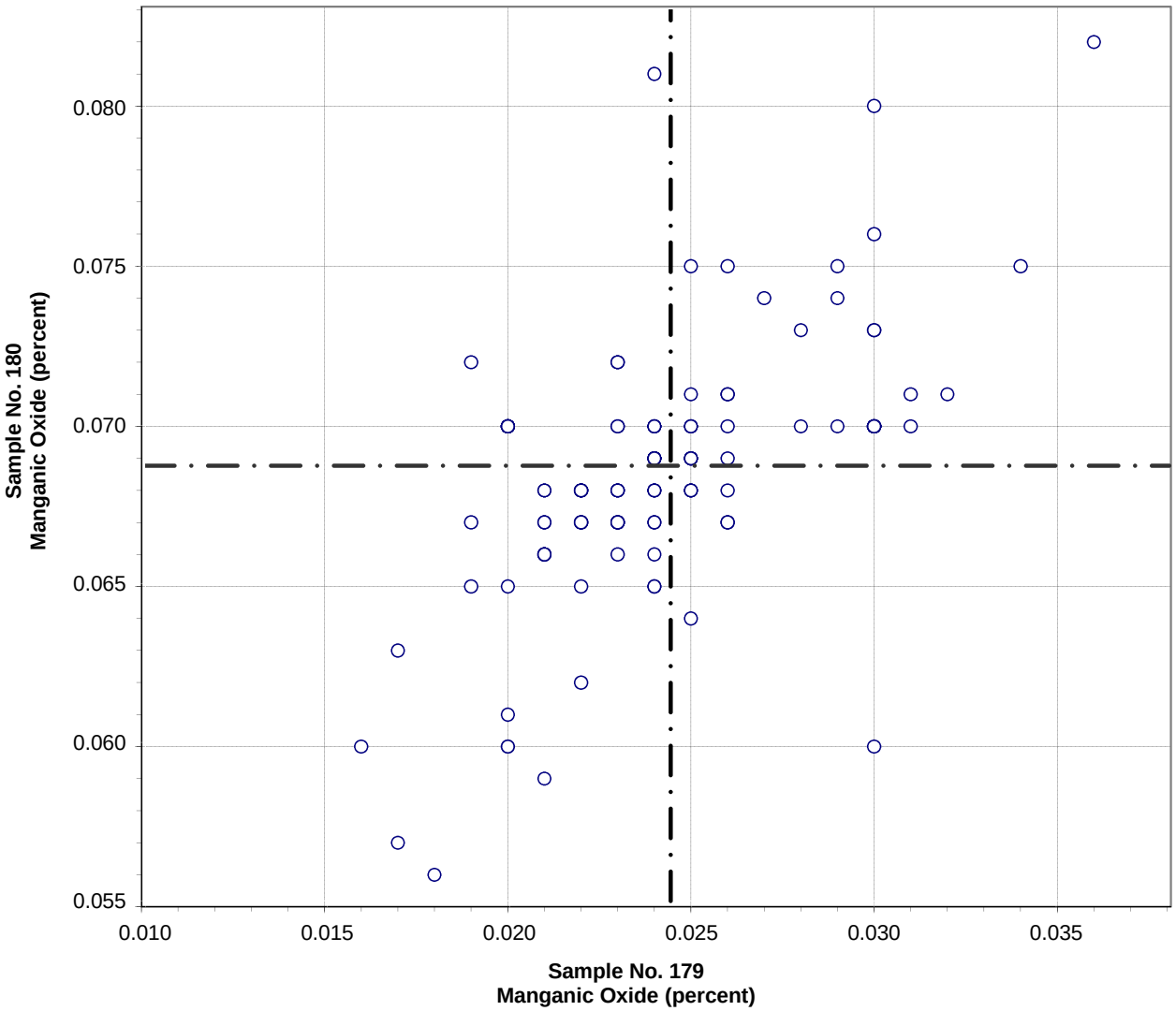



Test No. 99 Zinc Oxide 70 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.014 | S.D. | 0.002 | C.V. | 15 |
| Sample No. 180 | Ave | 0.060 | S.D. | 0.002 | C.V. | 4.1 |

Labs eliminated: 95, 408, 2483, 19, 206, 219, 407, 493, 54, 932, 3454, 3605

**CCRL Proficiency Sample Program**
**Manganic Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**



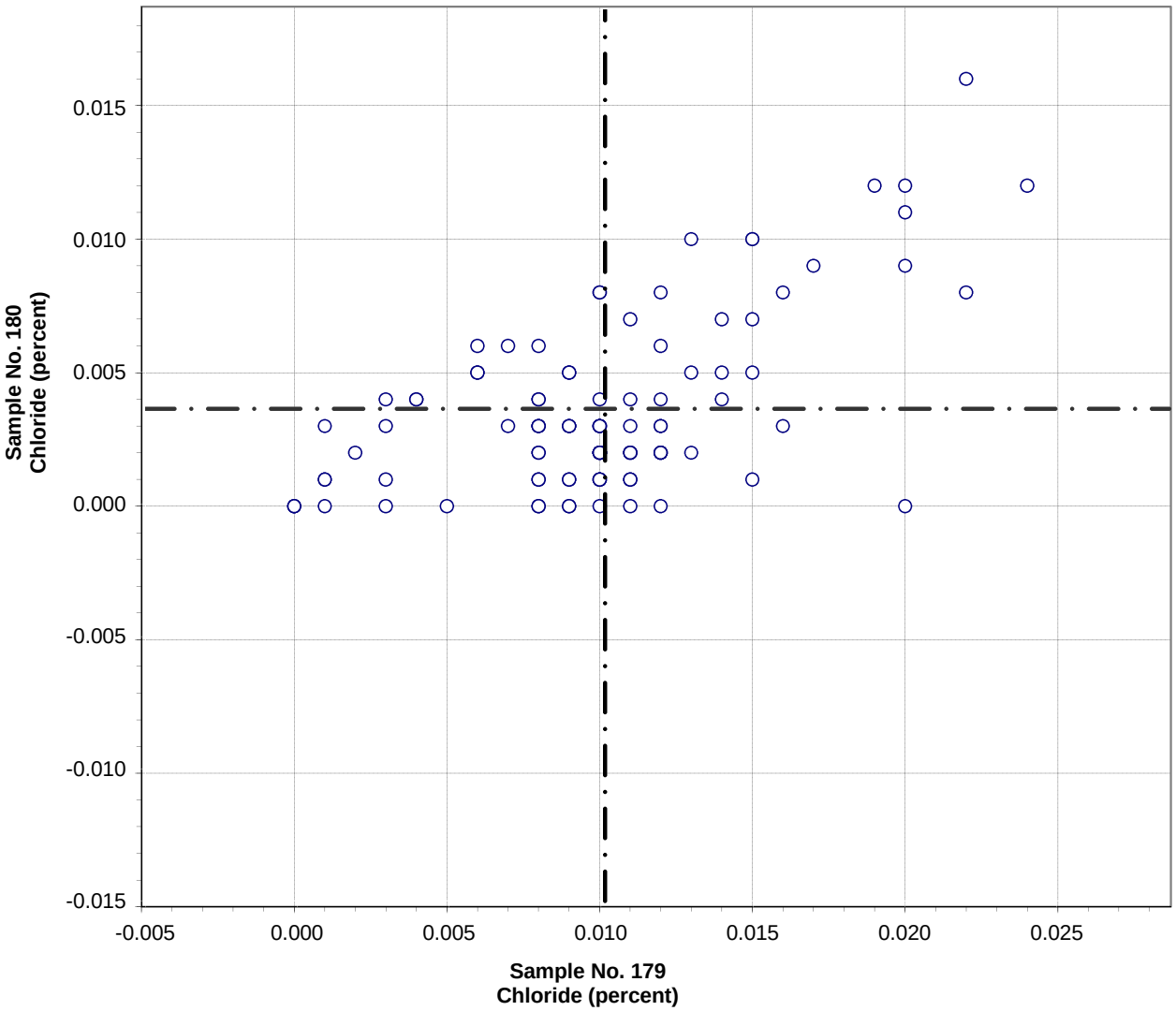

Test No. 101 Manganic Oxide 123 Points

Sample No. 179 Ave 0.024 S.D. 0.004 C.V. 17
Sample No. 180 Ave 0.069 S.D. 0.004 C.V. 5.9

Labs eliminated: 142, 247, 736, 2491, 11, 124, 162, 203, 205, 354, 457, 2462, 3454

Labs off Diagram: 209, 3368

**CCRL Proficiency Sample Program**
**Chloride**
**PORTLAND CEMENT Samples No. 179 and No. 180**

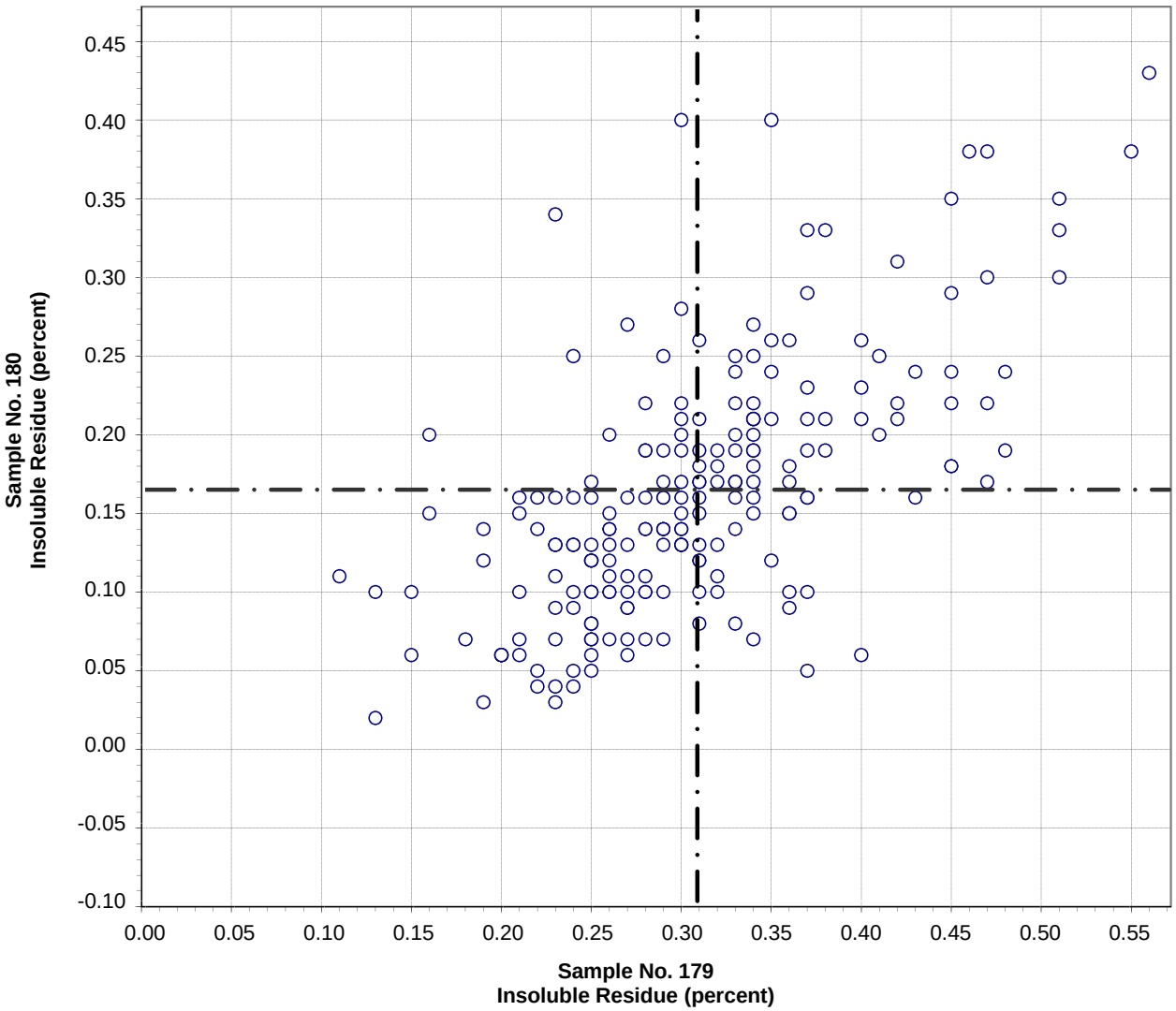



Test No. 104 Chloride 104 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.010 | S.D. | 0.005 | C.V. | 48 |
| Sample No. 180 | Ave | 0.004 | S.D. | 0.003 | C.V. | 90 |

Labs eliminated: 130, 142, 206, 1466, 158, 309, 768, 1594, 2482, 3057, 3422

**CCRL Proficiency Sample Program**
**Insoluble Residue**
**PORTLAND CEMENT Samples No. 179 and No. 180**

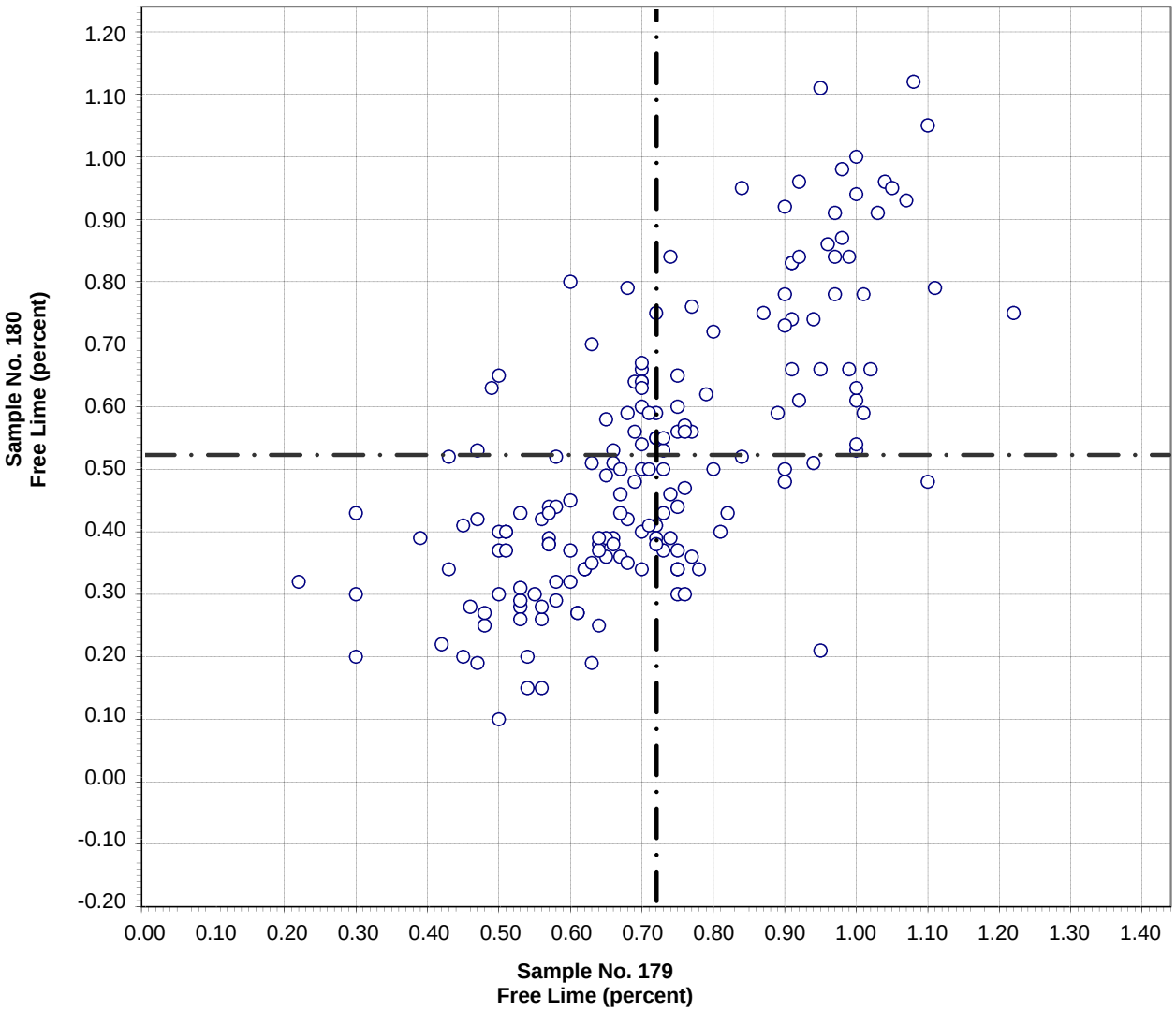



Test No. 80 Insoluble Residue 205 Points

Sample No. 179 Ave 0.31 S.D. 0.08 C.V. 26
Sample No. 180 Ave 0.16 S.D. 0.08 C.V. 49

Labs eliminated: 413, 491, 695, 696, 996, 2466, 56, 354, 450, 557, 1676, 2477, 2491, 3422

**CCRL Proficiency Sample Program**
**Free Lime**
**PORTLAND CEMENT Samples No. 179 and No. 180**

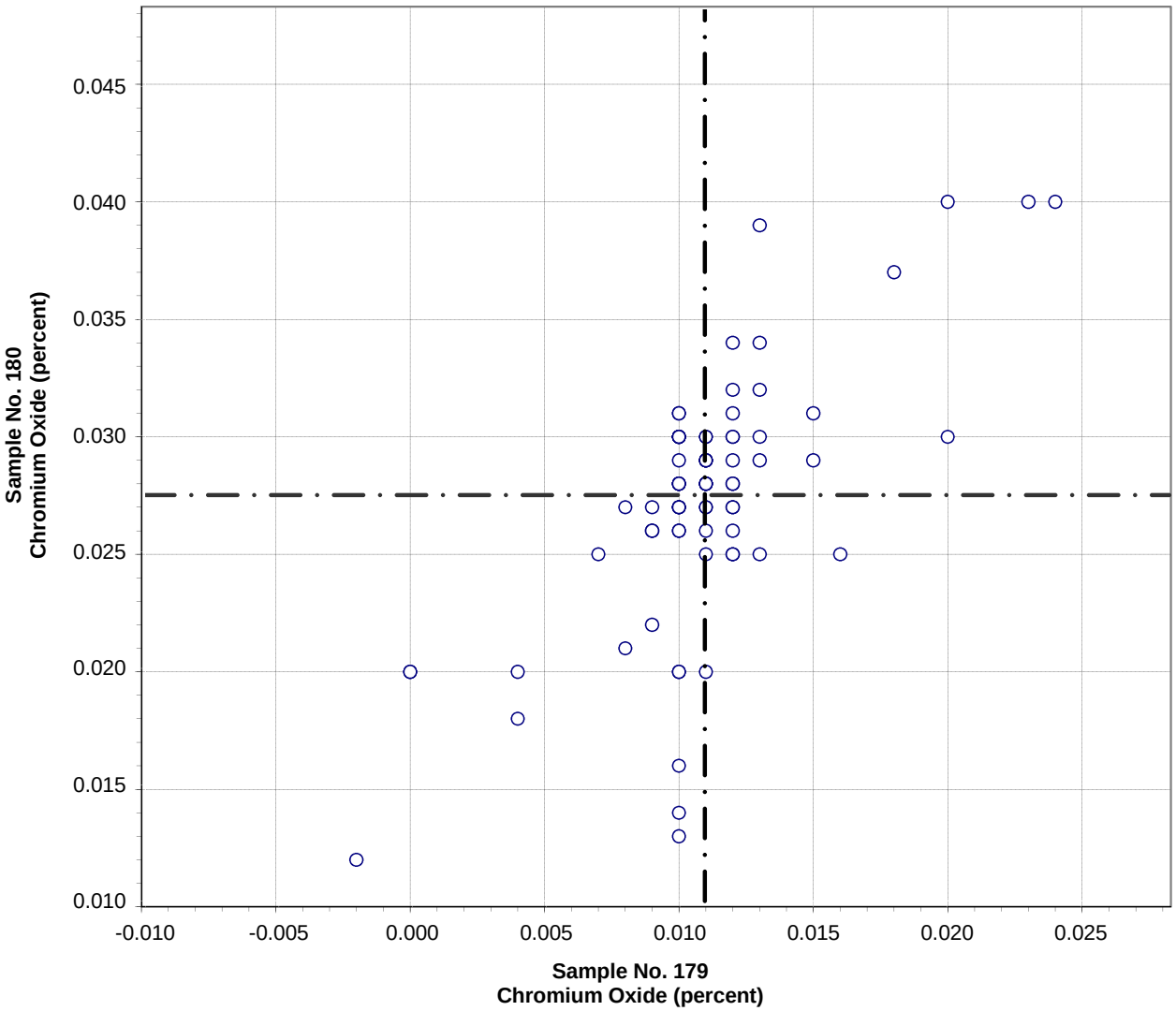



Test No. 41 Free Lime 177 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.72 | S.D. | 0.19 | C.V. | 26 |
| Sample No. 180 | Ave | 0.52 | S.D. | 0.22 | C.V. | 42 |

Labs eliminated: 221, 413, 557, 1676, 3249

**CCRL Proficiency Sample Program**
**Chromium Oxide**
**PORTLAND CEMENT Samples No. 179 and No. 180**

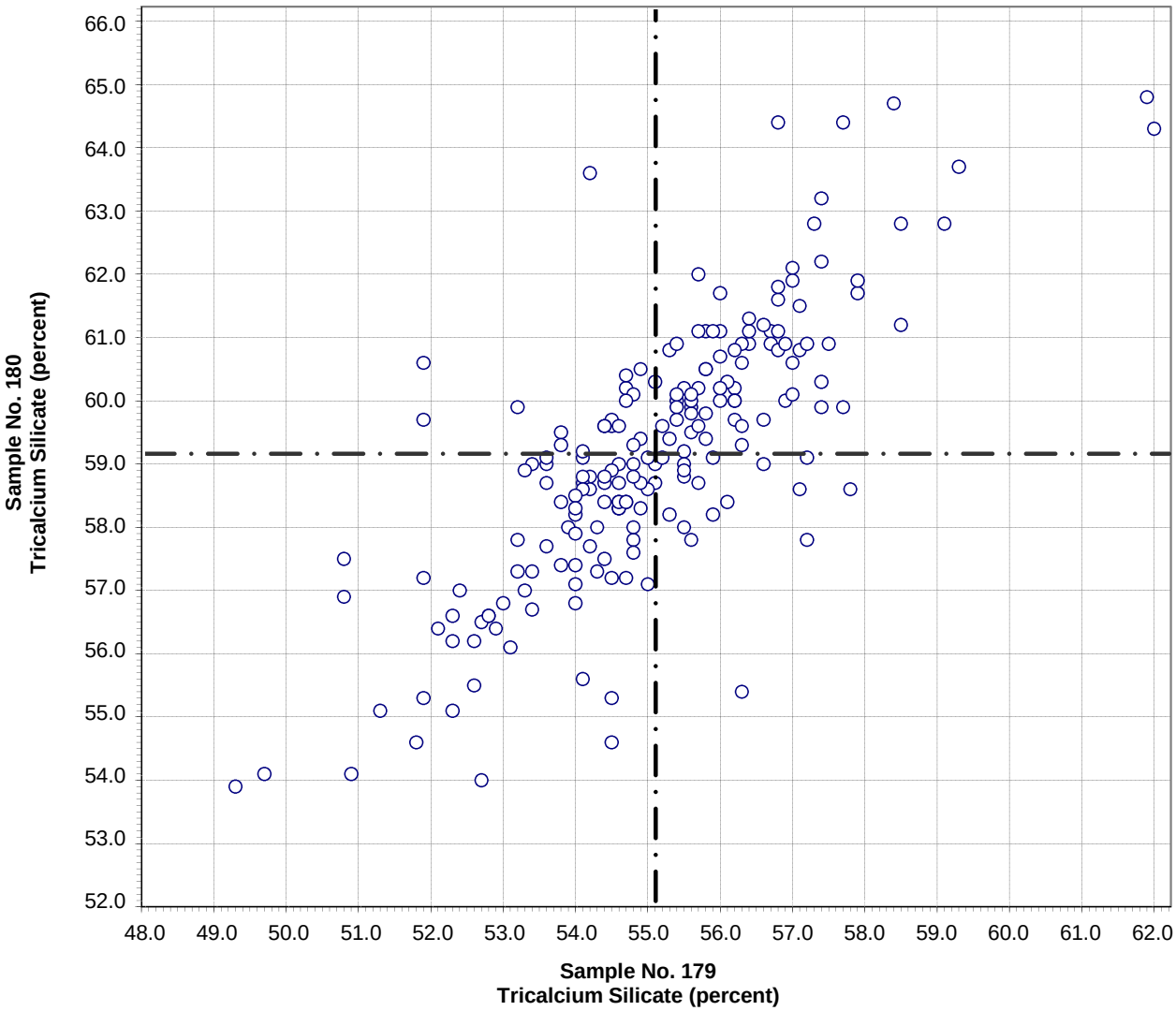



Test No. 105 Chromium Oxide 80 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.011 | S.D. | 0.004 | C.V. | 36 |
| Sample No. 180 | Ave | 0.027 | S.D. | 0.005 | C.V. | 20 |

Labs eliminated: 1676, 3233, 3454

## CCRL Proficiency Sample Program
## Tricalcium Silicate
## PORTLAND CEMENT Samples No. 179 and No. 180



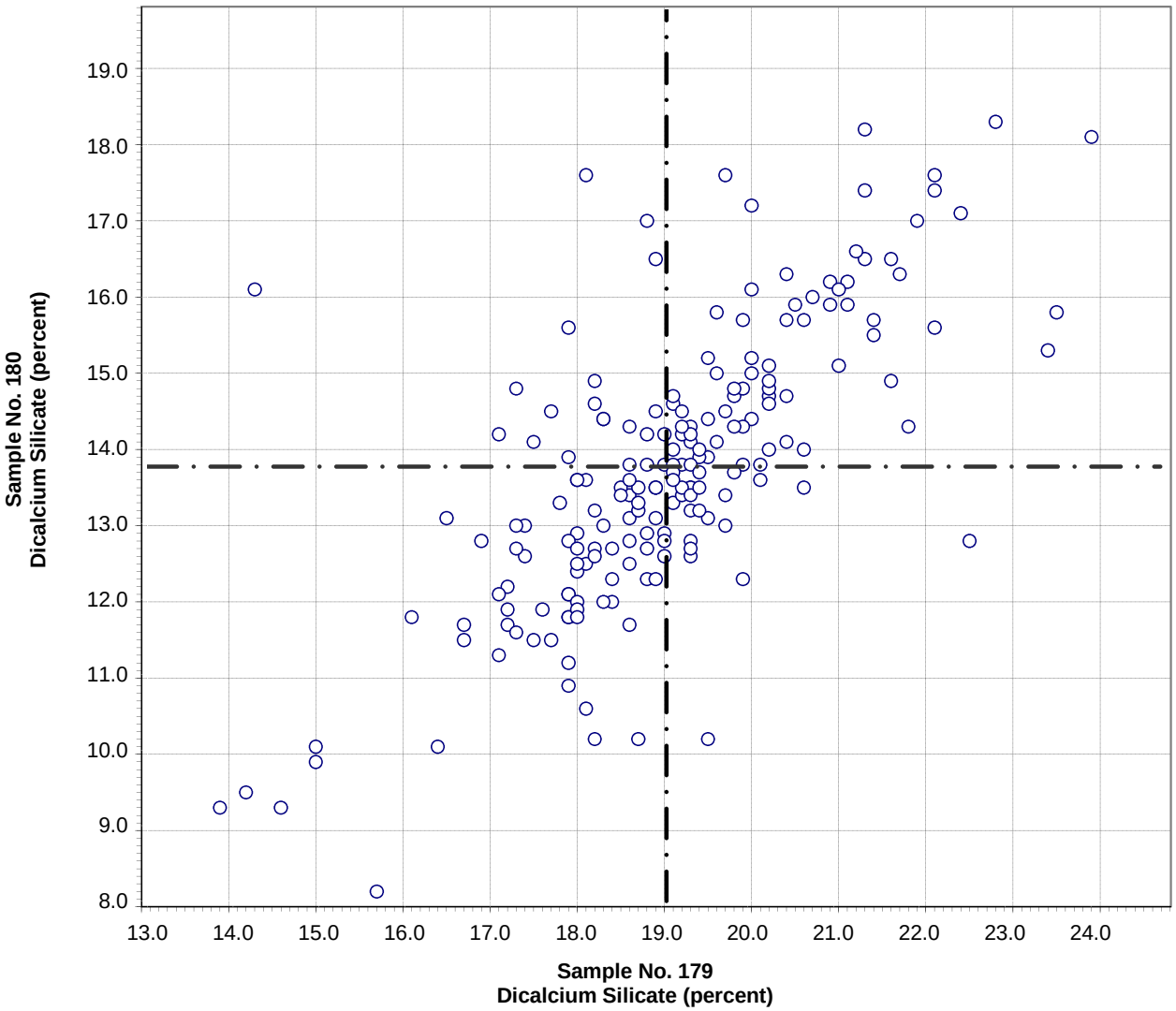

Test No. 106 Tricalcium Silicate 198 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 55.1 | S.D. | 2.0 | C.V. 3.6 |
| Sample No. 180 | Ave | 59.1 | S.D. | 2.2 | C.V. 3.7 |

Labs eliminated: 50, 695, 2296, 3454, 3577

Labs off Diagram: 53, 502

**CCRL Proficiency Sample Program**
**Dicalcium Silicate**
**PORTLAND CEMENT Samples No. 179 and No. 180**

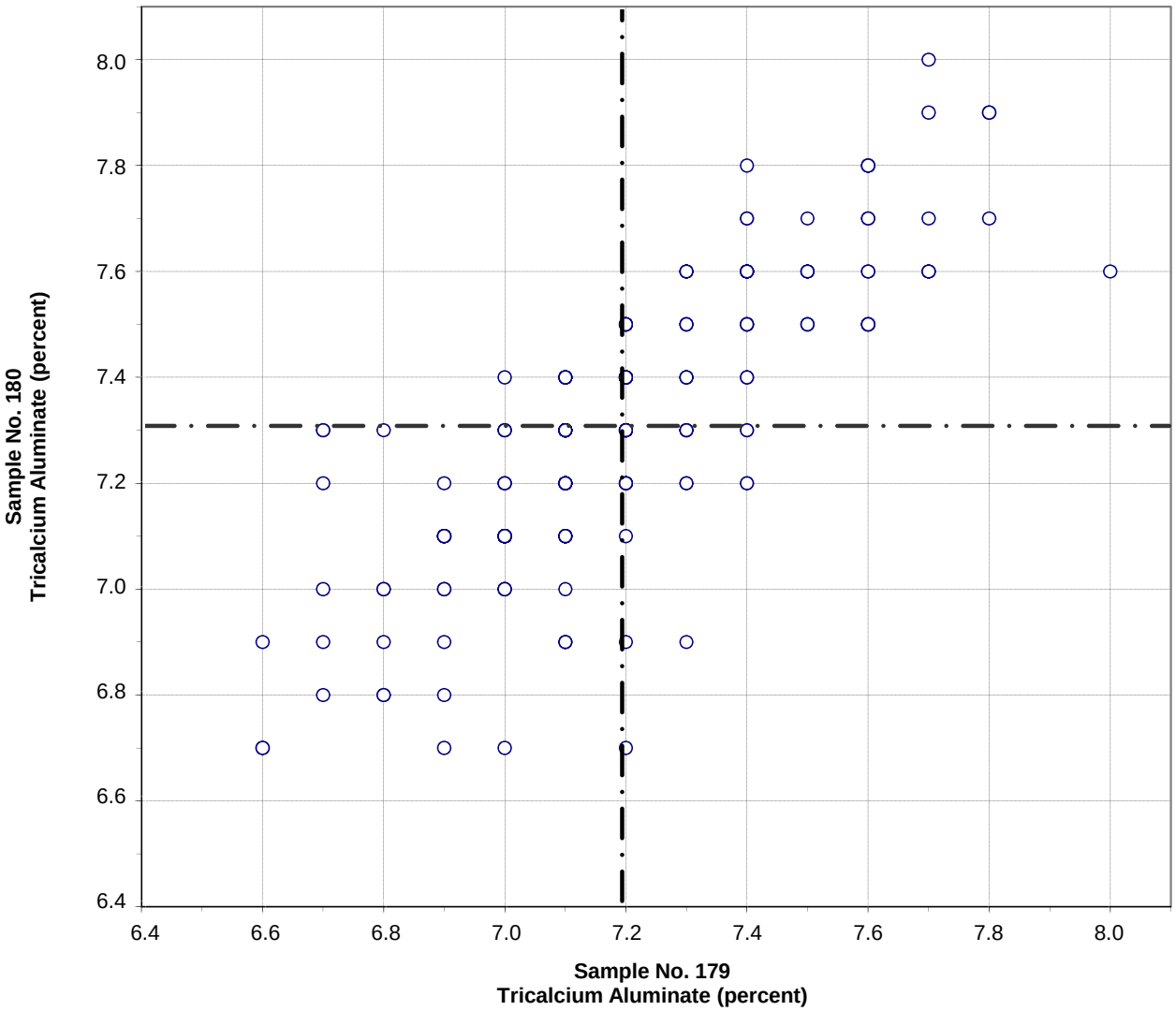



Test No. 107 Dicalcium Silicate 196 Points

Sample No. 179 Ave 19.1 S.D. 1.6 C.V. 8.6
Sample No. 180 Ave 13.8 S.D. 1.8 C.V. 13

Labs eliminated: 50, 502, 1799, 2296, 3454, 53, 284, 354, 695, 3577

**CCRL Proficiency Sample Program**
**Tricalcium Aluminate**
**PORTLAND CEMENT Samples No. 179 and No. 180**

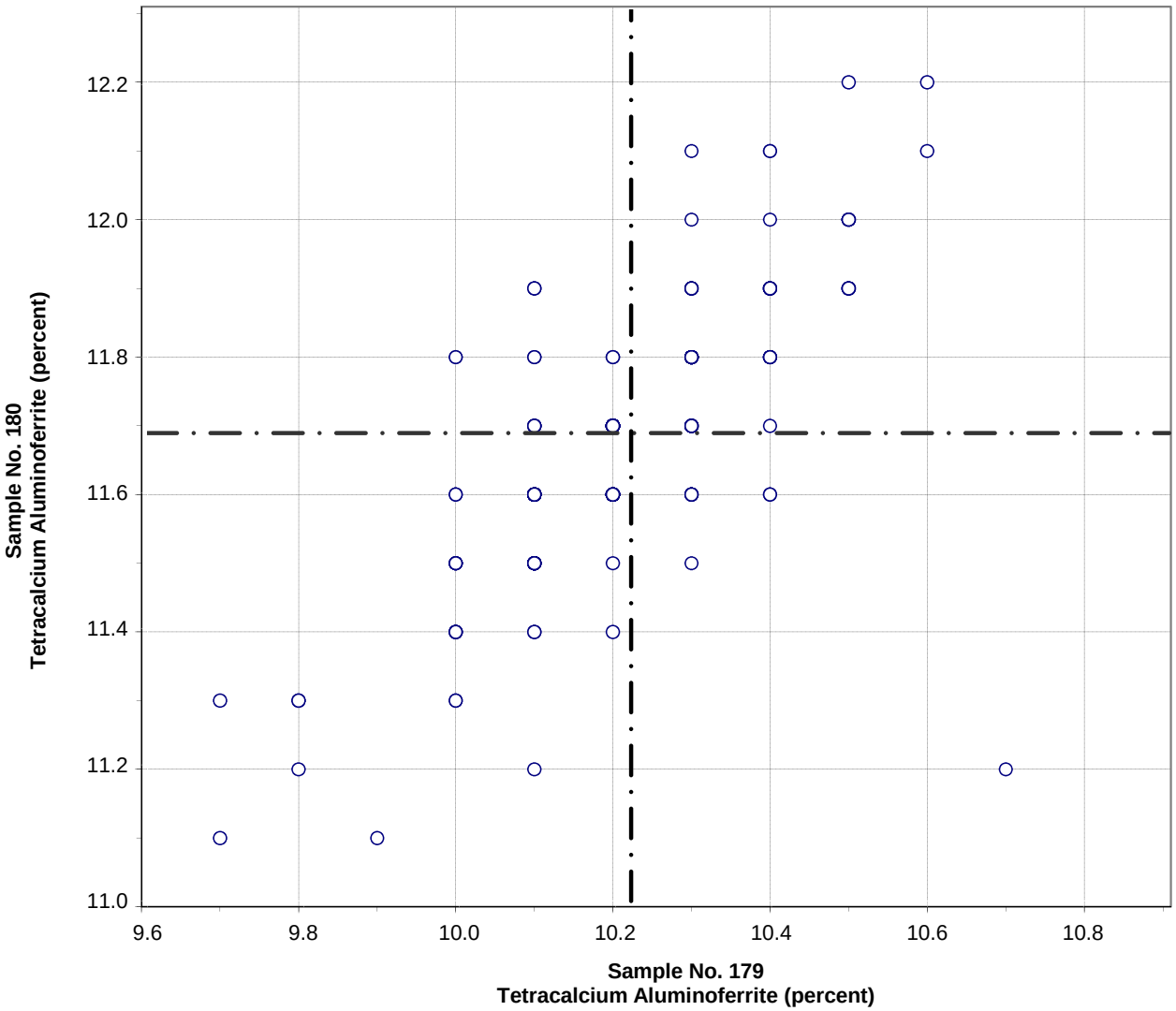



Test No. 108 Tricalcium Aluminate 201 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 7.2 | S.D. | 0.3 | C.V. 3.5 |
| Sample No. 180 | Ave | 7.3 | S.D. | 0.3 | C.V. 3.5 |

Labs eliminated: 206, 1799, 24, 151, 687, 736, 3606, 3607

**CCRL Proficiency Sample Program**
**Tetracalcium Aluminoferrite**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 109 Tetracalcium Aluminoferrite 203 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 10.2 | S.D. | 0.2 | C.V. | 1.5 |
| Sample No. 180 | Ave | 11.7 | S.D. | 0.2 | C.V. | 1.6 |

Labs eliminated: 159, 206, 407, 2463, 3454

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Physical Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| N.C. Water | % | 249 | 26.9 | 0.42 | 1.6 | 24.2 | 0.41 | 1.7 |
| N.C. Water | % | * 245 | 26.9 | 0.41 | 1.5 | 24.2 | 0.38 | 1.6 |
| Vicat TS Initial | min | 245 | 107 | 15 | 14 | 119 | 15 | 12 |
| Vicat TS Initial | min | * 238 | 105 | 12 | 11 | 118 | 13 | 11 |
| Vicat TS Final | min | 236 | 211 | 34 | 16 | 224 | 31 | 14 |
| Vicat TS Final | min | * 233 | 210 | 31 | 15 | 223 | 29 | 13 |
| Gilmore TS Initial | min | 149 | 143 | 24 | 16 | 150 | 26 | 18 |
| Gilmore TS Initial | min | * 147 | 142 | 21 | 15 | 149 | 25 | 17 |
| Gilmore TS Final | min | 148 | 240 | 34 | 14 | 252 | 34 | 13 |
| False Set | % | 191 | 84 | 8.4 | 9.9 | 61 | 13.2 | 22 |
| Autoclave Expan | % | 230 | -0.03 | 0.054 | 204 | -0.01 | 0.041 | 289 |
| Autoclave Expan | % | * 212 | -0.03 | 0.024 | 89 | -0.02 | 0.017 | 131 |

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

Normal Consistency 8 116 779 932

Vicat TS Initial 2 38 51 565 1483 3144 3422

Vicat TS Final 2 176 3605

Gillmore TS Initial 38 90

Autoclave Expansion 32 84 98 157 252 1054 1435 1466 3 51 222 438 2363 2466 2763 3057 3413 3577

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Physical Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| Air Content | % | 223 | 8.2 | 1.1 | 13 | 7.2 | 1.3 | 19 |
| Air Content | % | * 218 | 8.2 | 1.0 | 12 | 7.2 | 1.2 | 17 |
| AC Mix Water | % | 222 | 68.0 | 9.0 | 13 | 67.8 | 9.0 | 13 |
| AC Mix Water | % | * 214 | 69.3 | 2.1 | 3.1 | 69.0 | 2.2 | 3.2 |
| AC Flow | % | 221 | 88 | 4.0 | 4.6 | 86 | 4.3 | 5.0 |
| AC Flow | % | * 220 | 88 | 3.7 | 4.2 | 86 | 3.7 | 4.3 |
| Comp Str, 3 day | psi | 255 | 4128 | 370 | 9.0 | 3602 | 307 | 8.5 |
| Comp Str, 3 day | psi | * 247 | 4163 | 273 | 6.6 | 3618 | 238 | 6.6 |
| Comp Str, 7 day | psi | 255 | 5204 | 398 | 7.6 | 4809 | 375 | 7.8 |
| Comp Str, 7 day | psi | * 249 | 5226 | 319 | 6.1 | 4827 | 313 | 6.5 |
| Comp Str, 28 day | psi | 237 | 6741 | 450 | 6.7 | 6455 | 464 | 7.2 |
| Comp Str, 28 day | psi | * 235 | 6740 | 438 | 6.5 | 6453 | 437 | 6.8 |
| Comp Str, Flow | % | 227 | 112 | 11 | 9.6 | 114 | 11 | 10 |
| Comp Str, Flow | % | * 223 | 113 | 9 | 8.2 | 114 | 10 | 8.5 |

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

Air Content 39 47 975 1483 2490

Air Content Water 2 95 354 1079 12 47 2490 3422

Air Content Flow 142

Comp Strength - 3 day 37 52 667 736 1079 1435 1715 3511

Comp Strength - 7 day 37 49 103 1079 3422 3511

Comp Strength - 28 day 3422 3511

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Physical Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| **FINENESS** | | | | | | | | |
| Air Permeability | $m^2/kg$ | 251 | 434 | 16 | 3.8 | 390 | 14 | 3.7 |
| Air Permeability | $m^2/kg$ | * 233 | 435 | 10 | 2.2 | 389 | 9 | 2.3 |
| Wagner Turbidim | $m^2/kg$ | 9 | 232 | 14 | 6.0 | 206 | 11 | 5.2 |
| 45µm Sieve | % | 234 | 97.96 | 0.66 | 0.68 | 92.94 | 1.40 | 1.5 |
| 45µm Sieve | % | * 224 | 98.03 | 0.32 | 0.32 | 92.94 | 1.06 | 1.1 |
| **C1038 MORTAR BAR EXPANSION** | | | | | | | | |
| Mortar Expansion | % | 149 | 0.003 | 0.014 | 440 | 0.005 | 0.011 | 226 |
| Mortar Expansion | % | * 139 | 0.003 | 0.003 | 106 | 0.004 | 0.003 | 82 |
| Mortar Water | % | 146 | 242 | 13 | 5.2 | 240 | 13 | 5.3 |
| Mortar Water | % | * 142 | 241 | 5 | 2.2 | 239 | 6 | 2.3 |
| Mortar Flow | % | 147 | 109 | 6 | 5.6 | 110 | 6 | 5.8 |
| Mortar Flow | % | * 141 | 110 | 3 | 2.3 | 110 | 3 | 2.4 |

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

**FINENESS**

Air Permeability 4 6 49 175 207 413 1251 1956 8 46 51 958 1483 2295 2477 2982 3135 3621

45µm Sieve 29 207 413 2477 2482 17 51 501 2295 3422

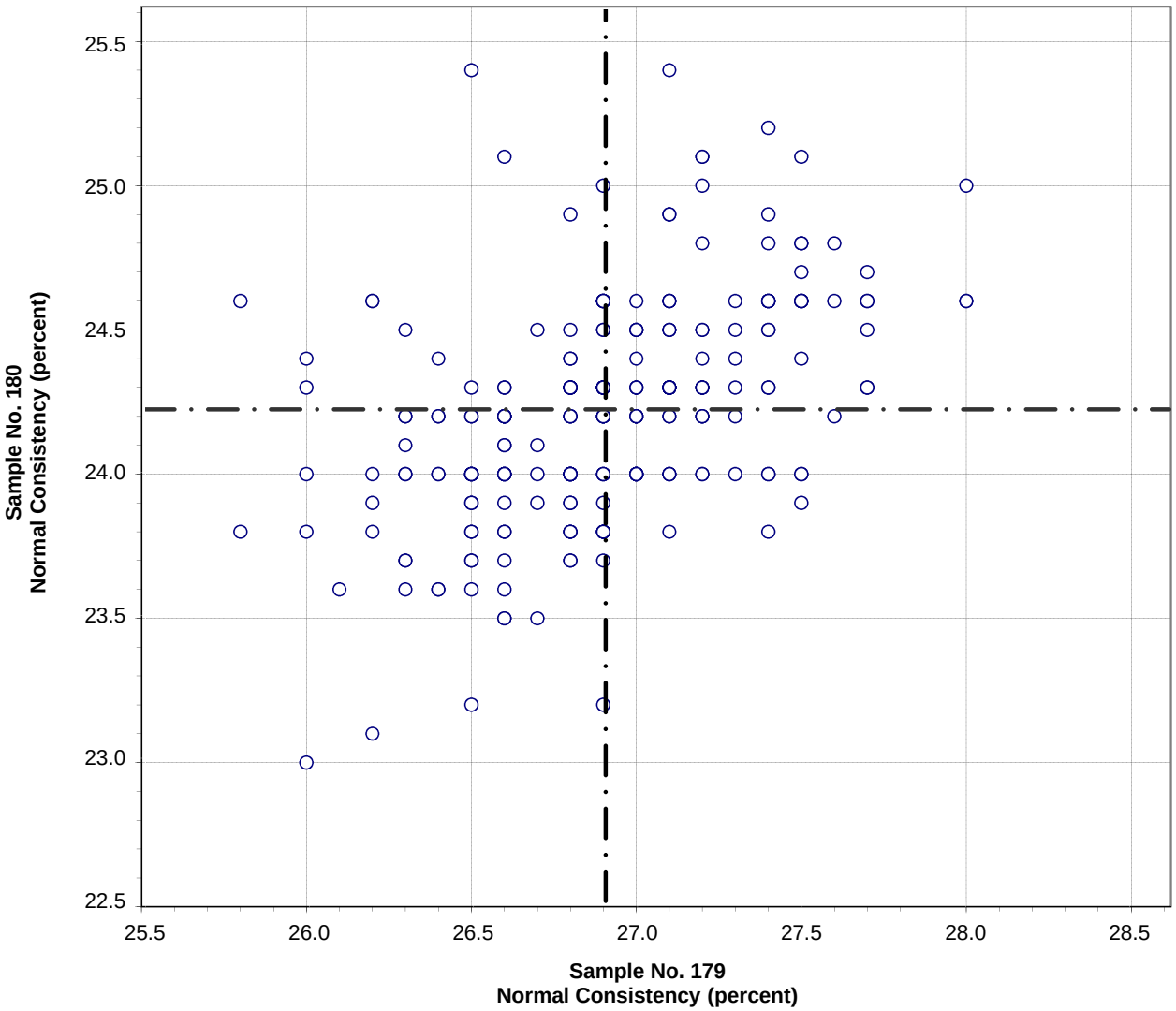
**C1038 MORTAR BAR EXPANSION**

Mortar Expansion 34 116 3057 49 51 157 205 2296 3413 3607

Mortar Water 49 611 3235 3607

Mortar Flow 56 134 203 46 3235 3368

**CCRL Proficiency Sample Program**
**Normal Consistency - % Water**
**PORTLAND CEMENT Samples No. 179 and No. 180**

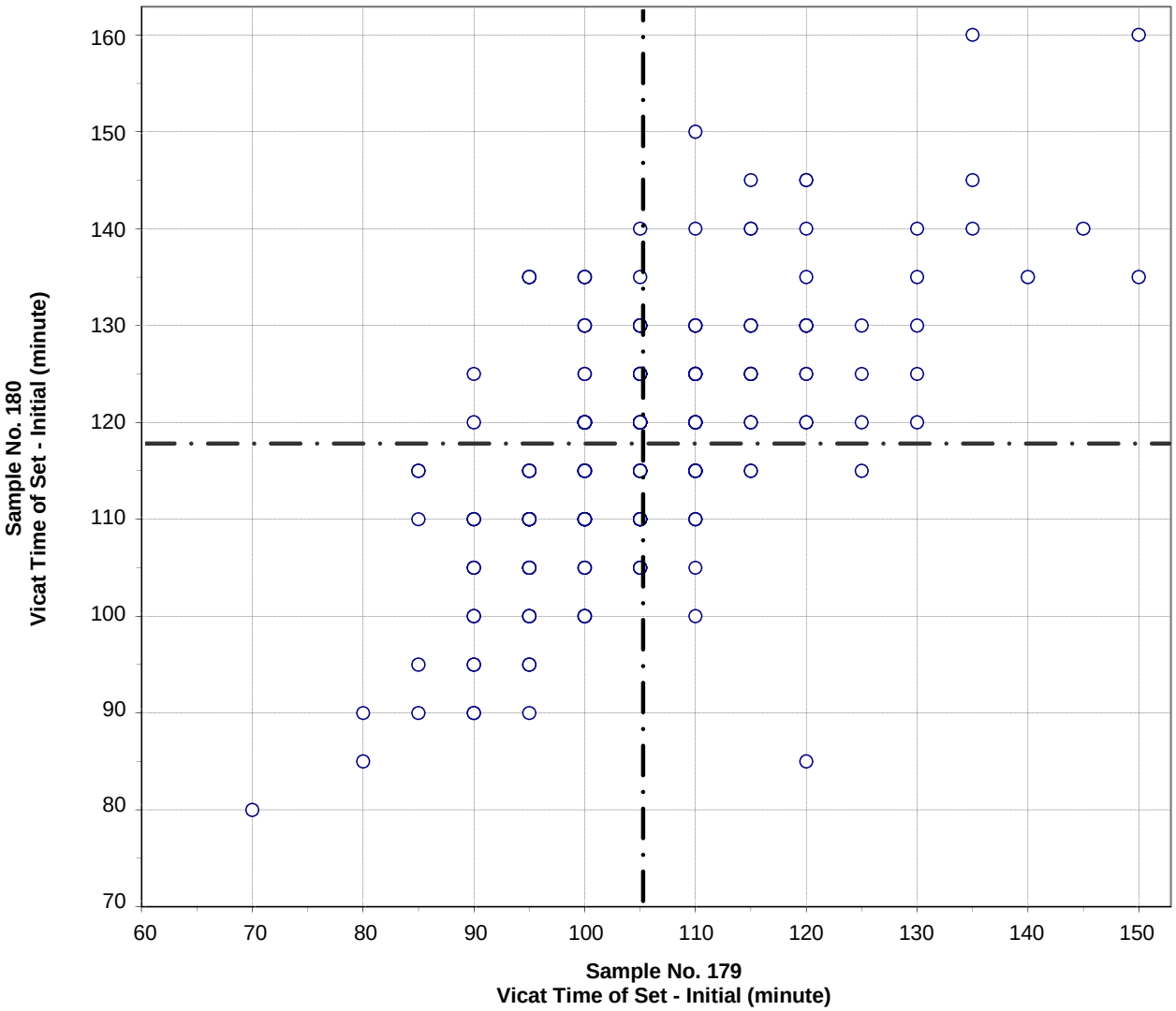



Test No. 110 Normal Consistency - % Water 245 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 26.9 | S.D. | 0.41 | C.V. | 1.5 |
| Sample No. 180 | Ave | 24.2 | S.D. | 0.38 | C.V. | 1.6 |

Labs eliminated: 8, 116, 779, 932

**CCRL Proficiency Sample Program**
**Vicat Time of Set - Initial**
**PORTLAND CEMENT Samples No. 179 and No. 180**

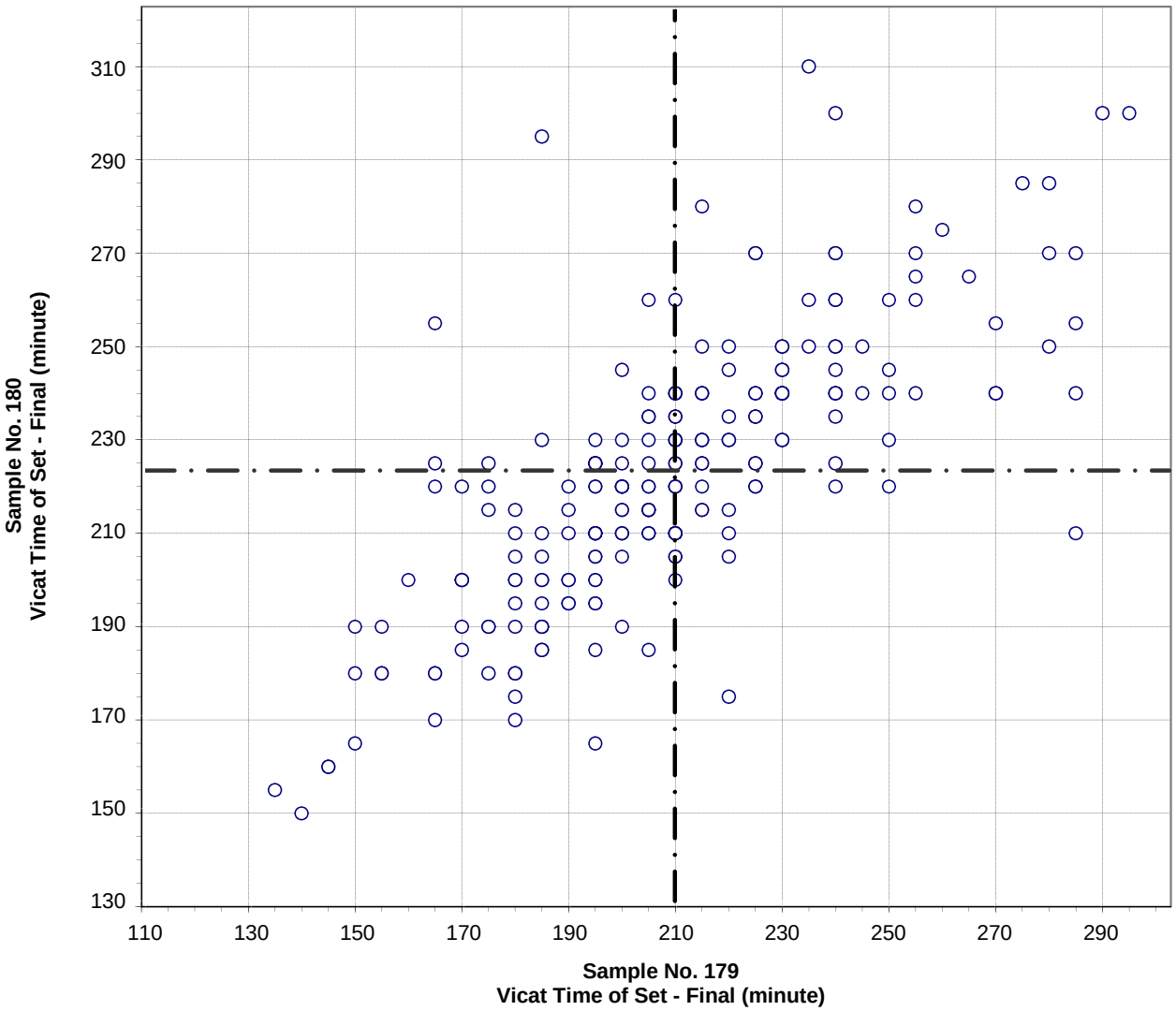



Test No. 120 Vicat Time of Set - Initial 238 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 105 | S.D. | 12 | C.V. | 11 |
| Sample No. 180 | Ave | 118 | S.D. | 13 | C.V. | 11 |

Labs eliminated: 2, 38, 51, 565, 1483, 3144, 3422

## CCRL Proficiency Sample Program
## Vicat Time of Set - Final
## PORTLAND CEMENT Samples No. 179 and No. 180



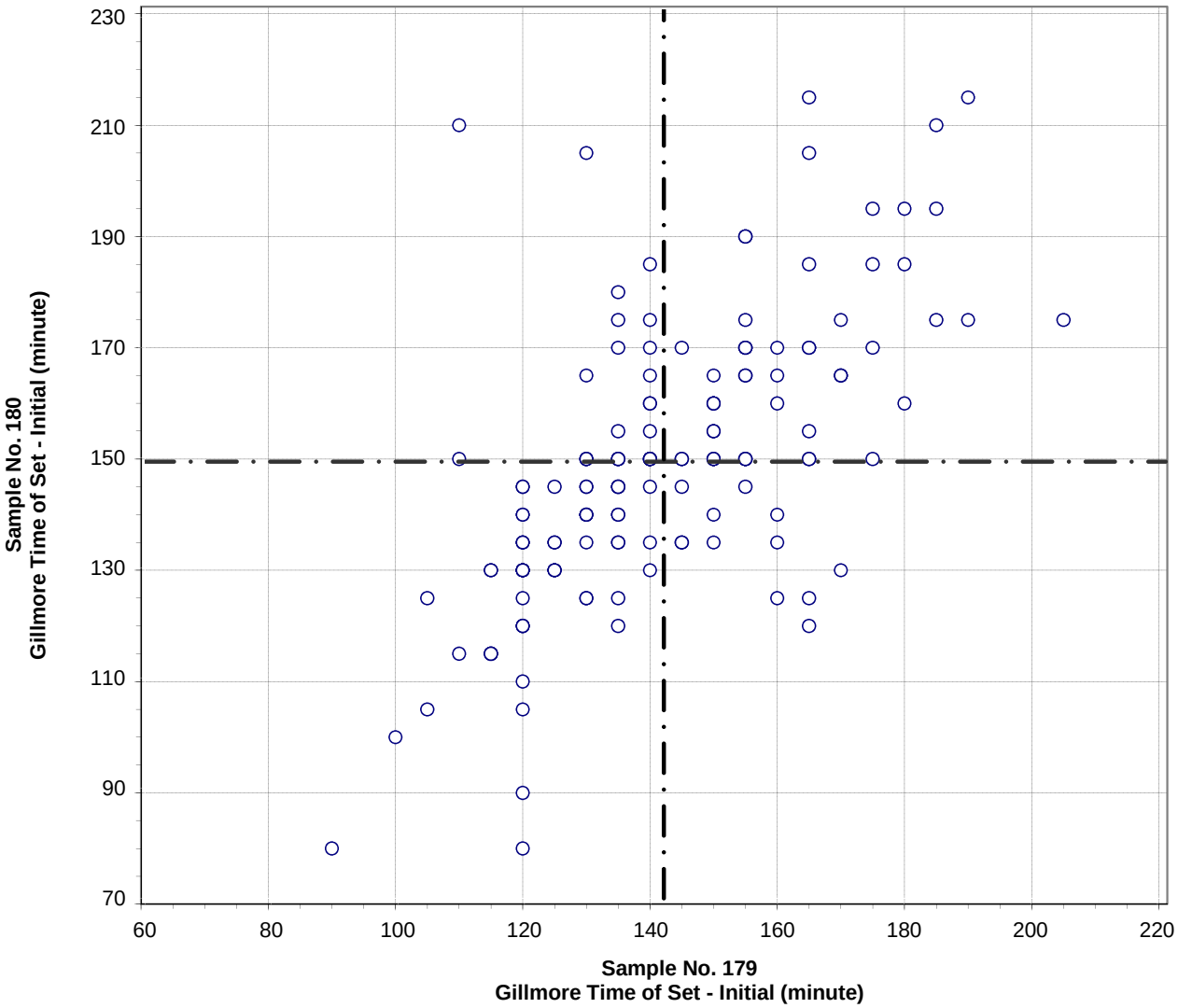

Test No. 121 Vicat Time of Set - Final 232 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 210 | S.D. | 31 | C.V. | 15 |
| Sample No. 180 | Ave | 223 | S.D. | 29 | C.V. | 13 |

Labs eliminated: 2, 176, 3605

Labs off Diagram: 29

## CCRL Proficiency Sample Program
## Gillmore Time of Set - Initial
## PORTLAND CEMENT Samples No. 179 and No. 180

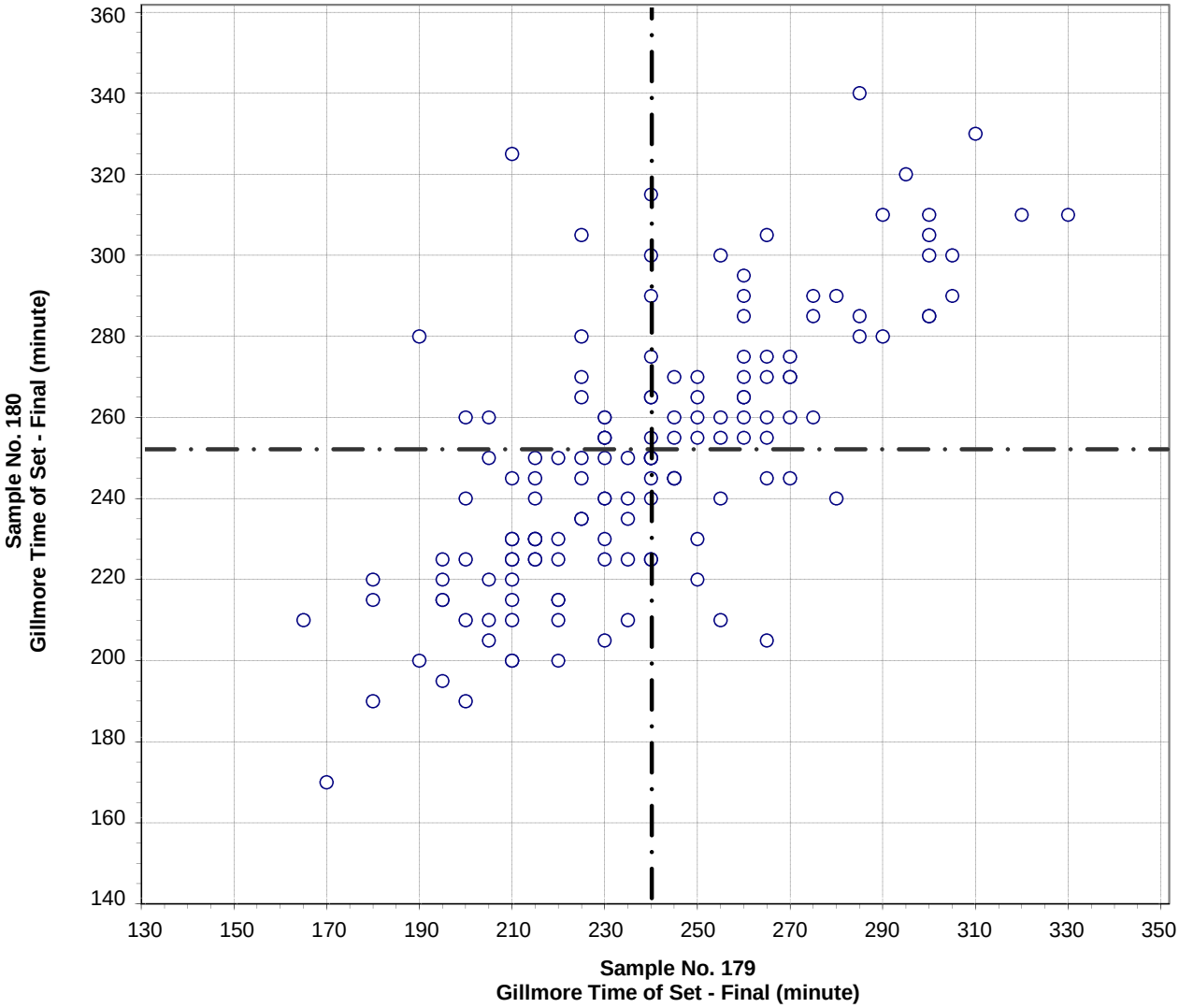



Test No. 130 Gillmore Time of Set - Initial 147 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 142 | S.D. | 21 | C.V. | 15 |
| Sample No. 180 | Ave | 149 | S.D. | 25 | C.V. | 17 |

Labs eliminated: 38, 90

**CCRL Proficiency Sample Program**
**Gillmore Time of Set - Final**
**PORTLAND CEMENT Samples No. 179 and No. 180**

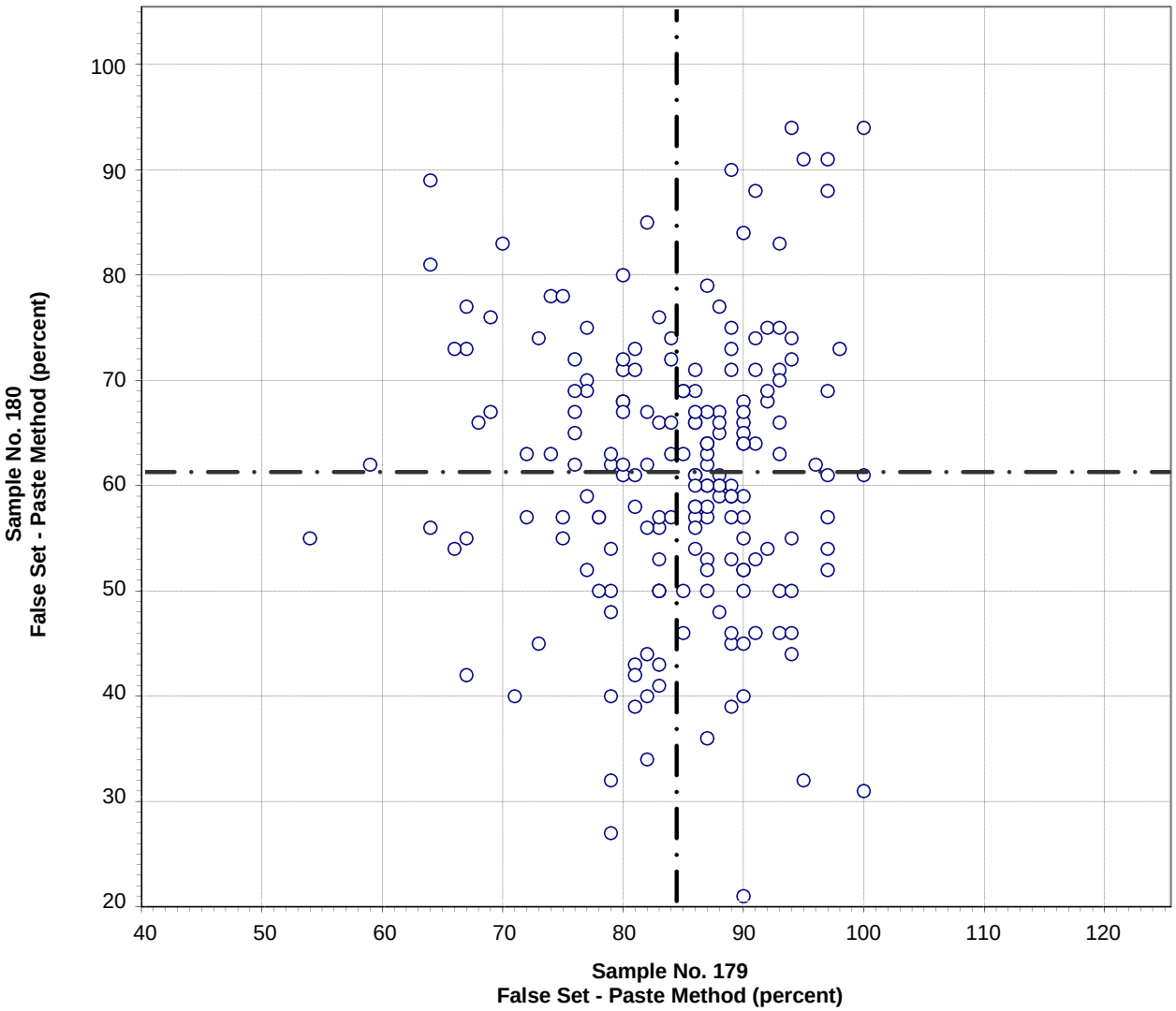



Test No. 140 Gillmore Time of Set - Final 147 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 240 | S.D. | 34 | C.V. | 14 |
| Sample No. 180 | Ave | 252 | S.D. | 34 | C.V. | 13 |

Labs off Diagram: 3605

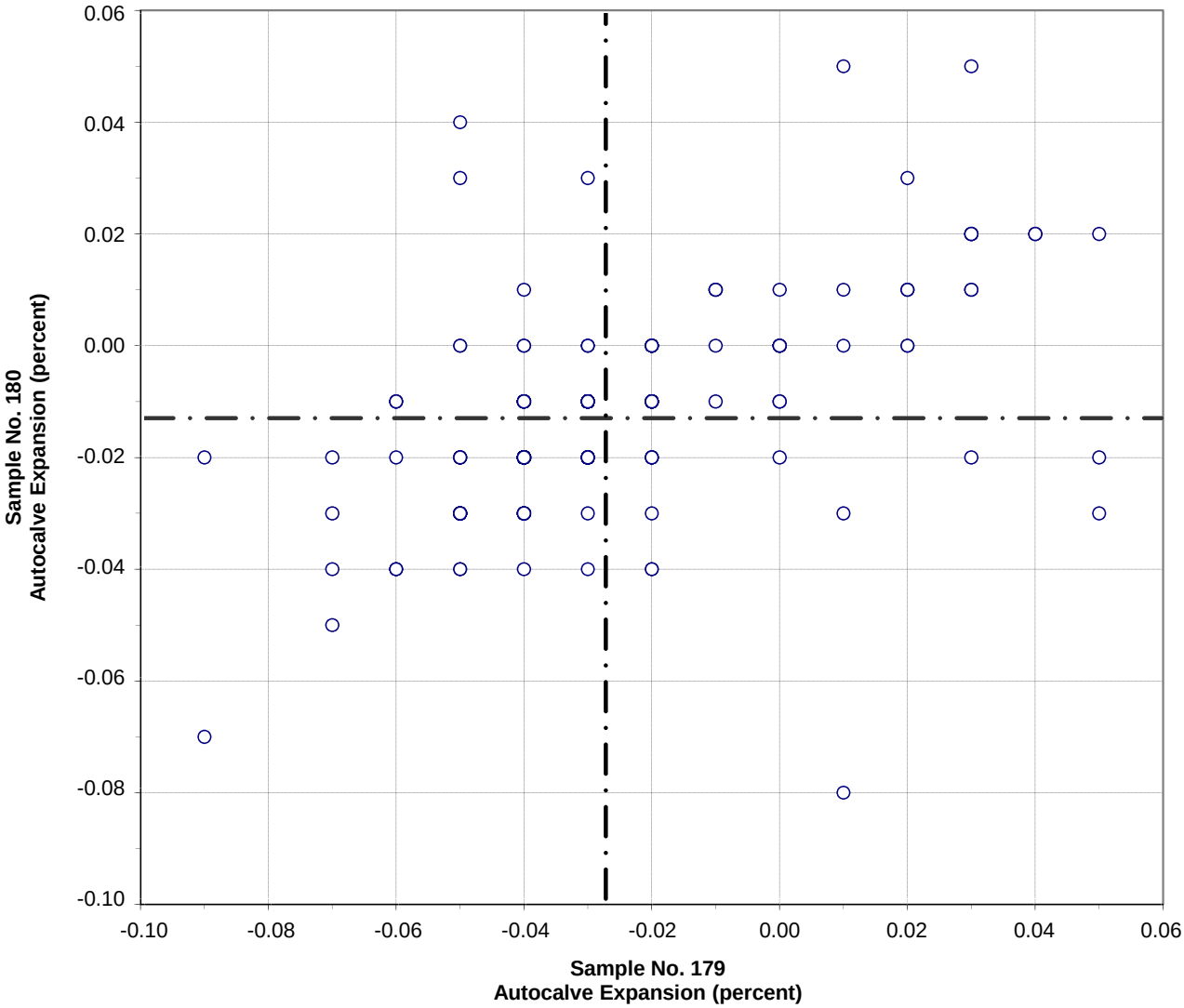
**CCRL Proficiency Sample Program**
**False Set - Paste Method**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 150 False Set - Paste Method 191 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 84 | S.D. | 8.4 | C.V. 9.9 |
| Sample No. 180 | Ave | 61 | S.D. | 13.2 | C.V. 22 |

**CCRL Proficiency Sample Program**
**Autoclave Expansion**
**PORTLAND CEMENT Samples No. 179 and No. 180**

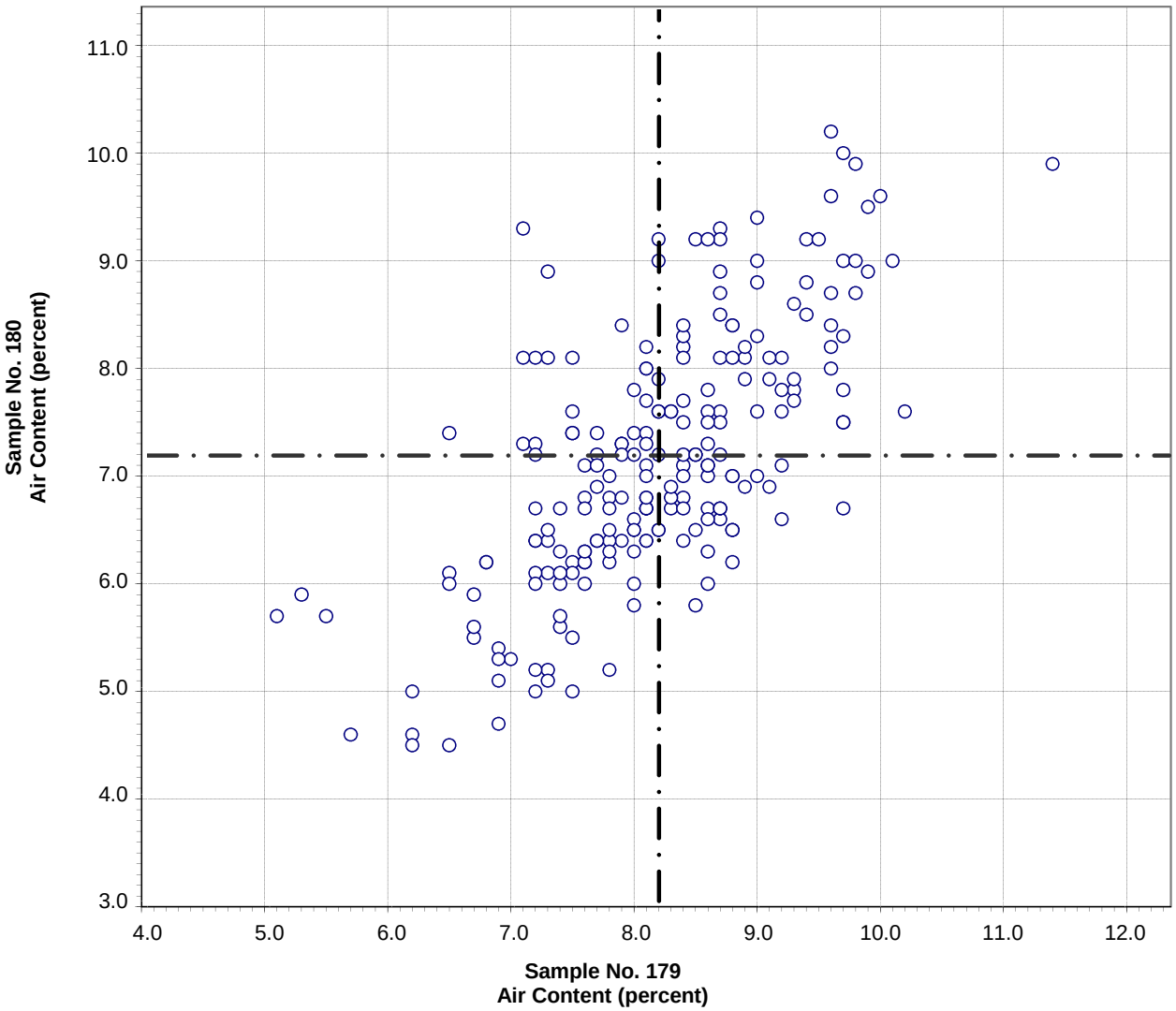



Test No. 160 Autoclave Expansion 212 Points

| | | | | |
|---|---|---|---|---|
| Sample No. 179 | Ave -0.03 | S.D. 0.024 | C.V. -89 |
| Sample No. 180 | Ave -0.02 | S.D. 0.017 | C.V. -131 |

Labs eliminated: 32, 84, 98, 157, 252, 1054, 1435, 1466, 3, 51, 222, 438, 2363, 2466, 2763, 3057, 3413, 3577

**CCRL Proficiency Sample Program**
**Air Content %**
**PORTLAND CEMENT Samples No. 179 and No. 180**

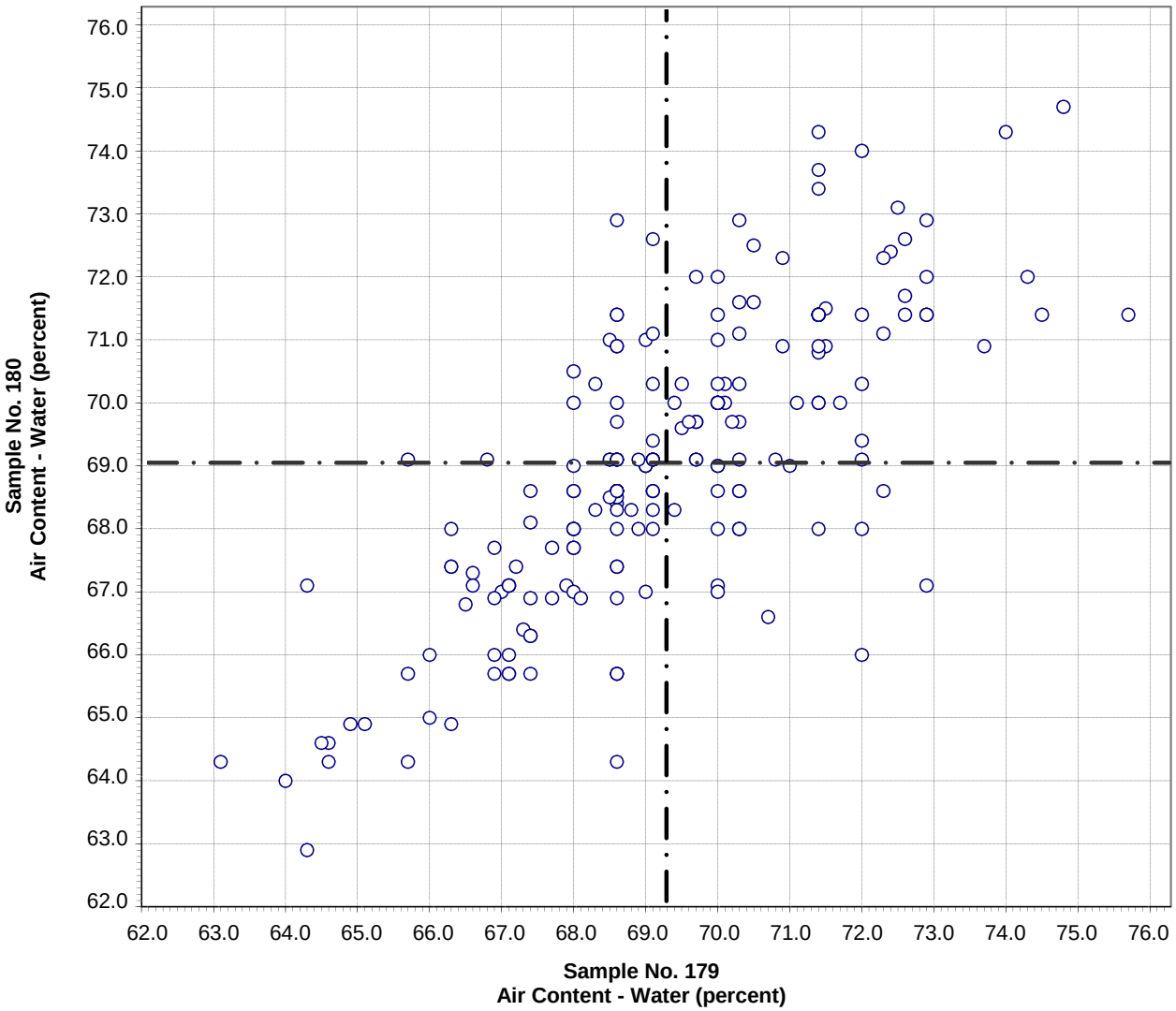



Test No. 170 Air Content % 218 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 8.2 | S.D. | 1.0 | C.V. 12 |
| Sample No. 180 | Ave | 7.2 | S.D. | 1.2 | C.V. 17 |

Labs eliminated: 39, 47, 975, 1483, 2490

**CCRL Proficiency Sample Program**
**Air Content - % Water**
**PORTLAND CEMENT Samples No. 179 and No. 180**

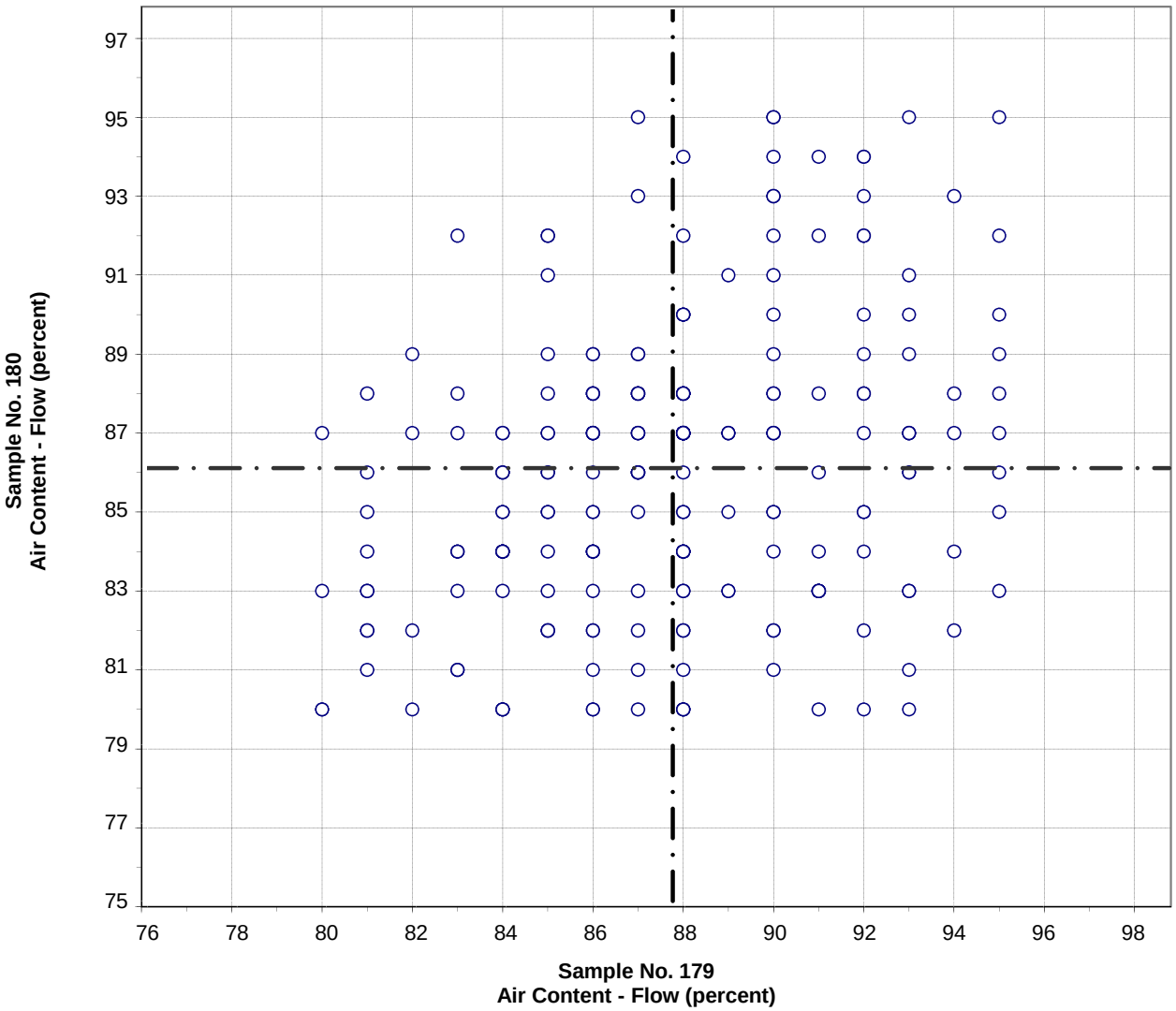



Test No. 180 Air Content - % Water 214 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 69.3 | S.D. | 2.1 | C.V. 3.1 |
| Sample No. 180 | Ave | 69.0 | S.D. | 2.2 | C.V. 3.2 |

Labs eliminated: 2, 95, 354, 1079, 12, 47, 2490, 3422

**CCRL Proficiency Sample Program**
**Air Content - Flow**
**PORTLAND CEMENT Samples No. 179 and No. 180**

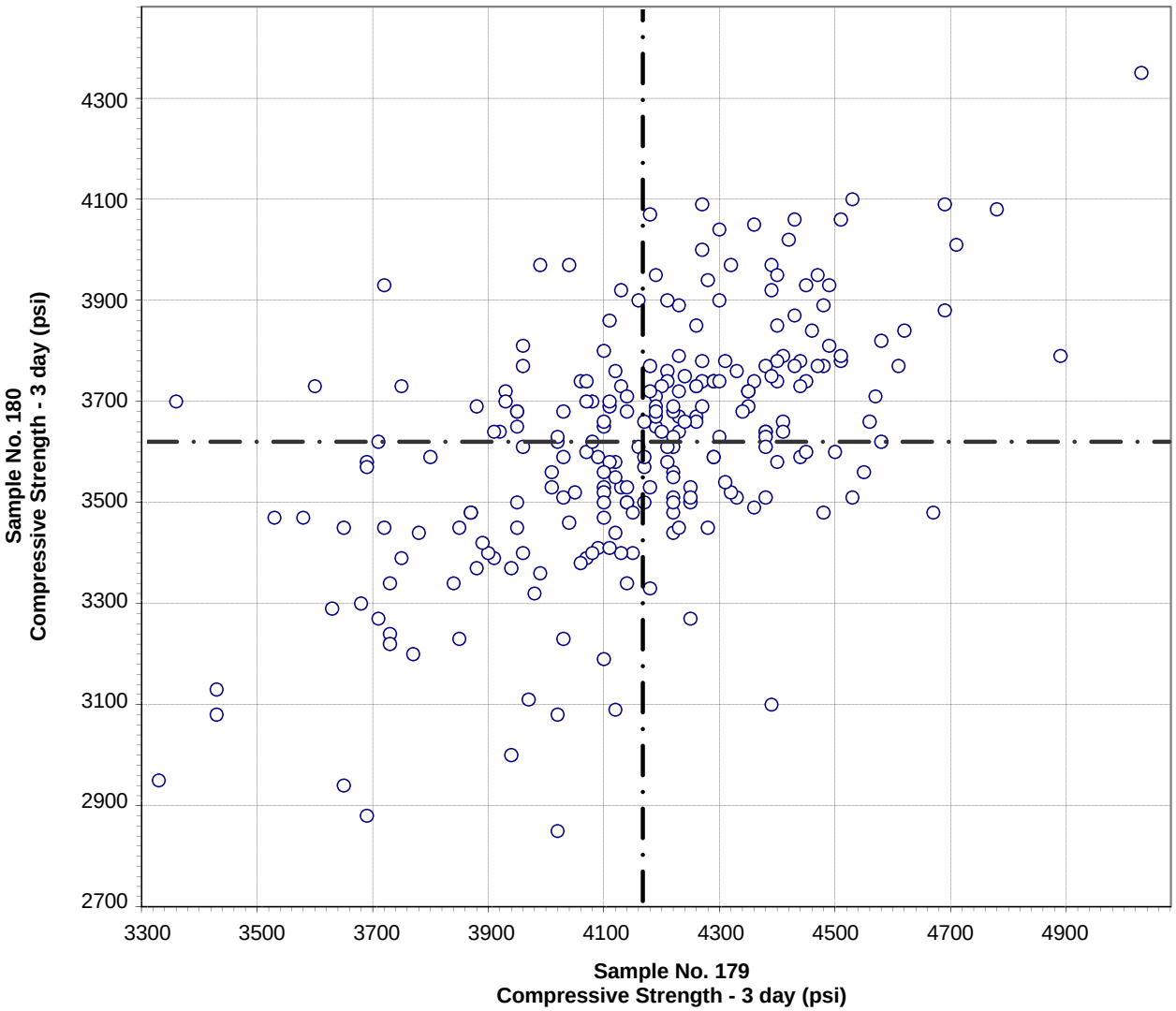



Test No. 190 Air Content - Flow 220 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 88 | S.D. | 3.7 | C.V. | 4.2 |
| Sample No. 180 | Ave | 86 | S.D. | 3.7 | C.V. | 4.3 |

Labs eliminated: 142

**CCRL Proficiency Sample Program**
**Compressive Strength - 3 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**



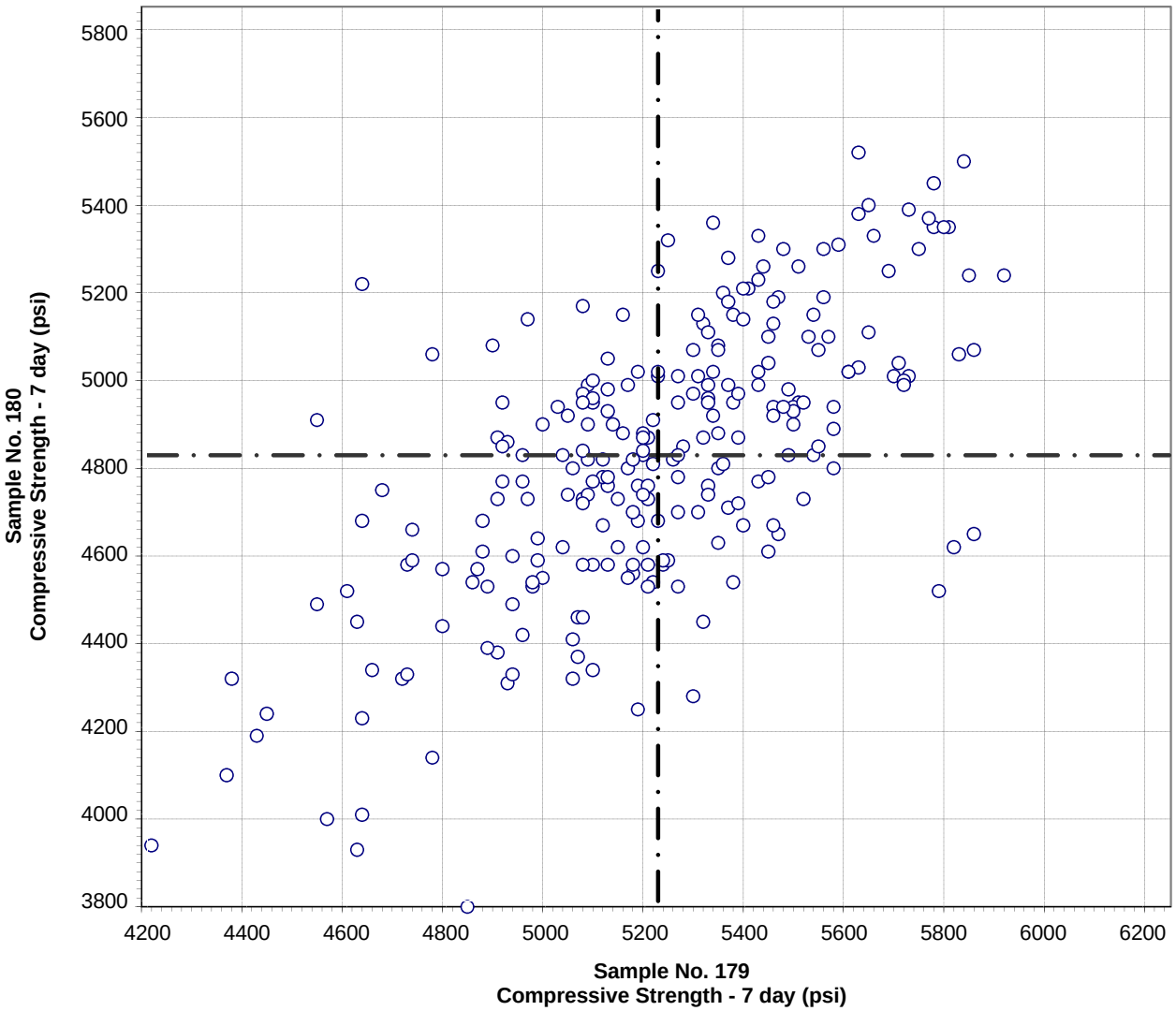

Test No. 200 Compressive Strength - 3 day 246 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 4163 | S.D. | 273 | C.V. | 6.6 |
| Sample No. 180 | Ave | 3618 | S.D. | 238 | C.V. | 6.6 |

Labs eliminated: 37, 52, 667, 736, 1079, 1435, 1715, 3511

Labs off Diagram: 103

## CCRL Proficiency Sample Program
## Compressive Strength - 7 day
## PORTLAND CEMENT Samples No. 179 and No. 180

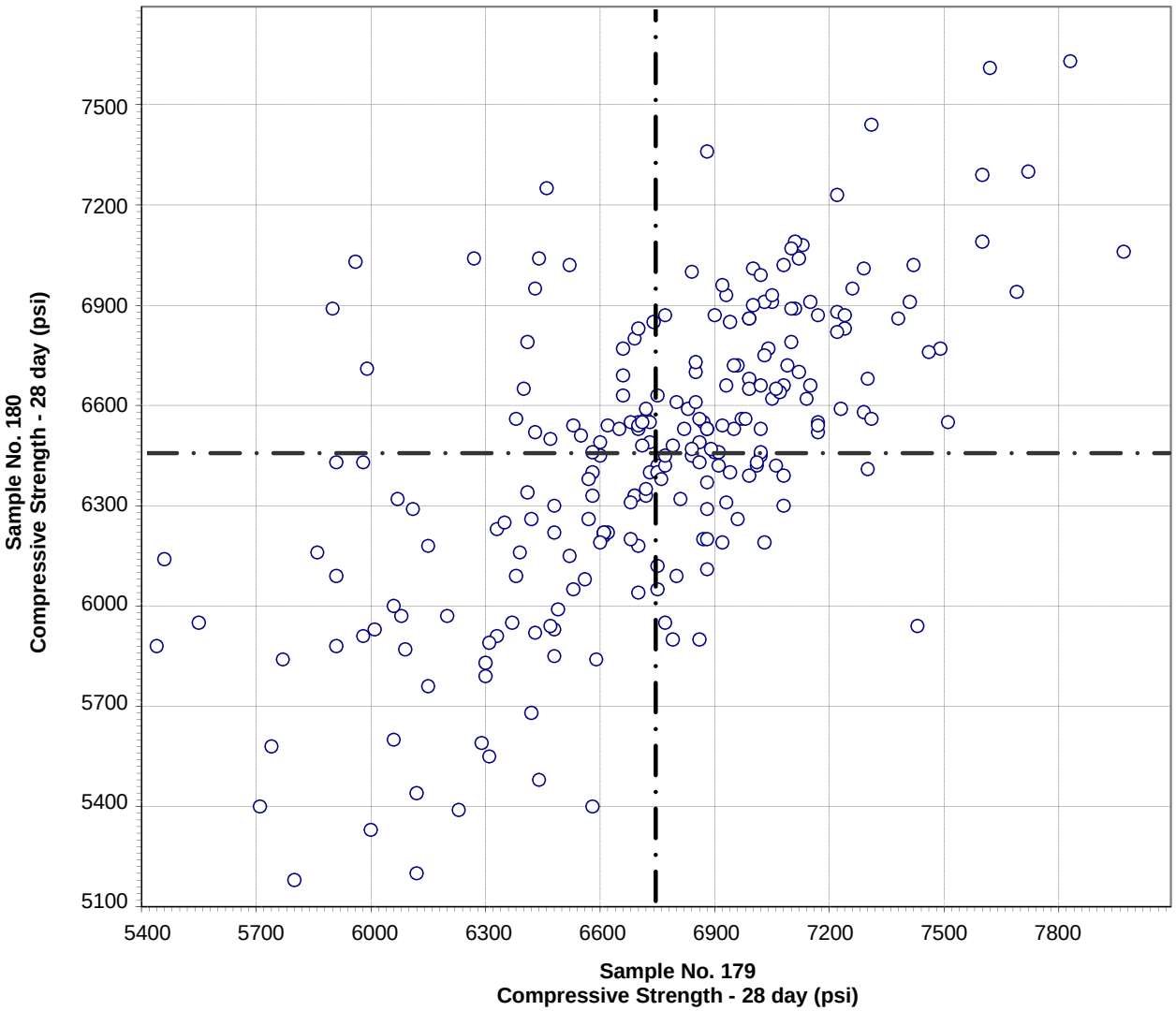



Test No. 210 Compressive Strength - 7 day 249 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 5226 | S.D. | 319 | C.V. | 6.1 |
| Sample No. 180 | Ave | 4827 | S.D. | 313 | C.V. | 6.5 |

Labs eliminated: 37, 49, 103, 1079, 3422, 3511

**CCRL Proficiency Sample Program**
**Compressive Strength - 28 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**

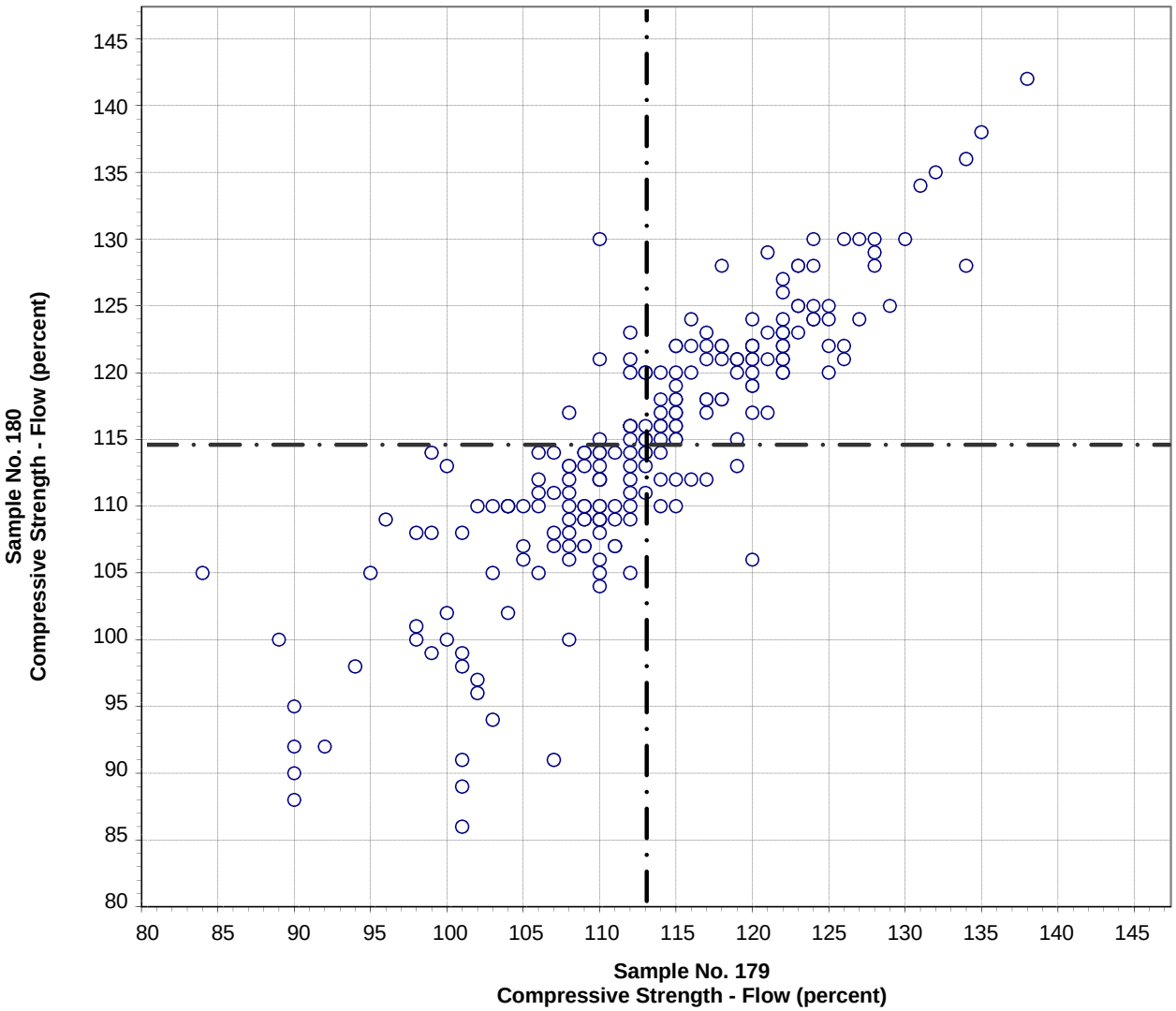



Test No. 211 Compressive Strength - 28 day 235 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 6740 | S.D. | 438 | C.V. | 6.5 |
| Sample No. 180 | Ave | 6453 | S.D. | 437 | C.V. | 6.8 |

Labs eliminated: 3422, 3511

**CCRL Proficiency Sample Program**
**Compressive Strength - Flow**
**PORTLAND CEMENT Samples No. 179 and No. 180**

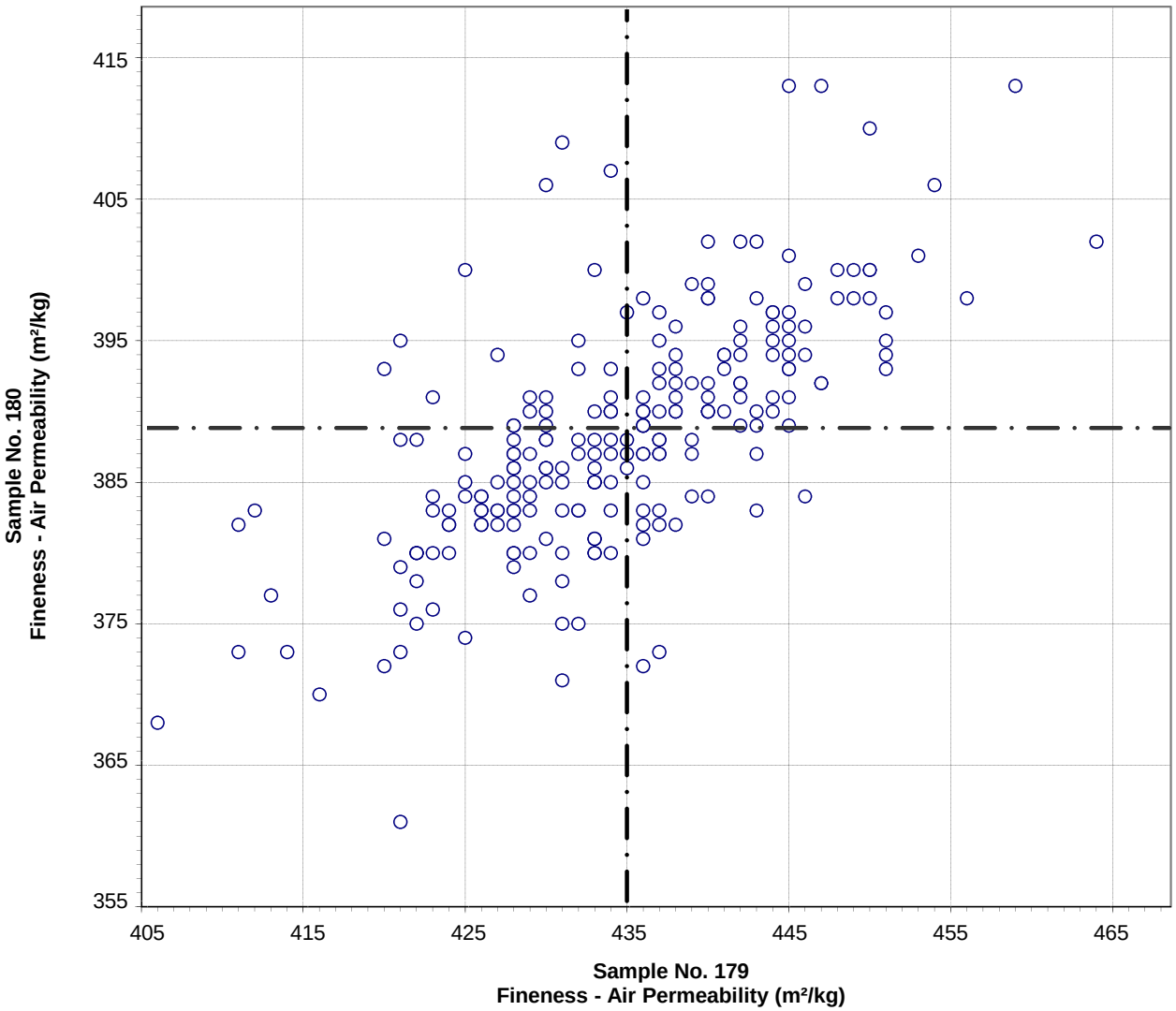



Test No. 230 Compressive Strength - Flow 223 Points

Sample No. 179 Ave 113 S.D. 9 C.V. 8.2
Sample No. 180 Ave 114 S.D. 10 C.V. 8.5

Labs eliminated: 12, 38, 2477, 3511

**CCRL Proficiency Sample Program**
**Fineness - Air Permeability**
**PORTLAND CEMENT Samples No. 179 and No. 180**



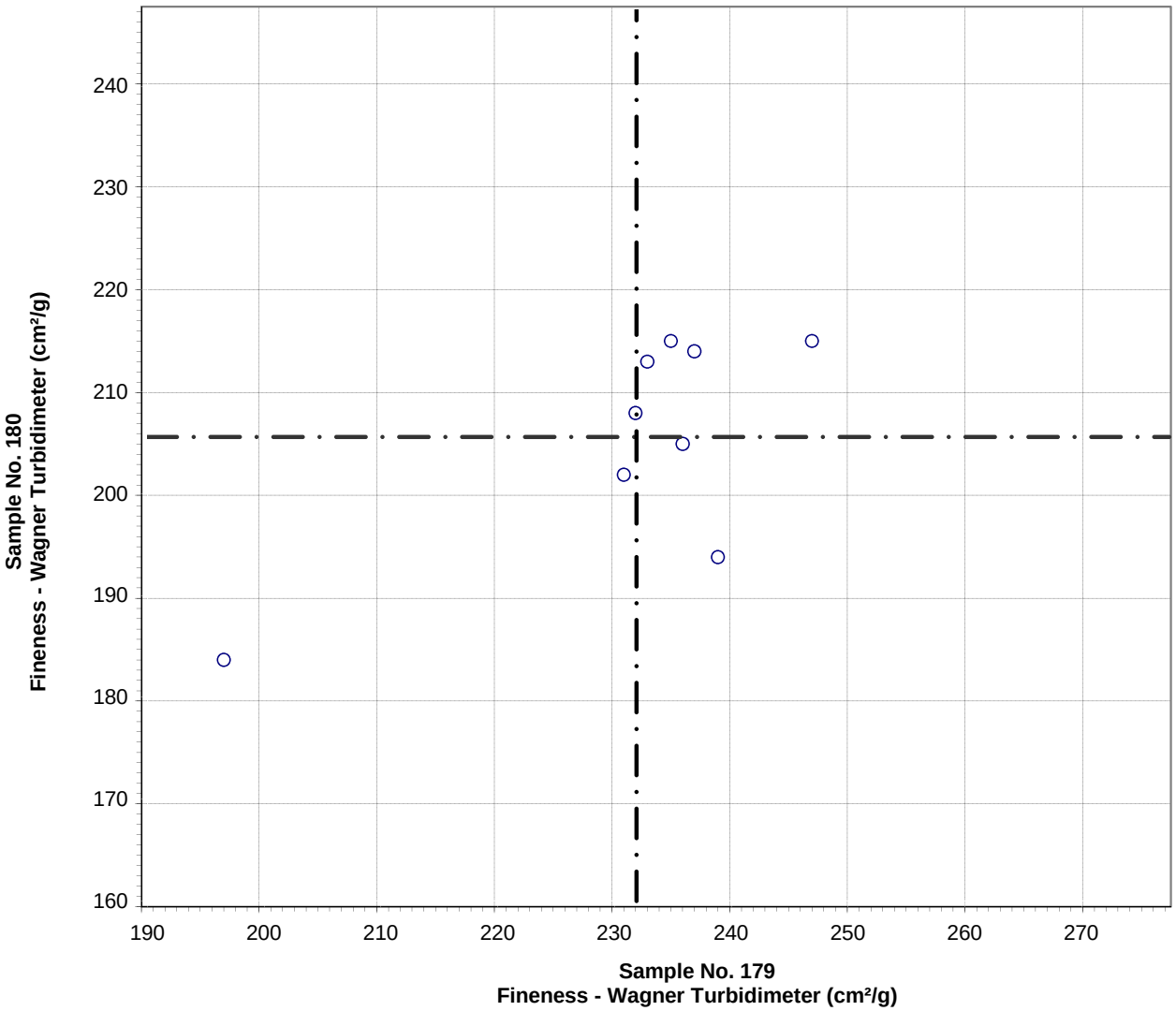

Test No. 270 Fineness - Air Permeability 230 Points

Sample No. 179 Ave 435 S.D. 10 C.V. 2.3
Sample No. 180 Ave 389 S.D. 9 C.V. 2.3

Labs eliminated: 4, 6, 49, 175, 207, 413, 1251, 1956, 8, 46, 51, 958, 1483, 2295, 2477, 2982, 3135, 3621

Labs off Diagram: 768, 3235, 3577

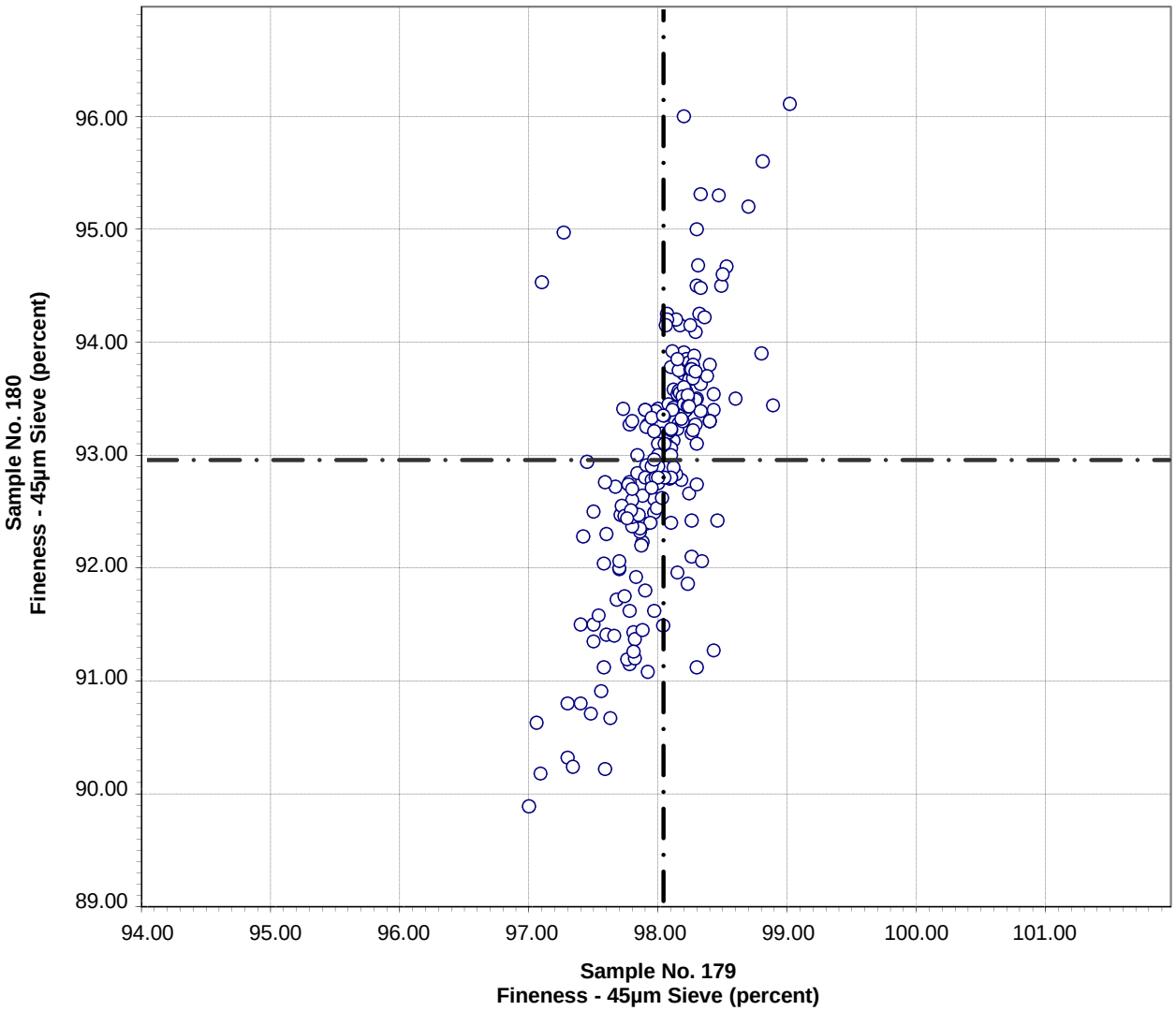
**CCRL Proficiency Sample Program**
**Fineness - Wagner Turbidimeter**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 280 Fineness - Wagner Turbidimeter 9 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 232 | S.D. | 14 | C.V. | 6.0 |
| Sample No. 180 | Ave | 206 | S.D. | 11 | C.V. | 5.2 |

**CCRL Proficiency Sample Program**
**Fineness - 45µm Sieve**
**PORTLAND CEMENT Samples No. 179 and No. 180**

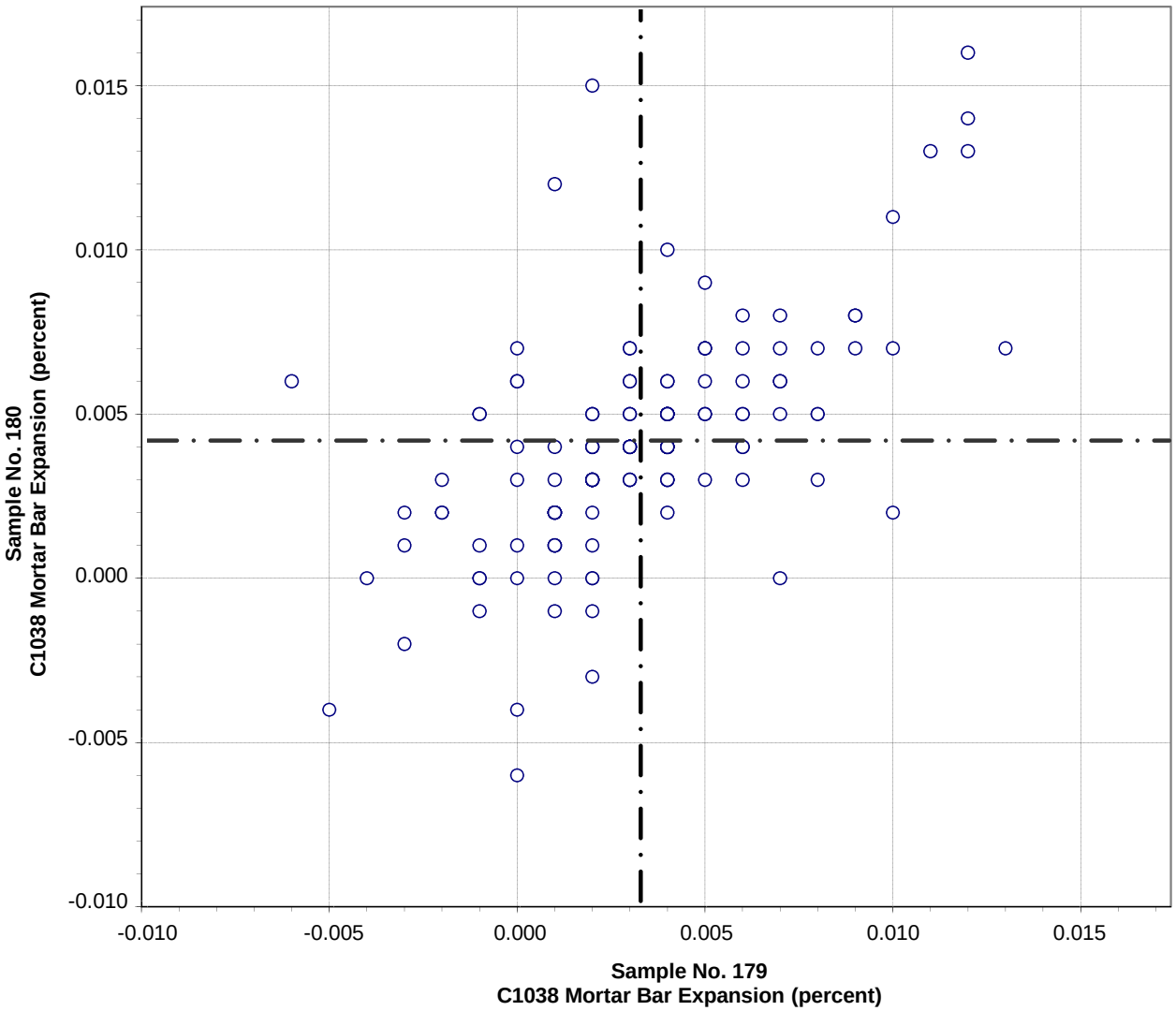



Test No. 281 Fineness - 45µm Sieve 224 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 98.03 | S.D. | 0.32 | C.V. 0.32 |
| Sample No. 180 | Ave | 92.94 | S.D. | 1.06 | C.V. 1.1 |

Labs eliminated: 29, 207, 413, 2477, 2482, 17, 51, 501, 2295, 3422

**CCRL Proficiency Sample Program**
**C1038 Mortar Bar Expansion**
**PORTLAND CEMENT Samples No. 179 and No. 180**

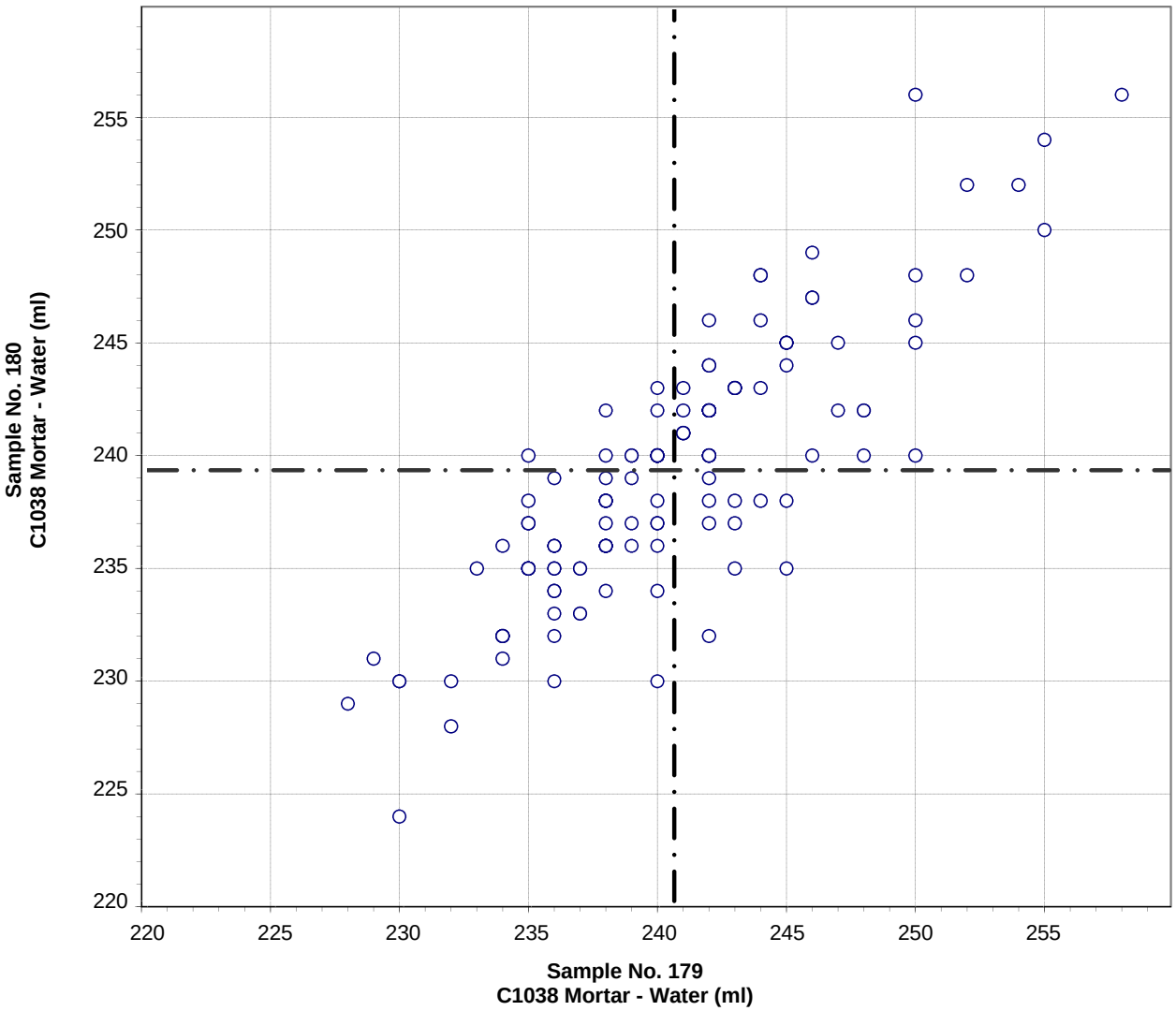



Test No. 400 C1038 Mortar Bar Expansion 139 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.003 | S.D. | 0.003 | C.V. | 106 |
| Sample No. 180 | Ave | 0.004 | S.D. | 0.003 | C.V. | 82 |

Labs eliminated: 34, 116, 3057, 49, 51, 157, 205, 2296, 3413, 3607

**CCRL Proficiency Sample Program**
**C1038 Mortar - Water**
**PORTLAND CEMENT Samples No. 179 and No. 180**

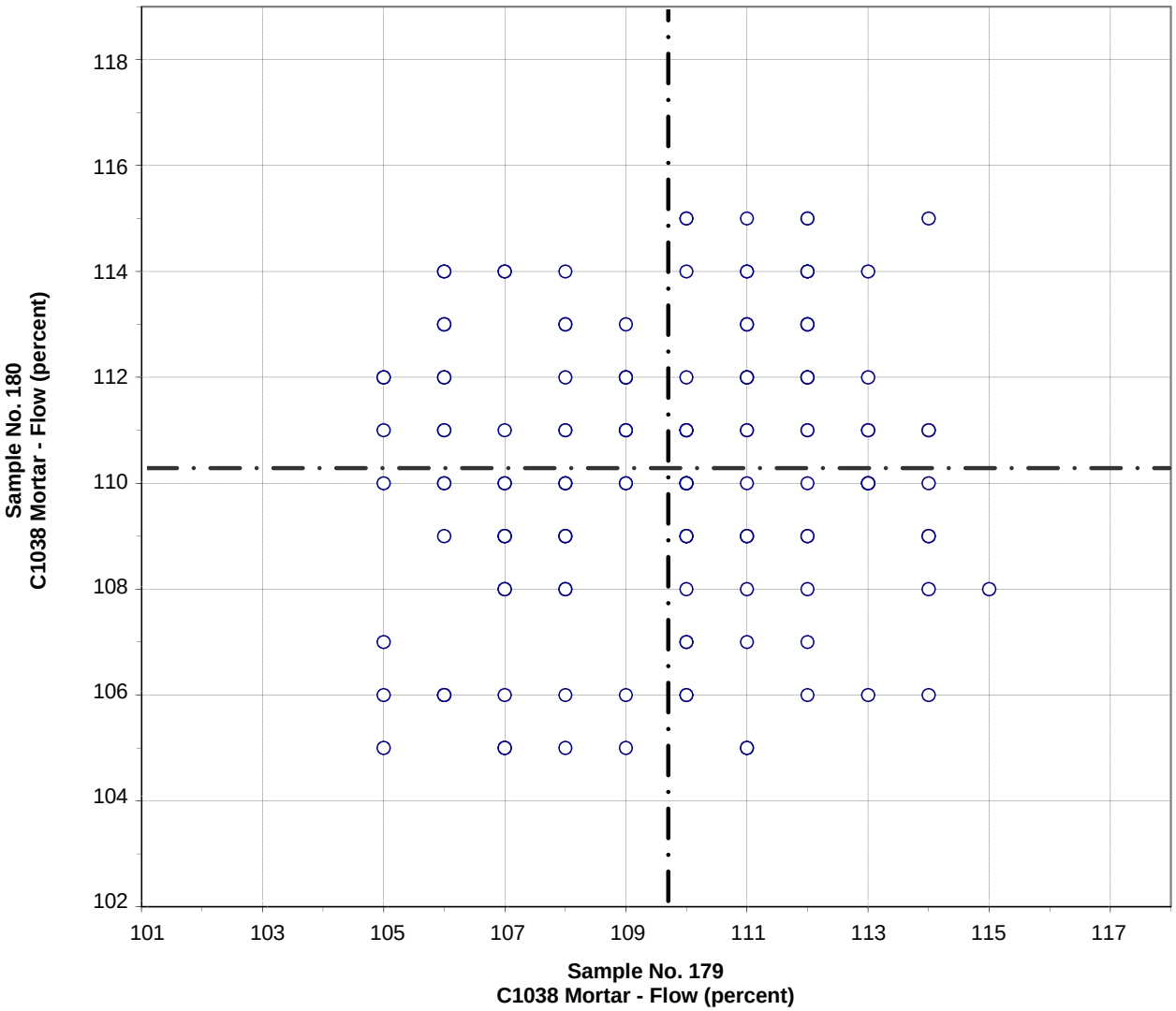



Test No. 401 C1038 Mortar - Water 142 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 241 | S.D. | 5 | C.V. 2.2 |
| Sample No. 180 | Ave | 239 | S.D. | 6 | C.V. 2.3 |

Labs eliminated: 49, 611, 3235, 3607

**CCRL Proficiency Sample Program**
**C1038 Mortar - Flow**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 402 C1038 Mortar - Flow 141 Points

| | | | | |
|---|---|---|---|---|
| Sample No. 179 | Ave 110 | S.D. 3 | C.V. 2.3 |
| Sample No. 180 | Ave 110 | S.D. 3 | C.V. 2.4 |

Labs eliminated: 56, 134, 203, 46, 3235, 3368

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Heat of Hydration Results
March 25, 2011

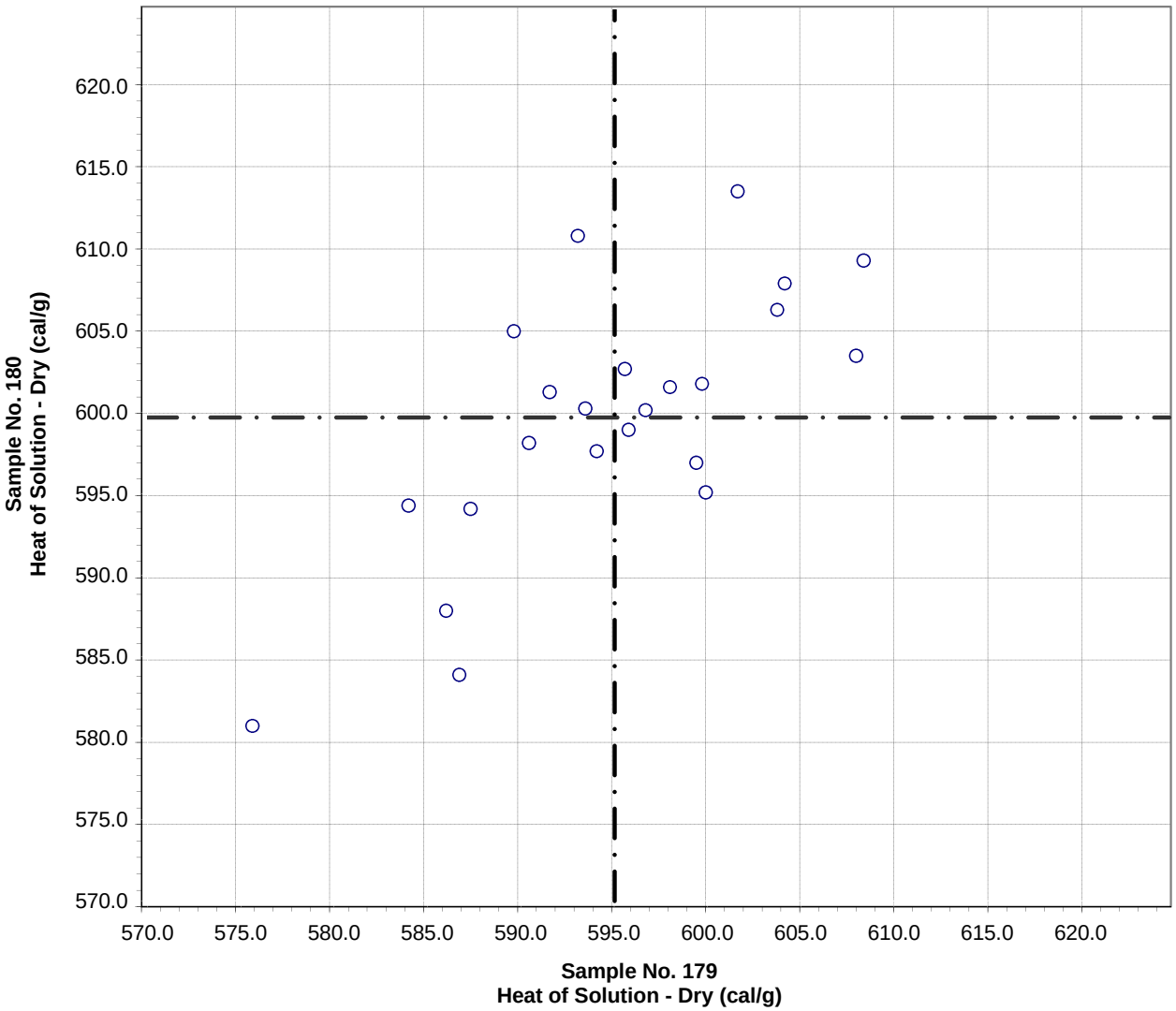
SUMMARY OF RESULTS

| Test | | #Labs | Sample No. 179 Average | S.D. | C.V. | Sample No. 180 Average | S.D. | C.V. |
|---|---|---|---|---|---|---|---|---|
| **C186 HEAT OF HYDRATION** | | | | | | | | |
| Heat Solution, Dry | cal/g | 24 | 593.7 | 10.1 | 1.7 | 598.2 | 10.8 | 1.8 |
| Heat Solution, Dry | cal/g * | 23 | 595.0 | 7.9 | 1.3 | 599.7 | 8.0 | 1.3 |
| Heat Sol, 7 day | cal/g | 24 | 508.2 | 15.8 | 3.1 | 518.1 | 11.2 | 2.2 |
| Heat Sol, 7 day | cal/g * | 22 | 512.2 | 7.2 | 1.4 | 520.0 | 8.9 | 1.7 |
| Heat Sol, 28 day | cal/g | 17 | 498.5 | 16.7 | 3.3 | 508.4 | 9.7 | 1.9 |
| Heat Sol, 28 day | cal/g * | 16 | 502.2 | 6.8 | 1.4 | 510.6 | 4.1 | 0.80 |
| Heat Hyd, 7 day | cal/g | 27 | 85.6 | 12.8 | 15 | 81.1 | 8.7 | 11 |
| Heat Hyd, 7 day | cal/g * | 24 | 83.8 | 4.3 | 5.2 | 79.1 | 5.3 | 6.7 |
| Heat Hyd, 28 day | cal/g | 20 | 95.0 | 15.9 | 17 | 90.8 | 14.2 | 16 |
| Heat Hyd, 28 day | cal/g * | 19 | 91.9 | 8.0 | 8.7 | 88.4 | 9.3 | 11 |
| **C1702 HEAT OF HYDRATION USING ISOTHERMAL CONDUCTION CALORIMETRY** | | | | | | | | |
| Heat Hyd, 3 day | J/g | 3 | 310 | 23 | 7.3 | 304 | 78 | 26 |
| Heat Hyd, 7 day | J/g | 3 | 333 | 39 | 12 | 336 | 23 | 6.9 |

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

| | |
|---|---|
| C186 Heat Sol, Dry | 148 |
| C186 Heat Sol, 7 day | 148 3605 |
| C186 Heat Sol, 28 day | 3605 |
| C186 Heat Hyd, 7 day | 343 491 3605 |
| C186 Heat Hyd, 28 day | 3605 |

**CCRL Proficiency Sample Program**
**C186 Heat of Solution - Dry**
**PORTLAND CEMENT Samples No. 179 and No. 180**

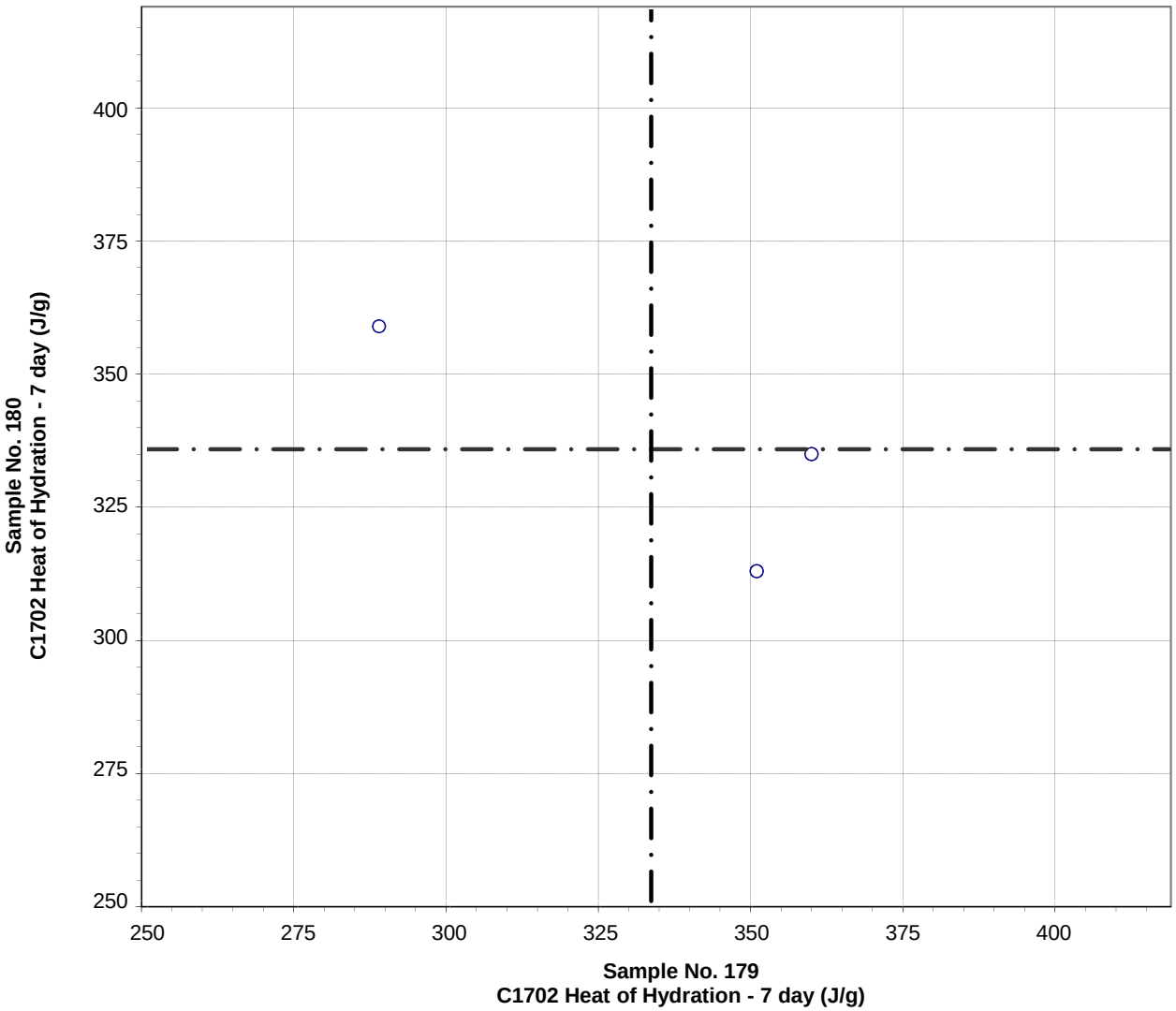



Test No. 291 C186 Heat of Solution - Dry 23 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 595.0 | S.D. | 7.9 | C.V. | 1.3 |
| Sample No. 180 | Ave | 599.7 | S.D. | 8.0 | C.V. | 1.3 |

Labs eliminated: 148

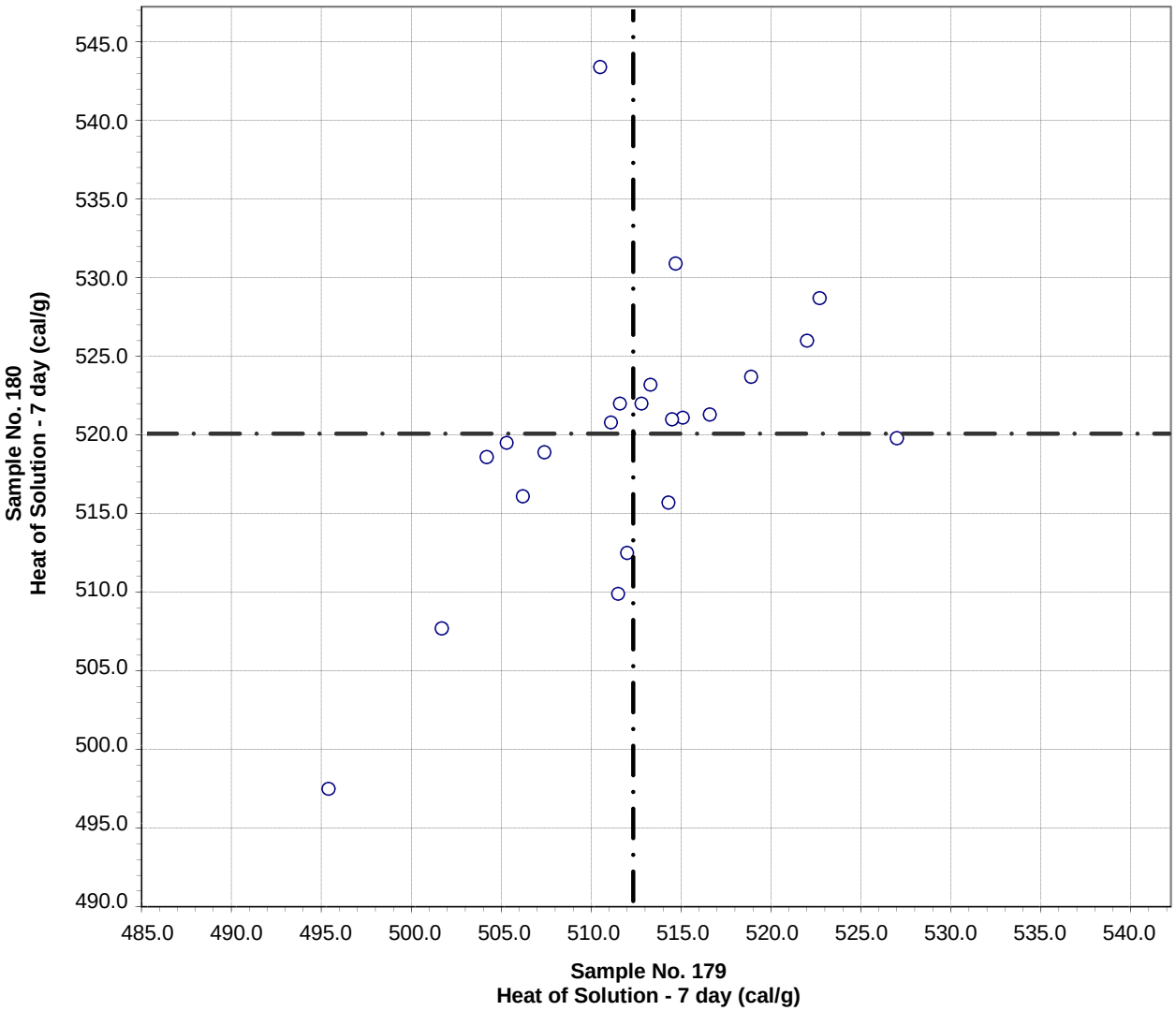
**CCRL Proficiency Sample Program**
**C1702 Heat of Hydration - 7 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 510 C1702 Heat of Hydration - 7 day 3 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 333 | S.D. | 39 | C.V. | 12 |
| Sample No. 180 | Ave | 336 | S.D. | 23 | C.V. | 6.9 |

**CCRL Proficiency Sample Program**
**C186 Heat of Solution - 7 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**

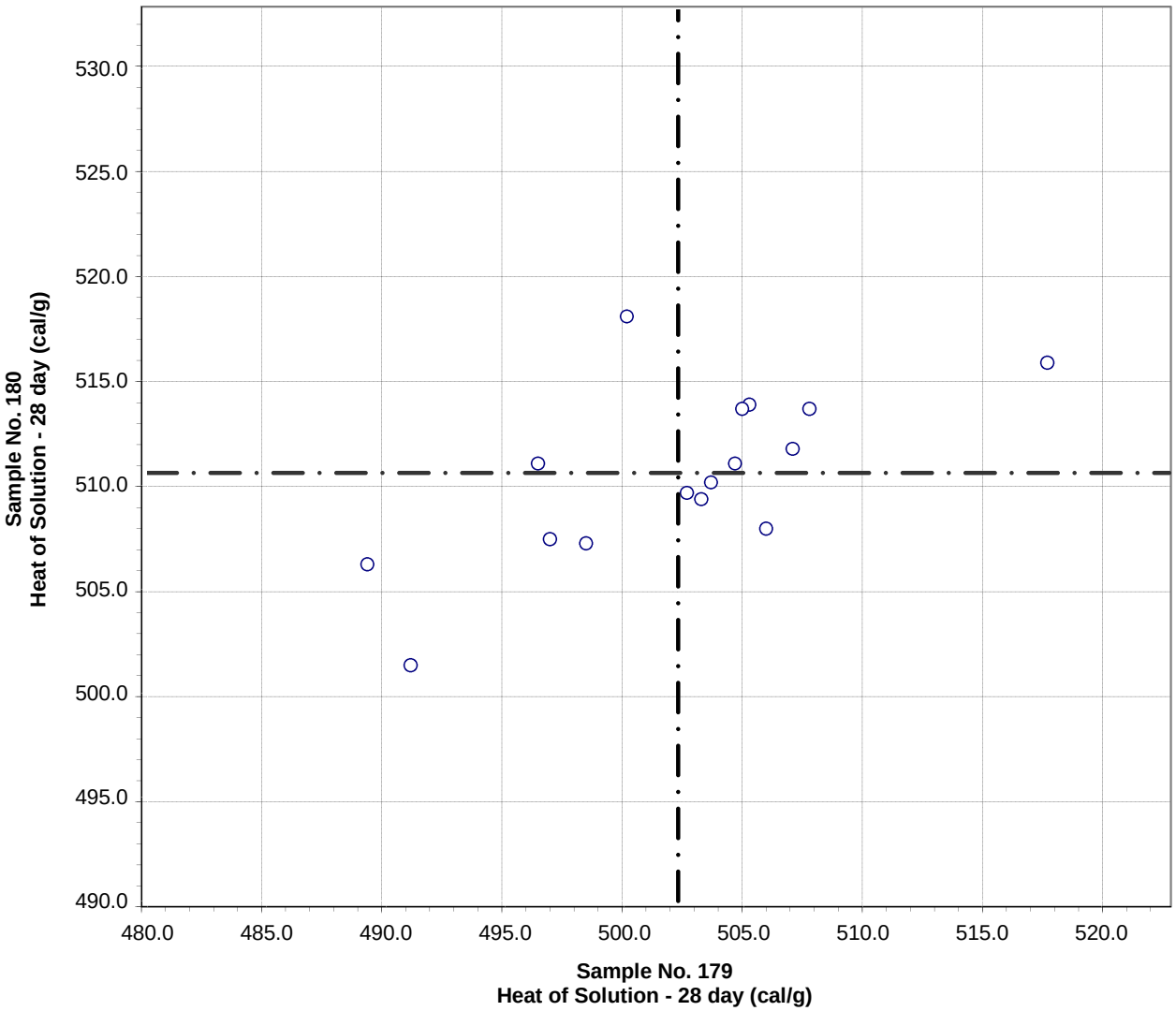



Test No. 292 C186 Heat of Solution - 7 day 22 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 512.2 | S.D. | 7.2 | C.V. | 1.4 |
| Sample No. 180 | Ave | 520.0 | S.D. | 8.9 | C.V. | 1.7 |

Labs eliminated: 148, 3605

**CCRL Proficiency Sample Program**
**C186 Heat of Solution - 28 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**

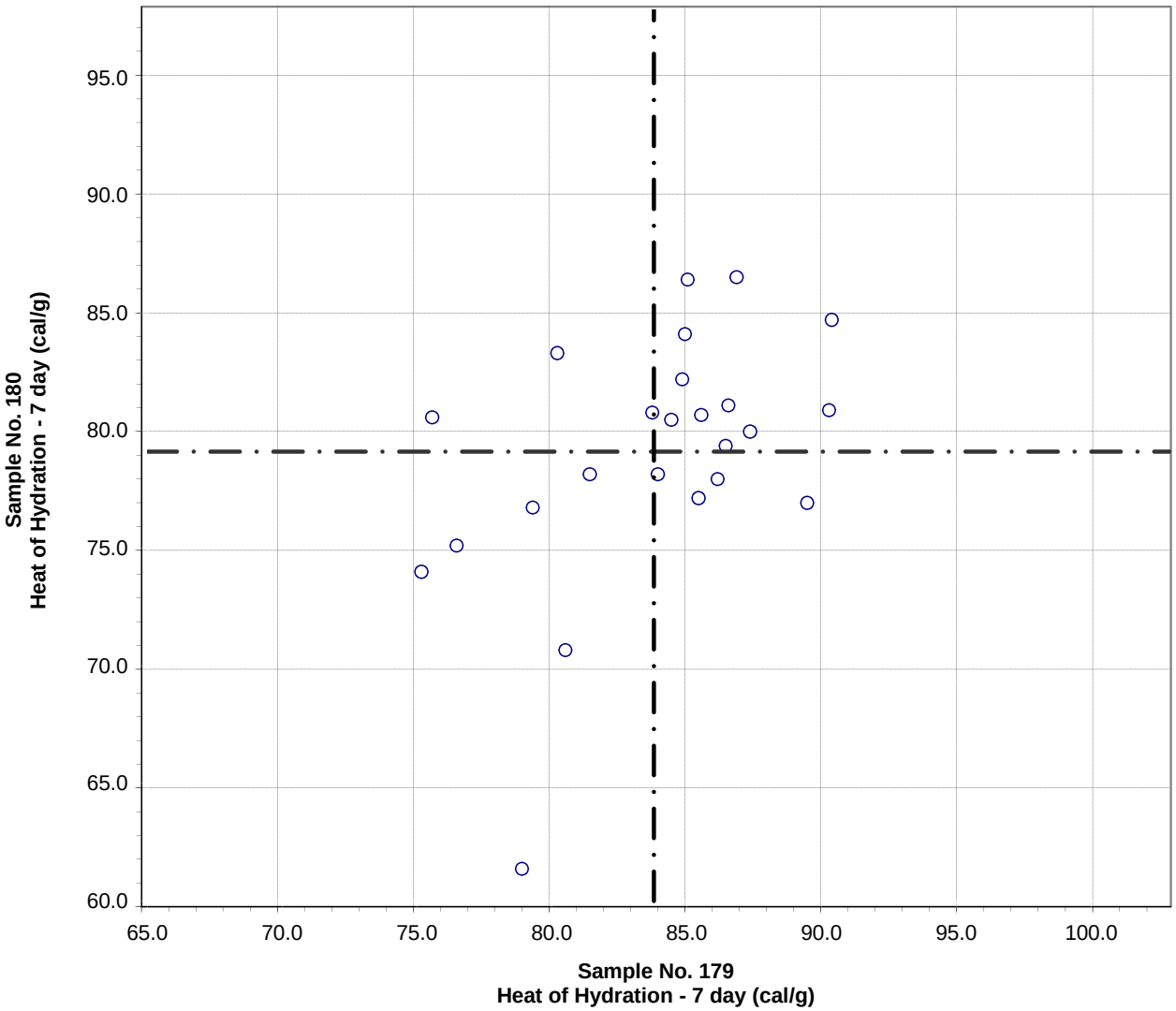



Test No. 301 C186 Heat of Solution - 28 day 16 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 502.3 | S.D. | 6.8 | C.V. | 1.4 |
| Sample No. 180 | Ave | 510.6 | S.D. | 4.1 | C.V. | 0.80 |

Labs eliminated: 3605

**CCRL Proficiency Sample Program**
**C186 Heat of Hydration - 7 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**

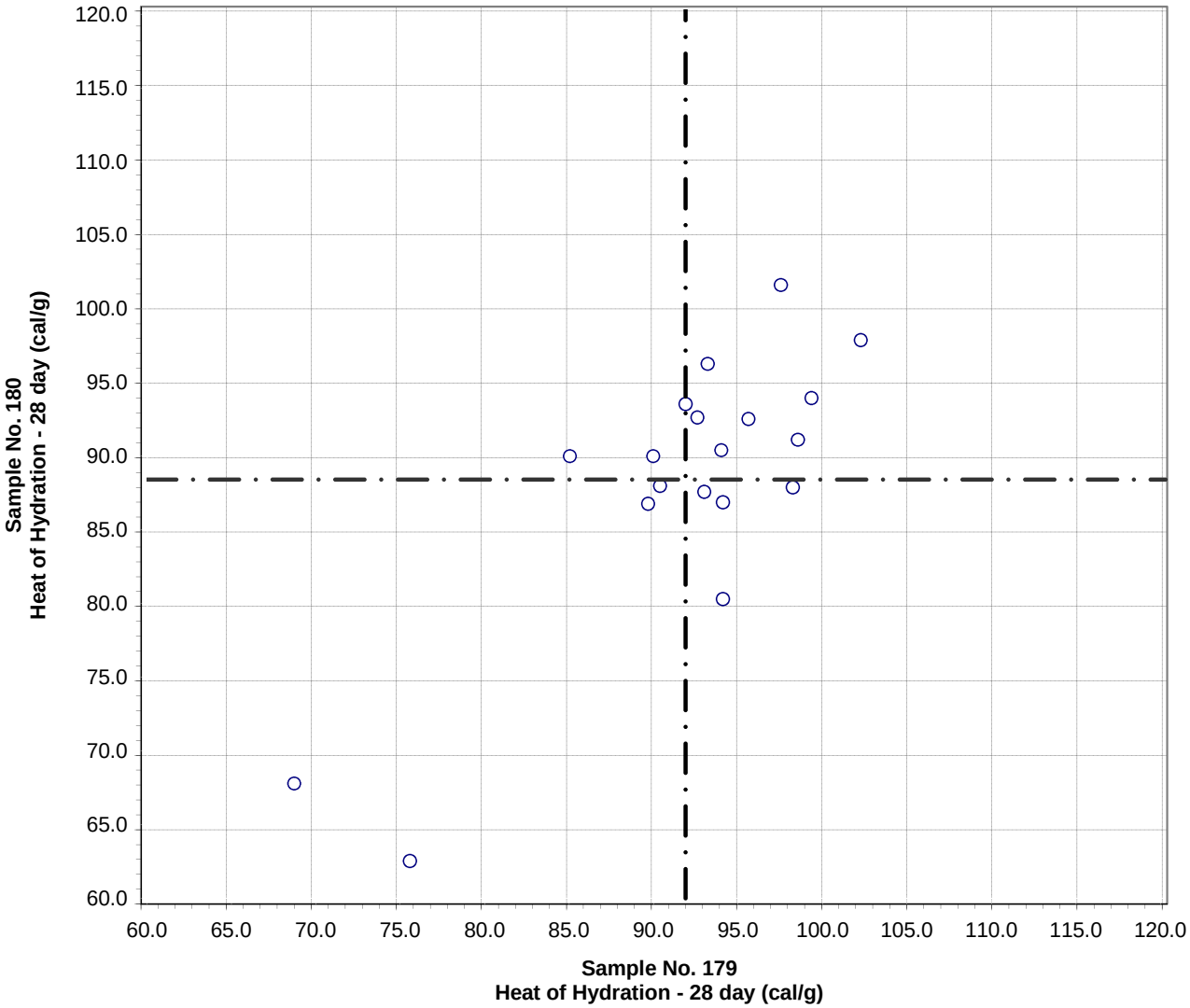



Test No. 290 C186 Heat of Hydration - 7 day 24 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 83.8 | S.D. | 4.3 | C.V. | 5.2 |
| Sample No. 180 | Ave | 79.1 | S.D. | 5.3 | C.V. | 6.7 |

Labs eliminated: 343, 491, 3605

**CCRL Proficiency Sample Program**
**C186 Heat of Hydration - 28 day**
**PORTLAND CEMENT Samples No. 179 and No. 180**

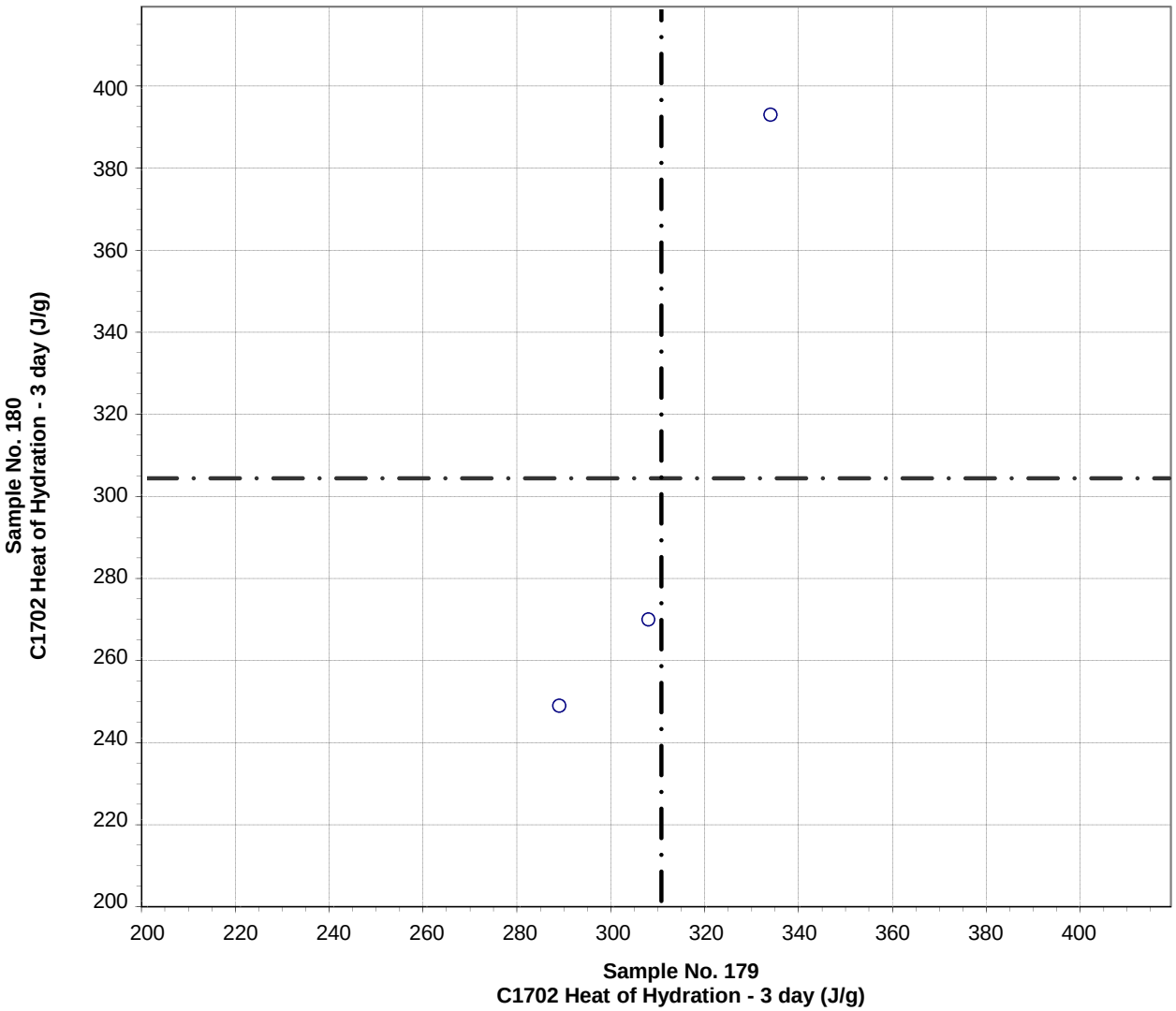



Test No. 300 C186 Heat of Hydration - 28 day 19 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 91.9 | S.D. | 8.0 | C.V. 8.7 |
| Sample No. 180 | Ave | 88.4 | S.D. | 9.3 | C.V. 11 |

Labs eliminated: 3605

## CCRL Proficiency Sample Program
## C1702 Heat of Hydration - 3 day
## PORTLAND CEMENT Samples No. 179 and No. 180




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

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 310 | S.D. | 23 | C.V. | 7.3 |
| Sample No. 180 | Ave | 304 | S.D. | 78 | C.V. | 26 |

# CEMENT AND CONCRETE REFERENCE LABORATORY

# PROFICIENCY SAMPLE PROGRAM

**Portland Cement Proficiency Samples**
**Number 179 and Number 180**

**Special Report on**

**Chemical XRF**
**Fused Glass and Pressed Powder Sample Preparation**

**45µm Sieve Fineness**
**Performed on Chemical Sample**

March 2011

CCRL CEMENT AND CONCRETE REFERENCE LABORATORY

March 25, 2011

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

**SUBJECT: Informational Report on Chemical XRF Analysis by Sample Preparation and 45µm Sieve Fineness using Chemical Sample Cement for Portland Cement Samples 179 & 180**

We thank everyone that submitted the optional test results for the 45µm sieve fineness using chemical sample cement. Information on these results are found on the following pages. The cements used for the chemical samples are a portion of the homogenized physical sample that receive some additional sieving and homogenization. These results can be compared to the fineness performed on the physical samples which are homogenized but not sieved by CCRL

Chemical results performed by XRF were extracted from the primary chemical results and grouped by sample preparation (fused glass and pressed powder). Information on these results are found on the following pages. These results can be compared to each other and the primary chemical results which include analysis by various methods.

These reports are for information only. CCRL has made no effort to draw conclusions from these results.

Sincerely,

Robin K. Haupt

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

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Chemical XRF Results
March 25, 2011

SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| Silicon Dioxide-FG | % | 116 | 21.10 | 0.17 | 0.79 | 20.30 | 0.17 | 0.85 |
| Silicon Dioxide-FG | % | *113 | 21.10 | 0.14 | 0.66 | 20.30 | 0.14 | 0.68 |
| Silicon Dioxide-PP | % | 77 | 21.16 | 0.24 | 1.2 | 20.44 | 0.28 | 1.4 |
| Silicon Dioxide-PP | % | * 74 | 21.19 | 0.20 | 1.0 | 20.44 | 0.20 | 1.0 |
| Aluminum Oxide-FG | % | 117 | 4.82 | 0.14 | 2.9 | 5.19 | 0.10 | 1.9 |
| Aluminum Oxide-FG | % | *113 | 4.84 | 0.08 | 1.7 | 5.20 | 0.08 | 1.6 |
| Aluminum Oxide-PP | % | 77 | 4.86 | 0.10 | 2.0 | 5.19 | 0.11 | 2.1 |
| Aluminum Oxide-PP | % | * 73 | 4.87 | 0.08 | 1.6 | 5.21 | 0.09 | 1.7 |
| Ferric Oxide-FG | % | 116 | 3.36 | 0.07 | 2.1 | 3.84 | 0.12 | 3.2 |
| Ferric Oxide-FG | % | *113 | 3.37 | 0.04 | 1.2 | 3.85 | 0.05 | 1.3 |
| Ferric Oxide-PP | % | 77 | 3.35 | 0.08 | 2.5 | 3.80 | 0.11 | 2.9 |
| Ferric Oxide-PP | % | * 75 | 3.34 | 0.07 | 2.2 | 3.81 | 0.08 | 2.0 |
| Calcium Oxide-FG | % | 112 | 64.35 | 0.38 | 0.59 | 64.60 | 0.50 | 0.77 |
| Calcium Oxide-FG | % | *110 | 64.38 | 0.30 | 0.47 | 64.58 | 0.31 | 0.47 |
| Calcium Oxide-PP | % | 78 | 64.32 | 0.46 | 0.71 | 64.55 | 0.50 | 0.77 |
| Calcium Oxide-PP | % | * 76 | 64.29 | 0.42 | 0.65 | 64.54 | 0.47 | 0.72 |

FG - fused glass sample preparation
PP - pressed powder sample preparation

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

| | |
|---|---|
| Silicon Dioxide-FG | 4 354 2464 |
| Silicon Dioxide-PP | 502 3422 3454 |
| Aluminum Oxide-FG | 4 151 557 736 |
| Aluminum Oxide-PP | 687 502 3422 3454 |
| Ferric Oxide-FG | 84 557 736 |
| Ferric Oxide-PP | 157 3454 |
| Calcium Oxide-FG | 123 2464 |
| Calcium Oxide-PP | 222 3422 |

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report - Chemical XRF Results
March 25, 2011

SUMMARY OF RESULTS

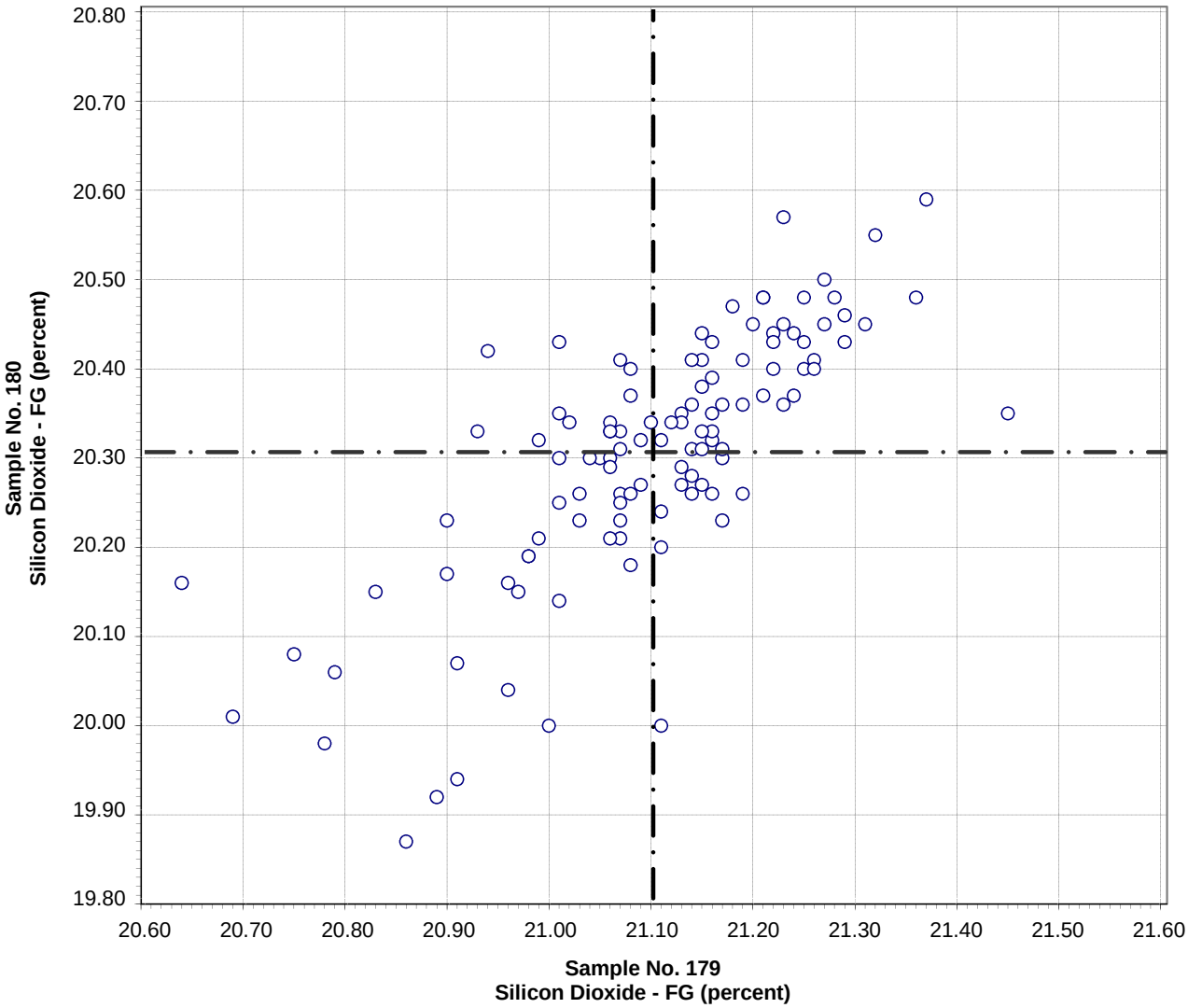
| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| Sulfur Trioxide-FG | % | 101 | 3.17 | 0.22 | 6.9 | 2.99 | 0.19 | 6.5 |
| Sulfur Trioxide-FG | % * | 96 | 3.11 | 0.07 | 2.1 | 2.98 | 0.06 | 2.1 |
| Sulfur Trioxide-PP | % | 77 | 3.08 | 0.12 | 3.8 | 2.98 | 0.11 | 3.7 |
| Sulfur Trioxide-PP | % * | 75 | 3.09 | 0.10 | 3.2 | 2.99 | 0.09 | 3.1 |
| Sodium Oxide-FG | % | 100 | 0.117 | 0.123 | 106 | 0.068 | 0.098 | 144 |
| Sodium Oxide-FG | % * | 87 | 0.095 | 0.020 | 21 | 0.047 | 0.021 | 44 |
| Sodium Oxide-PP | % | 85 | 0.096 | 0.034 | 35 | 0.052 | 0.036 | 68 |
| Sodium Oxide-PP | % * | 78 | 0.089 | 0.022 | 25 | 0.045 | 0.021 | 47 |
| Potassium Oxide-FG | % | 113 | 0.446 | 0.056 | 12 | 0.363 | 0.037 | 10 |
| Potassium Oxide-FG | % * | 108 | 0.455 | 0.015 | 3.3 | 0.366 | 0.011 | 3.1 |
| Potassium Oxide-PP | % | 82 | 0.457 | 0.016 | 3.6 | 0.367 | 0.020 | 5.5 |
| Potassium Oxide-PP | % * | 78 | 0.458 | 0.012 | 2.6 | 0.366 | 0.012 | 3.2 |
| Magnesium Oxide-FG | % | 115 | 0.92 | 0.15 | 16 | 0.85 | 0.14 | 17 |
| Magnesium Oxide-FG | % * | 105 | 0.95 | 0.04 | 4.6 | 0.87 | 0.05 | 5.5 |
| Magnesium Oxide-PP | % | 76 | 1.00 | 0.10 | 9.6 | 0.91 | 0.09 | 9.6 |
| Magnesium Oxide-PP | % * | 71 | 1.00 | 0.06 | 5.6 | 0.91 | 0.06 | 6.2 |

FG - fused glass sample preparation
PP - pressed powder sample preparation

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

| | |
|---|---|
| Sulfur Trioxide-FG | 53 134 247 1799 2982 |
| Sulfur Trioxide-PP | 20 43 |
| Sodium Oxide-FG | 116 130 2360 53 98 1466 2464 56 557 2296 2463 2477 2490 |
| Sodium Oxide-PP | 494 1251 157 1657 886 1025 3238 |
| Potassium Oxide-FG | 557 116 206 1053 2412 |
| Potassium Oxide-PP | 3422 3454 124 3607 |
| Magnesium Oxide-FG | 557 53 736 3233 25 169 2352 2464 2490 3249 |
| Magnesium Oxide-PP | 95 502 413 1251 3422 |

**CCRL Proficiency Sample Program**
**Silicon Dioxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**

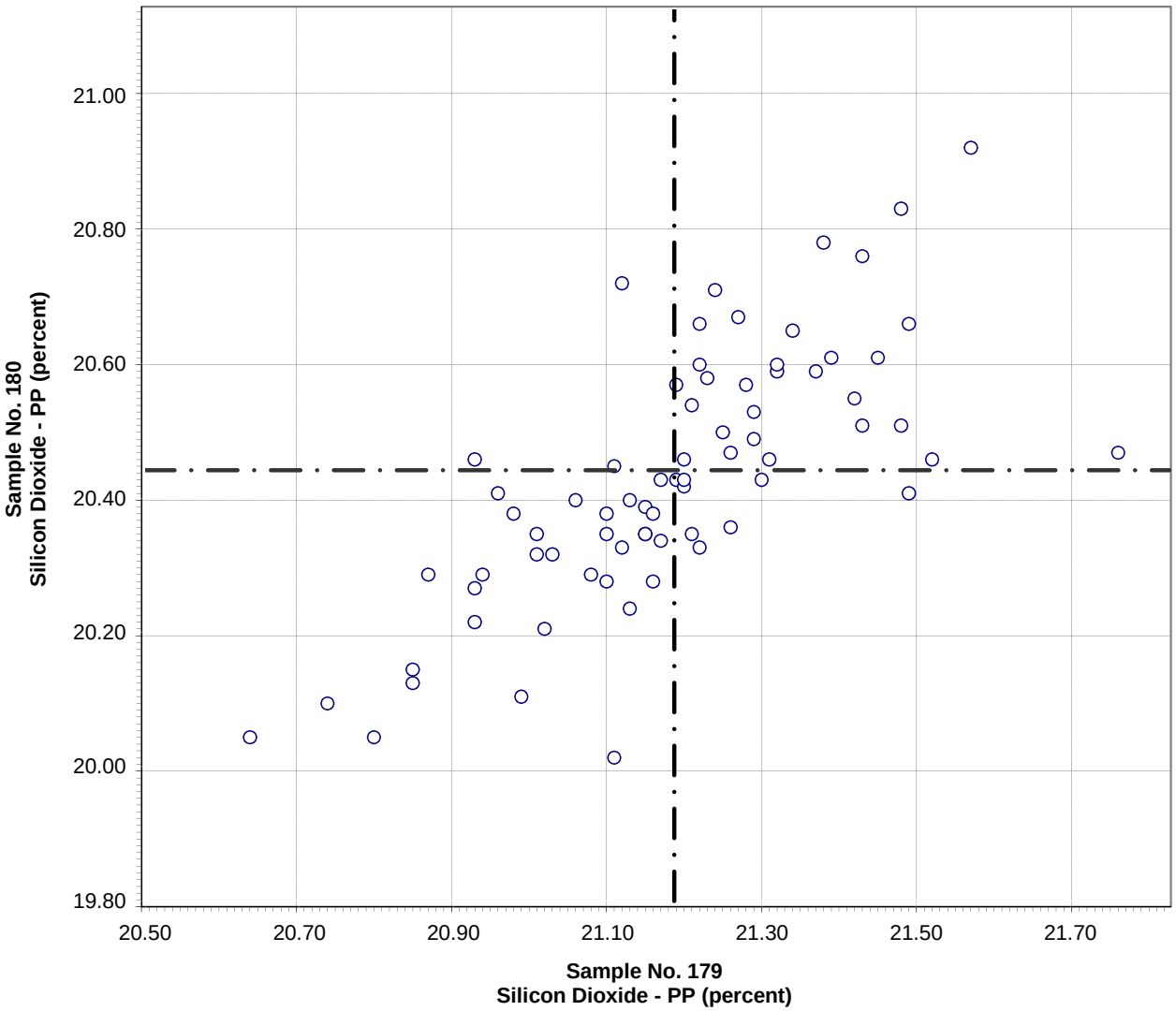



Test No. 12 Silicon Dioxide - Fused Glass 113 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 21.10 | S.D. | 0.14 | C.V. | 0.66 |
| Sample No. 180 | Ave | 20.31 | S.D. | 0.14 | C.V. | 0.68 |

Labs eliminated: 4, 354, 2464

**CCRL Proficiency Sample Program**
**Silicon Dioxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**



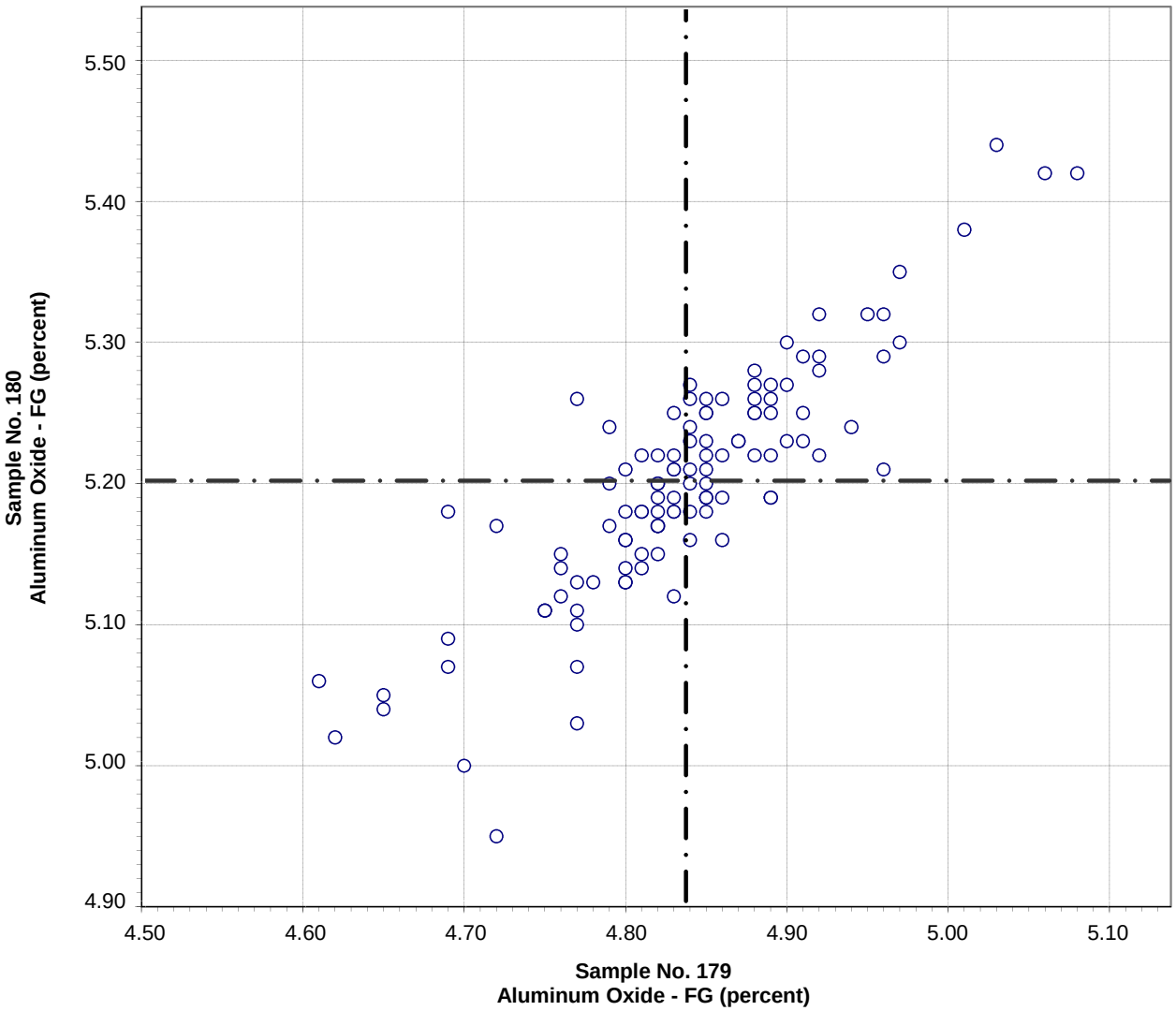

Test No. 13 Silicon Dioxide - Pressed Powder 73 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 21.19 | S.D. | 0.20 | C.V. 1.0 |
| Sample No. 180 | Ave | 20.44 | S.D. | 0.20 | C.V. 1.0 |

Labs eliminated: 502, 3422, 3454

Labs off Diagram: 124

**CCRL Proficiency Sample Program**
**Aluminum Oxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**

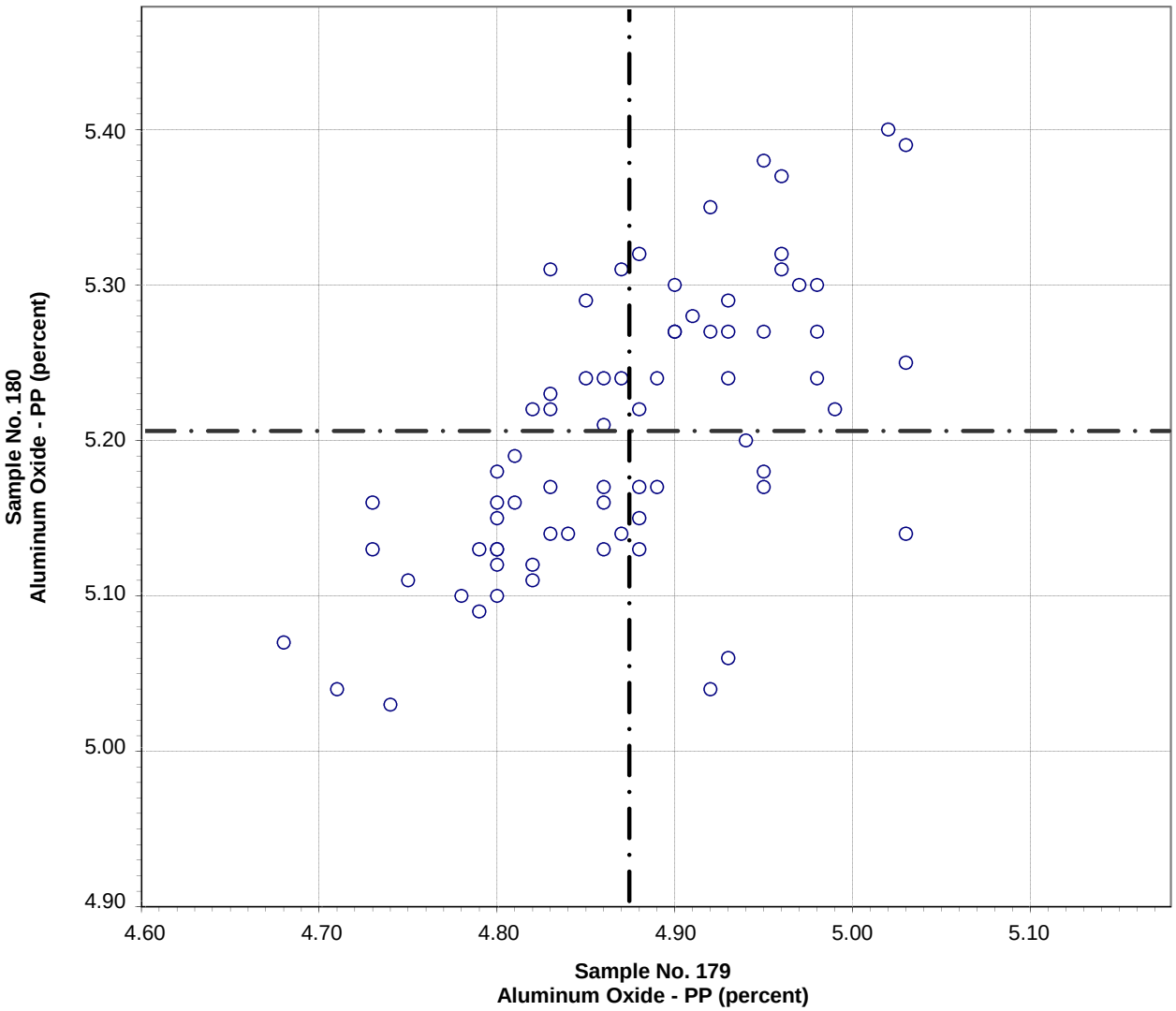



Test No. 22 Aluminum Oxide - Fused Glass 113 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 4.84 | S.D. | 0.08 | C.V. | 1.7 |
| Sample No. 180 | Ave | 5.20 | S.D. | 0.08 | C.V. | 1.6 |

Labs eliminated: 4, 151, 557, 736

**CCRL Proficiency Sample Program**
**Aluminum Oxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**

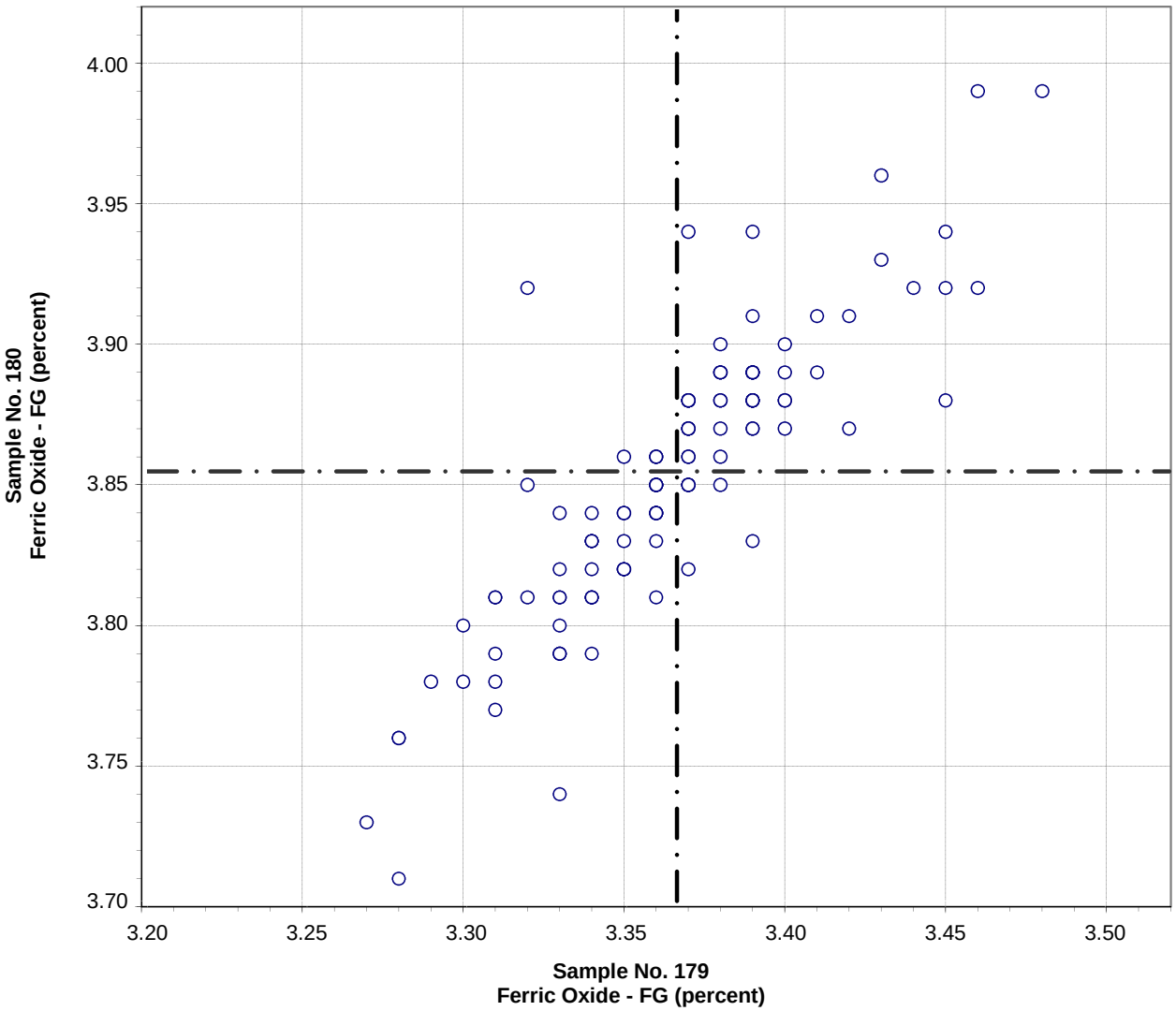



Test No. 23 Aluminum Oxide - Pressed Powder 73 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 4.87 | S.D. | 0.08 | C.V. | 1.6 |
| Sample No. 180 | Ave | 5.21 | S.D. | 0.09 | C.V. | 1.7 |

Labs eliminated: 687, 502, 3422, 3454

**CCRL Proficiency Sample Program**
**Ferric Oxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**

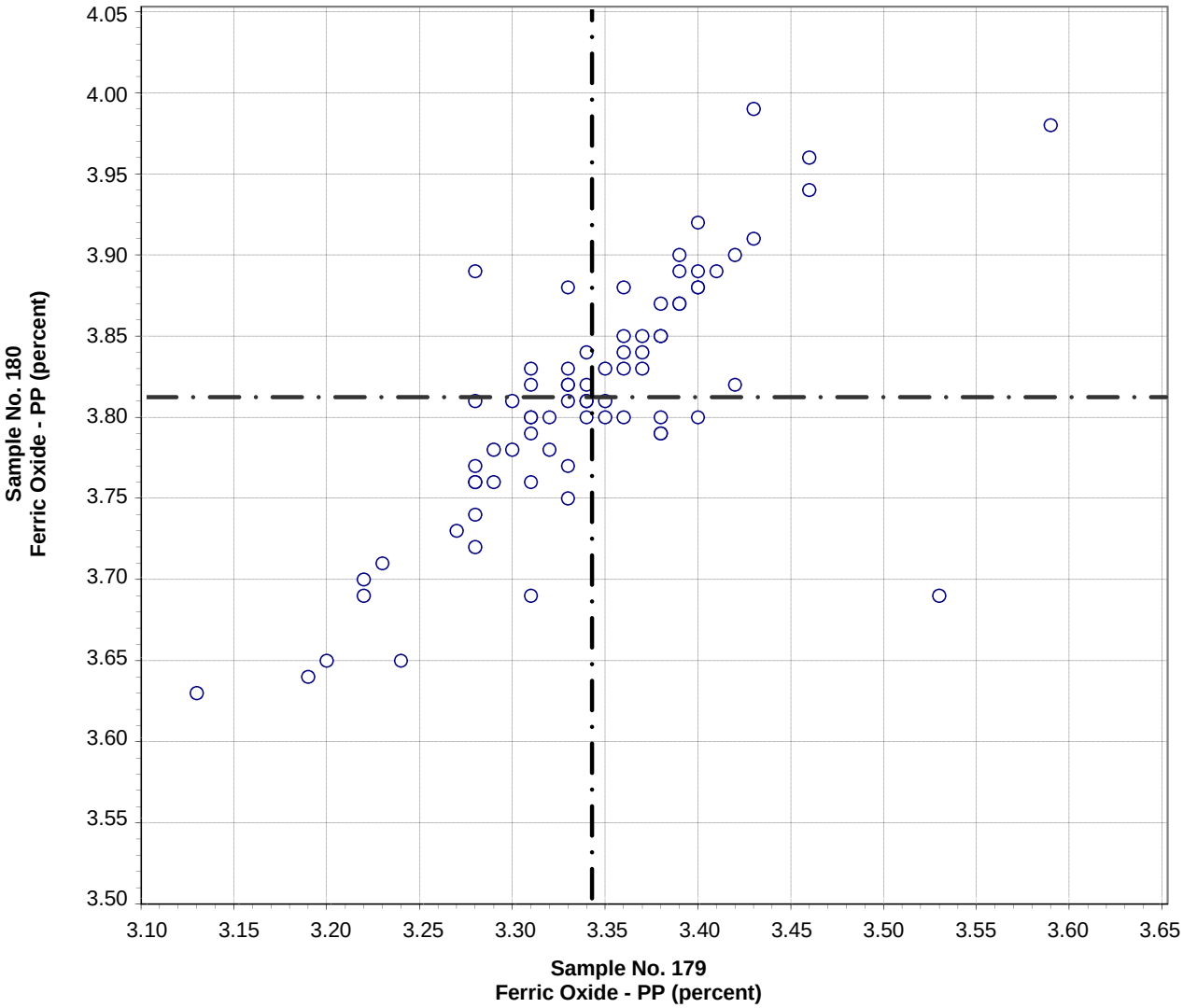



Test No. 32 Ferric Oxide - Fused Glass 113 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 3.37 | S.D. | 0.04 | C.V. | 1.2 |
| Sample No. 180 | Ave | 3.85 | S.D. | 0.05 | C.V. | 1.3 |

Labs eliminated: 84, 557, 736

**CCRL Proficiency Sample Program**
**Ferric Oxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**

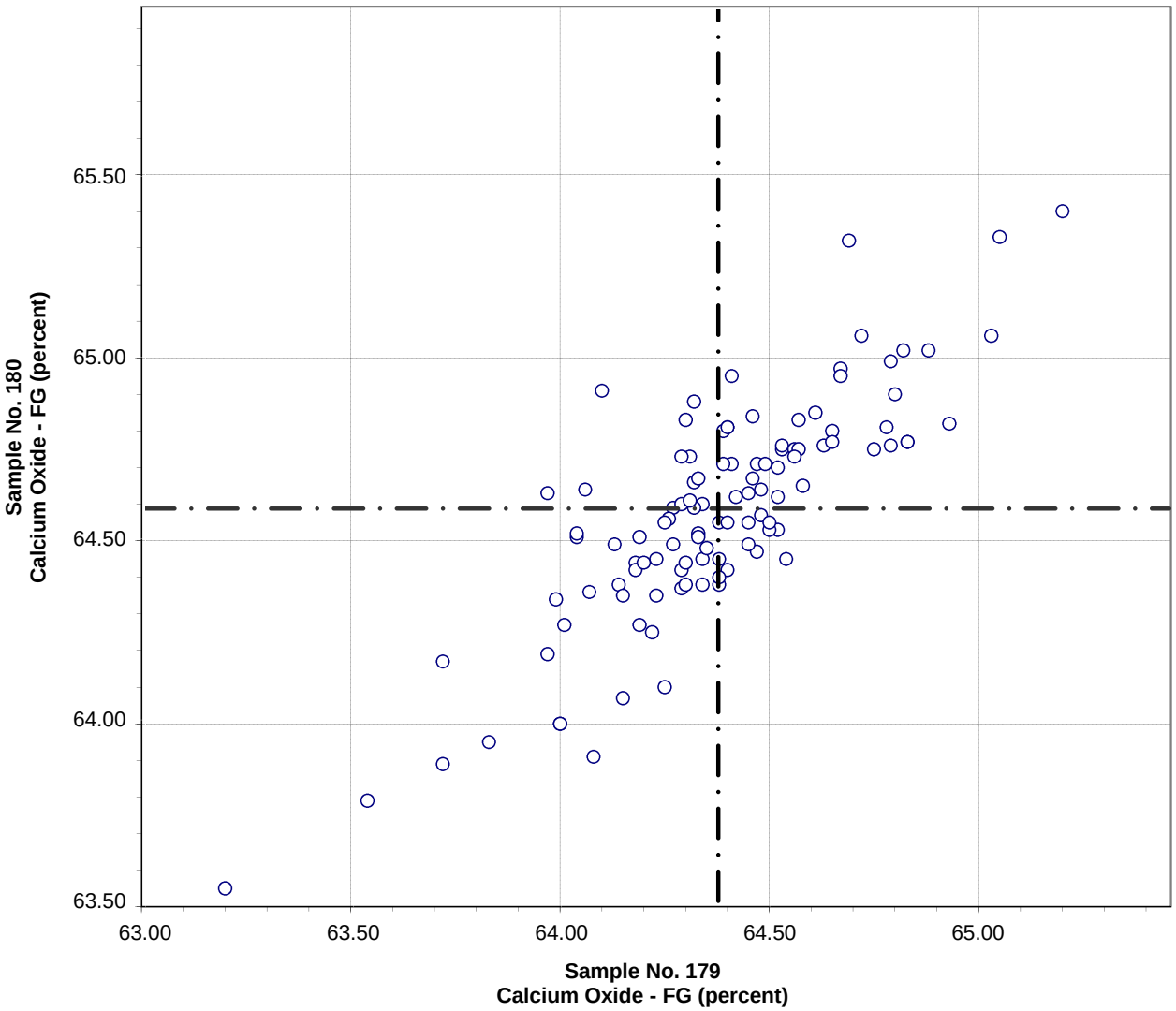



Test No. 33 Ferric Oxide - Pressed Powder 75 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 3.34 | S.D. | 0.07 | C.V. | 2.2 |
| Sample No. 180 | Ave | 3.81 | S.D. | 0.08 | C.V. | 2.0 |

Labs eliminated: 157, 3454

**CCRL Proficiency Sample Program**
**Calcium Oxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**

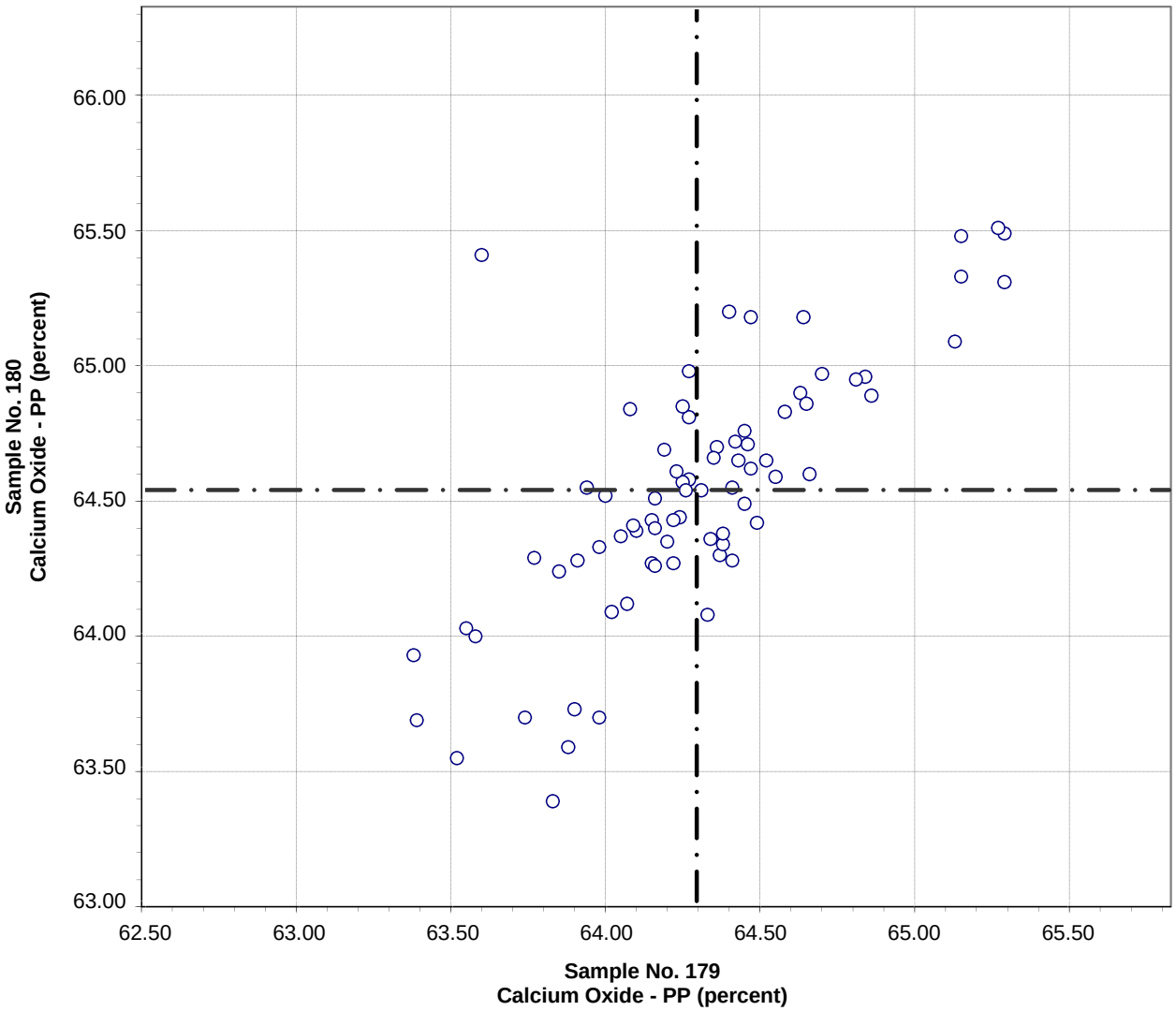



Test No. 42 Calcium Oxide - Fused Glass 110 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 64.38 | S.D. | 0.30 | C.V. | 0.47 |
| Sample No. 180 | Ave | 64.58 | S.D. | 0.31 | C.V. | 0.47 |

Labs eliminated: 123, 2464

**CCRL Proficiency Sample Program**
**Calcium Oxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**

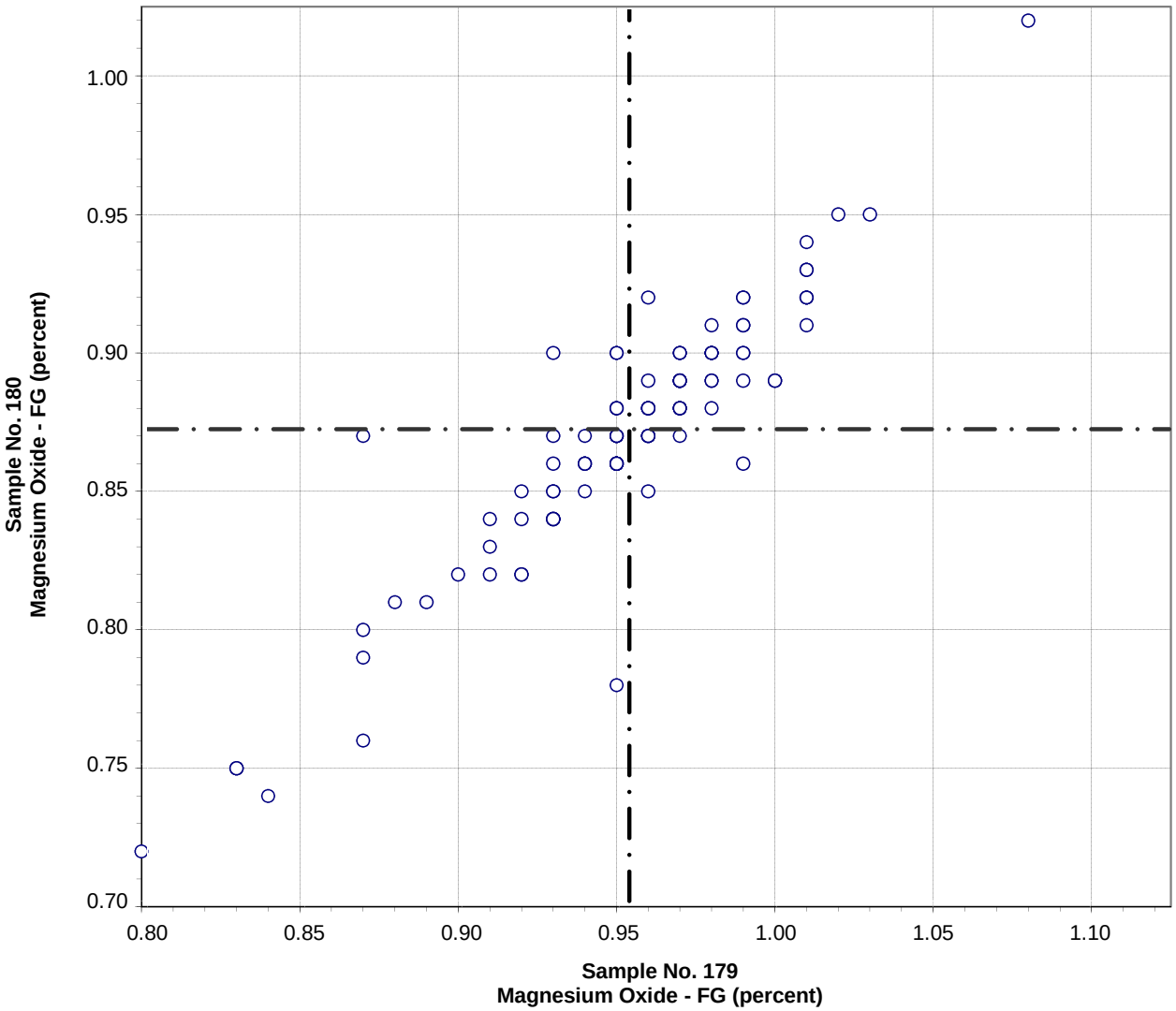



Test No. 43 Calcium Oxide - Pressed Powder 76 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 64.29 | S.D. | 0.42 | C.V. | 0.65 |
| Sample No. 180 | Ave | 64.54 | S.D. | 0.47 | C.V. | 0.72 |

Labs eliminated: 222, 3422

**CCRL Proficiency Sample Program**
**Magnesium Oxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**



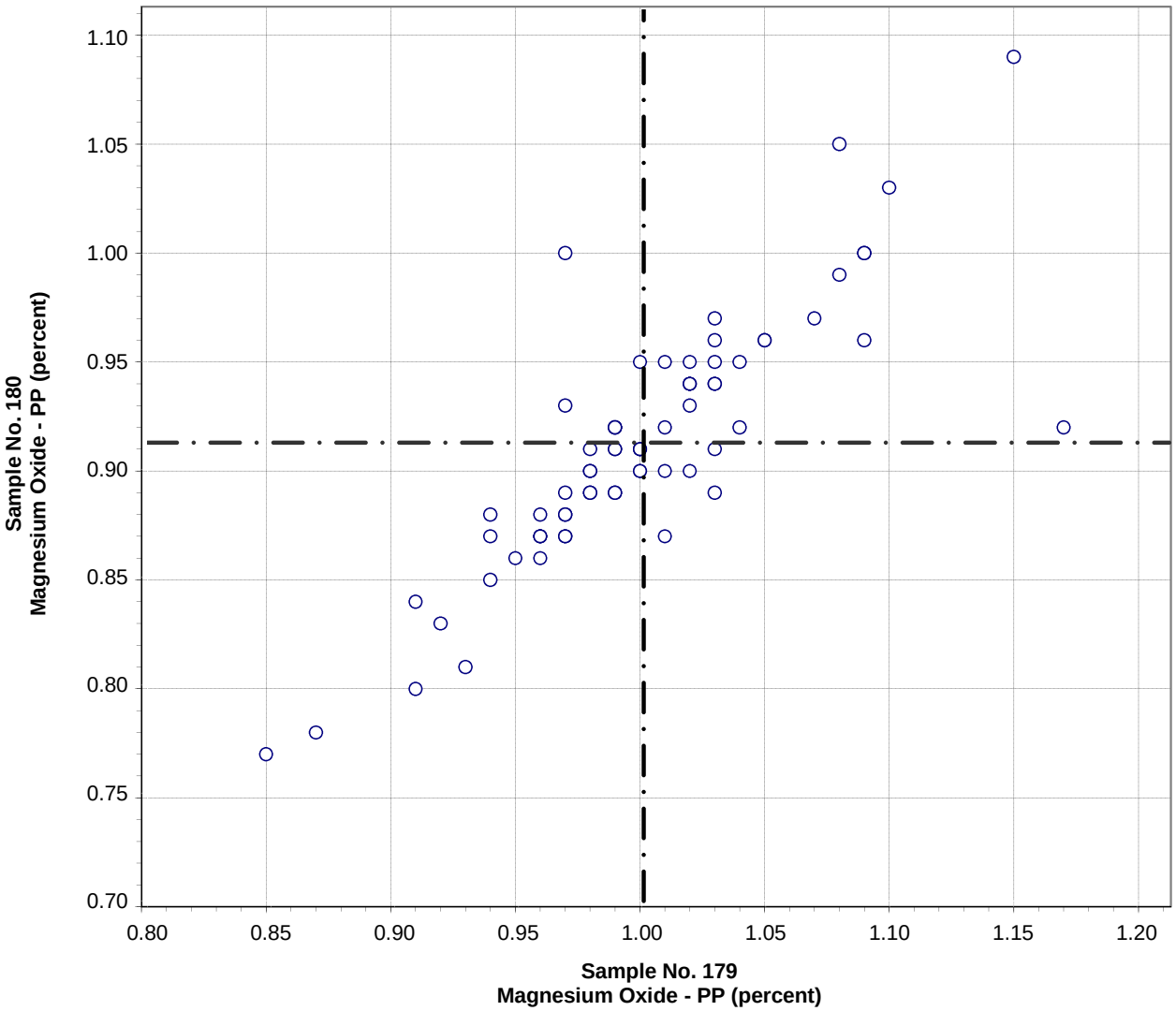

Test No. 52 Magnesium Oxide - Fused Glass 104 Points

Sample No. 179 Ave 0.95 S.D. 0.04 C.V. 4.6
Sample No. 180 Ave 0.87 S.D. 0.05 C.V. 5.5

Labs eliminated: 557, 53, 736, 3233, 25, 169, 2352, 2464, 2490, 3249

Labs off Diagram: 2466

**CCRL Proficiency Sample Program**
**Magnesium Oxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**

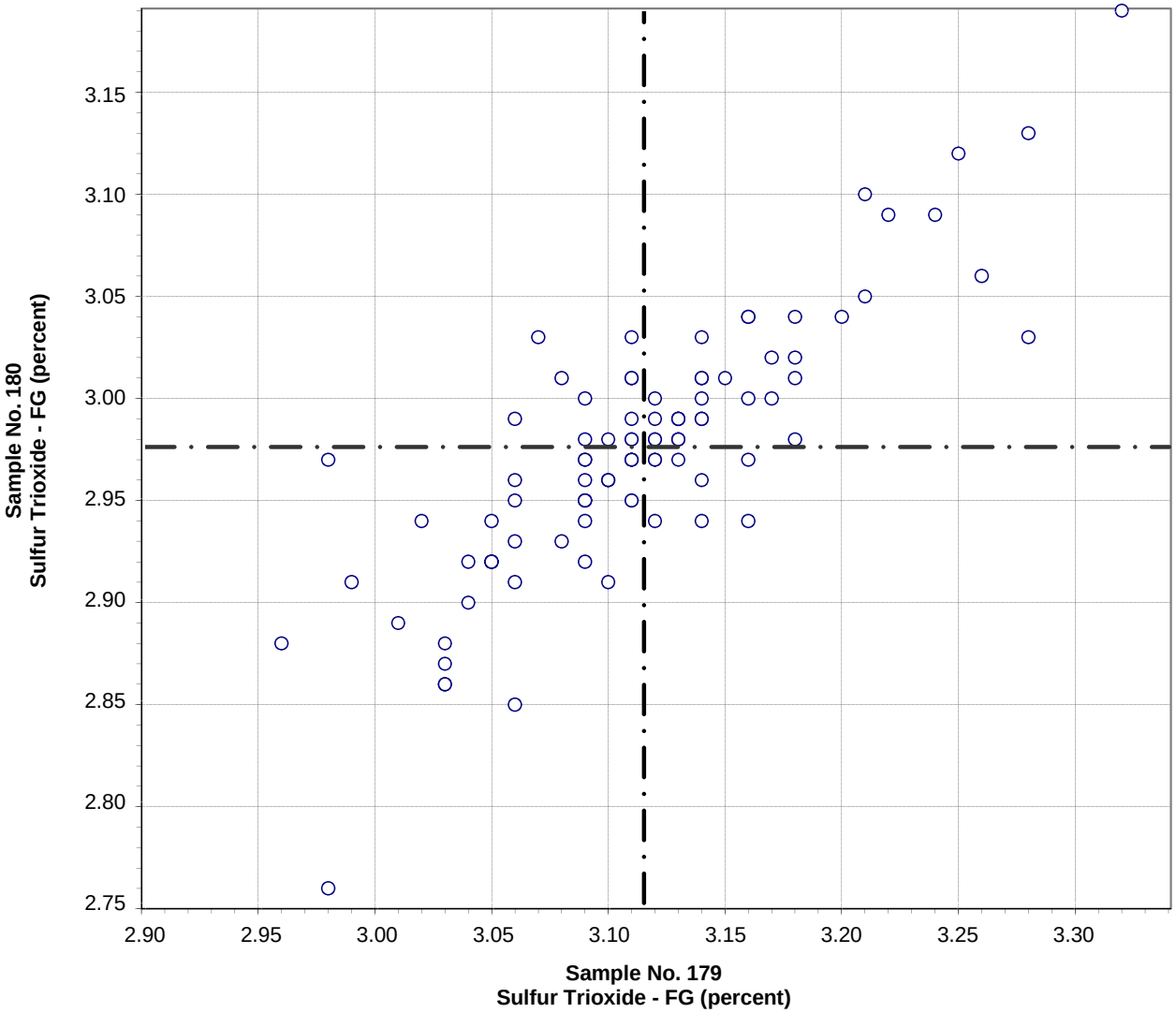



Test No. 53 Magnesium Oxide - Pressed Powder 71 Points

Sample No. 179 Ave 1.00 S.D. 0.06 C.V. 5.6
Sample No. 180 Ave 0.91 S.D. 0.06 C.V. 6.2

Labs eliminated: 95, 502, 413, 1251, 3422

**CCRL Proficiency Sample Program**
**Sulfur Trioxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**

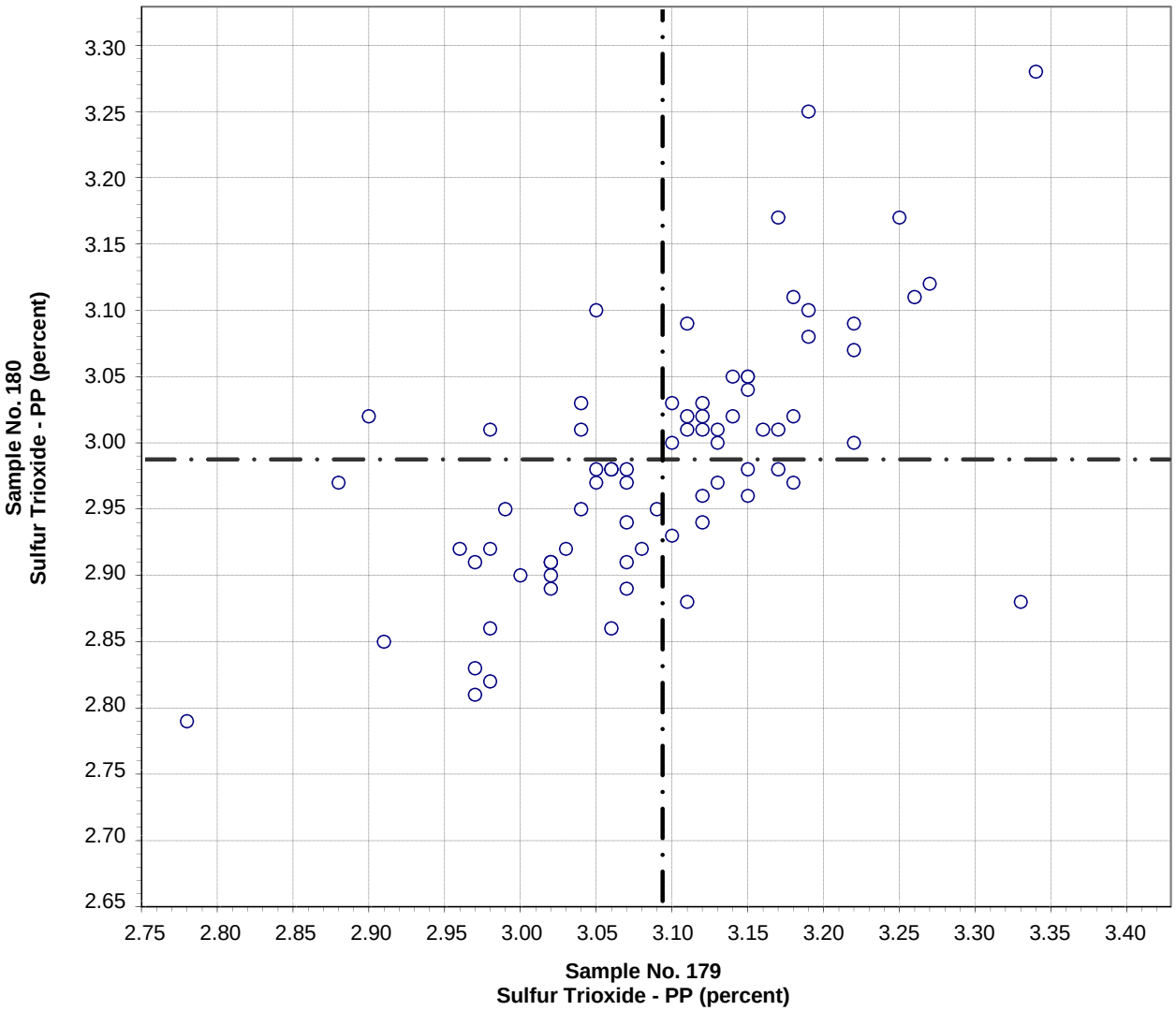



Test No. 62 Sulfur Trioxide - Fused Glass 96 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 3.11 | S.D. | 0.07 | C.V. | 2.1 |
| Sample No. 180 | Ave | 2.98 | S.D. | 0.06 | C.V. | 2.1 |

Labs eliminated: 53, 134, 247, 1799, 2982

**CCRL Proficiency Sample Program**
**Sulfur Trioxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**

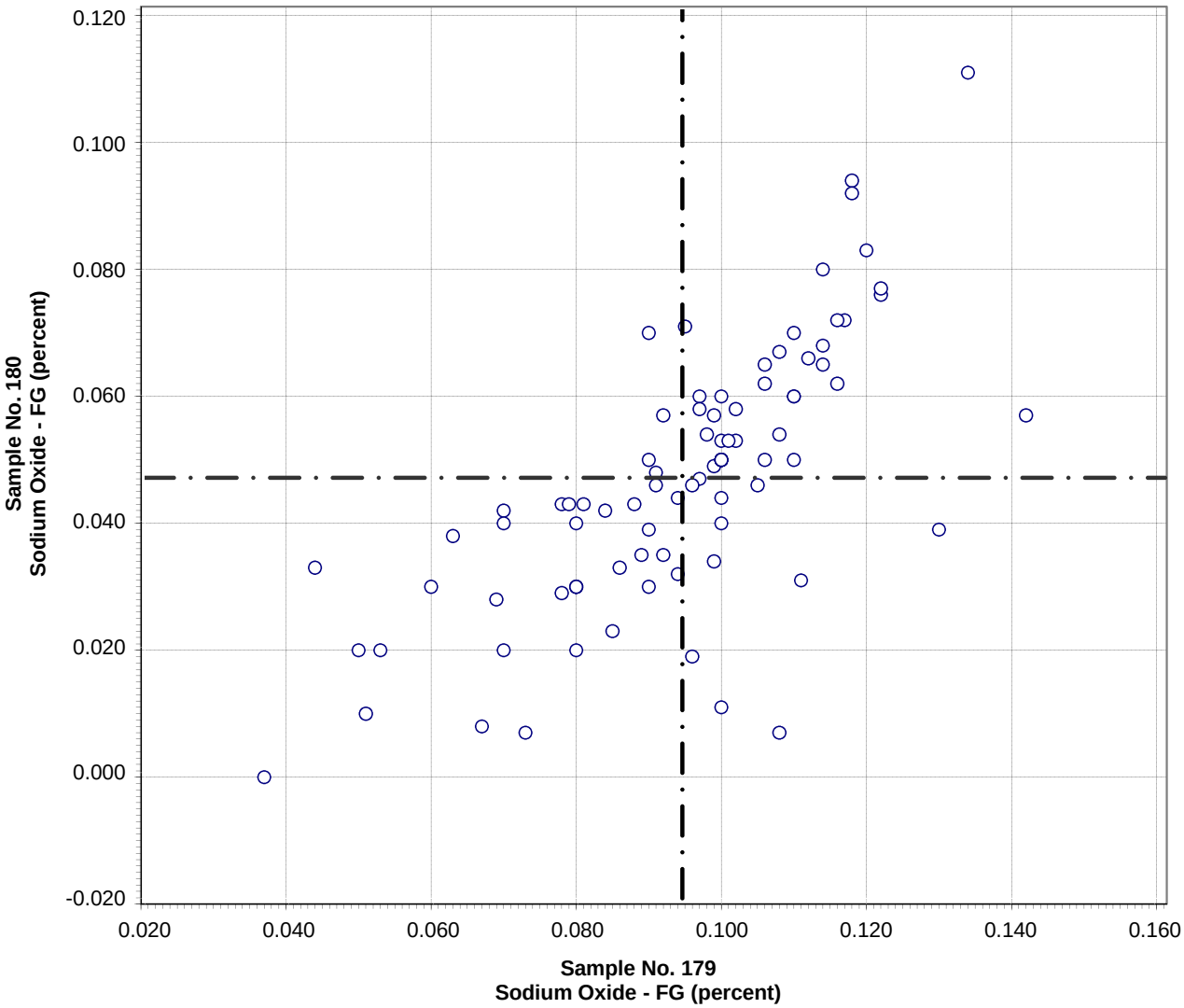



Test No. 63 Sulfur Trioxide - Pressed Powder 75 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 3.09 | S.D. | 0.10 | C.V. | 3.2 |
| Sample No. 180 | Ave | 2.99 | S.D. | 0.09 | C.V. | 3.1 |

Labs eliminated: 20, 43

## CCRL Proficiency Sample Program
## Sodium Oxide - Fused Glass
## PORTLAND CEMENT Samples No. 179 and No. 180

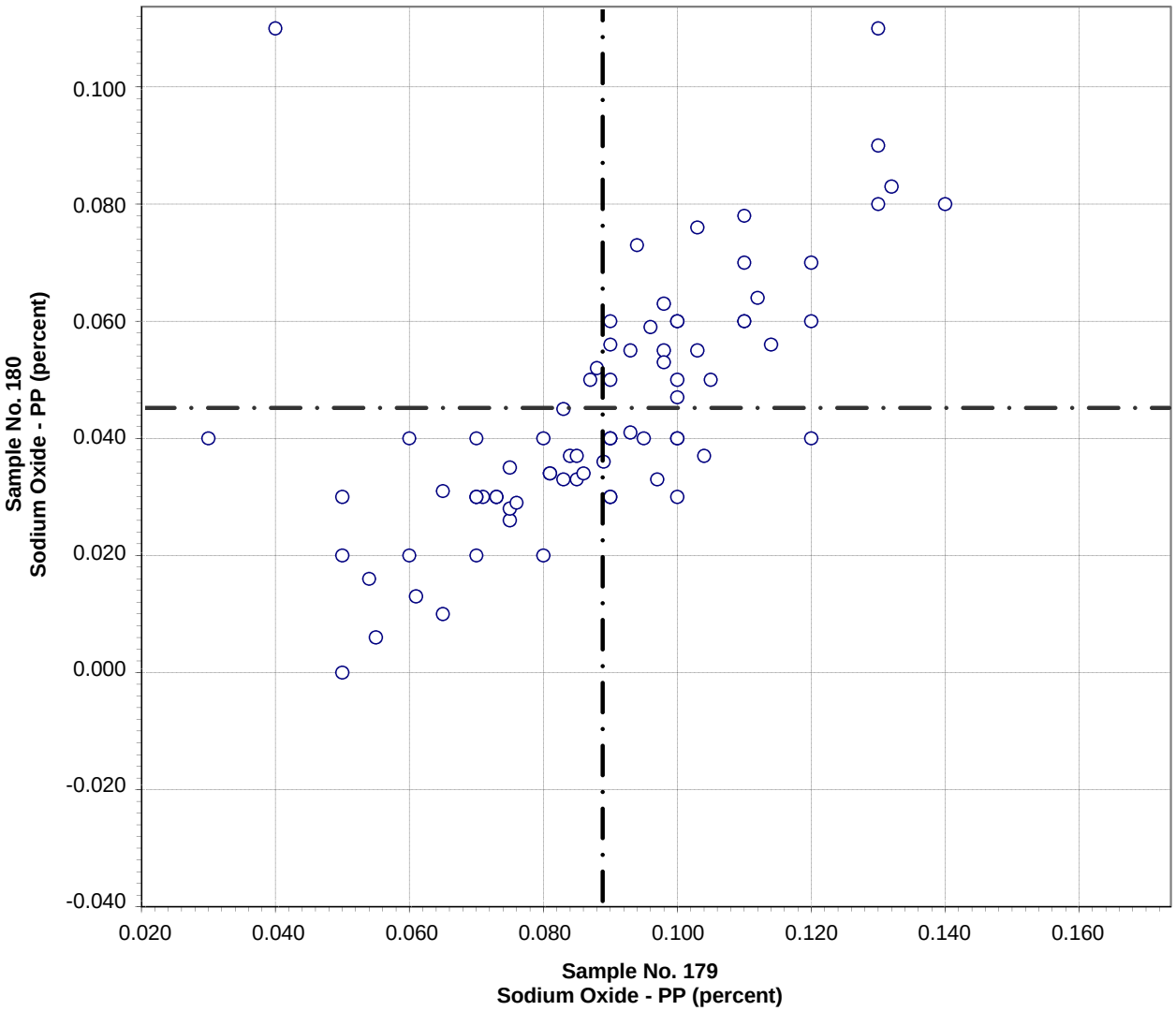



Test No. 92 Sodium Oxide - Fused Glass 87 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.095 | S.D. | 0.020 | C.V. | 21 |
| Sample No. 180 | Ave | 0.047 | S.D. | 0.021 | C.V. | 44 |

Labs eliminated: 116, 130, 2360, 53, 98, 1466, 2464, 56, 557, 2296, 2463, 2477, 2490

**CCRL Proficiency Sample Program**
**Sodium Oxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**

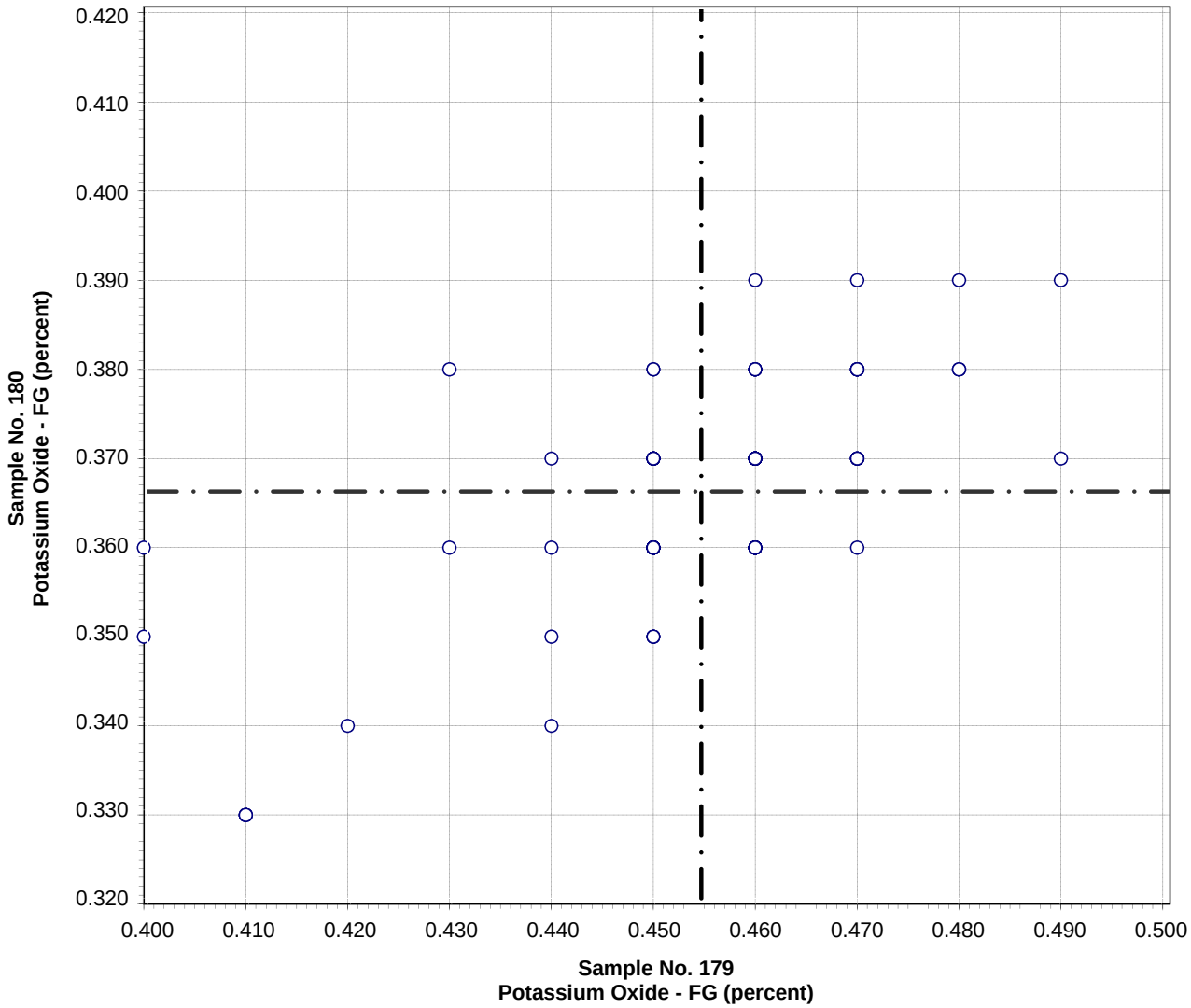



Test No. 93 Sodium Oxide - Pressed Powder 78 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.089 | S.D. | 0.022 | C.V. | 25 |
| Sample No. 180 | Ave | 0.045 | S.D. | 0.021 | C.V. | 47 |

Labs eliminated: 494, 1251, 157, 1657, 886, 1025, 3238

**CCRL Proficiency Sample Program**
**Potassium Oxide - Fused Glass**
**PORTLAND CEMENT Samples No. 179 and No. 180**

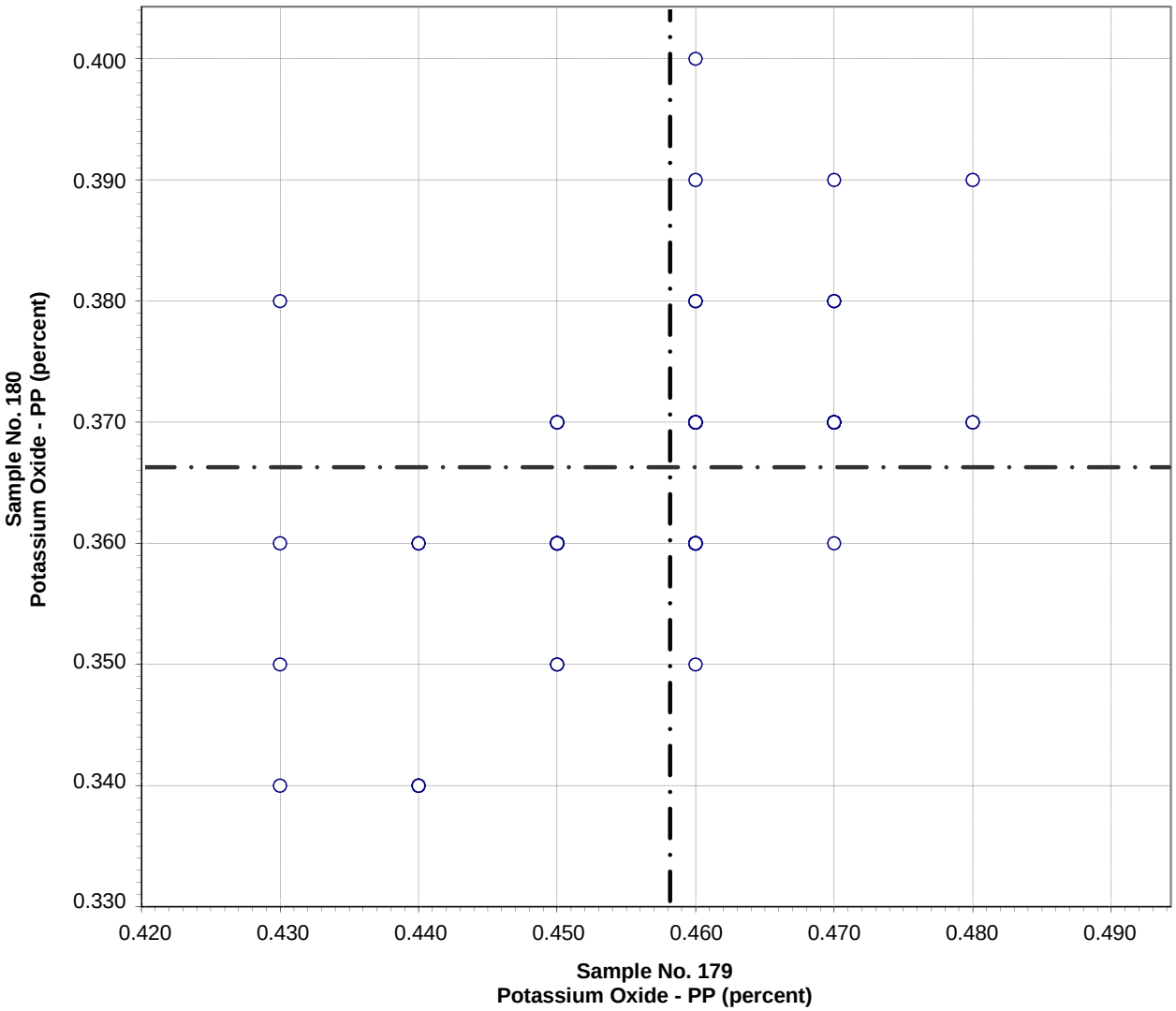



Test No. 102 Potassium Oxide - Fused Glass 108 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.455 | S.D. | 0.015 | C.V. | 3.3 |
| Sample No. 180 | Ave | 0.366 | S.D. | 0.011 | C.V. | 3.1 |

Labs eliminated: 557, 116, 206, 1053, 2412

**CCRL Proficiency Sample Program**
**Potassium Oxide - Pressed Powder**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 103 Potassium Oxide - Pressed Powder 78 Points

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample No. 179 | Ave | 0.458 | S.D. | 0.012 | C.V. | 2.6 |
| Sample No. 180 | Ave | 0.366 | S.D. | 0.012 | C.V. | 3.2 |

Labs eliminated: 3422, 3454, 124, 3607

CCRL PROFICIENCY SAMPLE PROGRAM
Portland Cement Proficiency Samples No. 179 and No. 180
Final Report
Optional Fineness - 45µm sieve Performed on Chemical Sample
March 25, 2011

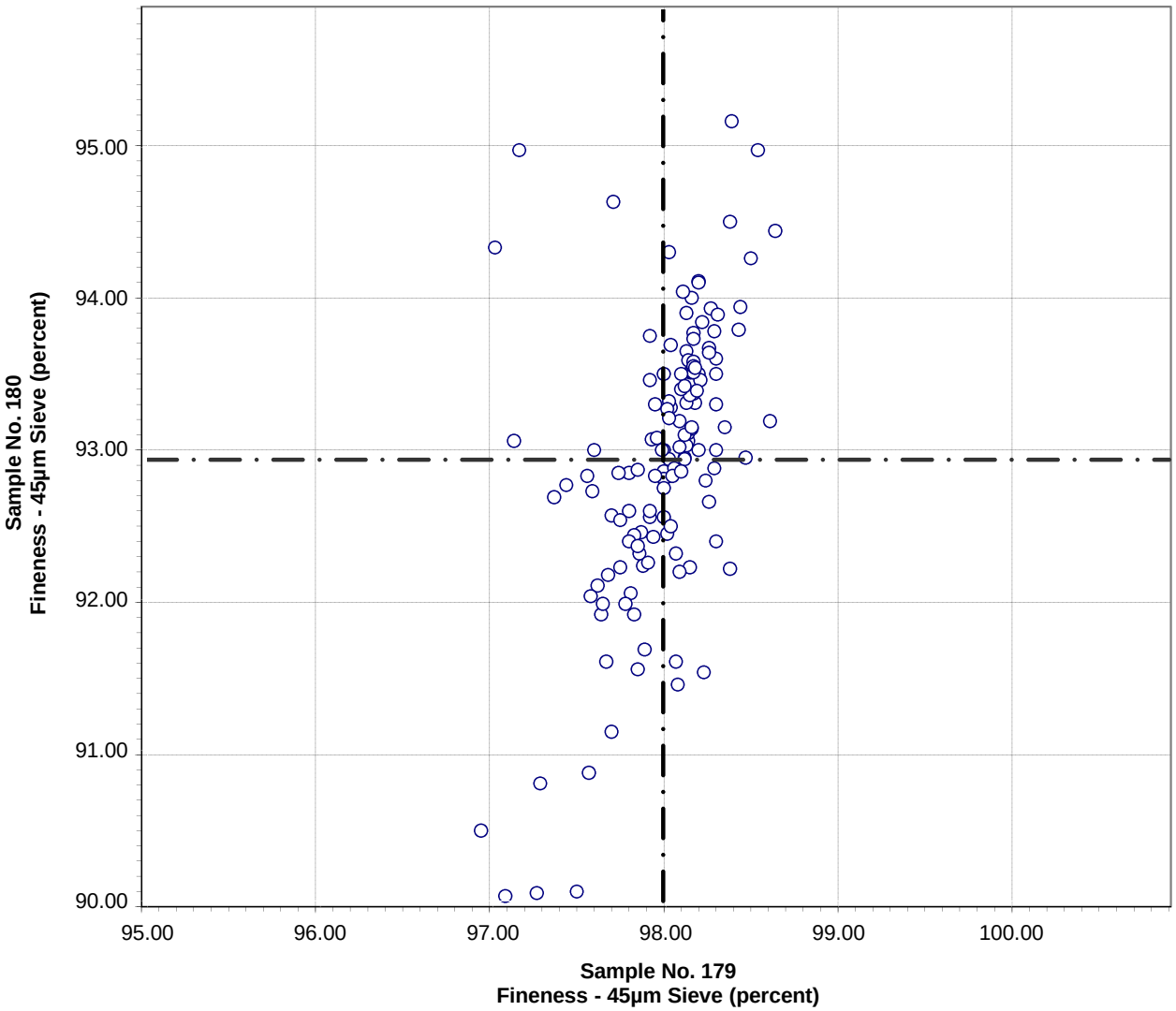
SUMMARY OF RESULTS

| | | | Sample No. 179 | | | Sample No. 180 | | |
|---|---|---|---|---|---|---|---|---|
| Test | | #Labs | Average | S.D. | C.V. | Average | S.D. | C.V. |
| 45µm sieve | % | 149 | 97.44 | 6.10 | 6.3 | 92.54 | 3.60 | 4.0 |
| 45µm sieve | % | * 140 | 97.98 | 0.33 | 0.33 | 92.93 | 0.95 | 1.0 |

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

Fineness - 45µm 1 29 222 2477 47 126 413 565 3135

**CCRL Proficiency Sample Program**
**Fineness - 45µm Sieve (Chemical Sample)**
**PORTLAND CEMENT Samples No. 179 and No. 180**




Test No. 282 Fineness - 45µm Sieve (Chemical Sample) 139 Points

| | | | | | |
|---|---|---|---|---|---|
| Sample No. 179 | Ave | 97.98 | S.D. | 0.33 | C.V. 0.33 |
| Sample No. 180 | Ave | 92.93 | S.D. | 0.95 | C.V. 1.0 |

Labs eliminated: 1, 29, 222, 2477, 47, 126, 413, 565, 3135

Labs off Diagram: 19