CEMENT AND CONCRETE REFERENCE LABORATORY

PROFICIENCY SAMPLE PROGRAM

Final Report
Blended Cement Proficiency Samples
Number 83 and Number 84

April 2019

CCRL
Cement and Concrete
Reference Laboratory

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Reference Laboratory

www.ccrl.us

April 30, 2019

TO: Participants in the CCRL Blended Cement Proficiency Sample Program

SUBJECT: Final Report on Blended Cement Proficiency Samples No. 83 and No. 84

Following is the final report for the current pair of CCRL **Blended Cement** Proficiency Samples which were distributed in February 2019. Both cements were an ASTM C595 Blended Hydraulic Cement. Sample No 83 was a Type IL (13) and No. 84 was a Type IL (10).

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/.

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 of CCRL EXTRA Samples.

It is presently anticipated that the next Blended Cement Proficiency Samples will be distributed in February 2020.

Sincerely,

Kent Niedzielski
Program Manager, Proficiency Samples
Cement and Concrete Reference Laboratory

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TO: Participants in the CCRL Blended Cement Proficiency Sample Program

FROM: Kent Niedzielski, Program Manager, Proficiency Samples

SUBJECT: Explanation of Final Report on Results of Tests for Blended Cement Proficiency Samples No. 83 and No. 84

This letter, and the material included with it, constitutes the final report and summary of results for the current pair of Blended Cement Proficiency Samples, which were distributed in February 2019. 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.

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

[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.*

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

Blended Cement Proficiency Samples No. 83 and No. 84

Final Report – April 30, 2019

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 83 Average	S.D.	C.V.	Sample No. 84 Average	S.D.	C.V.
Silicon Dioxide (**percent**)							
	93	17.98	0.46	2.6	17.98	0.38	2.1
	*90	17.93	0.38	2.1	17.96	0.34	1.9
* Labs Eliminated - 3059, 3287, 4251							
Aluminum Oxide (**percent**)							
	92	5.35	0.25	4.7	4.45	0.23	5.1
	*83	5.34	0.17	3.1	4.43	0.12	2.7
* Labs Eliminated - 14, 413, 694, 3059, 3247, 3287, 3431, 3910, 3930							
Ferric Oxide (**percent**)							
	92	1.24	0.16	13.2	3.12	0.08	2.5
	*85	1.21	0.06	4.7	3.13	0.06	1.9
* Labs Eliminated - 10, 3059, 3409, 3431, 3910, 3930, 4251							
Calcium Oxide (**percent**)							
	92	63.06	1.33	2.11	63.34	1.24	1.96
	*90	63.04	1.27	2.01	63.35	1.11	1.74
* Labs Eliminated - 43, 246							
Magnesium Oxide (**percent**)							
	93	2.42	0.14	5.6	1.36	0.36	26.2
	*86	2.42	0.07	3.0	1.32	0.05	3.8
* Labs Eliminated - 14, 50, 246, 354, 3287, 3910, 4310							
Sulfur Trioxide - All Data (**percent**)							
	96	3.23	0.13	4	3.44	0.14	4
	*94	3.24	0.10	3	3.45	0.11	3
* Labs Eliminated - 2477, 3910							
Loss on Ignition - All Data (**percent**)							
	98	6.62	0.19	3	5.86	0.15	2
	*95	6.62	0.12	2	5.86	0.10	2
* Labs Eliminated - 17, 246, 3297							

CCRL PROFICIENCY SAMPLE PROGRAM

Blended Cement Proficiency Samples No. 83 and No. 84

Final Report – April 30, 2019

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 83 Average	S.D.	C.V.	Sample No. 84 Average	S.D.	C.V.
Sodium Oxide (**percent**)							
	88	0.217	0.083	38	0.137	0.080	58
	*84	0.207	0.038	18	0.128	0.030	23
* Labs Eliminated - 2352, 3185, 3910, 4251							
Potassium Oxide (**percent**)							
	90	0.38	0.03	8.4	0.45	0.06	12.4
	*86	0.38	0.02	5.2	0.45	0.03	6.3
* Labs Eliminated - 246, 497, 2466, 4251							
Titanium Dioxide (**percent**)							
	71	0.26	0.016	6.1	0.24	0.013	5.3
	*70	0.26	0.013	4.8	0.24	0.011	4.6
* Labs Eliminated - 698							
Phosphorus Pentoxide (**percent**)							
	73	0.123	0.021	16.7	0.214	0.024	11.1
	*66	0.121	0.007	6.0	0.216	0.012	5.6
* Labs Eliminated - 47, 246, 441, 497, 698, 1956, 3930							
Zinc Oxide (**percent**)							
	34	0.010	0.017	159.7	0.070	0.012	16.7
	*31	0.007	0.001	17.9	0.071	0.002	3.4
* Labs Eliminated - 178, 413, 2360							
Manganic Oxide (**percent**)							
	58	0.102	0.010	9.8	0.103	0.014	13.9
	*56	0.100	0.007	6.7	0.101	0.008	7.8
* Labs Eliminated - 354, 3297							
Chloride (**percent**)							
	42	0.007	0.005	77	0.016	0.006	39
	*38	0.005	0.002	42	0.015	0.006	38
* Labs Eliminated - 34, 38, 101, 958							

CCRL PROFICIENCY SAMPLE PROGRAM

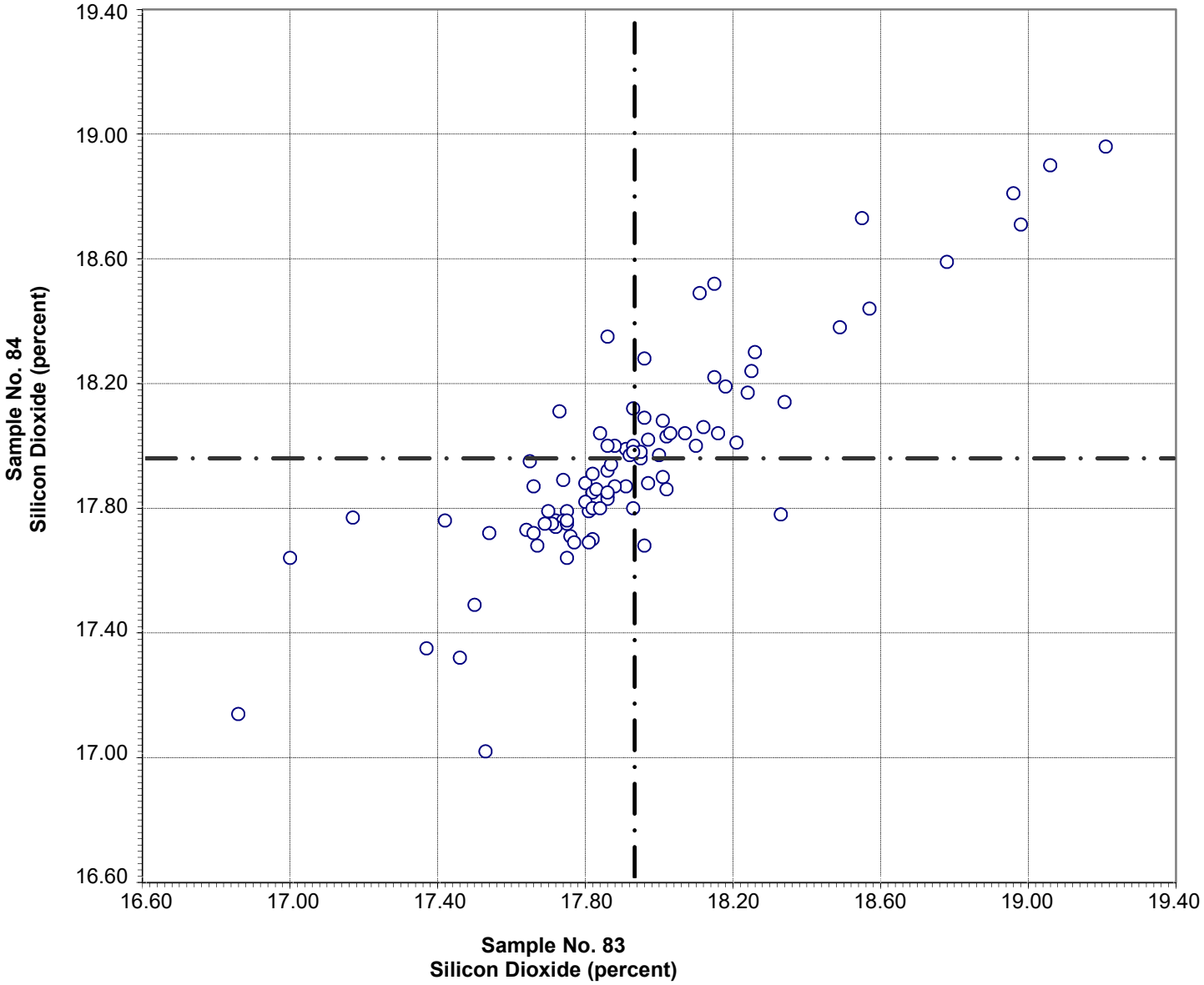
Blended Cement Proficiency Samples No. 83 and No. 84

Final Report – April 30, 2019

SUMMARY OF RESULTS

		Sample No. 83			Sample No. 84		
Test (unit)	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Insoluble Residue (**percent**)							
	81	0.91	0.23	25	0.68	0.23	33
	*74	0.90	0.13	14	0.63	0.13	20
* Labs Eliminated - 24, 40, 101, 698, 2938, 3911, 4251							
Chromium Oxide (**percent**)							
	36	0.016	0.017	102	0.021	0.002	10
	*33	0.013	0.002	13	0.021	0.002	9
* Labs Eliminated - 36, 101, 1466							

CCRL Proficiency Sample Program
Silicon Dioxide
BLENDED CEMENT Samples No. 83 and No. 84

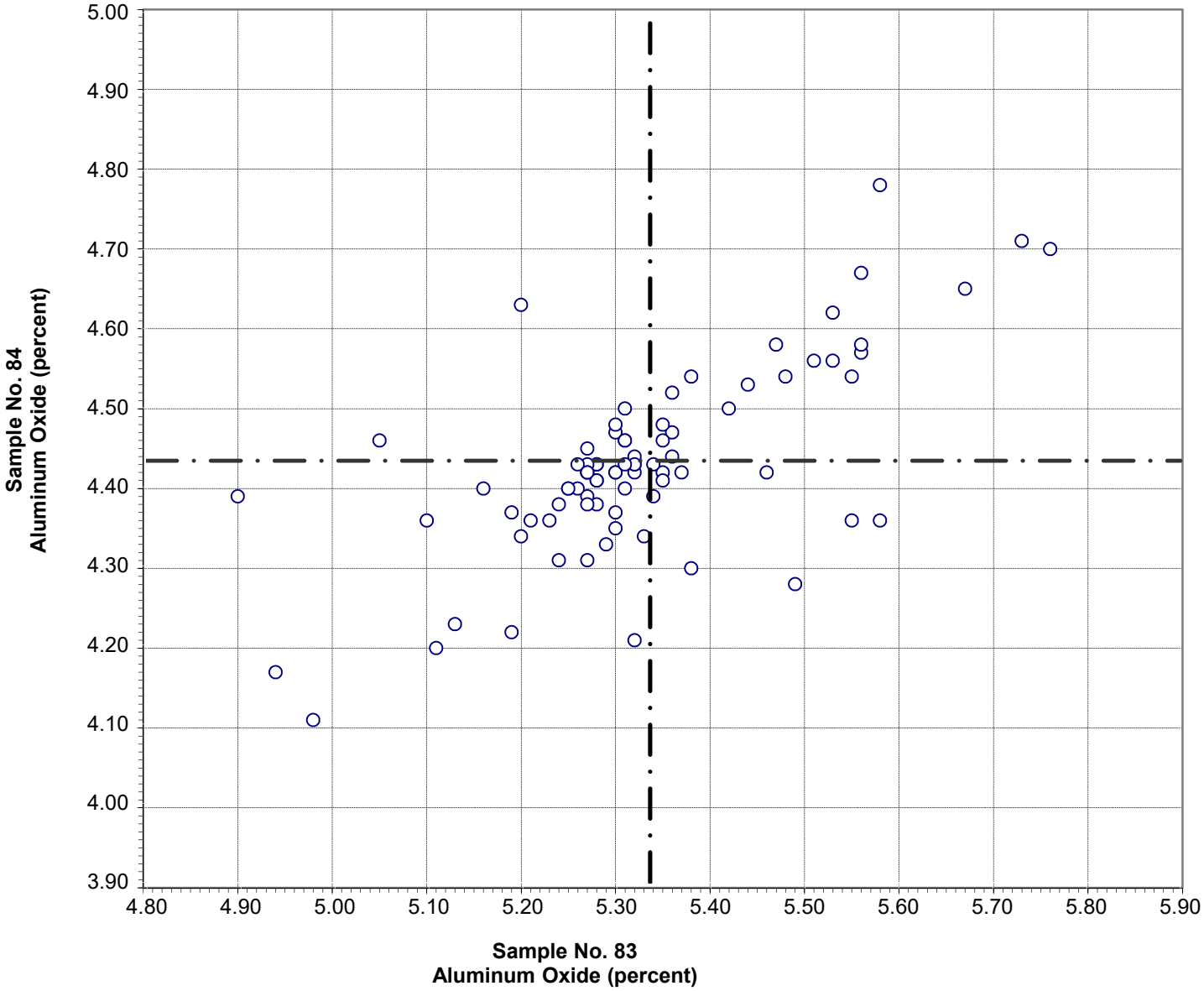


Test No. 10 Silicon Dioxide 90 Points

Sample No. 83	Ave	17.93	S.D.	0.38	C.V.	2.1
Sample No. 84	Ave	17.96	S.D.	0.34	C.V.	1.9

Labs Eliminated: 3059, 3287, 4251

CCRL Proficiency Sample Program
Aluminum Oxide
BLENDED CEMENT Samples No. 83 and No. 84



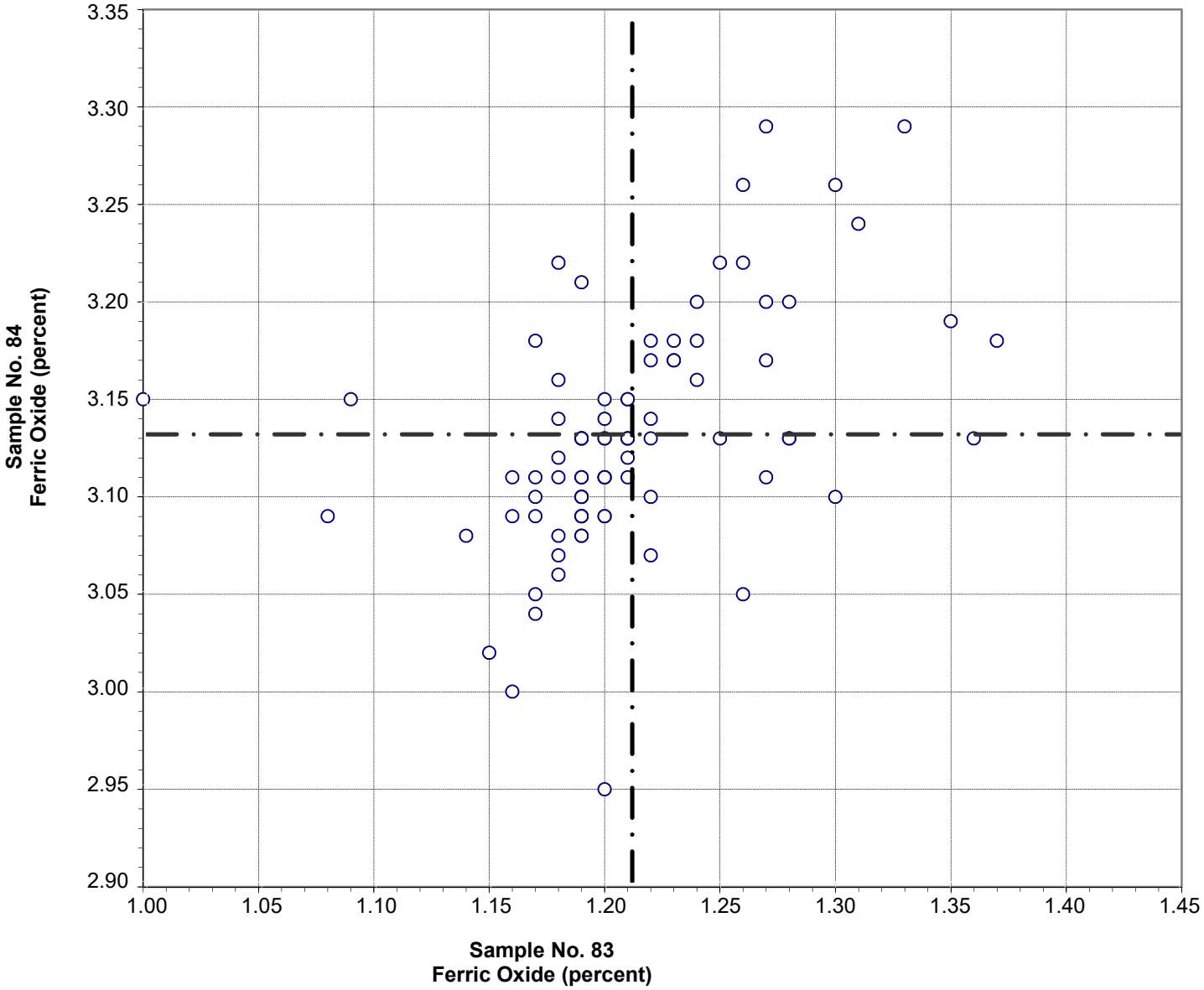
Test No. 21 Aluminum Oxide 82 Points

Sample No. 83	Ave	5.34	S.D.	0.17	C.V. 3.1
Sample No. 84	Ave	4.43	S.D.	0.12	C.V. 2.7

Labs Eliminated: 14, 413, 694, 3059, 3247, 3287, 3431, 3910, 3930

Labs off Diagram: 17

CCRL Proficiency Sample Program
Ferric Oxide
BLENDED CEMENT Samples No. 83 and No. 84

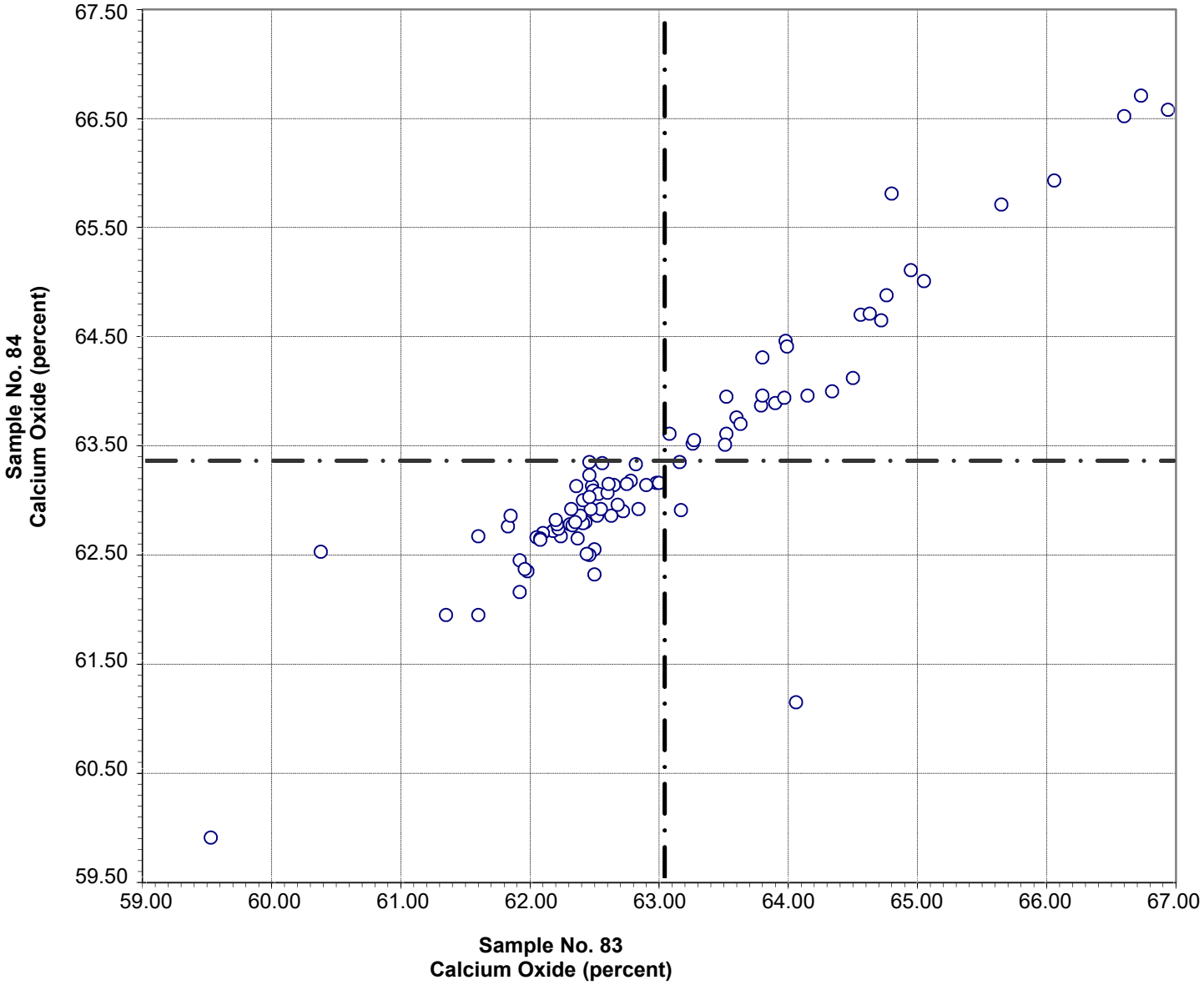


Test No. 30 Ferric Oxide 85 Points

Sample No. 83	Ave	1.21	S.D.	0.06	C.V. 4.7
Sample No. 84	Ave	3.13	S.D.	0.06	C.V. 1.9

Labs Eliminated: 10, 3059, 3409, 3431, 3910, 3930, 4251

CCRL Proficiency Sample Program
Calcium Oxide
BLENDED CEMENT Samples No. 83 and No. 84

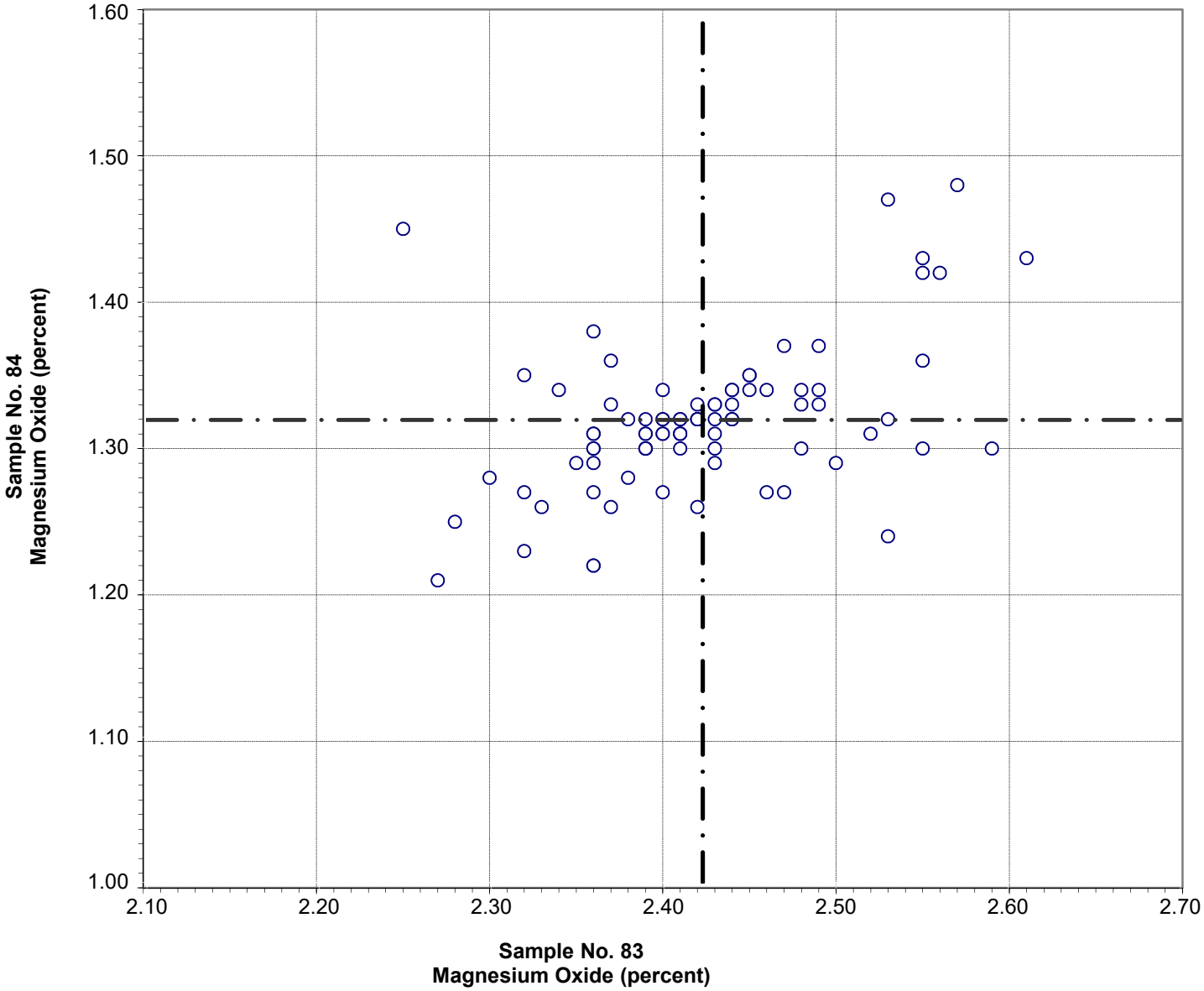


Test No. 40 Calcium Oxide 90 Points

Sample No. 83	Ave	63.04	S.D.	1.27	C.V. 2.01
Sample No. 84	Ave	63.35	S.D.	1.11	C.V. 1.74

Labs Eliminated: 43, 246

CCRL Proficiency Sample Program
Magnesium Oxide
BLENDED CEMENT Samples No. 83 and No. 84

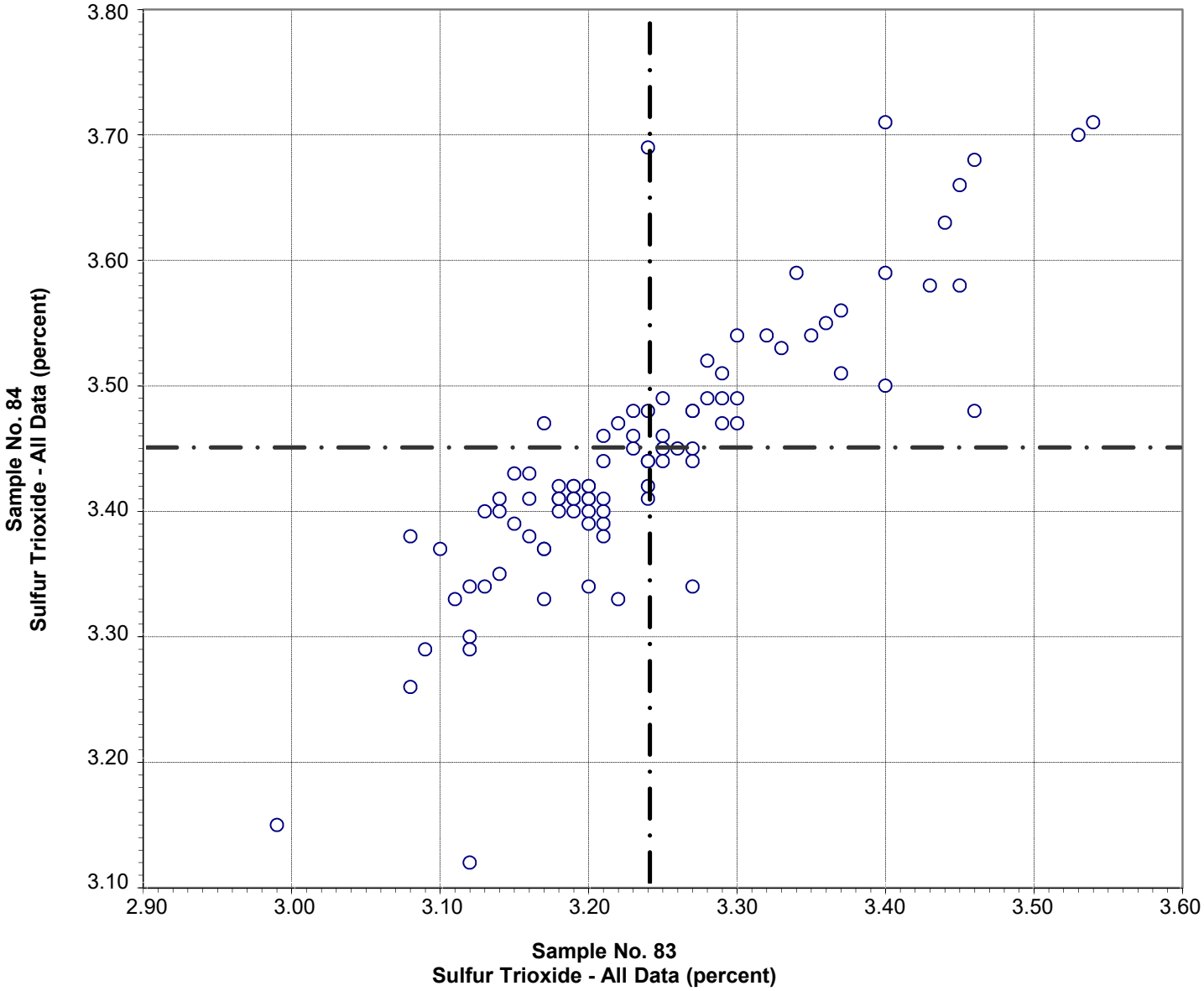


Test No. 50 Magnesium Oxide 86 Points

Sample No. 83	Ave	2.42	S.D.	0.07	C.V. 3.0
Sample No. 84	Ave	1.32	S.D.	0.05	C.V. 3.8

Labs Eliminated: 14, 50, 246, 354, 3287, 3910, 4310

CCRL Proficiency Sample Program
Sulfur Trioxide - All Data
BLENDED CEMENT Samples No. 83 and No. 84



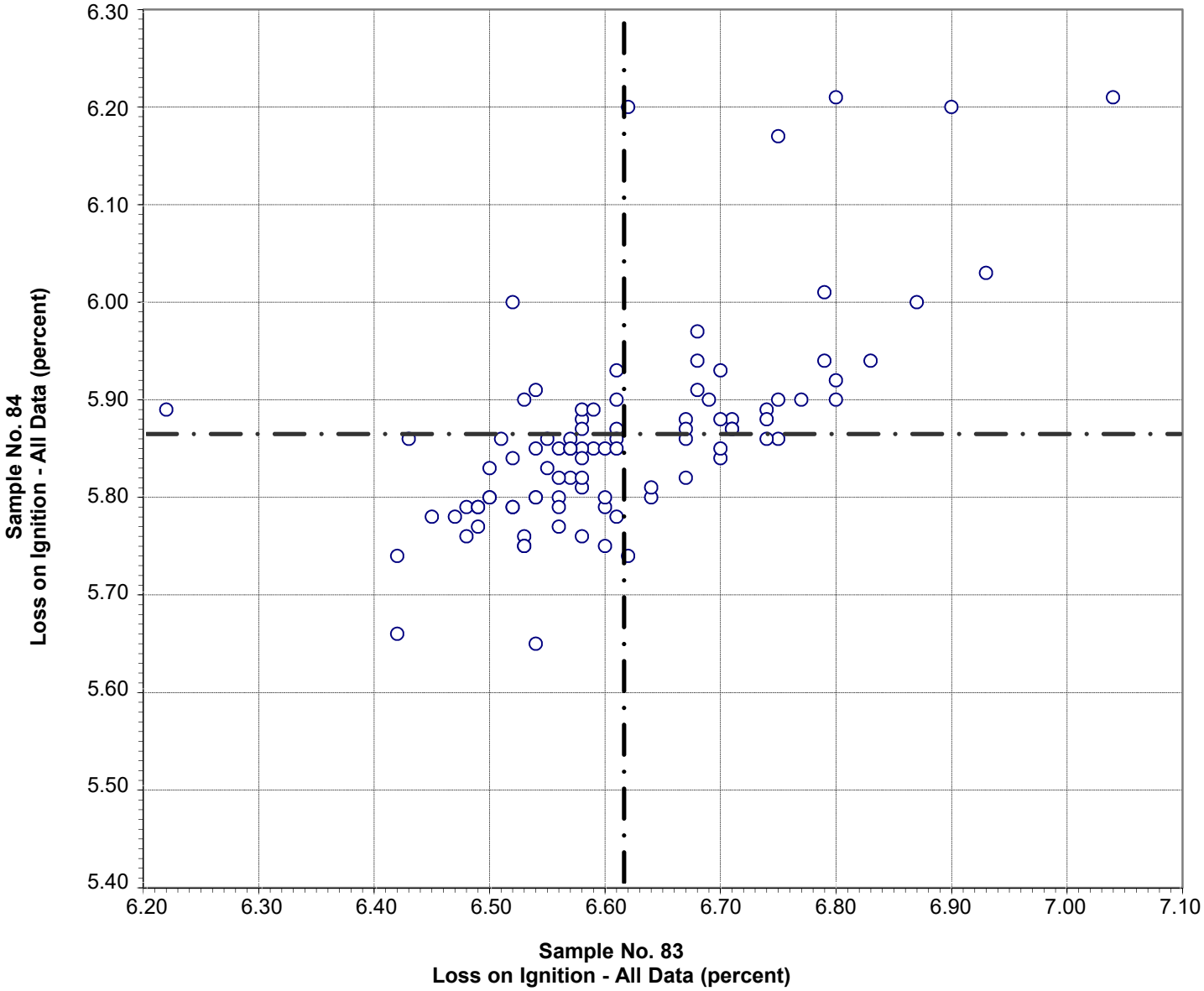
Test No. 60 Sulfur Trioxide - All Data 93 Points

Sample No. 83	Ave	3.24	S.D.	0.10	C.V. 3
Sample No. 84	Ave	3.45	S.D.	0.11	C.V. 3

Labs Eliminated: 2477, 3910

Labs off Diagram: 125

CCRL Proficiency Sample Program
Loss on Ignition - All Data
BLENDED CEMENT Samples No. 83 and No. 84

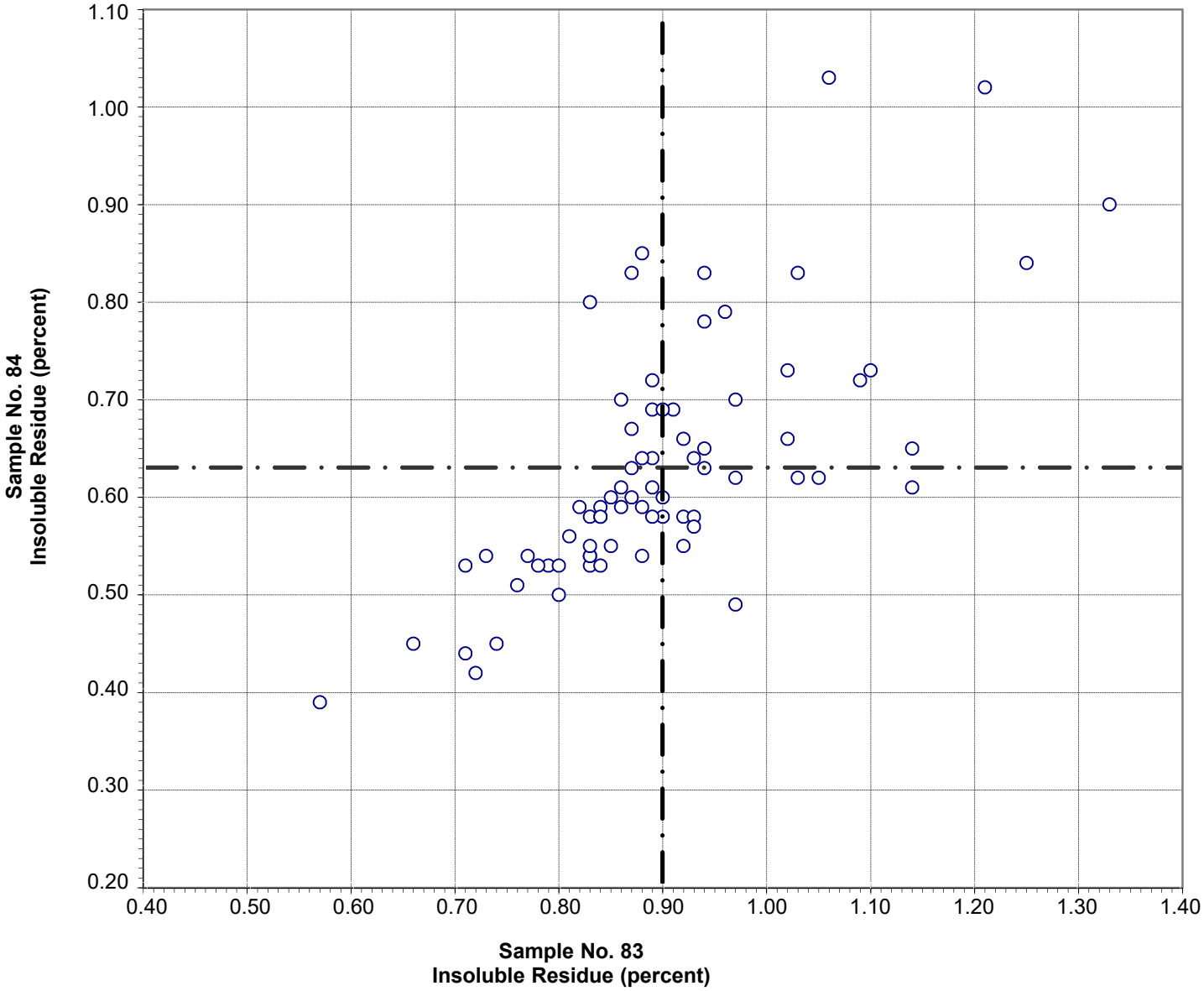


Test No. 70 Loss on Ignition - All Data 95 Points

Sample No. 83	Ave	6.62	S.D.	0.12	C.V. 2
Sample No. 84	Ave	5.86	S.D.	0.10	C.V. 2

Labs Eliminated: 17, 246, 3297

CCRL Proficiency Sample Program
Insoluble Residue
BLENDED CEMENT Samples No. 83 and No. 84

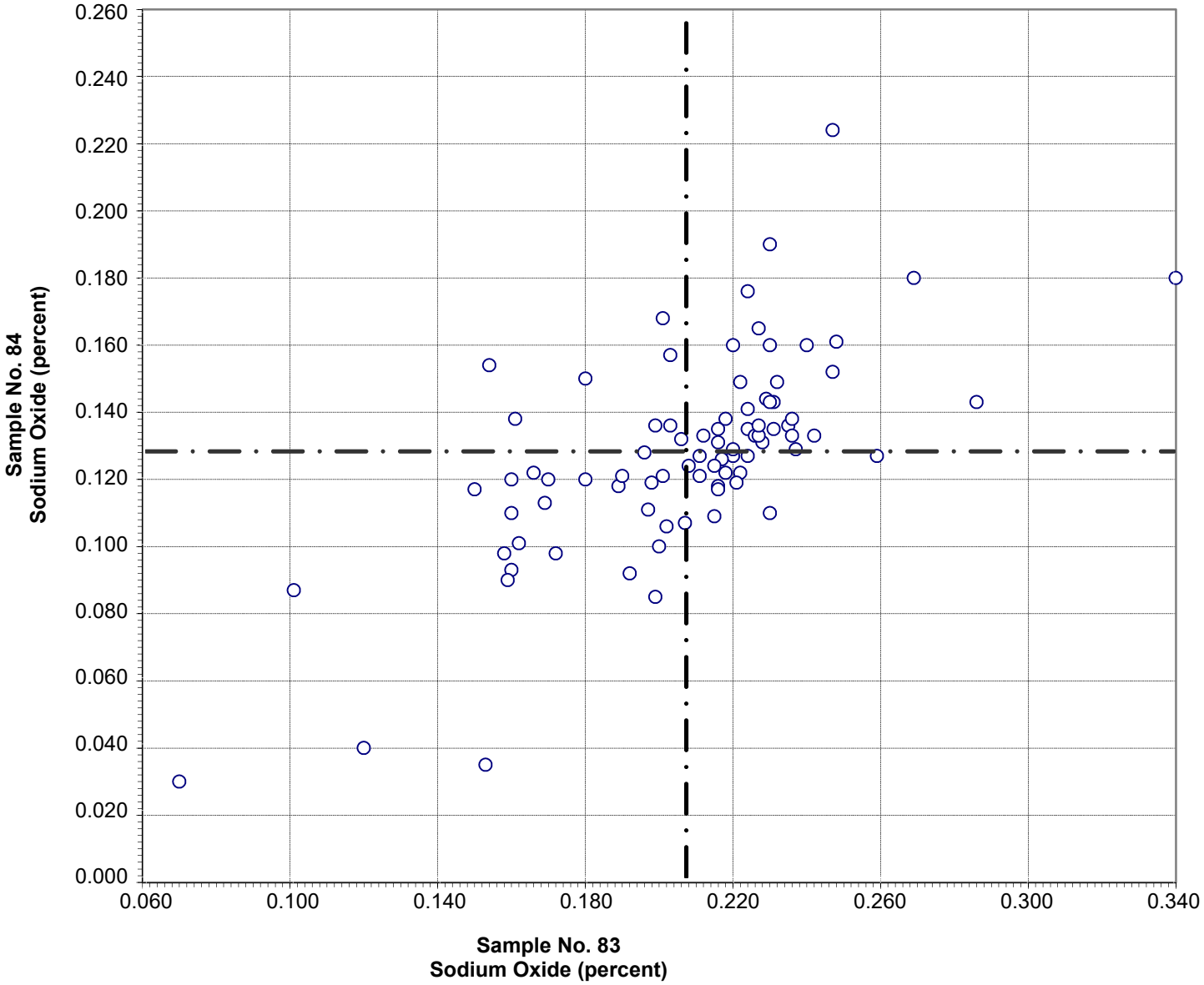


Test No. 80 Insoluble Residue 74 Points

Sample No. 83	Ave	0.90	S.D.	0.13	C.V. 14
Sample No. 84	Ave	0.63	S.D.	0.13	C.V. 20

Labs Eliminated: 24, 40, 101, 698, 2938, 3911, 4251

CCRL Proficiency Sample Program
Sodium Oxide
BLENDED CEMENT Samples No. 83 and No. 84

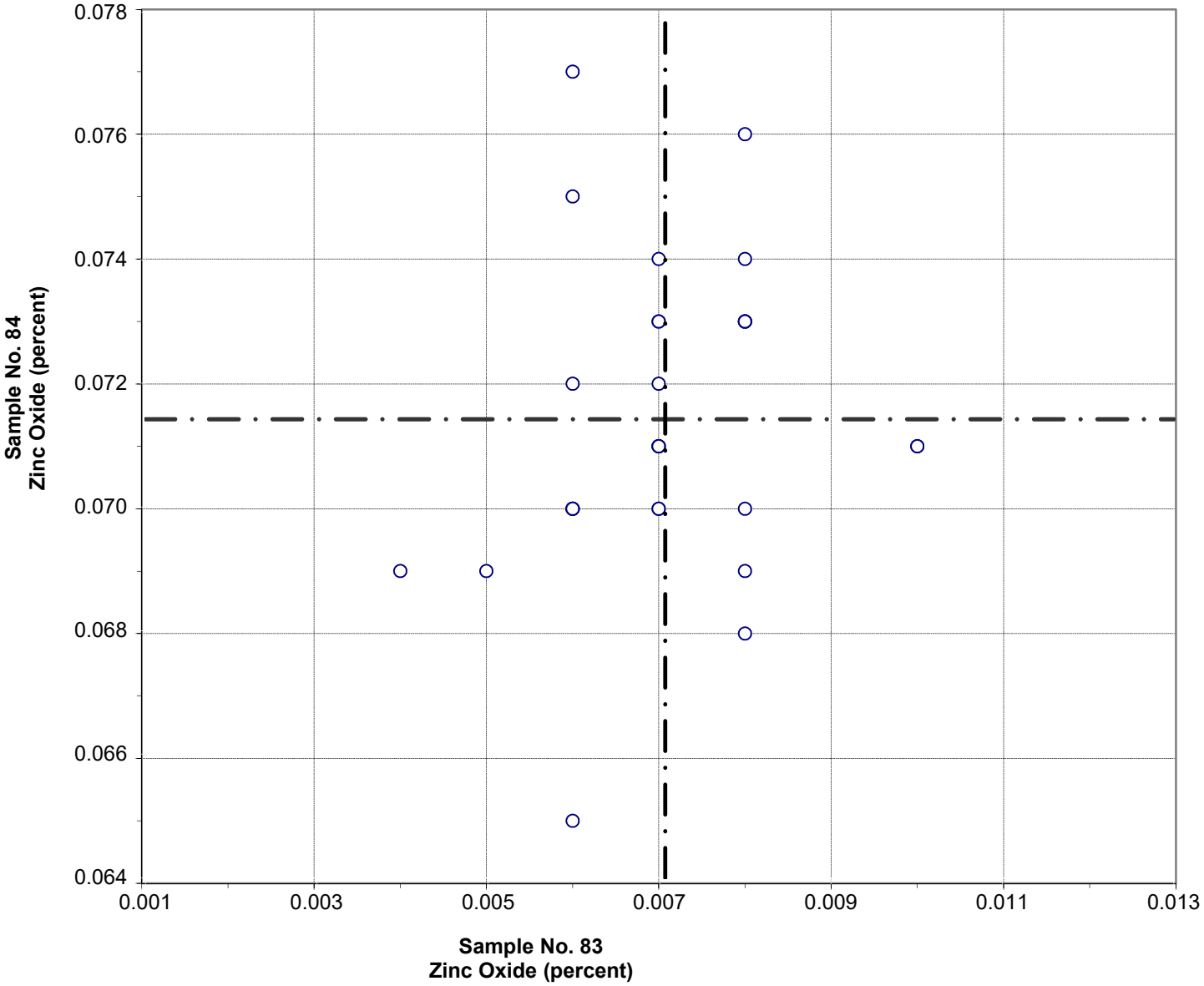


Test No. 90 Sodium Oxide 84 Points

Sample No. 83	Ave	0.207	S.D.	0.038	C.V. 18
Sample No. 84	Ave	0.128	S.D.	0.030	C.V. 23

Labs Eliminated: 2352, 3185, 3910, 4251

CCRL Proficiency Sample Program
Zinc Oxide
BLENDED CEMENT Samples No. 83 and No. 84

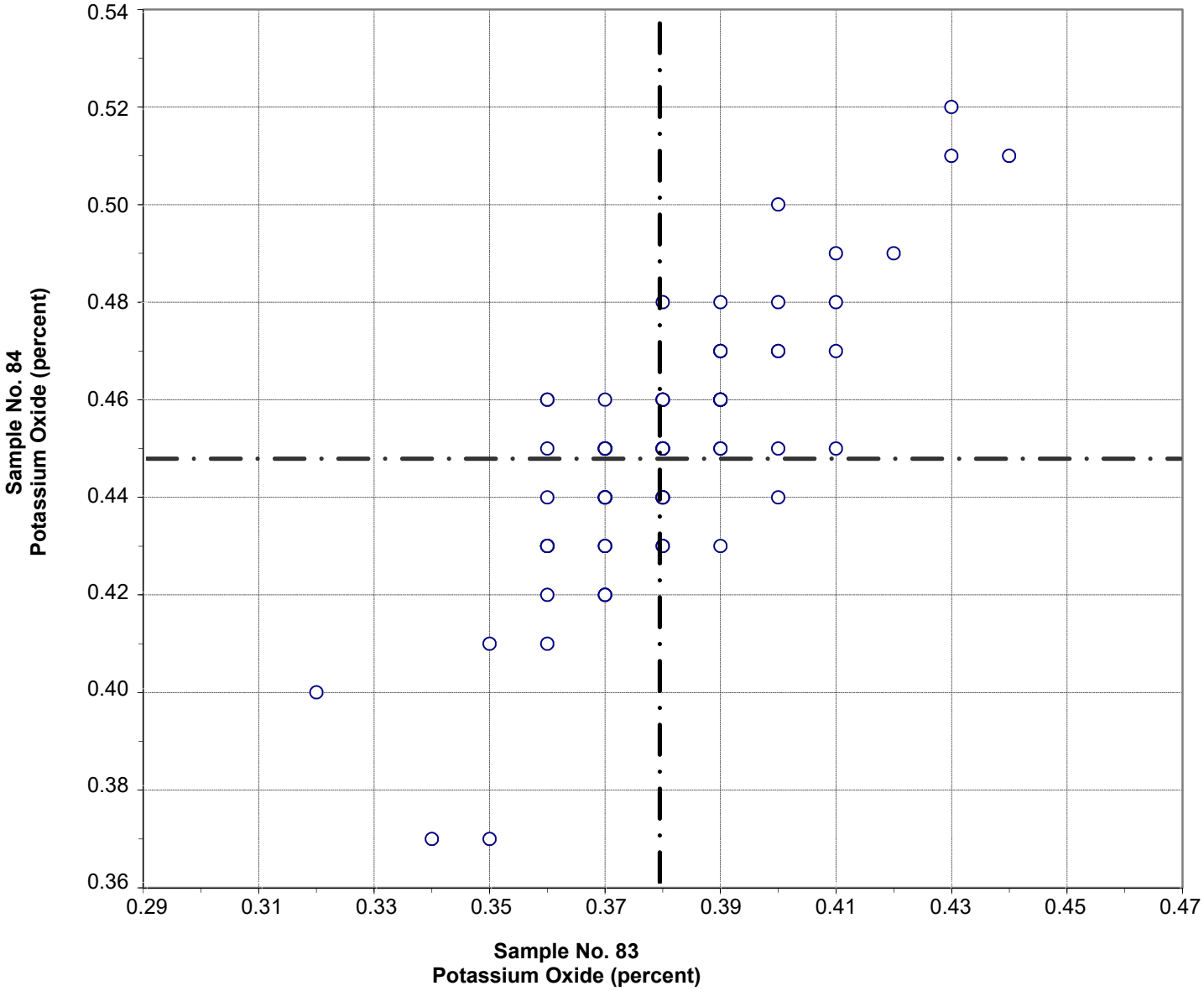


Test No. 99 Zinc Oxide 31 Points

Sample No. 83	Ave	0.007	S.D.	0.001	C.V. 17.9
Sample No. 84	Ave	0.071	S.D.	0.002	C.V. 3.4

Labs Eliminated: 178, 413, 2360

CCRL Proficiency Sample Program
Potassium Oxide
BLENDED CEMENT Samples No. 83 and No. 84



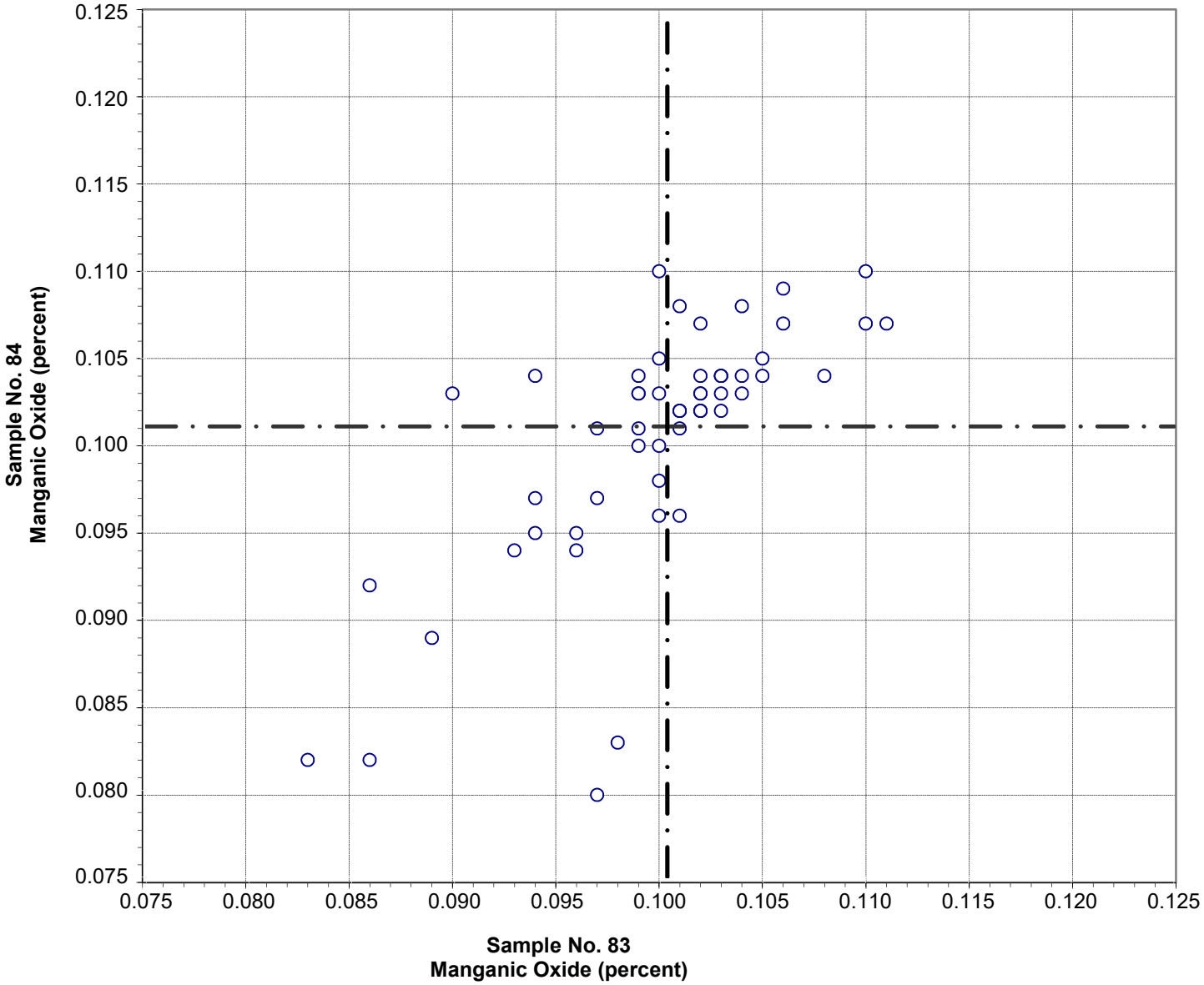
Test No. 100 Potassium Oxide 85 Points

Sample No. 83	Ave	0.38	S.D.	0.02	C.V. 5.2
Sample No. 84	Ave	0.45	S.D.	0.03	C.V. 6.3

Labs Eliminated: 246, 497, 2466, 4251

Labs off Diagram: 2412

CCRL Proficiency Sample Program
Manganic Oxide
BLENDED CEMENT Samples No. 83 and No. 84



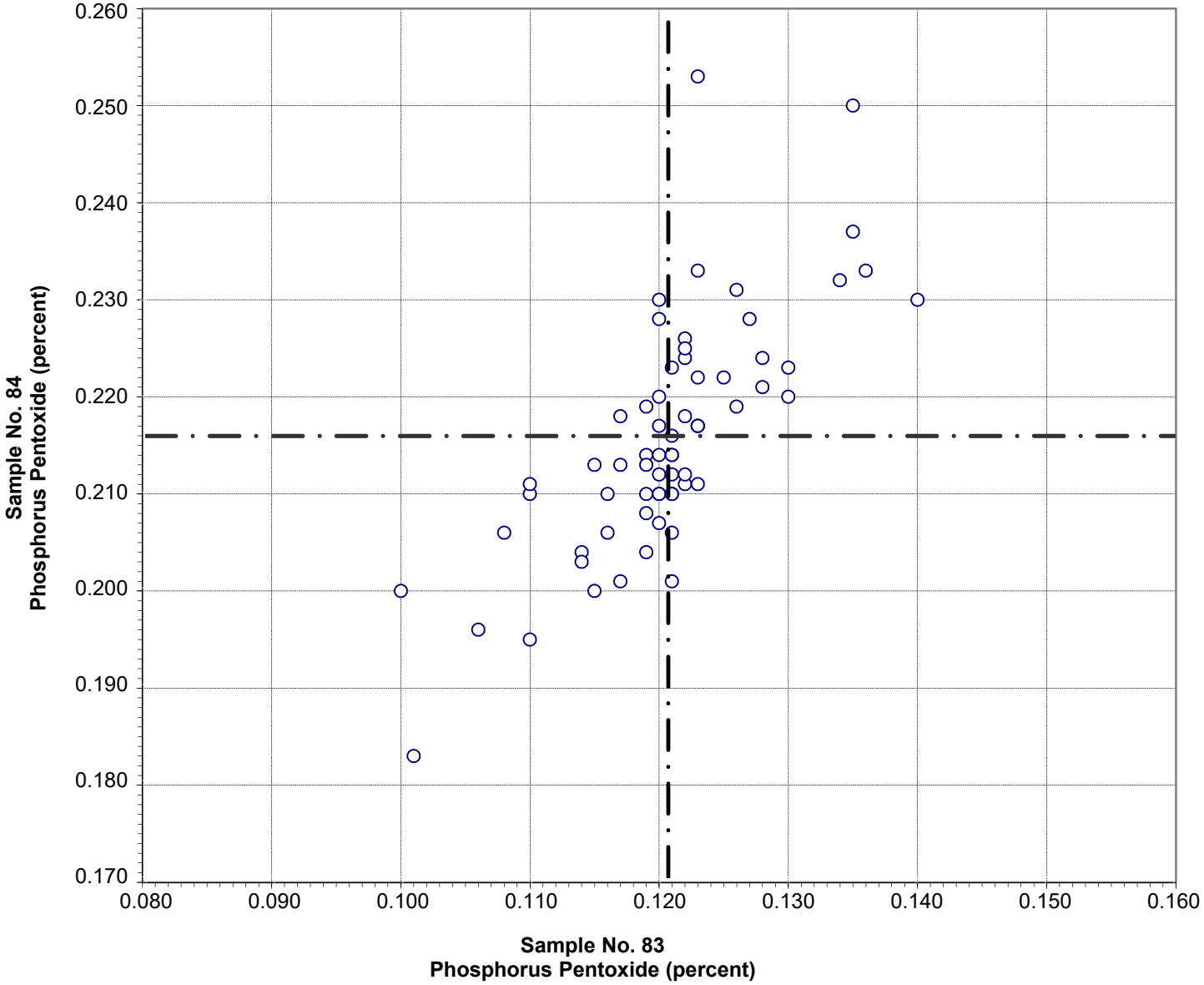
Test No. 101 Manganic Oxide 55 Points

Sample No. 83	Ave	0.100	S.D.	0.007	C.V. 6.7
Sample No. 84	Ave	0.101	S.D.	0.008	C.V. 7.8

Labs Eliminated: 354, 3297

Labs off Diagram: 25

CCRL Proficiency Sample Program
Phosphorus Pentoxide
BLENDED CEMENT Samples No. 83 and No. 84

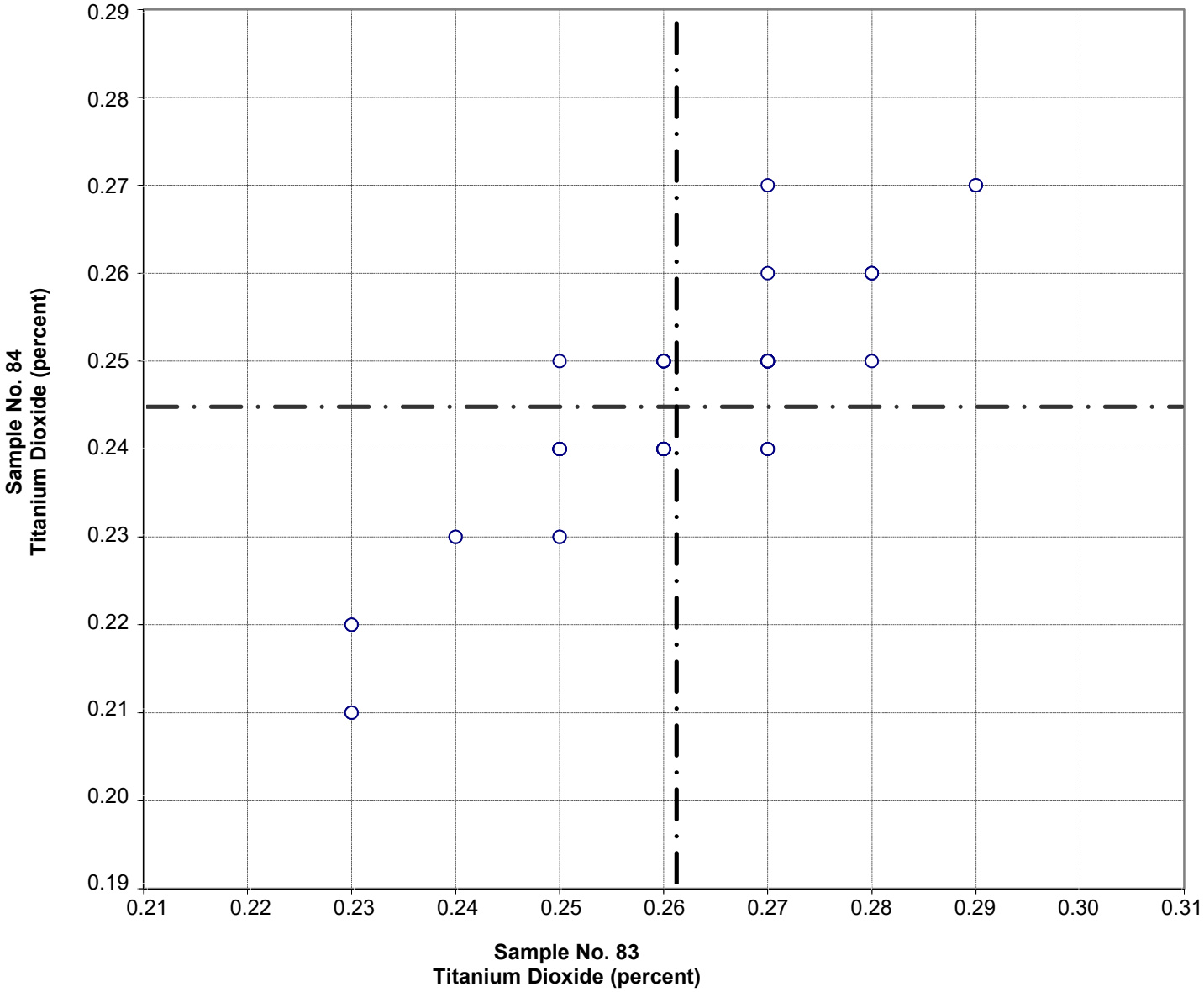


Test No. 102 Phosphorus Pentoxide 66 Points

Sample No. 83	Ave	0.121	S.D.	0.007	C.V. 6.0
Sample No. 84	Ave	0.216	S.D.	0.012	C.V. 5.6

Labs Eliminated: 47, 246, 441, 497, 698, 1956, 3930

CCRL Proficiency Sample Program
Titanium Dioxide
BLENDED CEMENT Samples No. 83 and No. 84

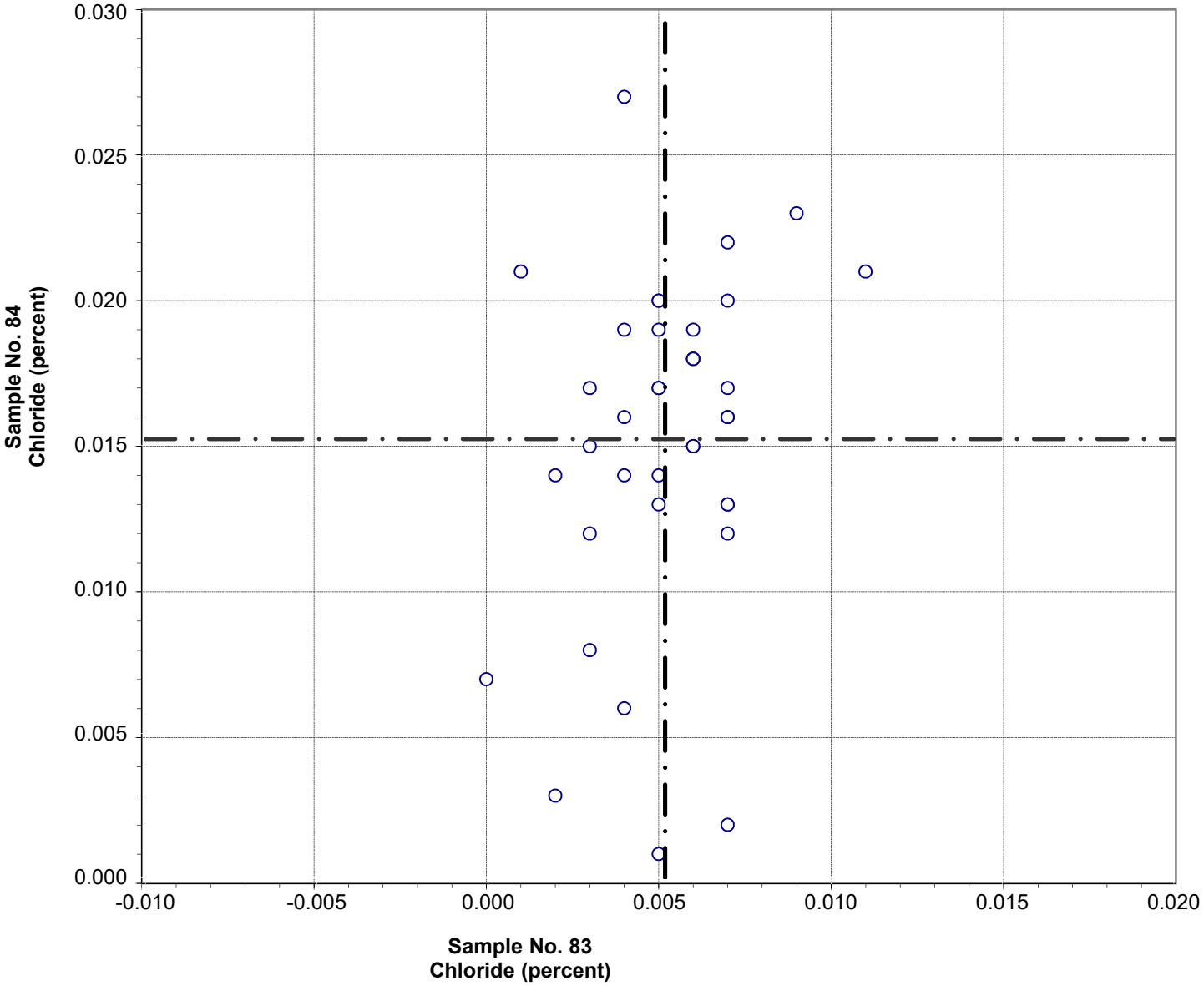


Test No. 103 Titanium Dioxide 70 Points

Sample No. 83	Ave	0.26	S.D.	0.013	C.V.	4.8
Sample No. 84	Ave	0.24	S.D.	0.011	C.V.	4.6

Labs Eliminated: 698

CCRL Proficiency Sample Program
Chloride
BLENDED CEMENT Samples No. 83 and No. 84

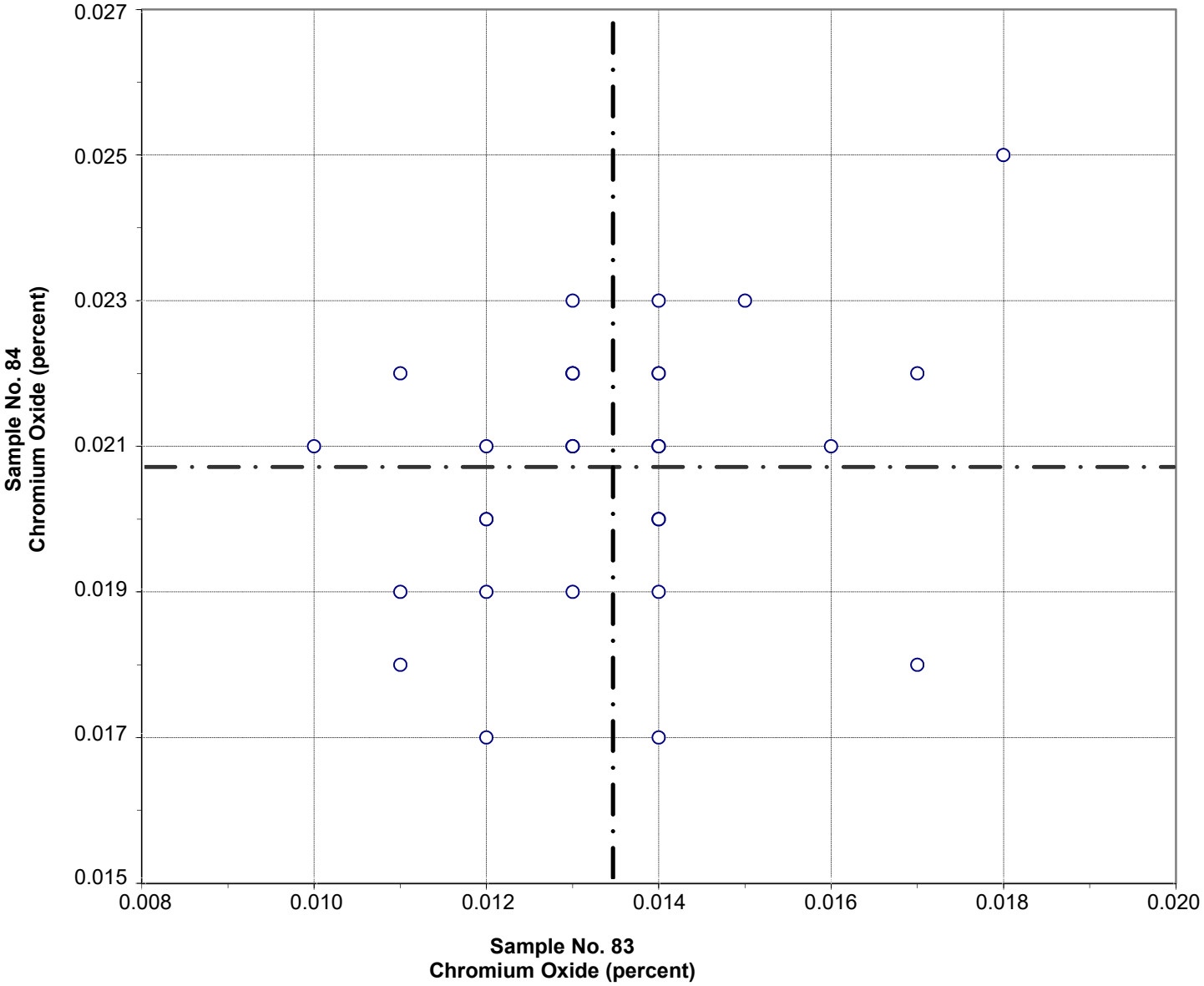


Test No. 104 Chloride 38 Points

Sample No. 83	Ave	0.005	S.D.	0.002	C.V. 42
Sample No. 84	Ave	0.015	S.D.	0.006	C.V. 38

Labs Eliminated: 34, 38, 101, 958

CCRL Proficiency Sample Program
Chromium Oxide
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 105 Chromium Oxide 33 Points

Sample No. 83	Ave	0.013	S.D.	0.002	C.V. 13
Sample No. 84	Ave	0.021	S.D.	0.002	C.V. 9

Labs Eliminated: 36, 101, 1466

CCRL PROFICIENCY SAMPLE PROGRAM

Blended Cement Proficiency Samples No. 83 and No. 84

Final Report – April 30, 2019

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 83 Average	S.D.	C.V.	Sample No. 84 Average	S.D.	C.V.
Normal Consistency - % Water (**percent**)							
	107	27.7	0.6	2.0	25.3	0.5	1.9
	*105	27.7	0.5	1.7	25.3	0.5	1.9
* Labs Eliminated - 124, 3912							
Vicat Time of Set - Initial (**min**)							
	107	109	12	10.9	127	13	9.9
	*104	108	10	8.8	127	11	9.0
* Labs Eliminated - 413, 2466, 4051							
Vicat Time of Set - Final (**min**)							
	101	208	27	13	226	30	13
	*99	208	27	13	224	26	12
* Labs Eliminated - 44, 1435							
Autoclave Expansion (**percent**)							
	94	0.11	0.04	39	-0.03	0.03	-69
	*86	0.12	0.03	30	-0.04	0.02	-39
* Labs Eliminated - 34, 36, 46, 47, 1715, 3297, 3413, 3912							
Air Content % (**percent**)							
	91	6.9	1.2	18	8.3	1.2	15
	*90	6.9	1.2	17	8.3	1.2	15
* Labs Eliminated - 1251							
Air Content - % Water (**percent**)							
	89	70.5	4.8	6.8	67.6	4.6	6.8
	*87	71.1	2.4	3.3	68.2	2.3	3.4
* Labs Eliminated - 126, 3911							
Air Content - Flow (**percent**)							
	89	86	3.4	4.0	88	3.1	3.6
No Labs Eliminated for This Test							

CCRL PROFICIENCY SAMPLE PROGRAM

Blended Cement Proficiency Samples No. 83 and No. 84

Final Report – April 30, 2019

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 83 Average	S.D.	C.V.	Sample No. 84 Average	S.D.	C.V.
Specific Gravity (**g/cm³**)							
	90	3.04	0.03	1.1	3.08	0.04	1.3
	*87	3.04	0.03	0.9	3.08	0.03	1.1
* Labs Eliminated - 25, 698, 3911							
Compressive Strength - 3 day (**psi**)							
	107	4189	289	6.9	4551	345	7.6
	*105	4205	265	6.3	4574	302	6.6
* Labs Eliminated - 33, 51							
Compressive Strength - 7 day (**psi**)							
	108	4989	303	6.1	5354	444	8.3
	*107	4988	304	6.1	5379	360	6.7
* Labs Eliminated - 1466							
Compressive Strength - 28 day (**psi**)							
	107	5920	397	6.7	6289	437	7.0
	*106	5931	384	6.5	6305	403	6.4
* Labs Eliminated - 33							
Compressive Strength - % Water (**percent**)							
	104	47.8	10.8	22.7	46.2	10.4	22.4
	*98	50.3	1.4	2.8	48.5	1.0	2.1
* Labs Eliminated - 37, 504, 694, 2352, 2464, 4310							
Compressive Strength - Flow (**percent**)							
	104	108	5.3	4.9	111	3.7	3.3
	*101	109	3.3	3.1	111	2.5	2.2
* Labs Eliminated - 38, 47, 3413							
Fineness - Air Permeability (**m²/kg**)							
	99	534	33	6.1	566	41	7.3
	*98	535	32	5.9	568	38	6.7
* Labs Eliminated - 3912							

CCRL PROFICIENCY SAMPLE PROGRAM

Blended Cement Proficiency Samples No. 83 and No. 84

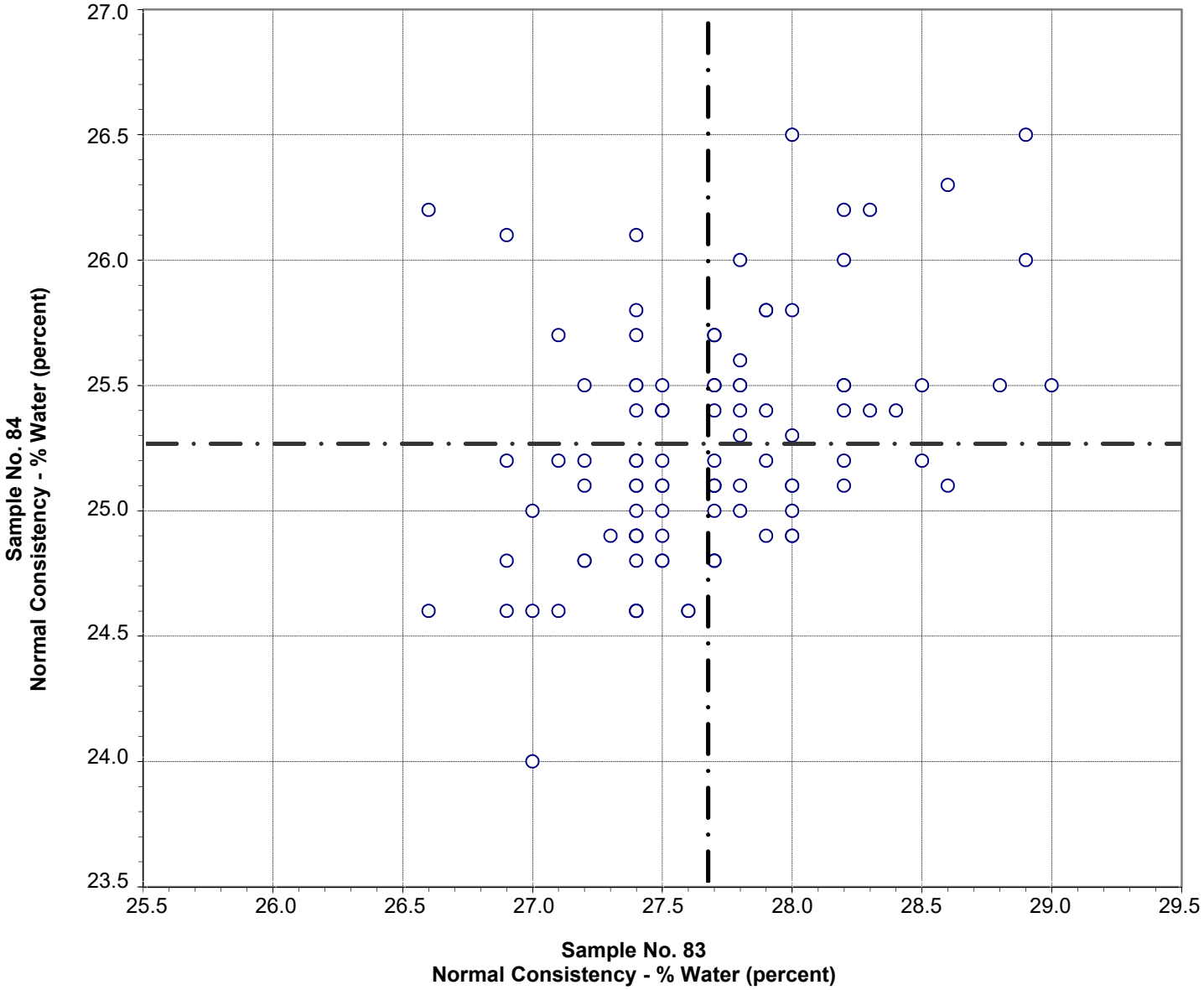
Final Report – April 30, 2019

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 83 Average	S.D.	C.V.	Sample No. 84 Average	S.D.	C.V.
Fineness - 45µm % Passing (**percent**)							
	102	97.80	0.47	0.48	98.42	0.34	0.34
	*101	97.81	0.46	0.47	98.43	0.32	0.33

* Labs Eliminated - 47

CCRL Proficiency Sample Program
Normal Consistency - % Water
BLENDED CEMENT Samples No. 83 and No. 84

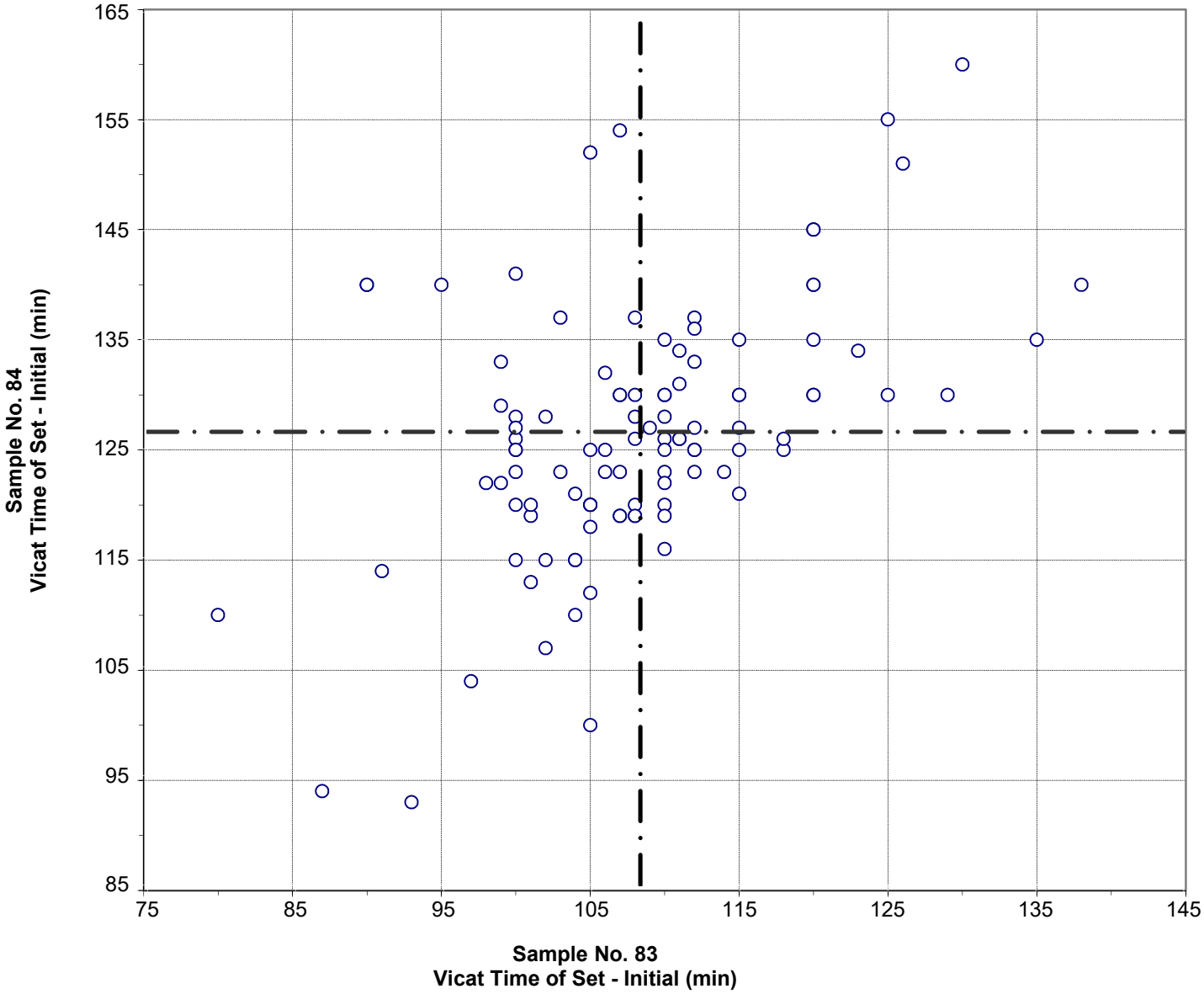


Test No. 110 Normal Consistency - % Water 105 Points

Sample No. 83	Ave	27.7	S.D.	0.5	C.V. 1.7
Sample No. 84	Ave	25.3	S.D.	0.5	C.V. 1.9

Labs Eliminated: 124, 3912

CCRL Proficiency Sample Program
Vicat Time of Set - Initial
BLENDED CEMENT Samples No. 83 and No. 84

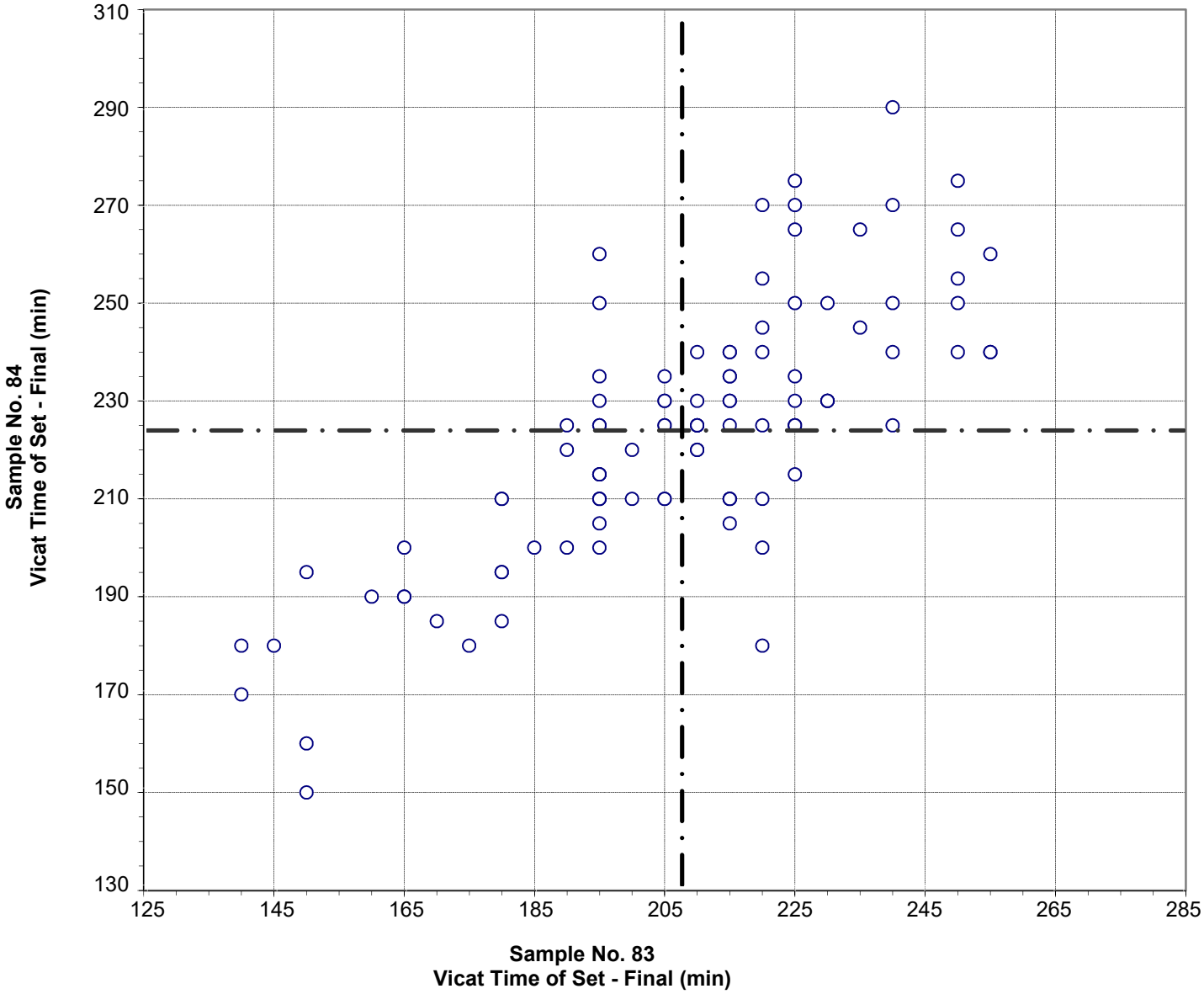


Test No. 120 Vicat Time of Set - Initial 104 Points

Sample No. 83	Ave	108	S.D.	10	C.V. 8.8
Sample No. 84	Ave	127	S.D.	11	C.V. 9.0

Labs Eliminated: 413, 2466, 4051

CCRL Proficiency Sample Program
Vicat Time of Set - Final
BLENDED CEMENT Samples No. 83 and No. 84

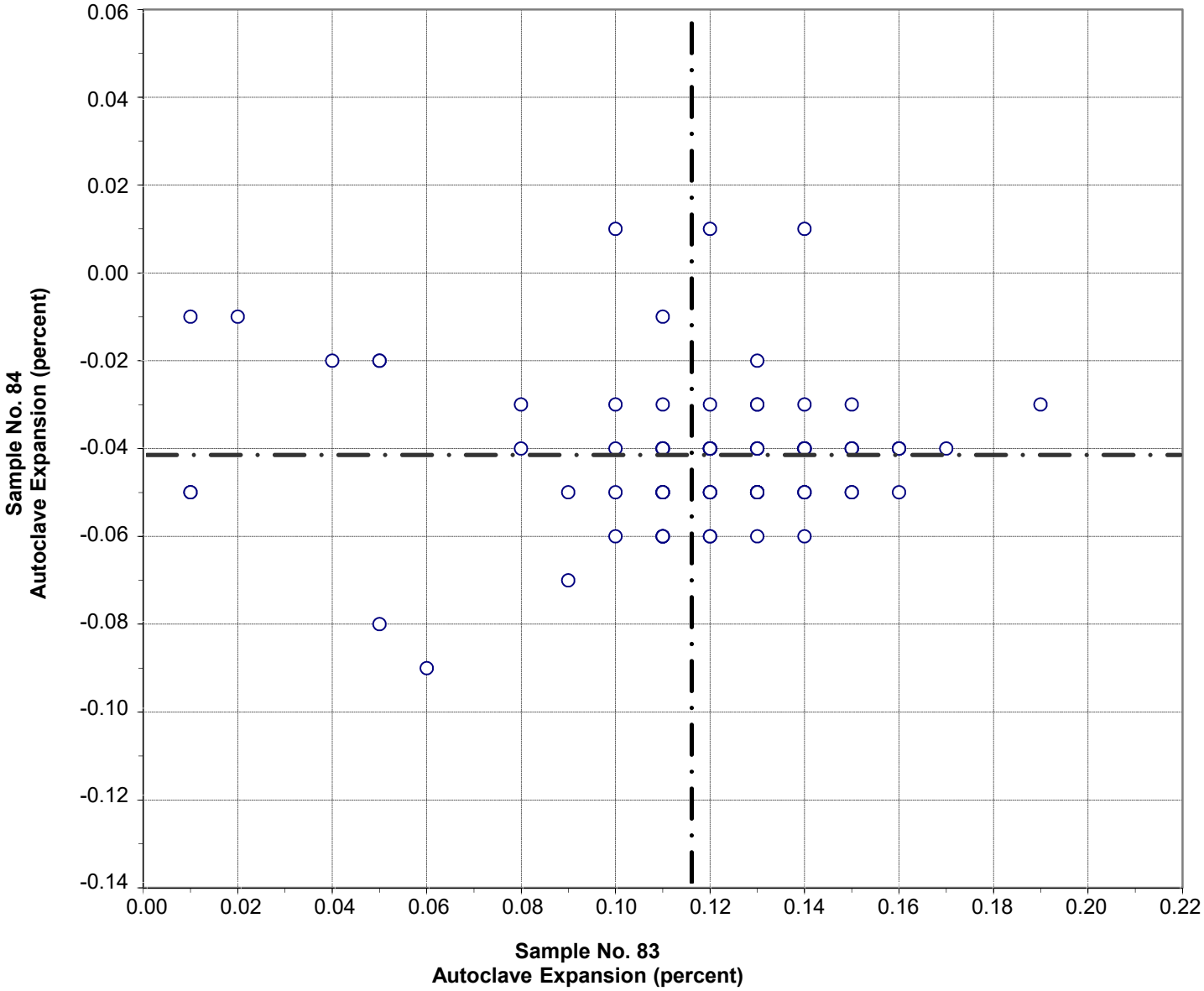


Test No. 121 Vicat Time of Set - Final 99 Points

Sample No. 83	Ave 208	S.D. 27	C.V. 13
Sample No. 84	Ave 224	S.D. 26	C.V. 12

Labs Eliminated: 44, 1435

CCRL Proficiency Sample Program
Autoclave Expansion
BLENDED CEMENT Samples No. 83 and No. 84

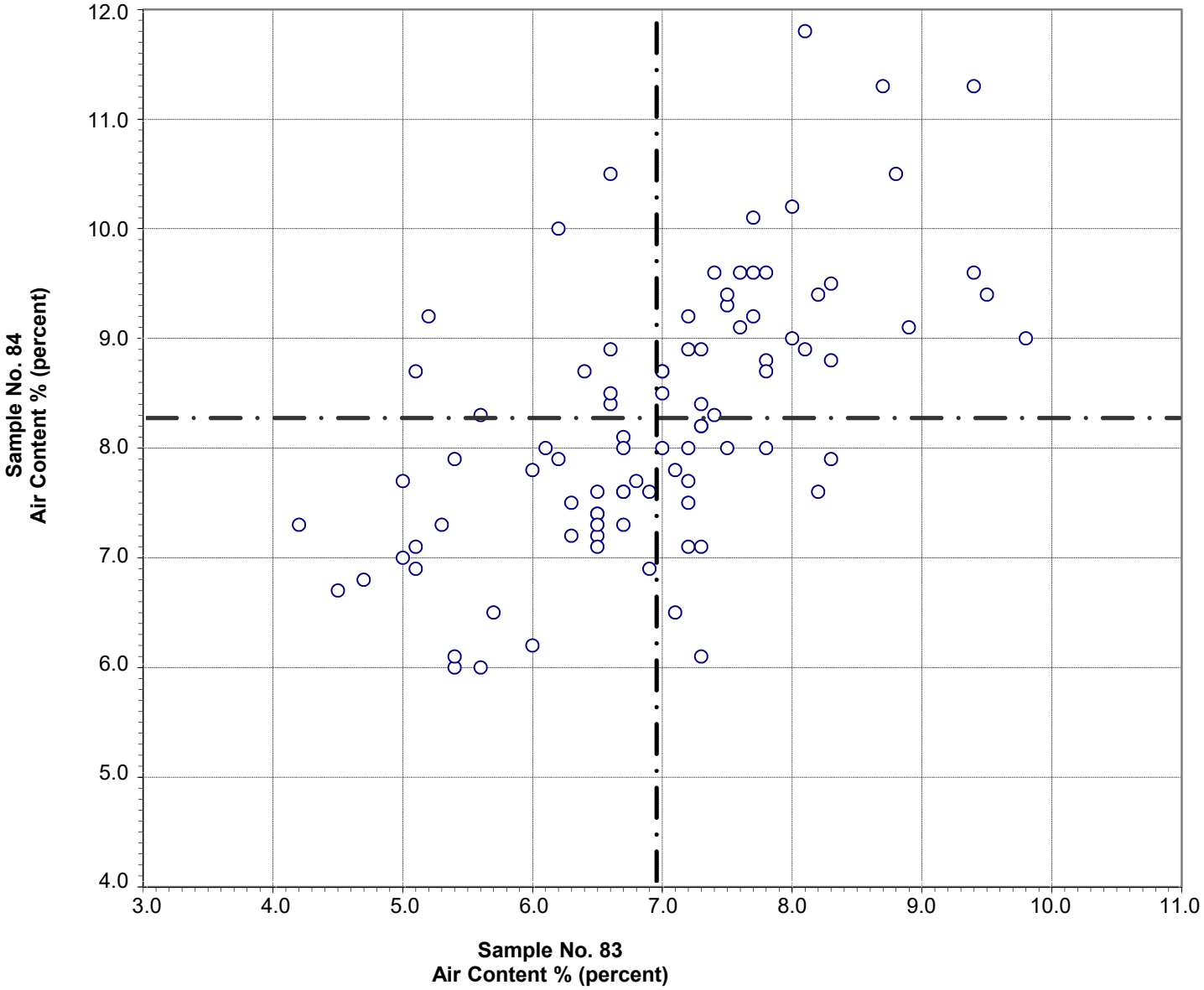


Test No. 160 Autoclave Expansion 86 Points

Sample No. 83	Ave 0.12	S.D. 0.03	C.V. 30
Sample No. 84	Ave -0.04	S.D. 0.02	C.V. -39

Labs Eliminated: 34, 36, 46, 47, 1715, 3297, 3413, 3912

CCRL Proficiency Sample Program
Air Content %
BLENDED CEMENT Samples No. 83 and No. 84

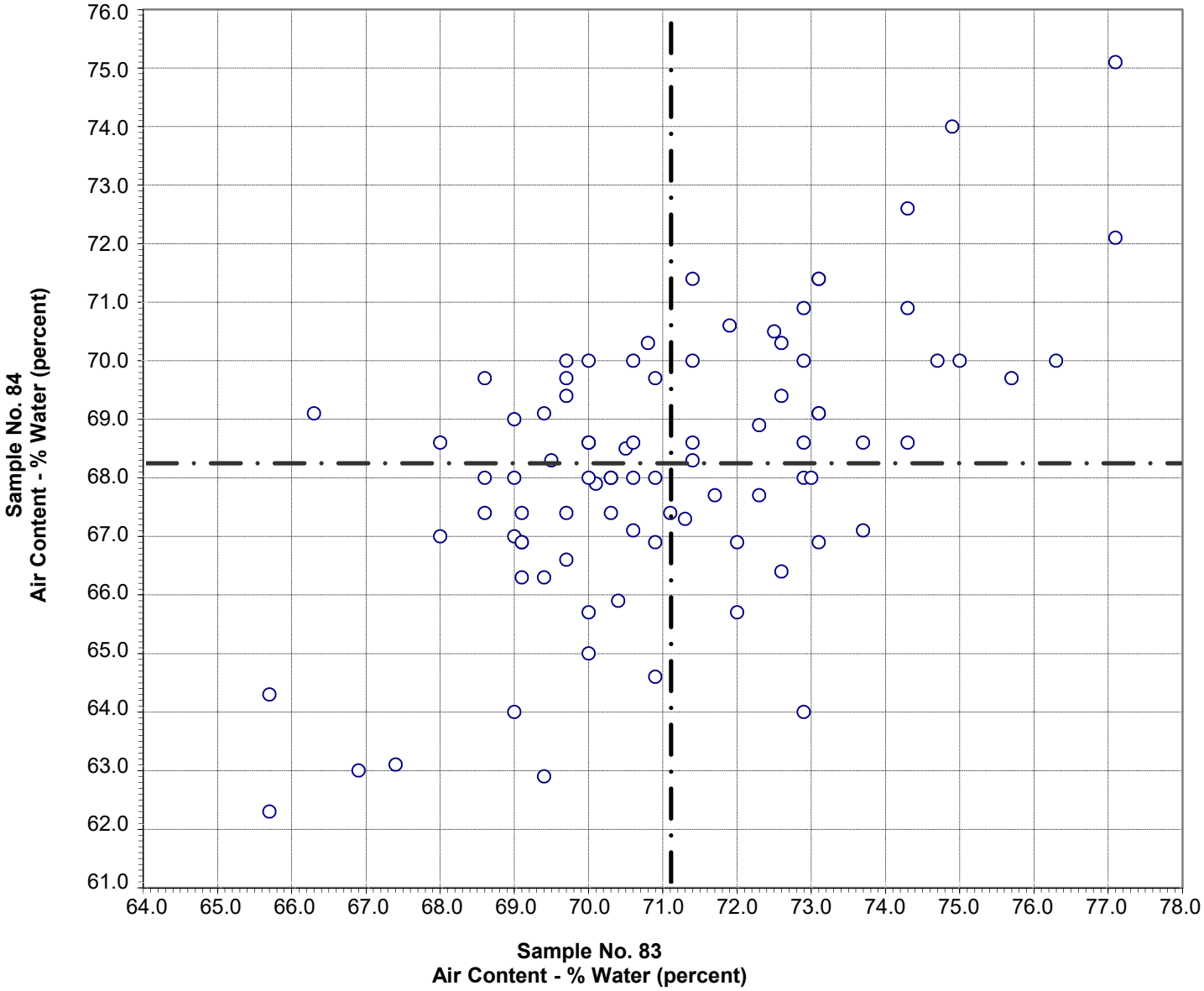


Test No. 170 Air Content % 90 Points

Sample No. 83	Ave	6.9	S.D.	1.2	C.V. 17
Sample No. 84	Ave	8.3	S.D.	1.2	C.V. 15

Labs Eliminated: 1251

CCRL Proficiency Sample Program
Air Content - % Water
BLENDED CEMENT Samples No. 83 and No. 84

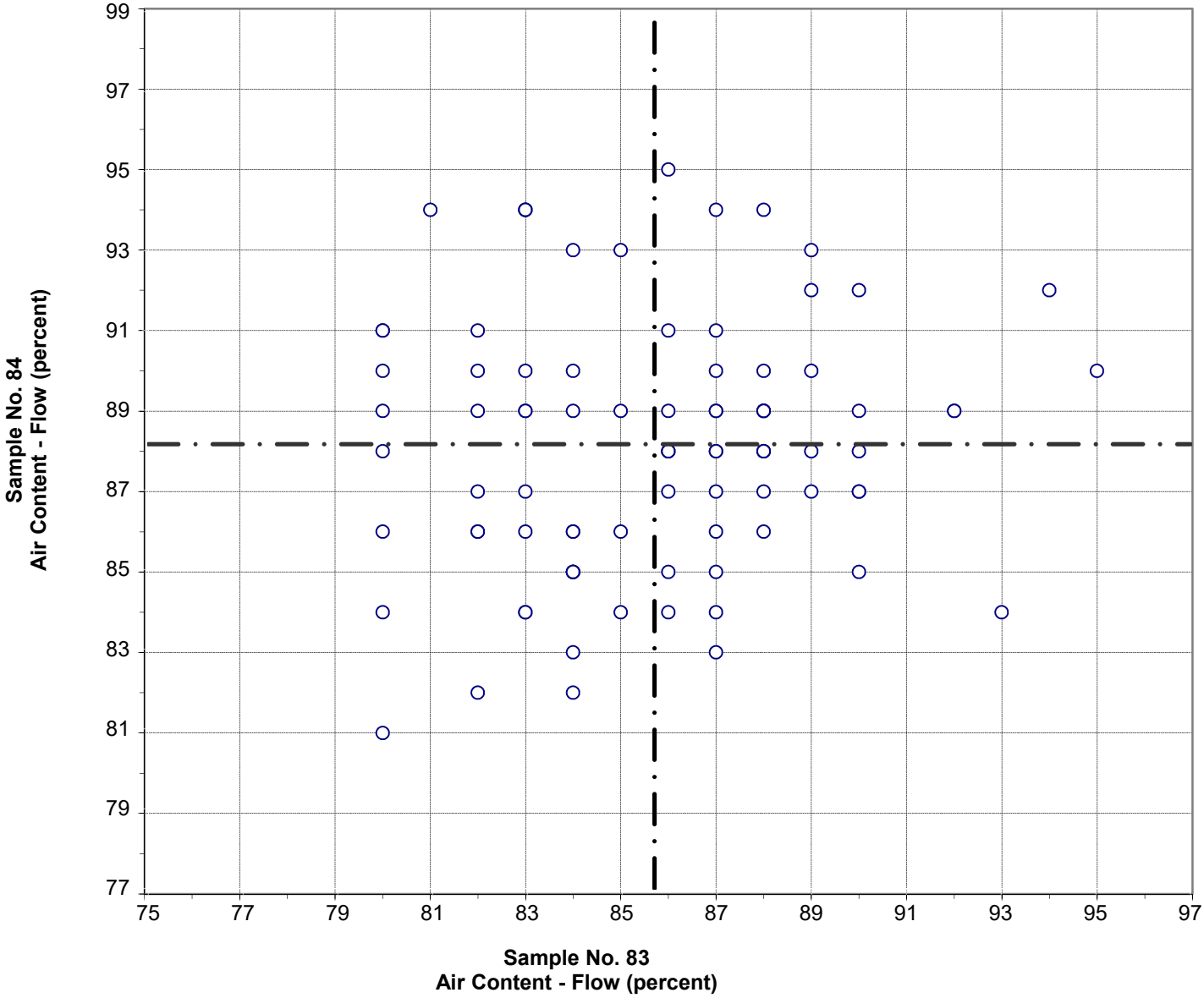


Test No. 180 Air Content - % Water 87 Points

Sample No. 83	Ave	71.1	S.D.	2.4	C.V. 3.3
Sample No. 84	Ave	68.2	S.D.	2.3	C.V. 3.4

Labs Eliminated: 126, 3911

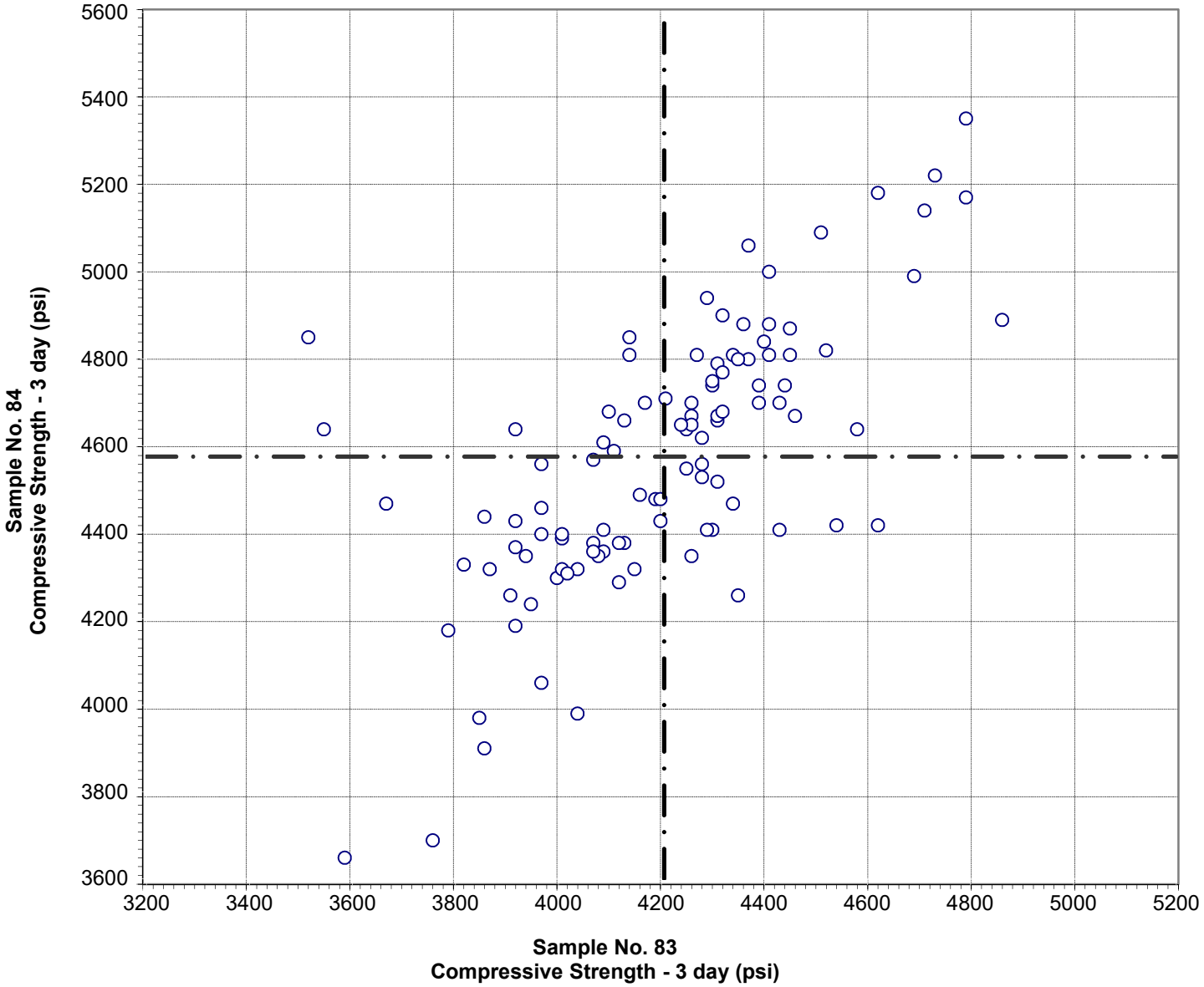
CCRL Proficiency Sample Program
Air Content - Flow
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 190 Air Content - Flow 89 Points

Sample No. 83	Ave	86	S.D.	3.4	C.V.	4.0
Sample No. 84	Ave	88	S.D.	3.1	C.V.	3.6

CCRL Proficiency Sample Program
Compressive Strength - 3 day
BLENDED CEMENT Samples No. 83 and No. 84

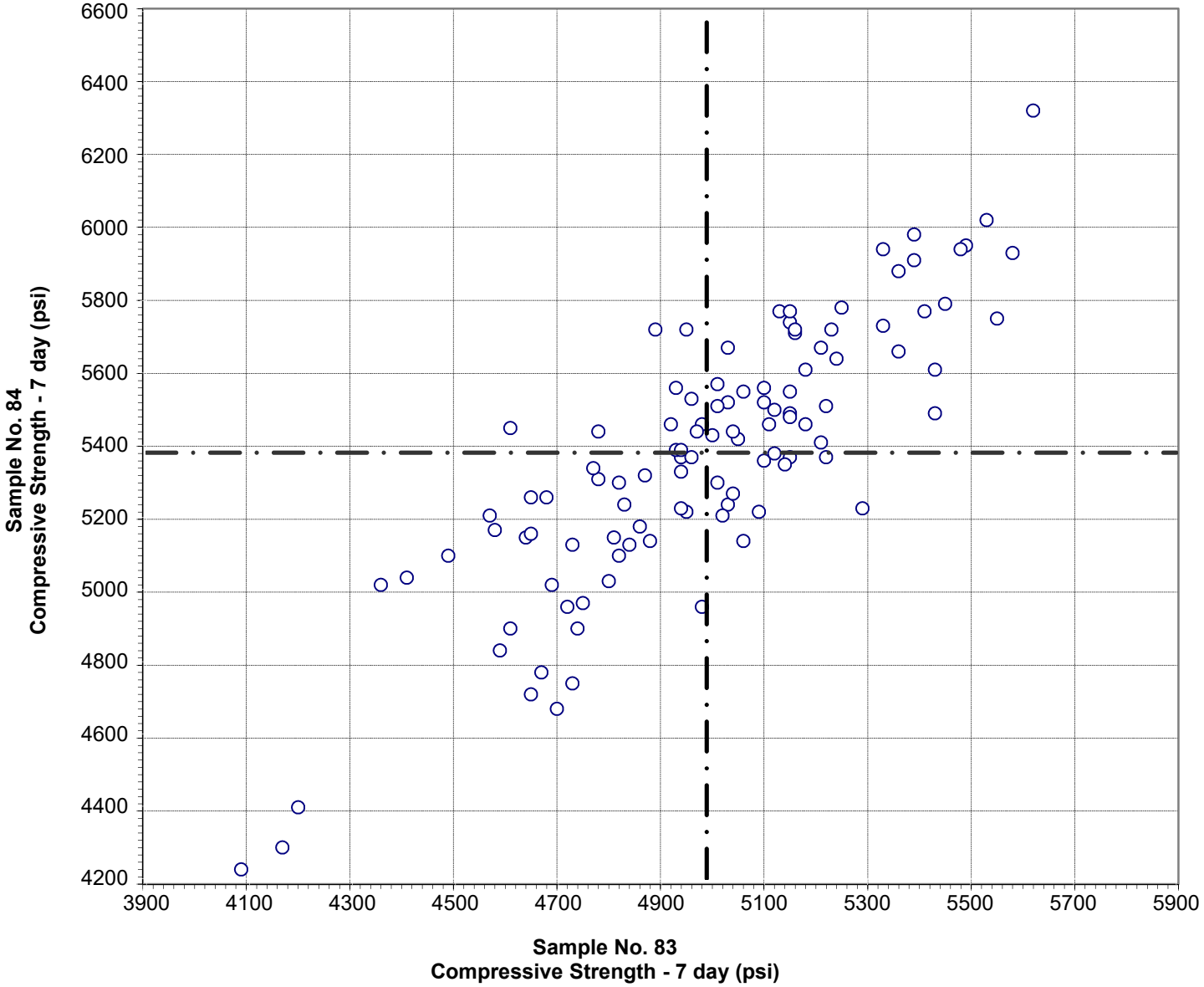


Test No. 200 Compressive Strength - 3 day 105 Points

Sample No. 83	Ave 4205	S.D. 265	C.V. 6.3
Sample No. 84	Ave 4574	S.D. 302	C.V. 6.6

Labs Eliminated: 33, 51

CCRL Proficiency Sample Program
Compressive Strength - 7 day
BLENDED CEMENT Samples No. 83 and No. 84

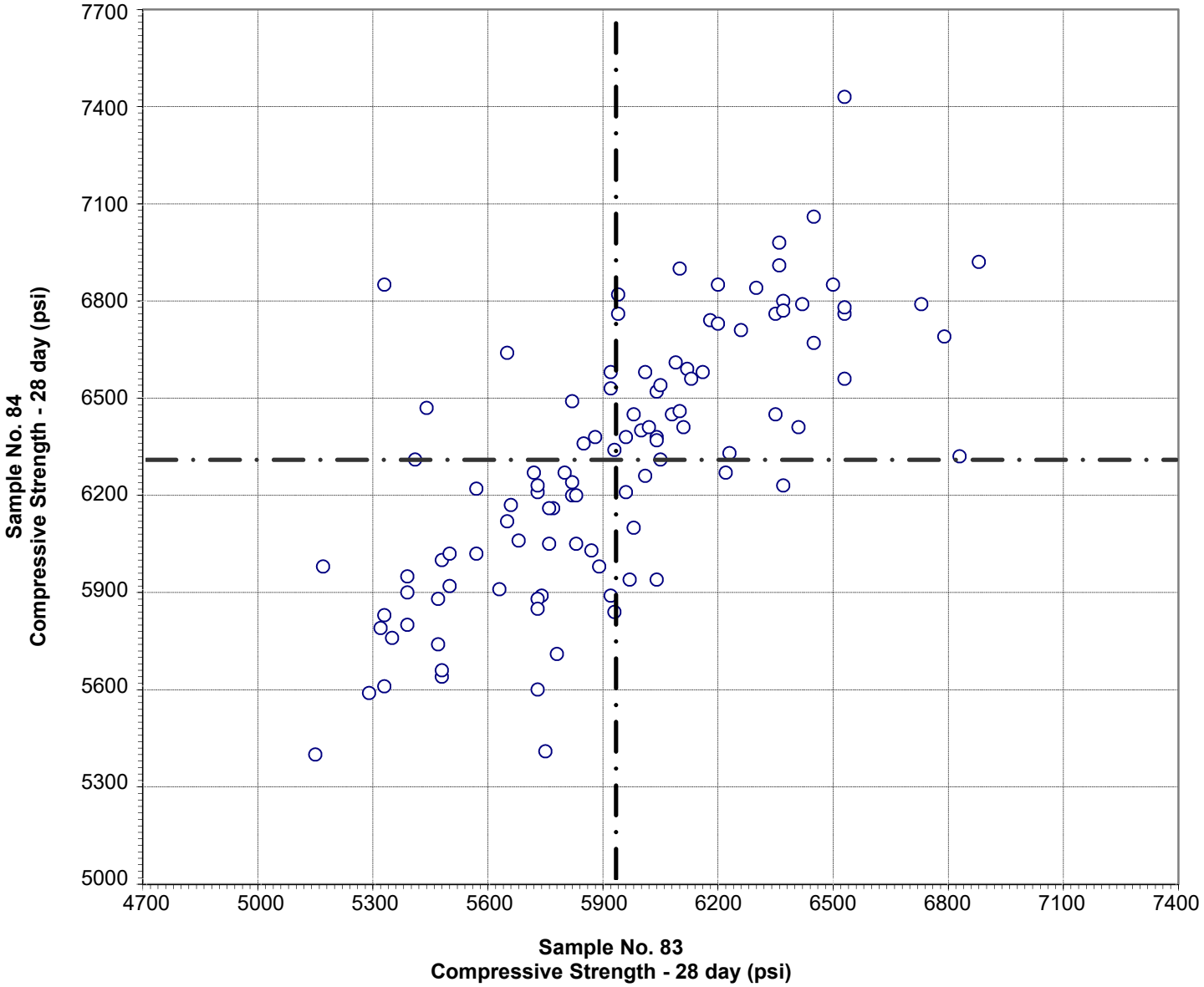


Test No. 210 Compressive Strength - 7 day 107 Points

Sample No. 83	Ave	4988	S.D.	304	C.V. 6.1
Sample No. 84	Ave	5379	S.D.	360	C.V. 6.7

Labs Eliminated: 1466

CCRL Proficiency Sample Program
Compressive Strength - 28 day
BLENDED CEMENT Samples No. 83 and No. 84

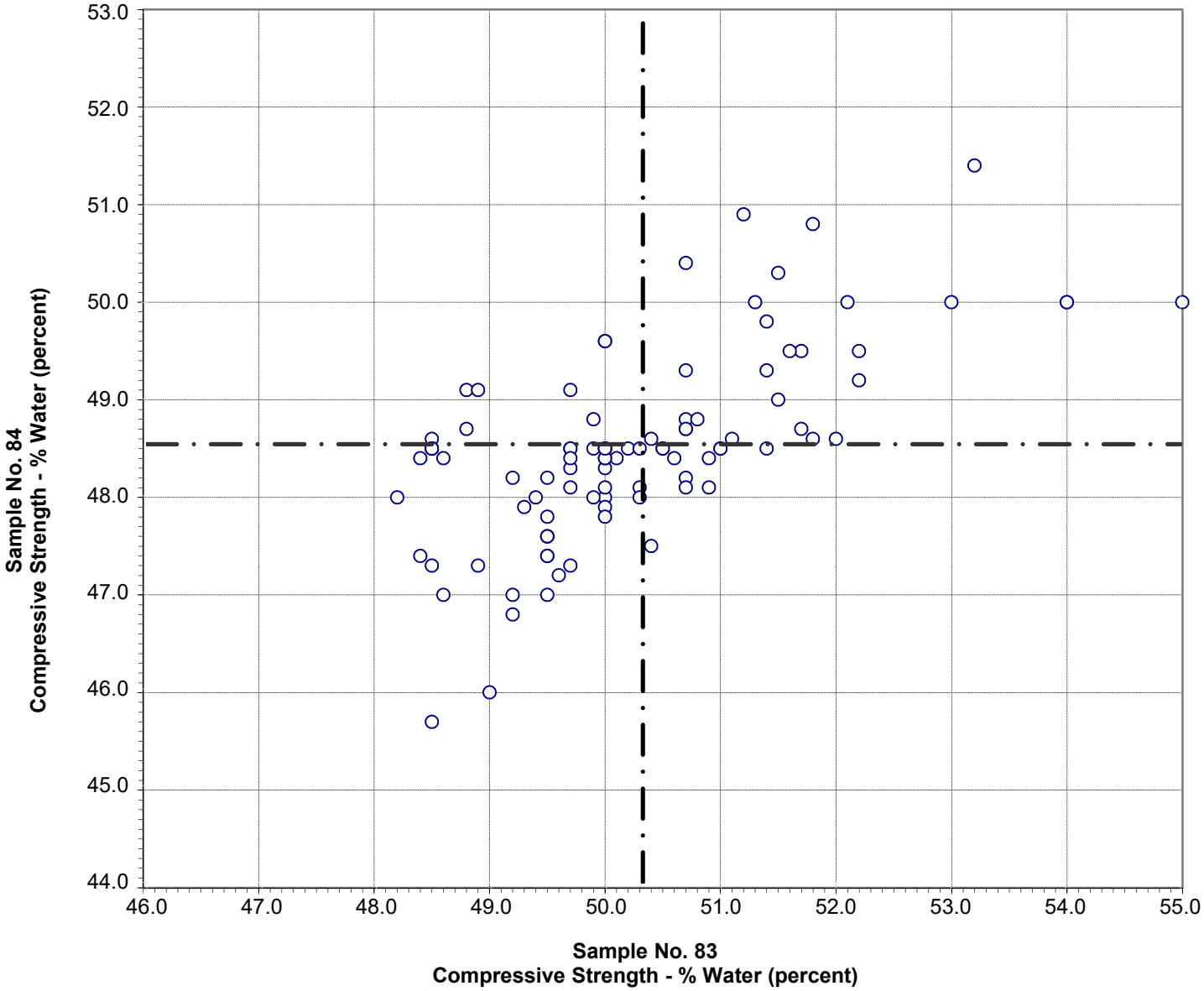


Test No. 211 Compressive Strength - 28 day 106 Points

Sample No. 83	Ave	5931	S.D.	384	C.V. 6.5
Sample No. 84	Ave	6305	S.D.	403	C.V. 6.4

Labs Eliminated: 33

CCRL Proficiency Sample Program
Compressive Strength - % Water
BLENDED CEMENT Samples No. 83 and No. 84



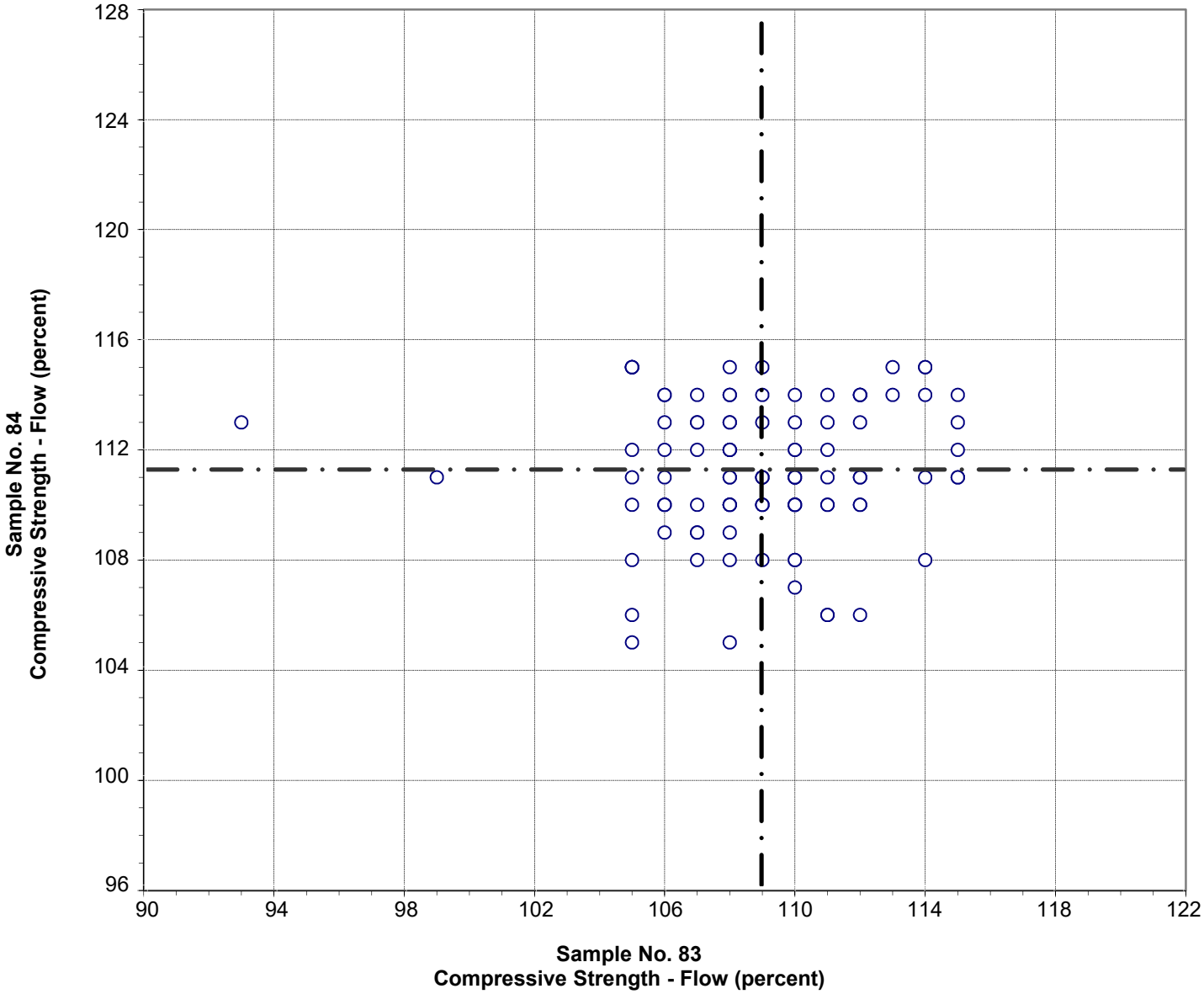
Test No. 220 Compressive Strength - % Water 97 Points

Sample No. 83	Ave	50.3	S.D.	1.4	C.V. 2.8
Sample No. 84	Ave	48.5	S.D.	1.0	C.V. 2.1

Labs Eliminated: 37, 504, 694, 2352, 2464, 4310

Labs off Diagram: 46

CCRL Proficiency Sample Program
Compressive Strength - Flow
BLENDED CEMENT Samples No. 83 and No. 84

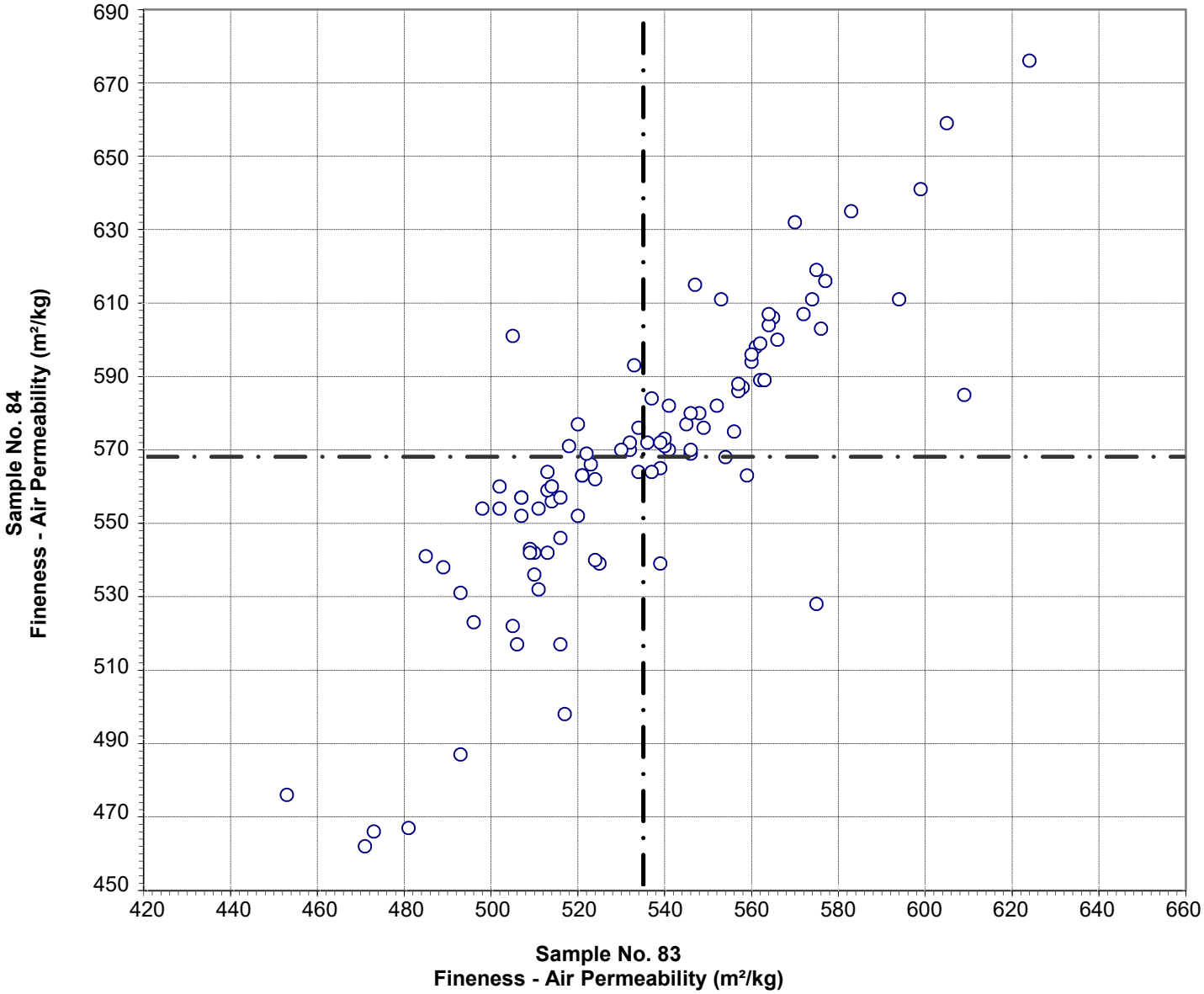


Test No. 230 Compressive Strength - Flow 101 Points

Sample No. 83	Ave	109	S.D.	3.3	C.V. 3.1
Sample No. 84	Ave	111	S.D.	2.5	C.V. 2.2

Labs Eliminated: 38, 47, 3413

CCRL Proficiency Sample Program
Fineness - Air Permeability
BLENDED CEMENT Samples No. 83 and No. 84

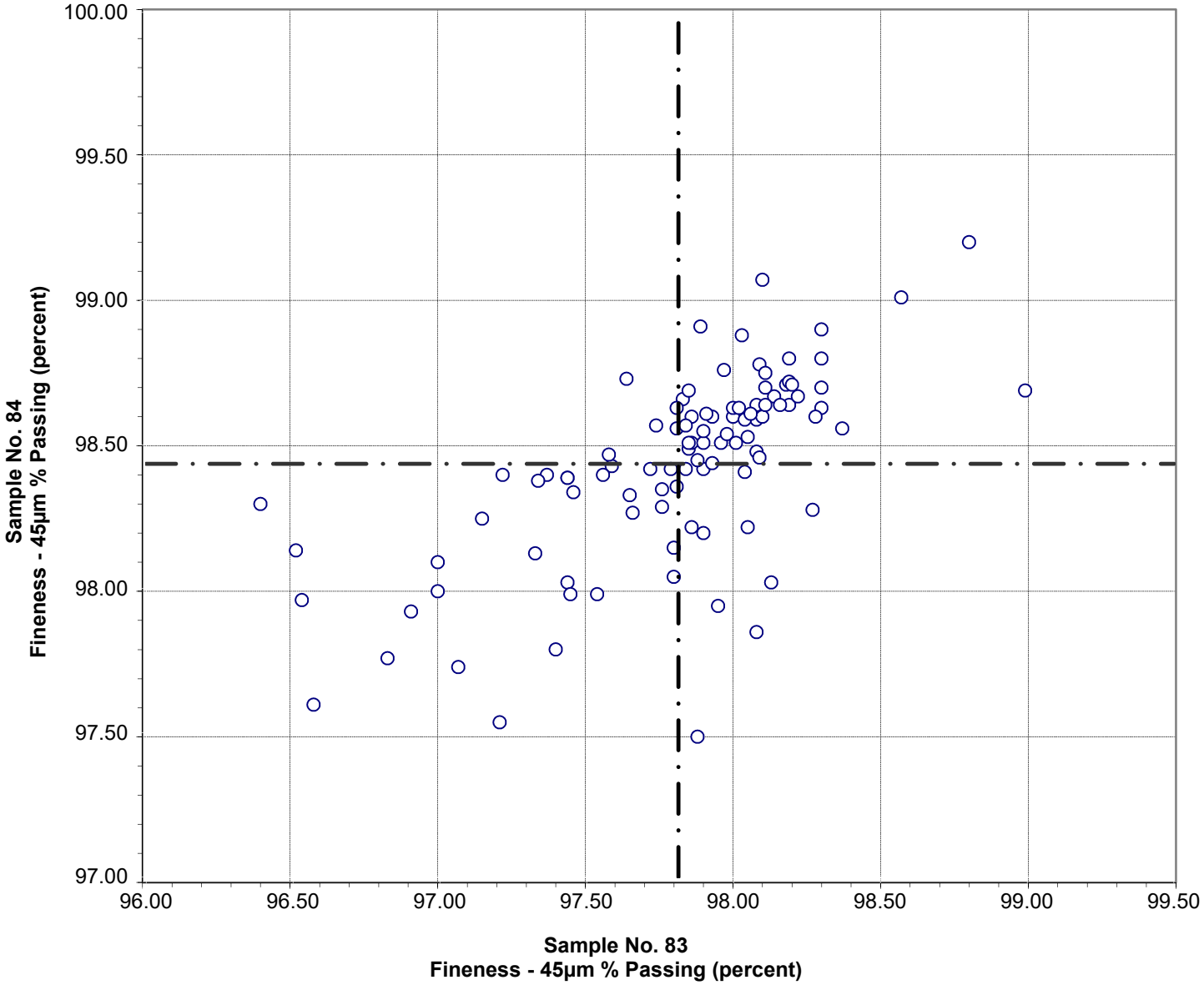


Test No. 270 Fineness - Air Permeability 98 Points

Sample No. 83	Ave	535	S.D.	32	C.V. 5.9
Sample No. 84	Ave	568	S.D.	38	C.V. 6.7

Labs Eliminated: 3912

CCRL Proficiency Sample Program
Fineness - 45µm % Passing
BLENDED CEMENT Samples No. 83 and No. 84

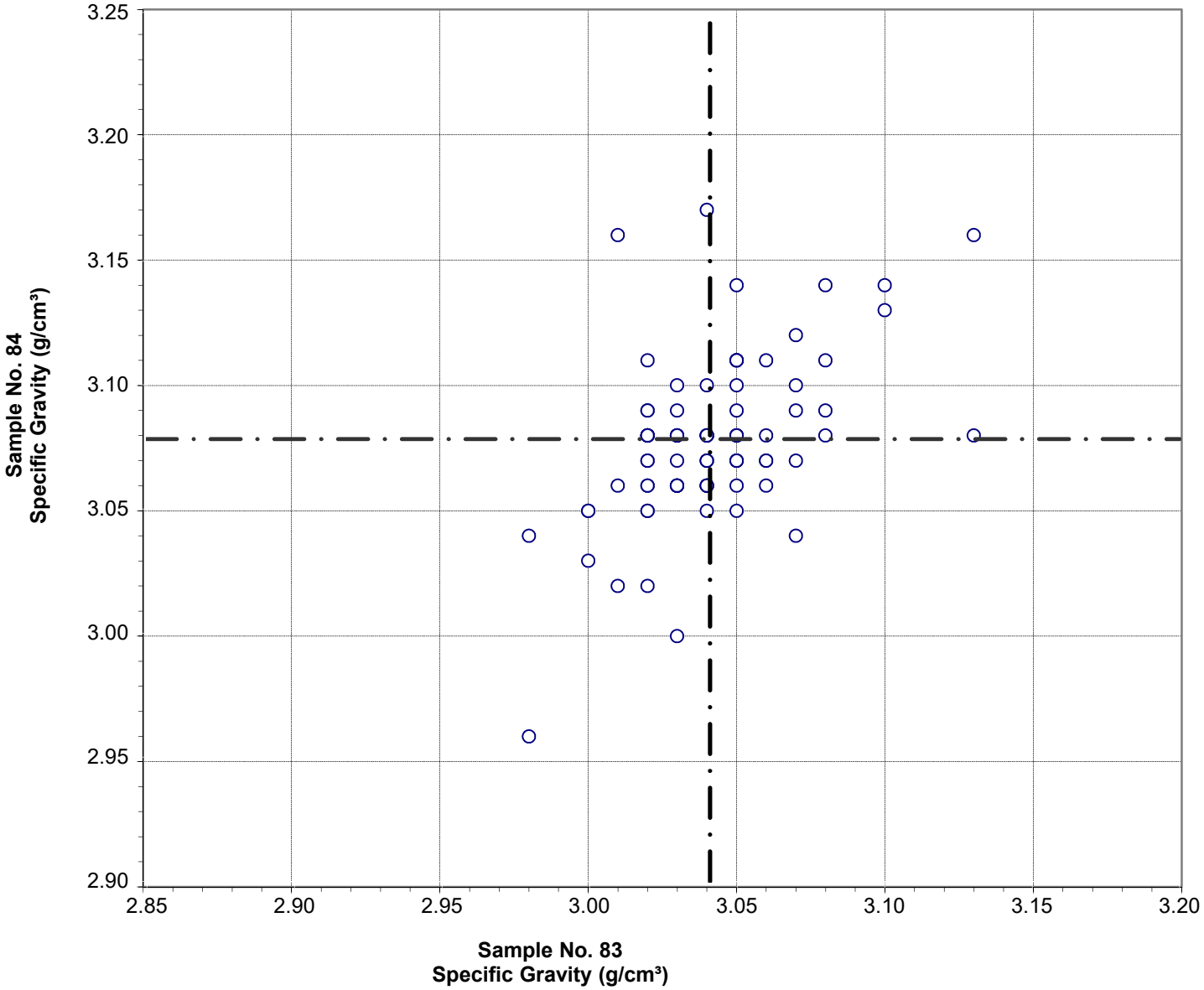


Test No. 281 Fineness - 45µm % Passing 101 Points

Sample No. 83	Ave	97.81	S.D.	0.46	C.V.	0.47
Sample No. 84	Ave	98.43	S.D.	0.32	C.V.	0.33

Labs Eliminated: 47

CCRL Proficiency Sample Program
Specific Gravity
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 310 Specific Gravity 87 Points

Sample No. 83	Ave	3.04	S.D.	0.03	C.V. 0.9
Sample No. 84	Ave	3.08	S.D.	0.03	C.V. 1.1

Labs Eliminated: 25, 698, 3911

CCRL PROFICIENCY SAMPLE PROGRAM

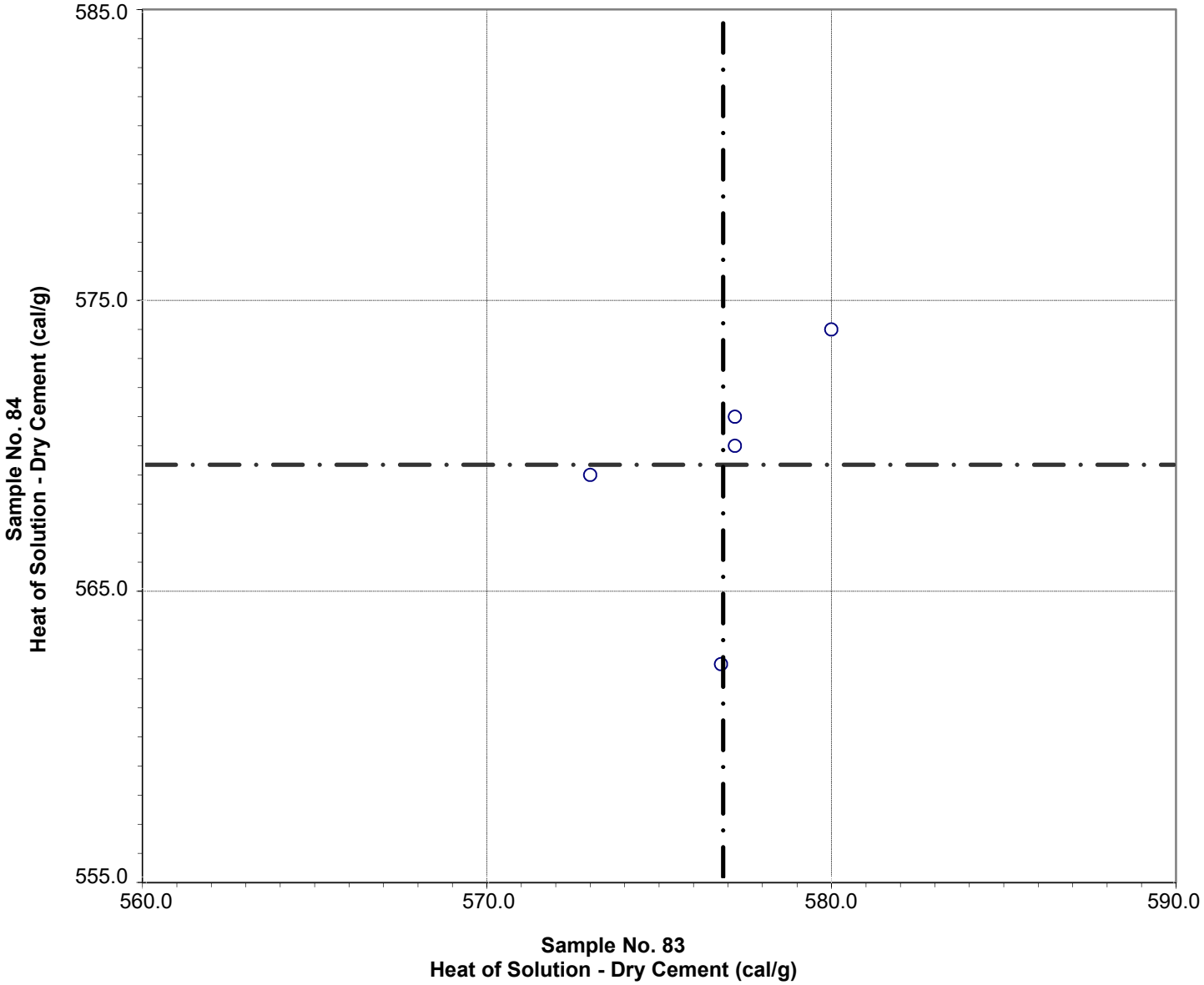
Blended Cement Proficiency Samples No. 83 and No. 84

Final Report – April 30, 2019

SUMMARY OF RESULTS

Test (unit)	#Labs	Sample No. 83 Average	S.D.	C.V.	Sample No. 84 Average	S.D.	C.V.
Heat of Solution - Dry Cement (**cal/g**)							
	5	576.8	2.5	0.4	569.3	4.2	0.7
No Labs Eliminated for This Test							
Heat of Solution - 7 day (**cal/g**)							
	5	491.4	5.9	1.2	488.8	6.1	1.3
No Labs Eliminated for This Test							
Heat of Solution - 28 day (**cal/g**)							
	4	477.6	15.0	3.14	478.5	11.8	2.46
No Labs Eliminated for This Test							
Heat of Hydration - 7 day (**cal/g**)							
	6	86.9	4.4	5.1	82.2	6.2	7.6
No Labs Eliminated for This Test							
Heat of Hydration - 28 day (**cal/g**)							
	4	102.2	14.1	13.8	94.6	6.6	7.0
No Labs Eliminated for This Test							
C1702 Heat of Hydration - 3 day (**J/g**)							
	9	339	22	6.5	312	17	5.4
No Labs Eliminated for This Test							
C1702 Heat of Hydration - 7 day (**J/g**)							
	9	384	25	6.6	359	19	5.4
No Labs Eliminated for This Test							

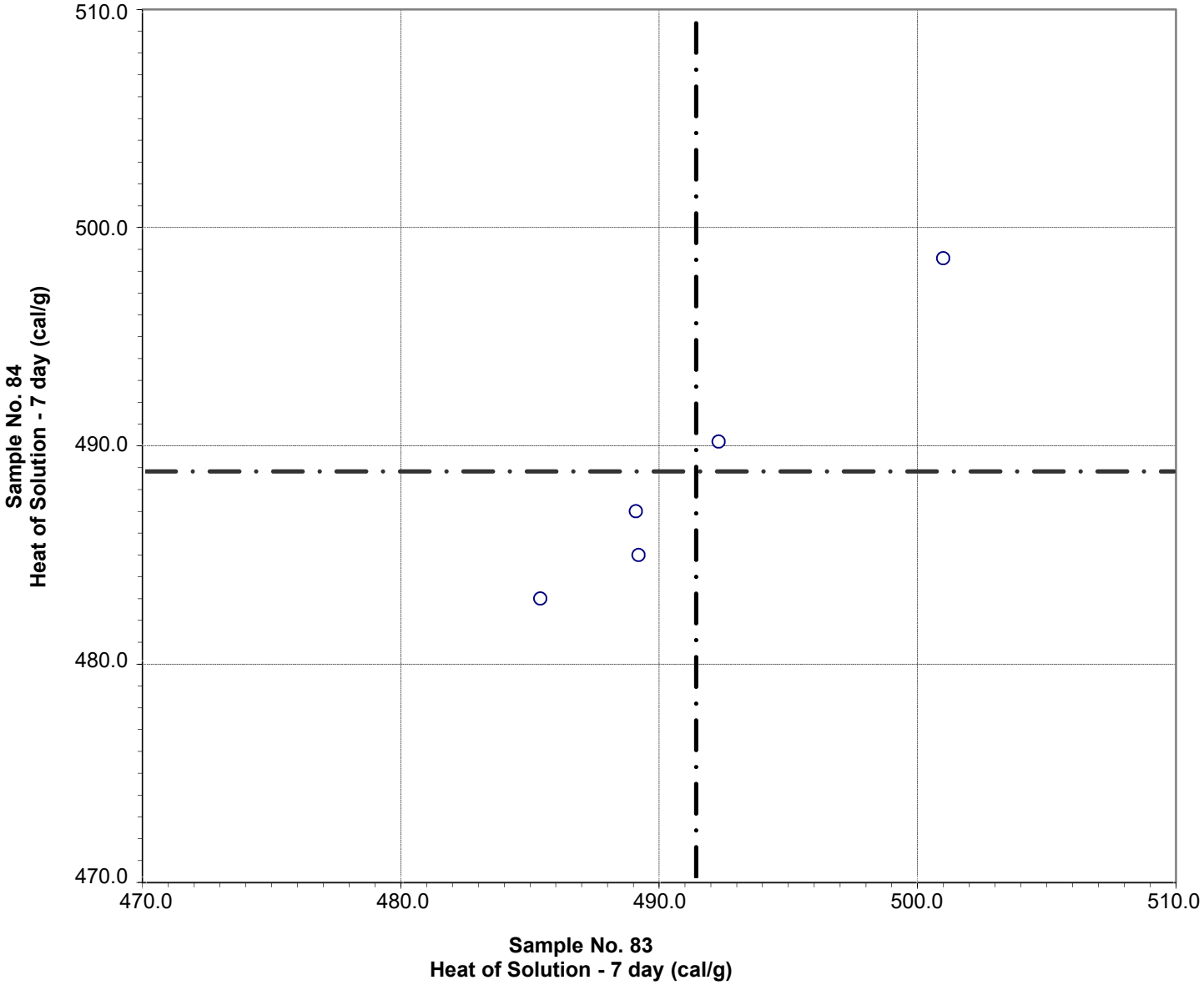
CCRL Proficiency Sample Program
Heat of Solution - Dry Cement
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 291 Heat of Solution - Dry Cement 5 Points

Sample No. 83	Ave	576.8	S.D.	2.5	C.V.	0.4
Sample No. 84	Ave	569.3	S.D.	4.2	C.V.	0.7

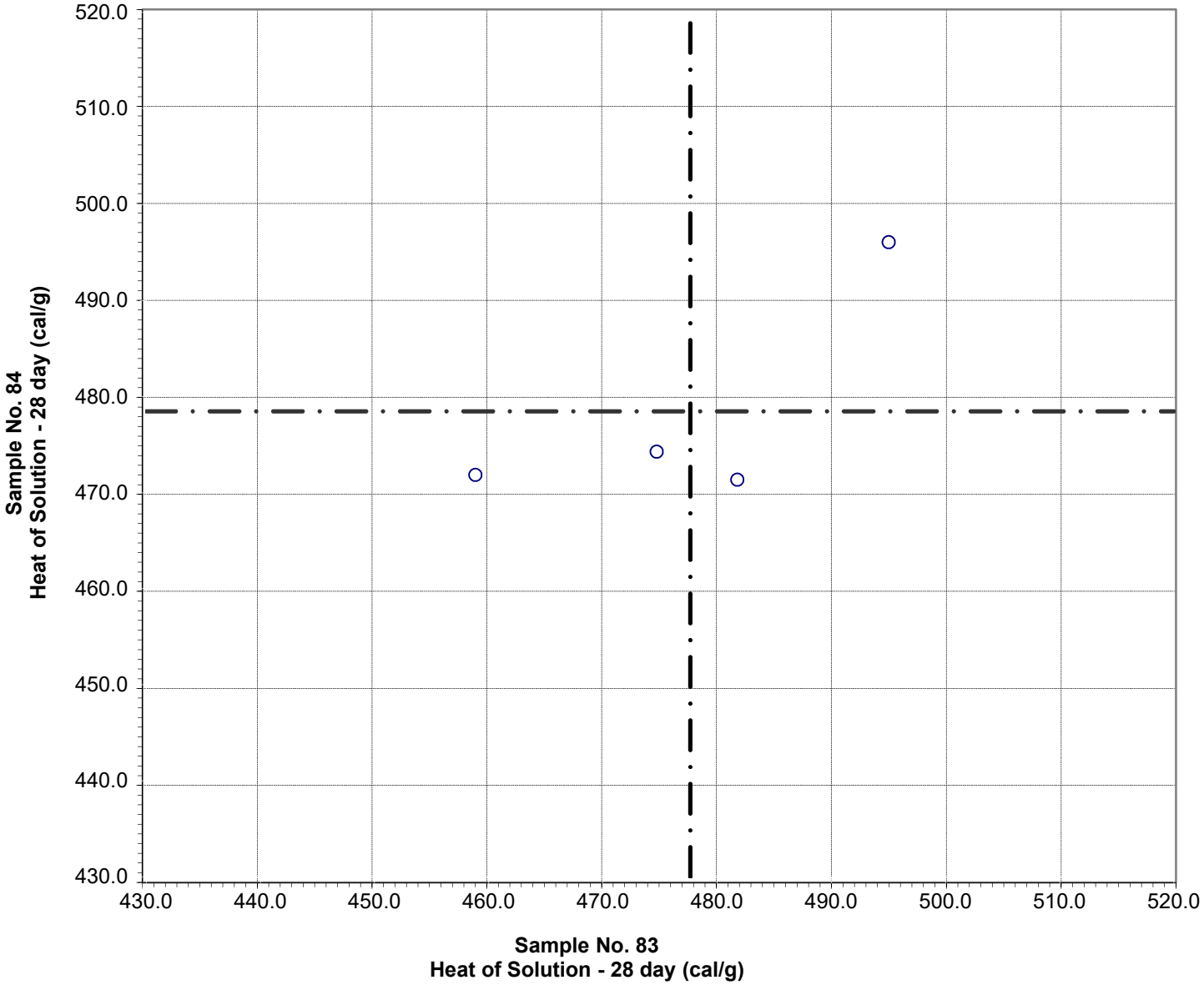
CCRL Proficiency Sample Program
Heat of Solution - 7 day
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 292 Heat of Solution - 7 day 5 Points

Sample No. 83	Ave	491.4	S.D.	5.9	C.V.	1.2
Sample No. 84	Ave	488.8	S.D.	6.1	C.V.	1.3

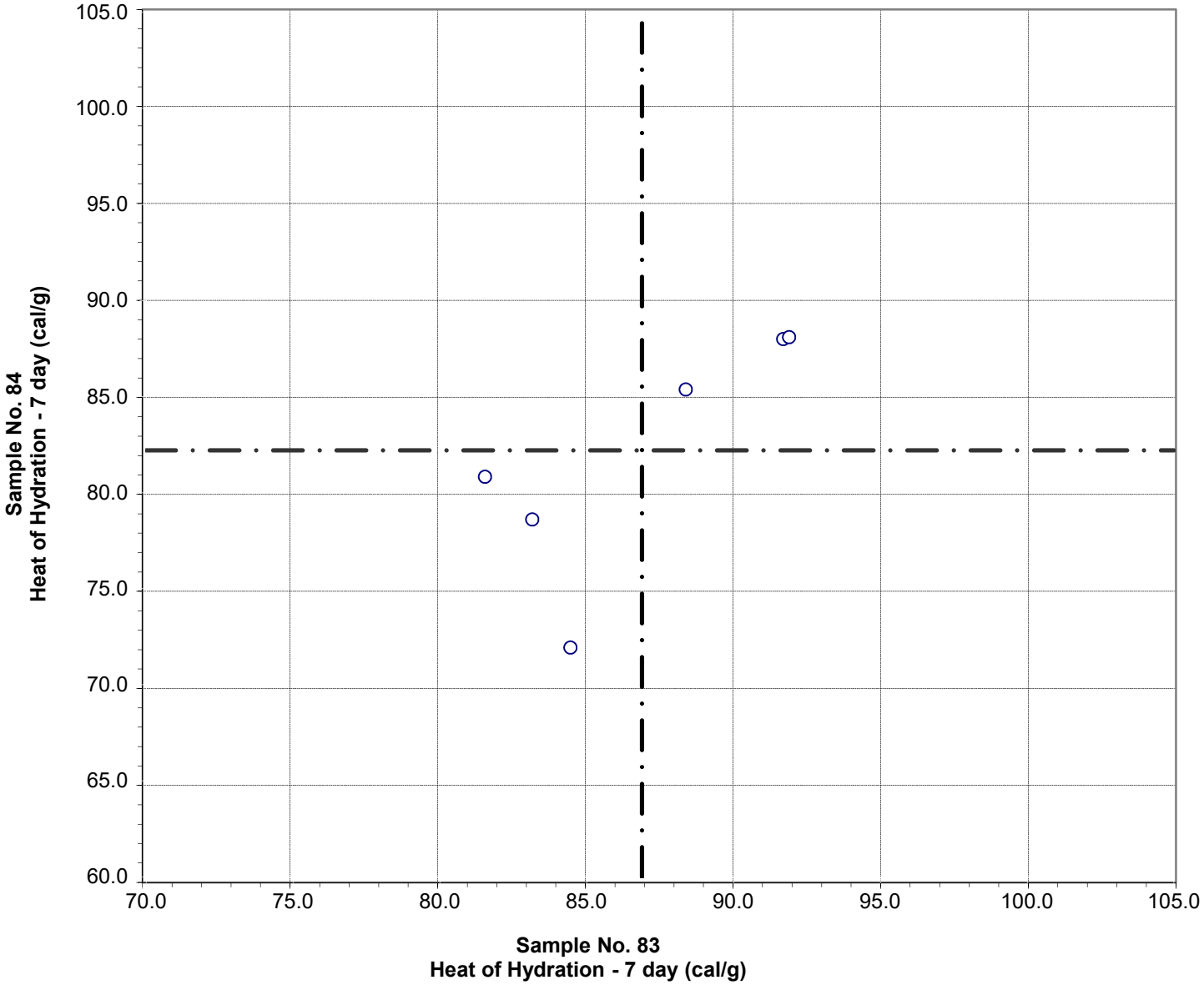
CCRL Proficiency Sample Program
Heat of Solution - 28 day
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 301 Heat of Solution - 28 day 4 Points

Sample No. 83	Ave	477.6	S.D.	15.0	C.V. 3.14
Sample No. 84	Ave	478.5	S.D.	11.8	C.V. 2.46

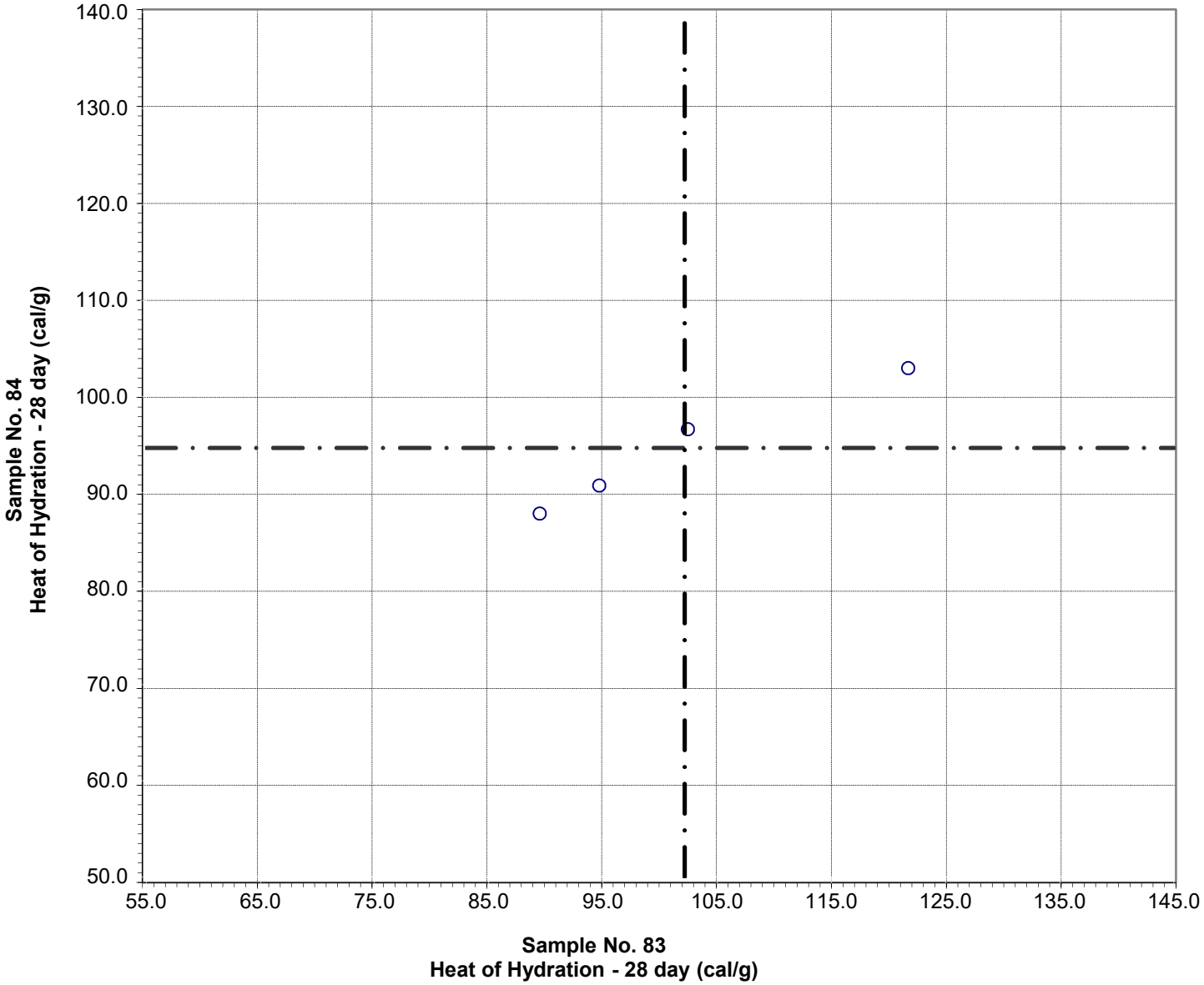
CCRL Proficiency Sample Program
Heat of Hydration - 7 day
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 290 Heat of Hydration - 7 day 6 Points

Sample No. 83	Ave 86.9	S.D. 4.4	C.V. 5.1
Sample No. 84	Ave 82.2	S.D. 6.2	C.V. 7.6

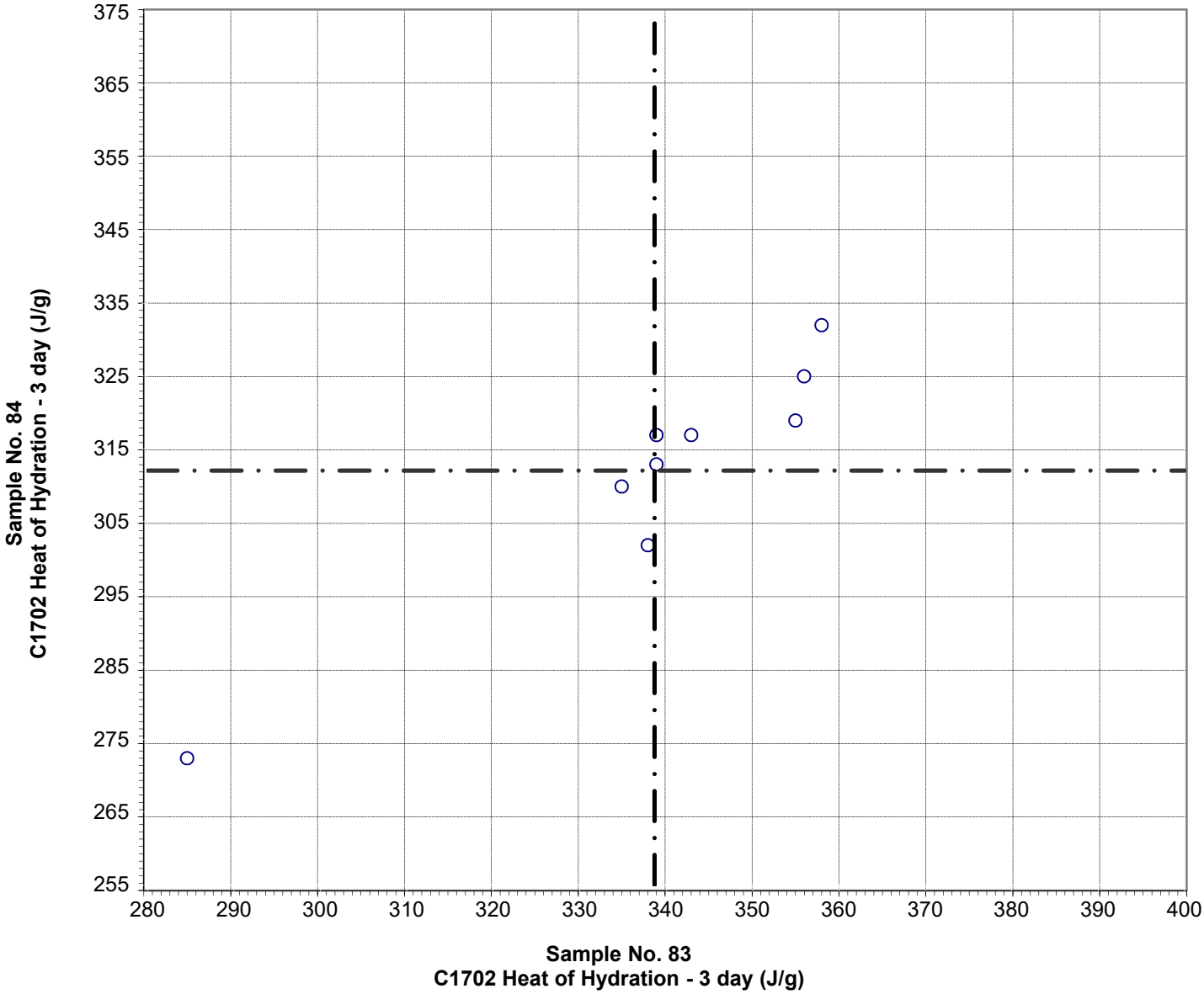
CCRL Proficiency Sample Program
Heat of Hydration - 28 day
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 300 Heat of Hydration - 28 day 4 Points

Sample No. 83	Ave	102.2	S.D.	14.1	C.V.	13.8
Sample No. 84	Ave	94.7	S.D.	6.6	C.V.	7.0

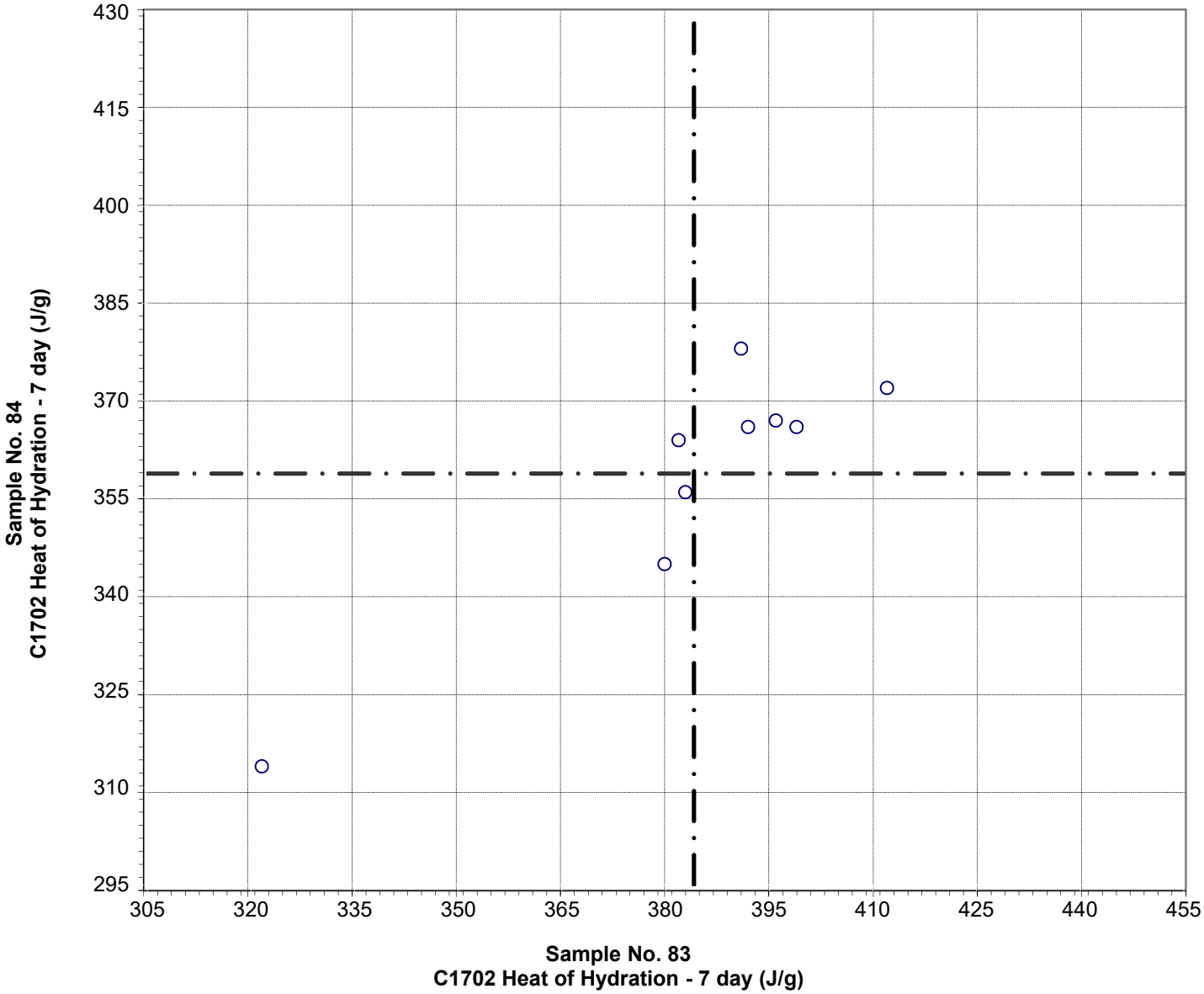
CCRL Proficiency Sample Program
C1702 Heat of Hydration - 3 day
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 500 C1702 Heat of Hydration - 3 day 9 Points

Sample No. 83	Ave	339	S.D.	22	C.V.	6.5
Sample No. 84	Ave	312	S.D.	17	C.V.	5.4

CCRL Proficiency Sample Program
C1702 Heat of Hydration - 7 day
BLENDED CEMENT Samples No. 83 and No. 84



Test No. 510 C1702 Heat of Hydration - 7 day 9 Points

Sample No. 83	Ave 384	S.D. 25	C.V. 6.6
Sample No. 84	Ave 359	S.D. 19	C.V. 5.4