

**CEMENT AND CONCRETE REFERENCE LABORATORY**  
**PROFICIENCY SAMPLE PROGRAM**

**Final Report**  
**Blended Cement Proficiency Samples**  
**Number 77 and Number 78**

April 2016



**CCRL**  
Cement and Concrete  
Reference Laboratory

[www.ccrl.us](http://www.ccrl.us)

April 26, 2016

**To: Participants in the CCRL Blended Cement Proficiency Sample Program**

**SUBJECT: Final Report on Blended Cement Proficiency Samples No. 77 and No. 78**

Following is the final report for the current pair of CCRL **Blended Cement** Proficiency Samples which were distributed in February 2016. Both cements were an ASTM C595 Blended Hydraulic Cement. Sample No 77 was a Type IL (10) and No. 78 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 2017.

Sincerely,

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

**To: Participants in the CCRL Blended Cement Proficiency Sample Program**

**FROM: Robin K. Haupt, Supervisor, PSP**

**SUBJECT: Explanation of Final Report on Results of Tests for Blended Cement Proficiency Samples No. 77 and No. 78**

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 2016. 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 62<sup>nd</sup> 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.

<b>Ratings</b>	<b>Range (Number of Standard Deviations)</b>	<b>Number (Per 100) of Laboratories achieving the rating <sup>1</sup></b>
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.

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

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  $87.5 \pm 7.5$  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 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  $\pm 1$  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. 77 and No. 78

Final Report – Chemical Results  
May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Silicon Dioxide (percent)</b>							
	95	18.01	0.41	2.3	19.17	0.48	2.5
	*91	18.02	0.33	1.8	19.17	0.34	1.8
	* Labs Eliminated - 14, 38, 50, 2463						
<b>Aluminum Oxide (percent)</b>							
	94	4.62	0.16	3.5	4.43	0.15	3.3
	*91	4.61	0.14	3.1	4.42	0.12	2.7
	* Labs Eliminated - 14, 2463, 3431						
<b>Ferric Oxide (percent)</b>							
	95	3.23	0.10	3.0	3.25	0.33	10.2
	*88	3.23	0.05	1.5	3.22	0.06	1.7
	* Labs Eliminated - 246, 2463, 3185, 3297, 3431, 3504, 3930						
<b>Calcium Oxide (percent)</b>							
	94	63.86	0.93	1.45	64.19	1.10	1.71
	*90	63.83	0.75	1.18	64.21	0.80	1.25
	* Labs Eliminated - 14, 90, 2463, 3297						
<b>Magnesium Oxide (percent)</b>							
	95	1.53	0.10	6.8	0.82	0.10	12.6
	*93	1.55	0.06	4.0	0.82	0.06	7.3
	* Labs Eliminated - 3413, 3504						
<b>Sulfur Trioxide - All Data (percent)</b>							
	98	3.04	0.09	3.1	3.00	0.11	3.5
	*90	3.03	0.06	1.9	3.00	0.06	2.2
	* Labs Eliminated - 14, 24, 43, 46, 694, 1715, 3431, 3504						
<b>Loss on Ignition - All Data (percent)</b>							
	98	4.80	0.30	6.2	4.84	0.09	1.9
	*95	4.83	0.08	1.7	4.84	0.08	1.6
	* Labs Eliminated - 47, 500, 690						

**CCRL PROFICIENCY SAMPLE PROGRAM**  
Blended Cement Proficiency Samples No. 77 and No. 78

Final Report – Chemical Results  
May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Sodium Oxide (percent)</b>							
	89	0.177	0.039	22	0.109	0.035	32
	*82	0.181	0.025	14	0.109	0.025	23
	* Labs Eliminated - 148, 284, 1251, 2463, 2982, 3297, 3504						
<b>Potassium Oxide (percent)</b>							
	92	0.48	0.04	8.9	0.23	0.07	31.6
	*85	0.49	0.02	4.7	0.22	0.01	6.6
	* Labs Eliminated - 50, 2463, 2465, 3249, 3413, 3503, 3504						
<b>Titanium Dioxide (percent)</b>							
	73	0.26	0.014	5.2	0.24	0.017	7.4
	*68	0.26	0.008	3.2	0.23	0.007	3.2
	* Labs Eliminated - 246, 2462, 2463, 3413, 3930						
<b>Phosphorus Pentoxide (percent)</b>							
	72	0.170	0.020	11.8	0.098	0.016	16.2
	*66	0.169	0.006	3.8	0.095	0.005	5.4
	* Labs Eliminated - 2463, 3059, 3235, 3413, 3504, 3930						
<b>Zinc Oxide (percent)</b>							
	36	0.101	0.012	12.0	0.058	0.011	19.1
	*33	0.103	0.005	5.0	0.058	0.004	6.1
	* Labs Eliminated - 2463, 3413, 3662						
<b>Manganic Oxide (percent)</b>							
	56	0.090	0.012	13.6	0.018	0.014	75.2
	*50	0.091	0.004	4.8	0.015	0.004	25.8
	* Labs Eliminated - 181, 413, 2463, 3059, 3413, 3504						
<b>Chloride (percent)</b>							
	43	0.013	0.007	53	0.006	0.005	83
	*40	0.013	0.006	49	0.005	0.003	60
	* Labs Eliminated - 105, 1435, 3250						

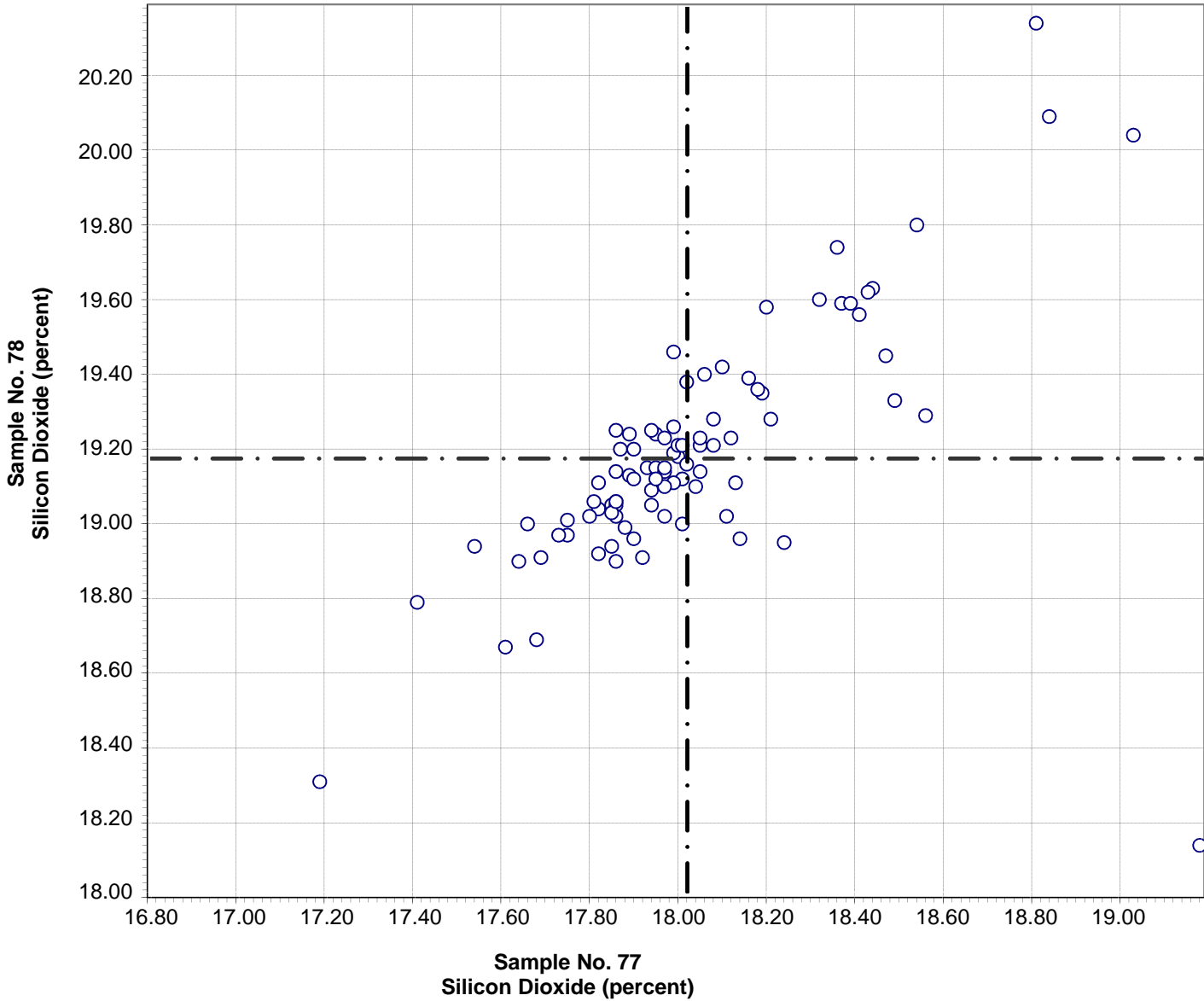
**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Blended Cement Proficiency Samples No. 77 and No. 78

Final Report – Chemical Results  
 May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Insoluble Residue (percent)</b>							
	85	0.39	0.13	34	0.54	0.13	24
	*80	0.39	0.10	26	0.53	0.09	17
* Labs Eliminated - 24, 121, 441, 2466, 4050							
<b>Chromium Oxide (percent)</b>							
	33	0.019	0.005	25	0.013	0.002	18
	*32	0.019	0.003	16	0.012	0.002	15
* Labs Eliminated - 2463							

**CCRL Proficiency Sample Program  
Silicon Dioxide  
BLENDED CEMENT Samples No. 77 and No. 78**



Test No. 10 Silicon Dioxide 90 Points

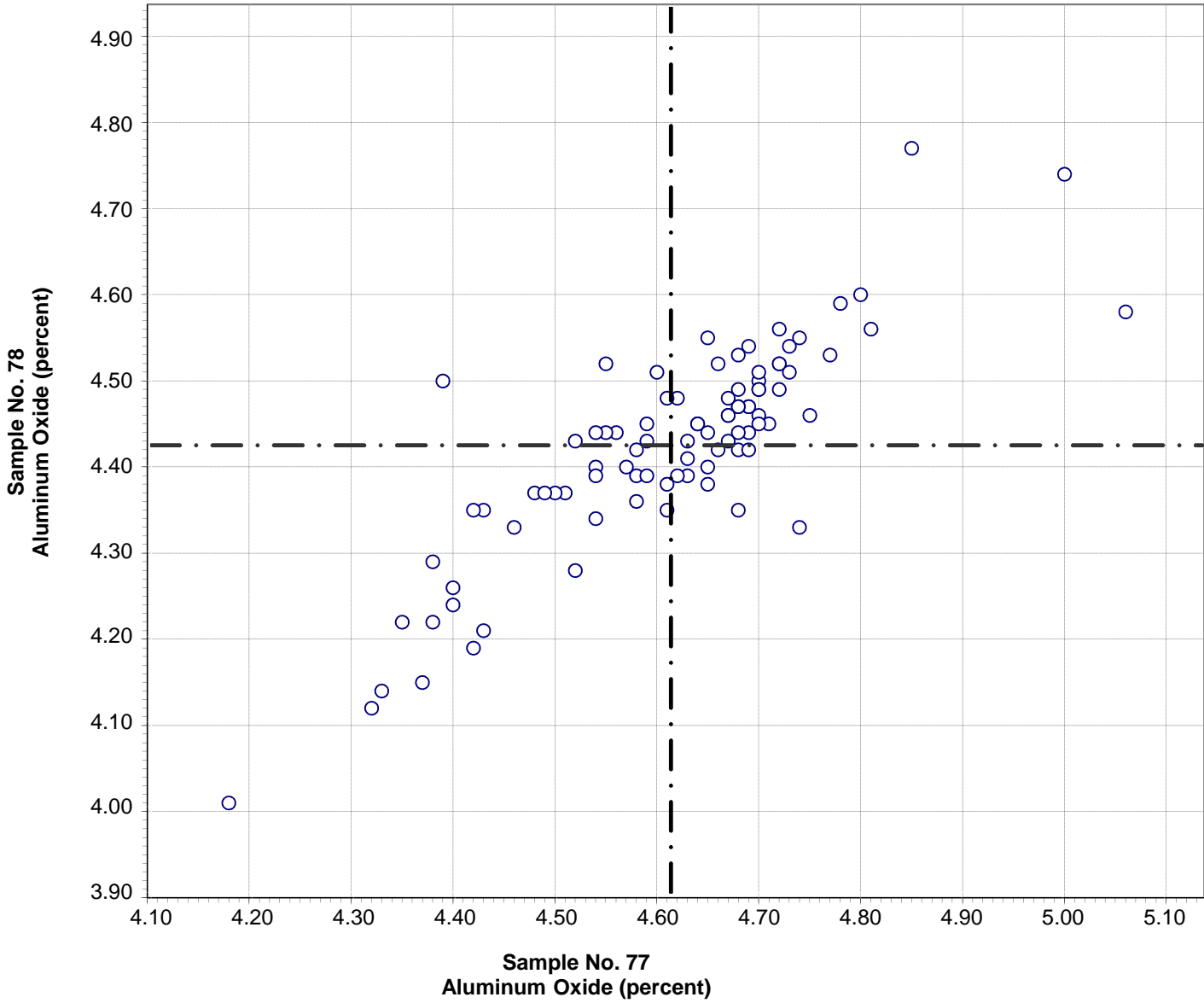
Sample No. 77	Ave 18.02	S.D. 0.33	C.V. 1.8
Sample No. 78	Ave 19.17	S.D. 0.34	C.V. 1.8

Labs Eliminated: 14, 38, 50, 2463

Labs off Diagram: 3297



**CCRL Proficiency Sample Program  
Aluminum Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**

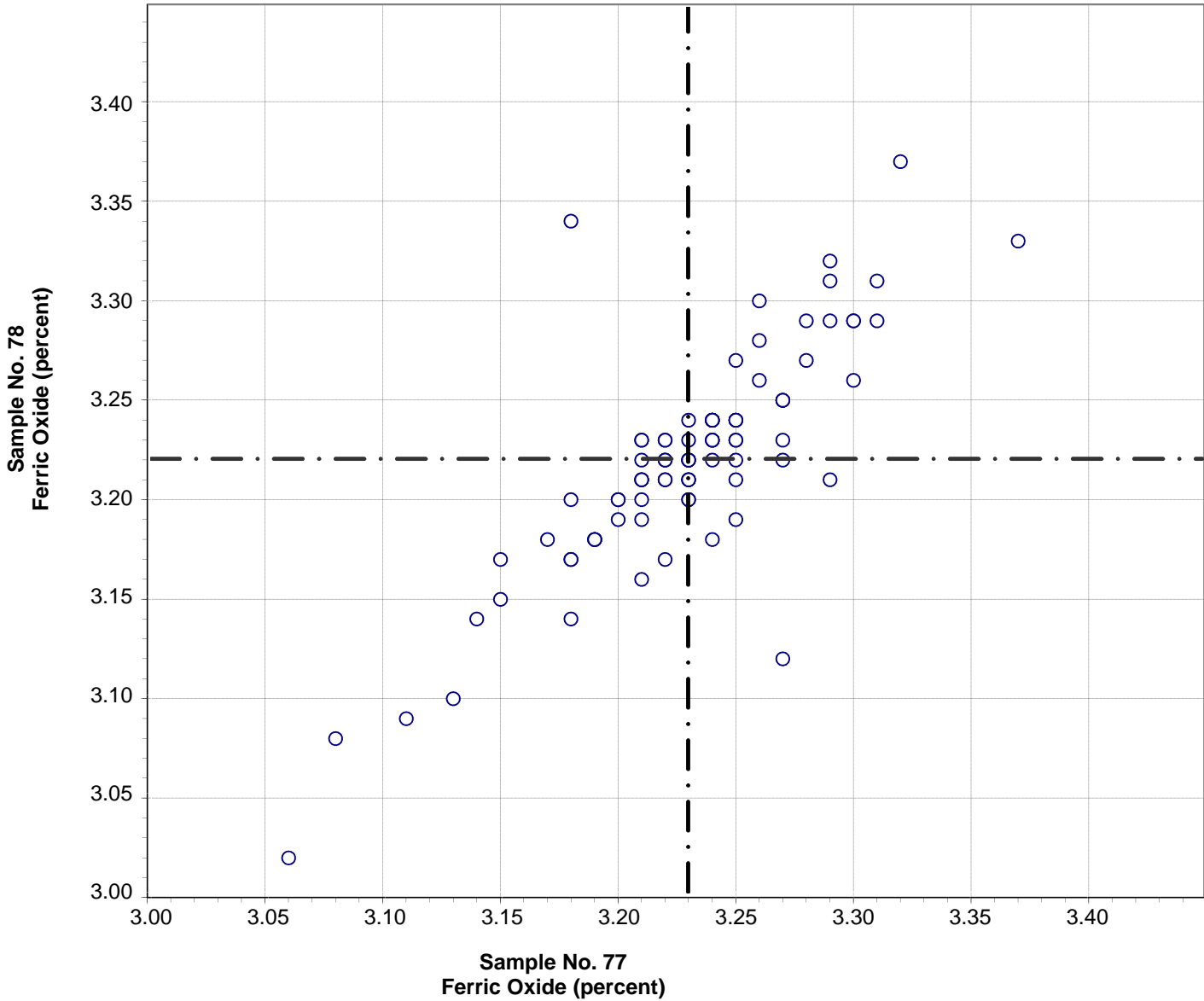


Test No. 21 Aluminum Oxide 91 Points

Sample No. 77	Ave 4.61	S.D. 0.14	C.V. 3.1
Sample No. 78	Ave 4.42	S.D. 0.12	C.V. 2.7

Labs Eliminated: 14, 2463, 3431

**CCRL Proficiency Sample Program  
 Ferric Oxide  
 BLENDED CEMENT Samples No. 77 and No. 78**

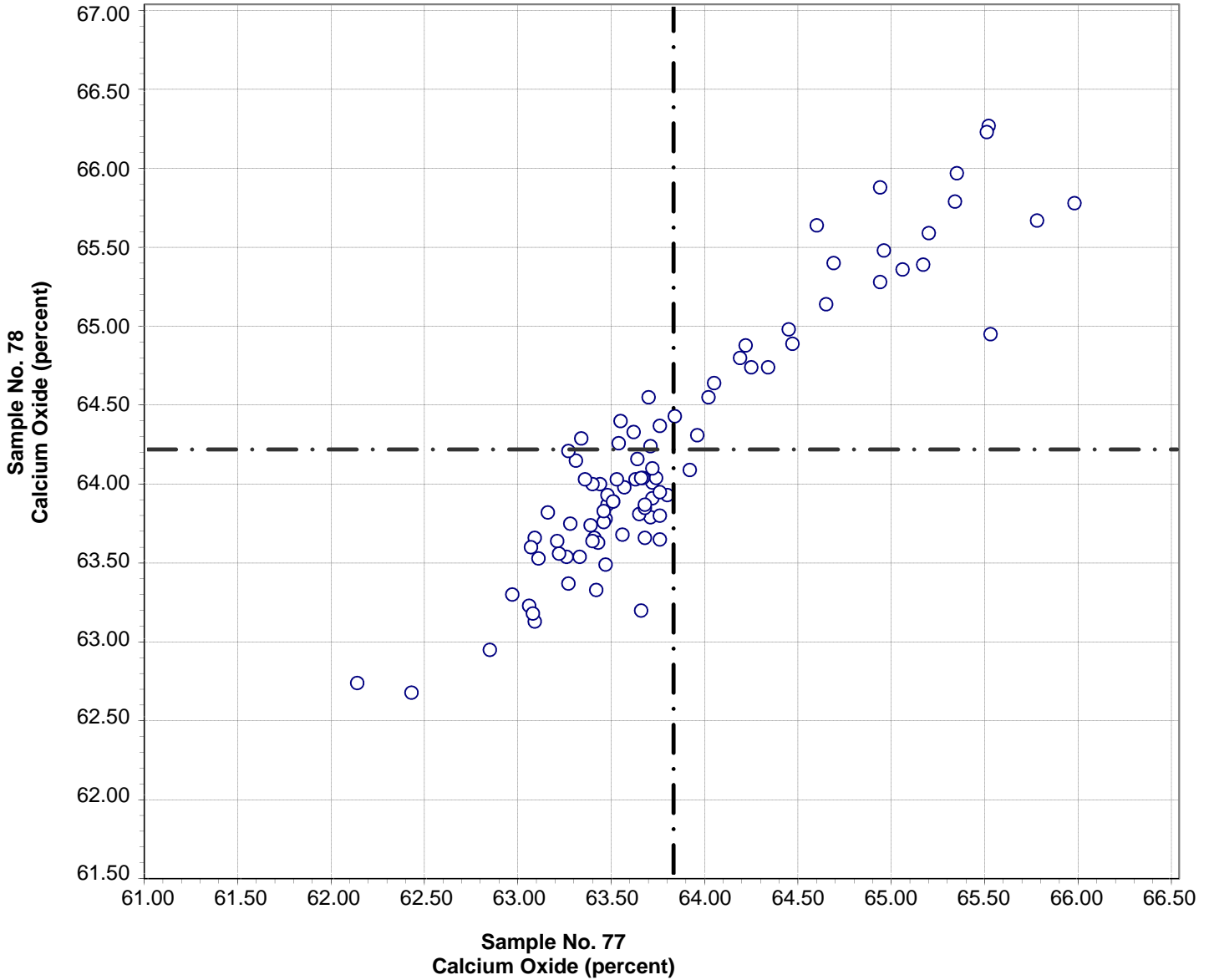


Test No. 30 Ferric Oxide 88 Points

Sample No. 77	Ave 3.23	S.D. 0.05	C.V. 1.5
Sample No. 78	Ave 3.22	S.D. 0.06	C.V. 1.7

Labs Eliminated: 246, 2463, 3185, 3297, 3431, 3504, 3930

**CCRL Proficiency Sample Program  
Calcium Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**

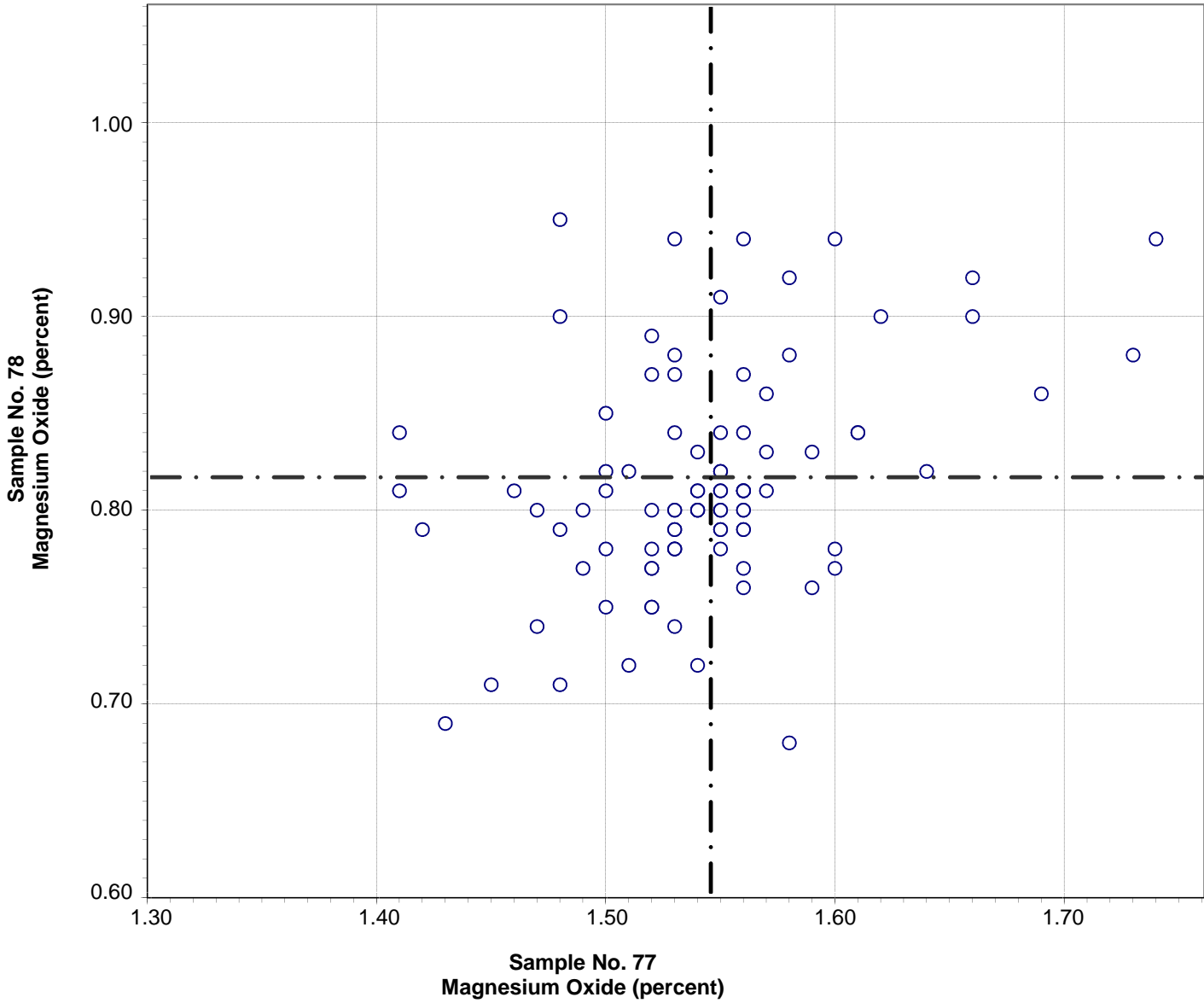


Test No. 40    Calcium Oxide    90 Points

Sample No. 77	Ave 63.83	S.D. 0.75	C.V. 1.18
Sample No. 78	Ave 64.21	S.D. 0.80	C.V. 1.25

Labs Eliminated: 14, 90, 2463, 3297

**CCRL Proficiency Sample Program  
Magnesium Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**



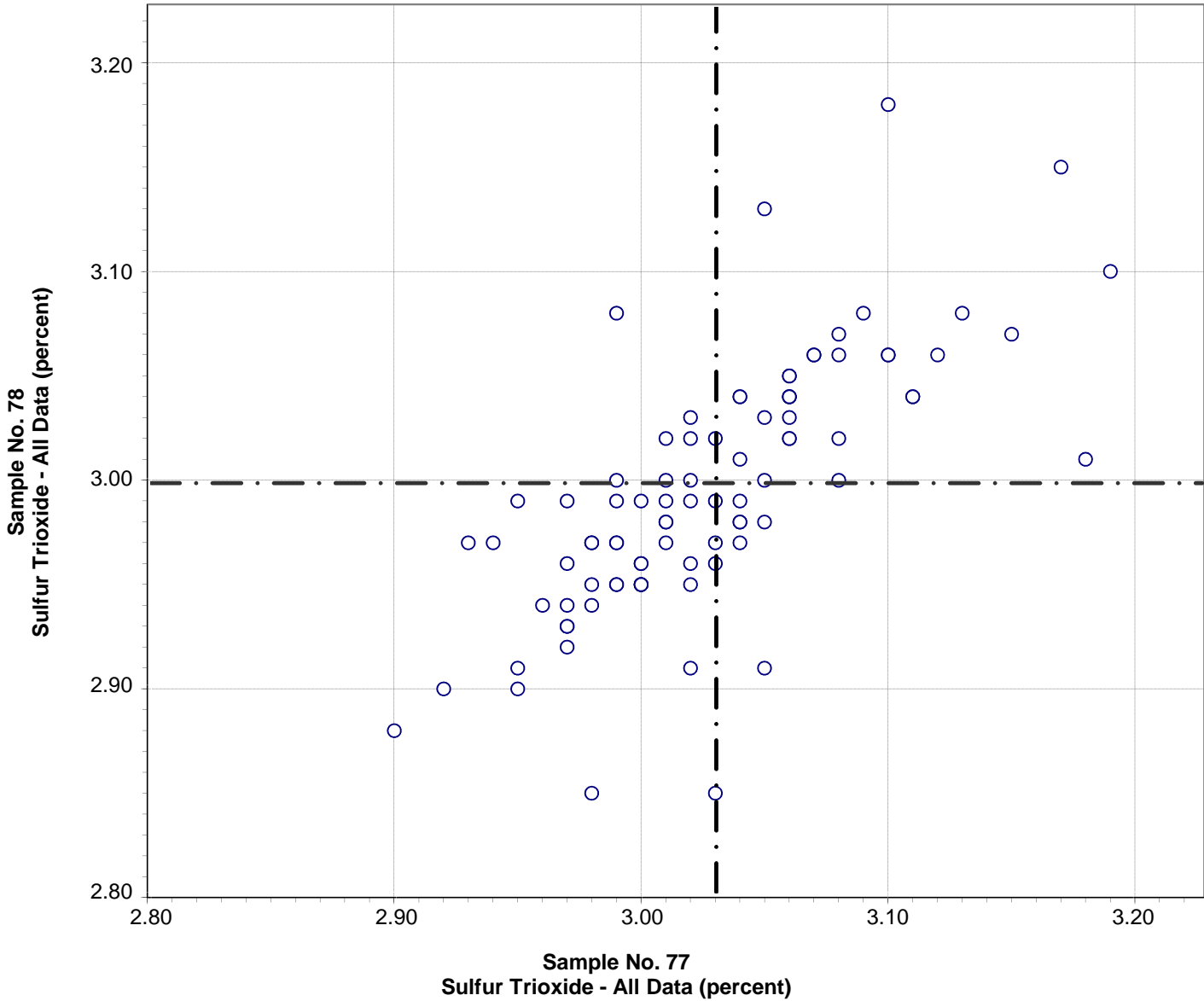
Test No. 50    Magnesium Oxide    92 Points

Sample No. 77	Ave 1.55	S.D. 0.06	C.V. 4.0
Sample No. 78	Ave 0.82	S.D. 0.06	C.V. 7.3

Labs Eliminated: 3413, 3504

Labs off Diagram: 3431

**CCRL Proficiency Sample Program  
Sulfur Trioxide - All Data  
BLENDED CEMENT Samples No. 77 and No. 78**



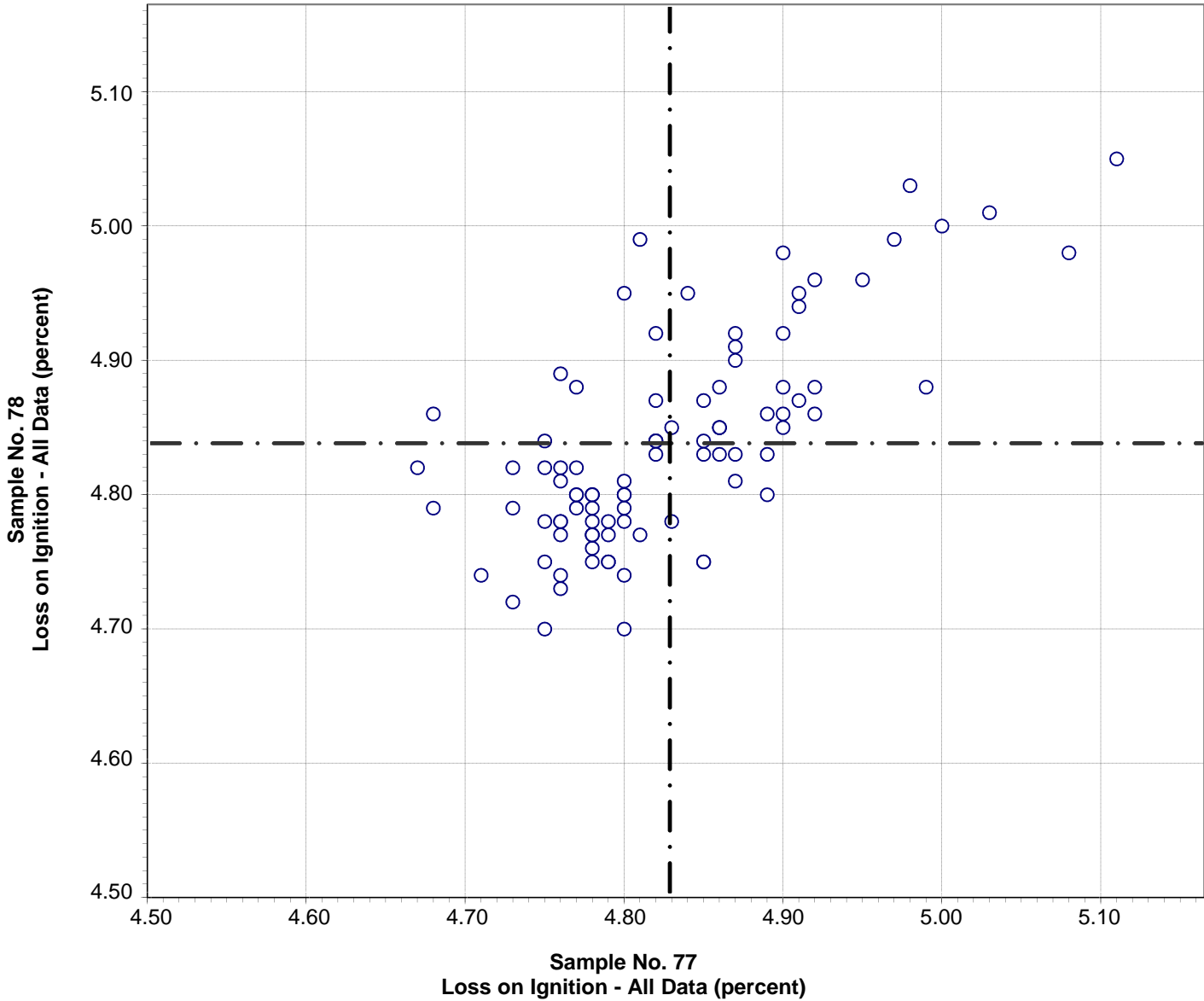
**Test No. 60 Sulfur Trioxide - All Data 89 Points**

Sample No. 77	Ave 3.03	S.D. 0.06	C.V. 1.9
Sample No. 78	Ave 3.00	S.D. 0.06	C.V. 2.2

Labs Eliminated: 14, 24, 43, 46, 694, 1715, 3431, 3504

Labs off Diagram: 3297

**CCRL Proficiency Sample Program  
Loss on Ignition - All Data  
BLENDED CEMENT Samples No. 77 and No. 78**

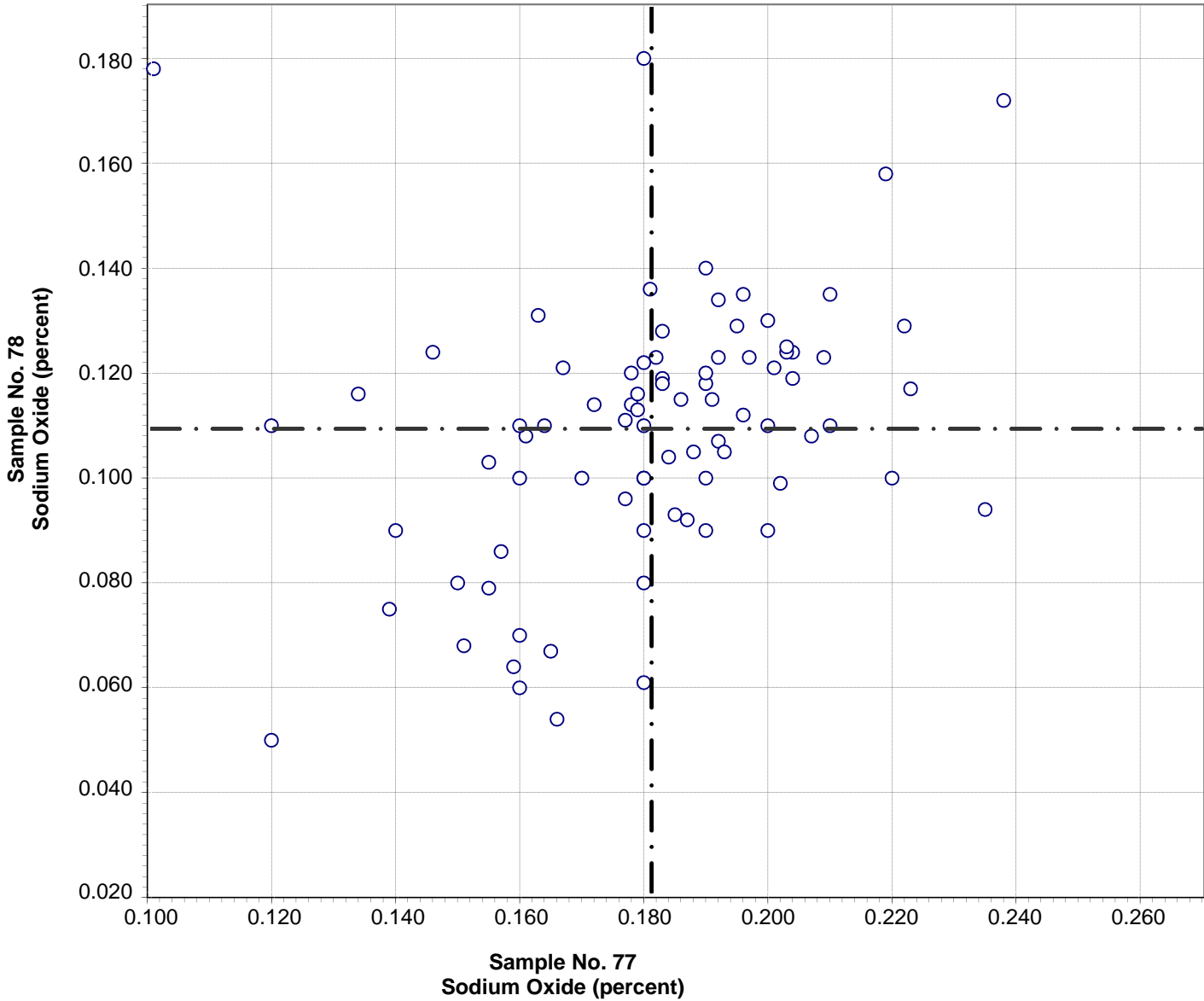


Test No. 70    Loss on Ignition - All Data    95 Points

Sample No. 77	Ave 4.83	S.D. 0.08	C.V. 1.7
Sample No. 78	Ave 4.84	S.D. 0.08	C.V. 1.6

Labs Eliminated: 47, 500, 690

**CCRL Proficiency Sample Program  
Sodium Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**

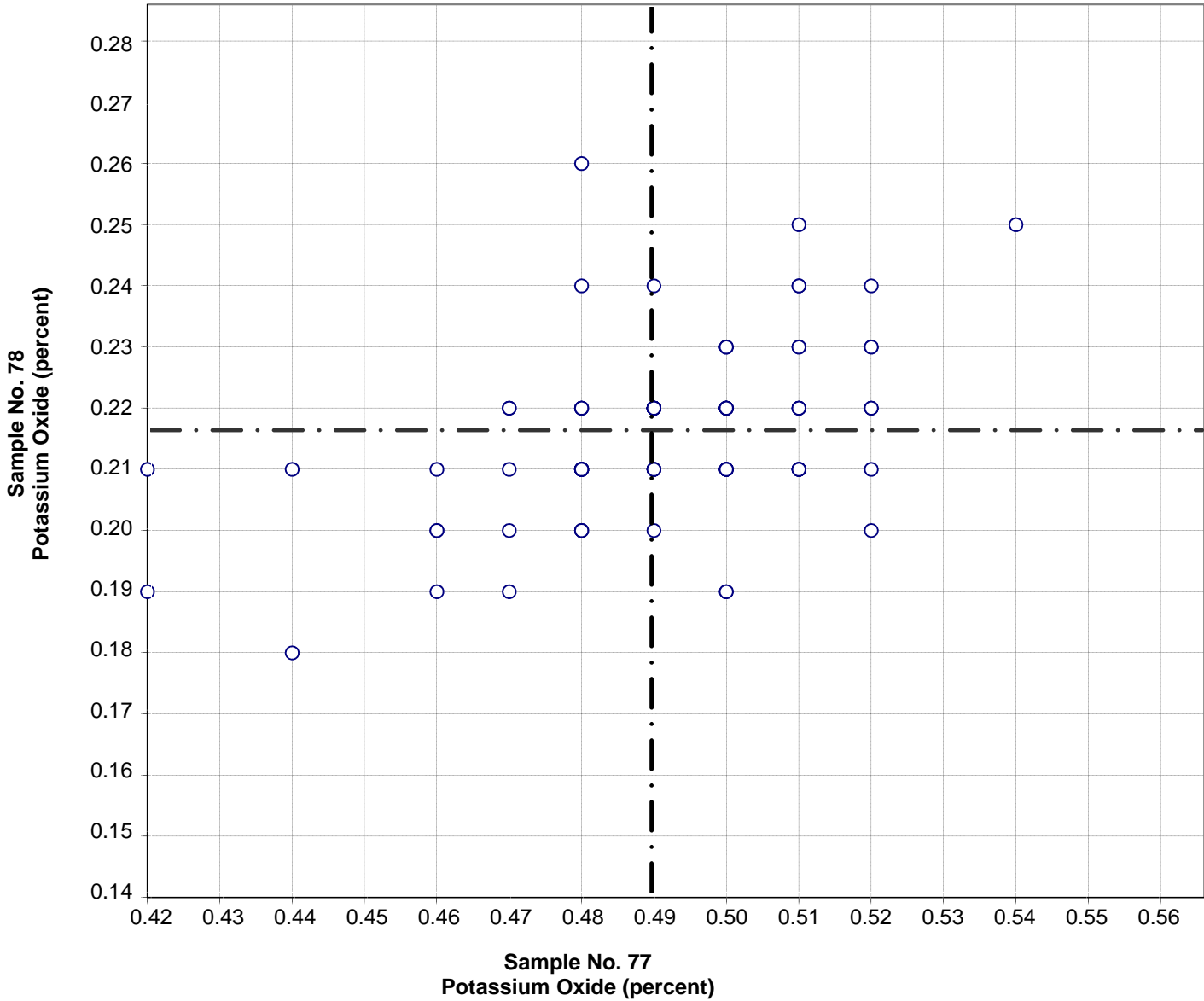


Test No. 90 Sodium Oxide 82 Points

Sample No. 77	Ave 0.181	S.D. 0.025	C.V. 14
Sample No. 78	Ave 0.109	S.D. 0.025	C.V. 23

Labs Eliminated: 148, 284, 1251, 2463, 2982, 3297, 3504

**CCRL Proficiency Sample Program  
Potassium Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**



Test No. 100 Potassium Oxide 84 Points

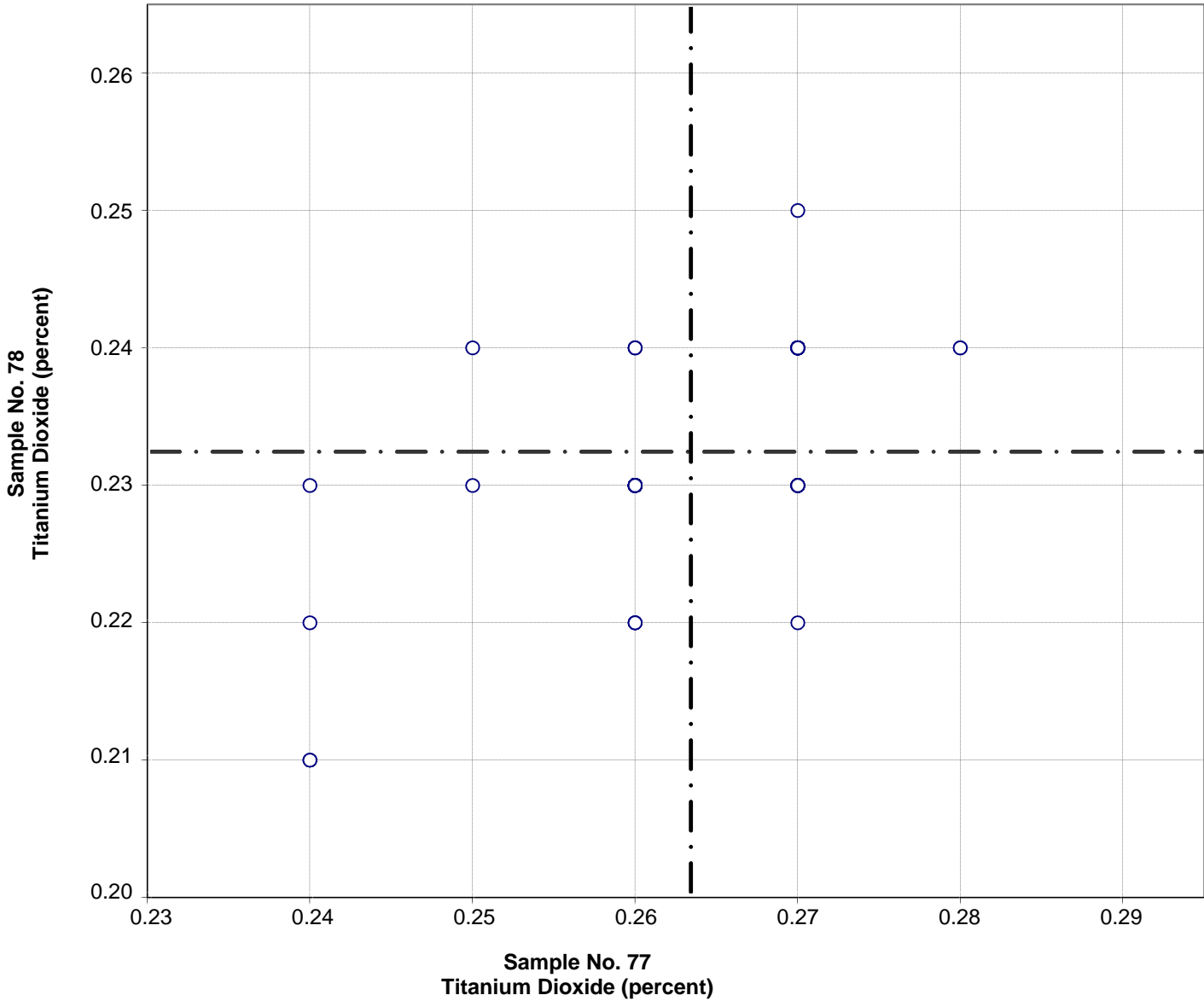
Sample No. 77 Ave 0.49 S.D. 0.02 C.V. 4.7  
 Sample No. 78 Ave 0.22 S.D. 0.01 C.V. 6.6

Labs Eliminated: 50, 2463, 2465, 3249, 3413, 3503, 3504

Labs off Diagram: 54



**CCRL Proficiency Sample Program  
Titanium Dioxide  
BLENDED CEMENT Samples No. 77 and No. 78**

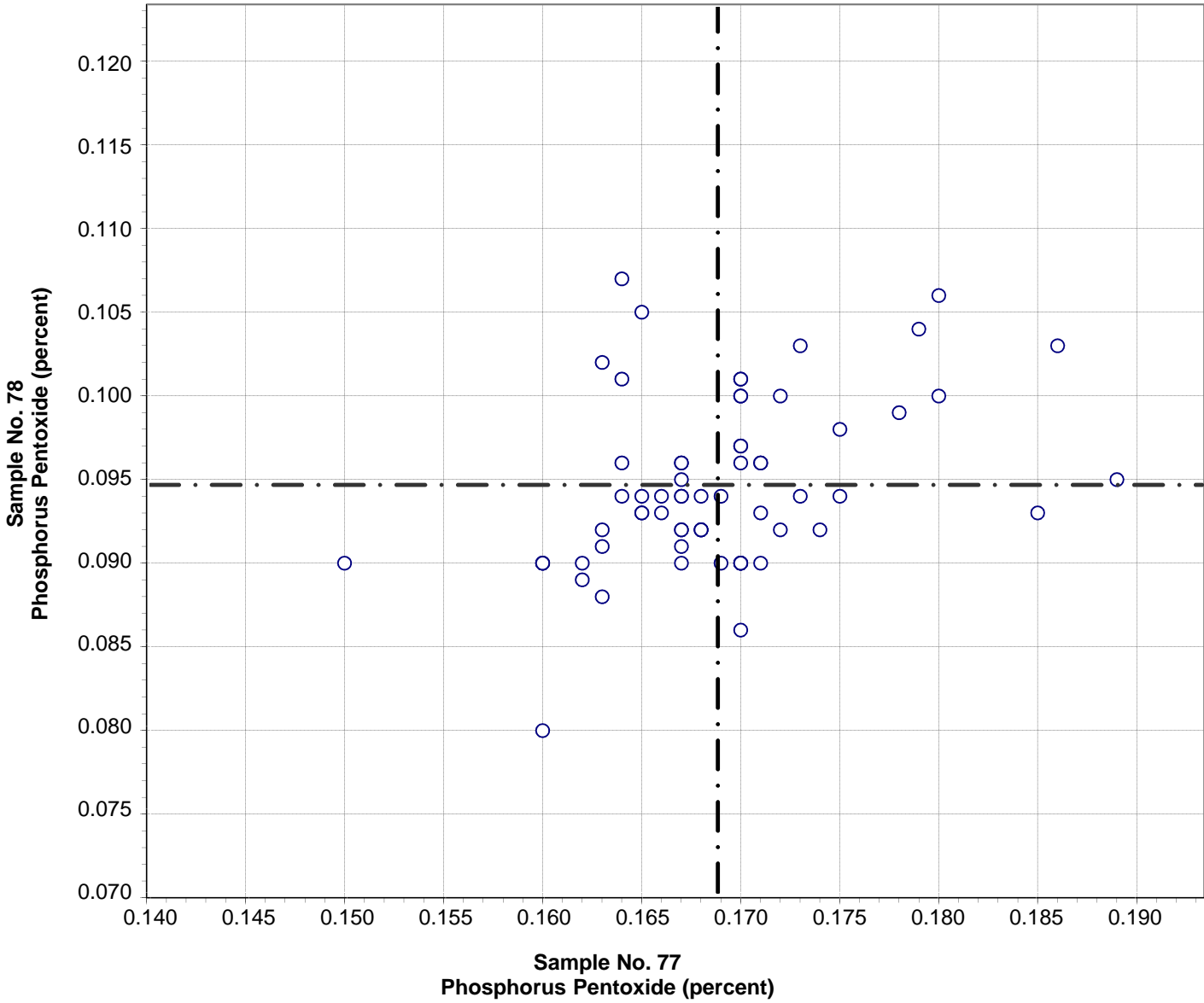


Test No. 103 Titanium Dioxide 68 Points

Sample No. 77	Ave 0.26	S.D. 0.008	C.V. 3.2
Sample No. 78	Ave 0.23	S.D. 0.007	C.V. 3.2

Labs Eliminated: 246, 2462, 2463, 3413, 3930

**CCRL Proficiency Sample Program  
Phosphorus Pentoxide  
BLENDED CEMENT Samples No. 77 and No. 78**

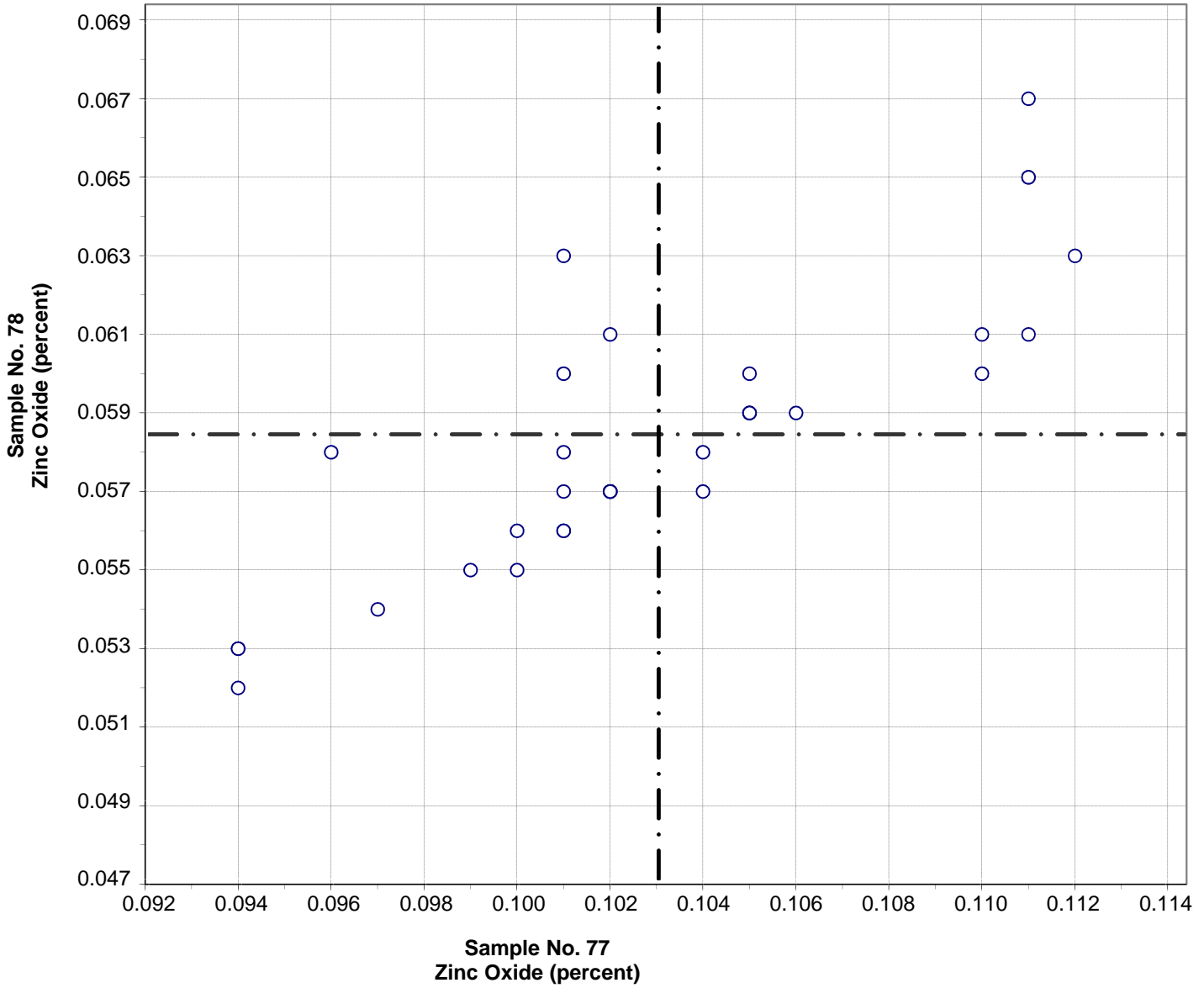


Test No. 102 Phosphorus Pentoxide 66 Points

Sample No. 77	Ave 0.169	S.D. 0.006	C.V. 3.8
Sample No. 78	Ave 0.095	S.D. 0.005	C.V. 5.4

Labs Eliminated: 2463, 3059, 3235, 3413, 3504, 3930

**CCRL Proficiency Sample Program  
Zinc Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**

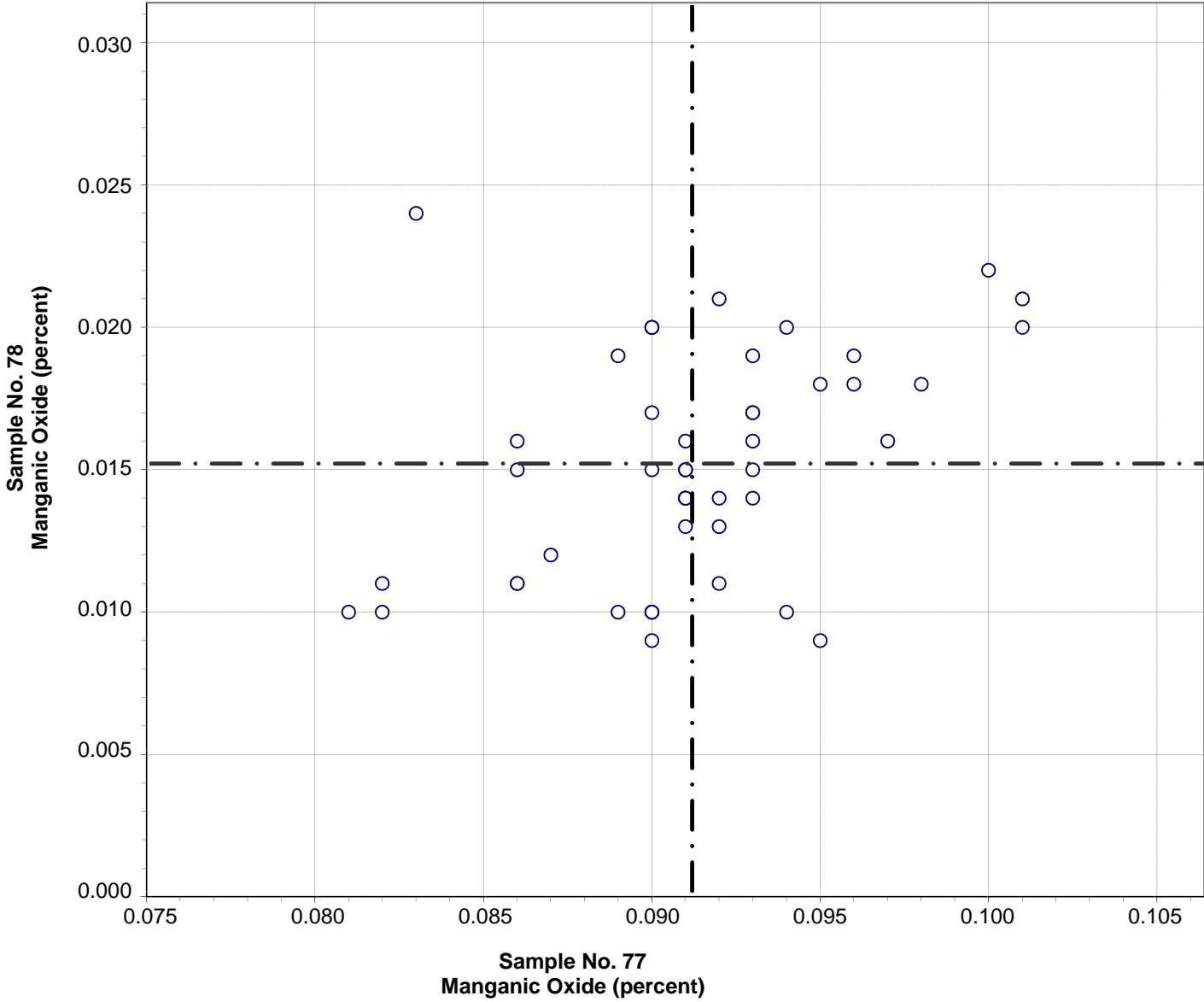


Test No. 99    Zinc Oxide    33 Points

Sample No. 77	Ave 0.103	S.D. 0.005	C.V. 5.0
Sample No. 78	Ave 0.058	S.D. 0.004	C.V. 6.1

Labs Eliminated: 2463, 3413, 3662

**CCRL Proficiency Sample Program  
Manganic Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**

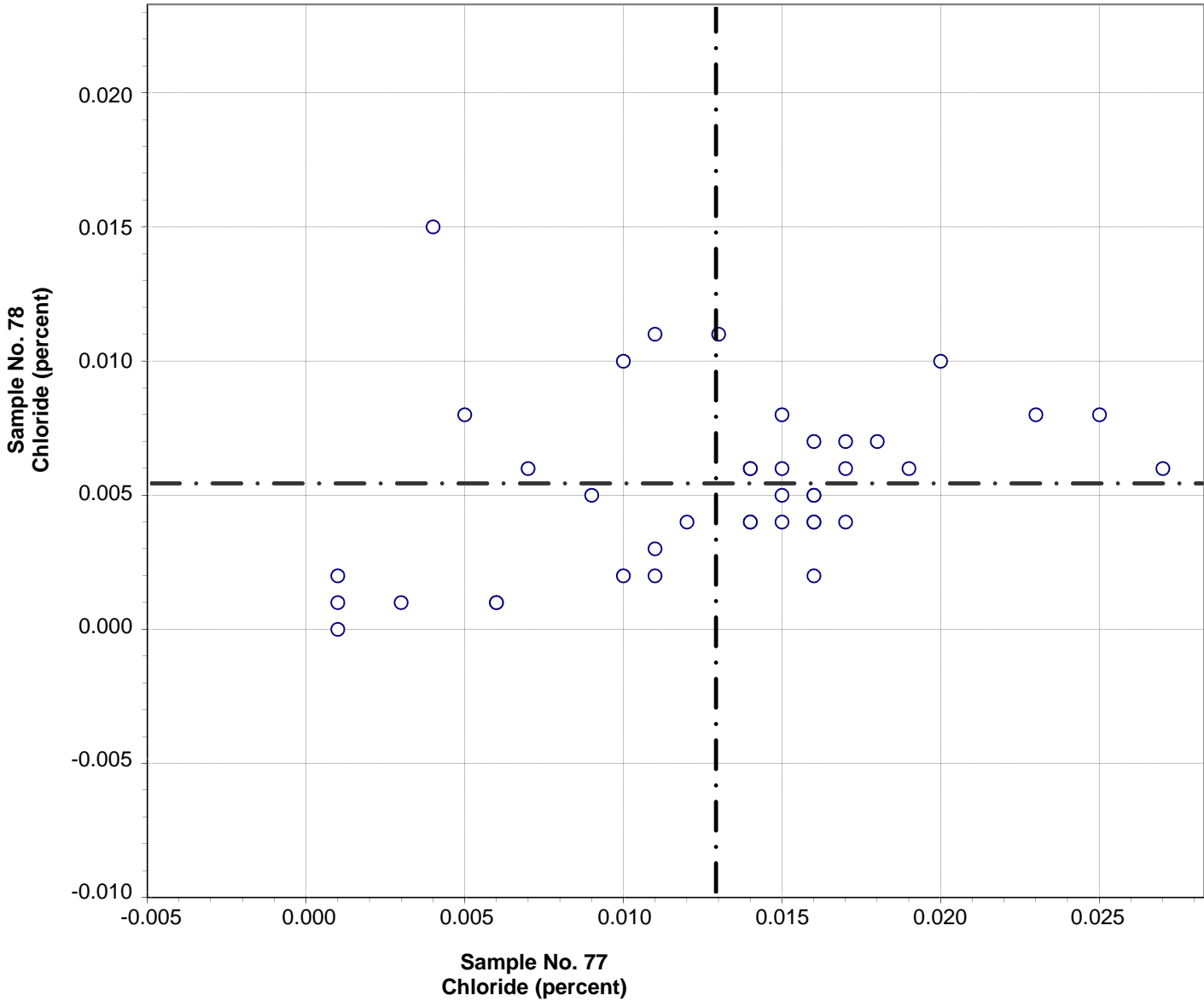


Test No. 101 Manganic Oxide 50 Points

Sample No. 77	Ave 0.091	S.D. 0.004	C.V. 4.8
Sample No. 78	Ave 0.015	S.D. 0.004	C.V. 25.8

Labs Eliminated: 181, 413, 2463, 3059, 3413, 3504

**CCRL Proficiency Sample Program  
Chloride  
BLENDED CEMENT Samples No. 77 and No. 78**

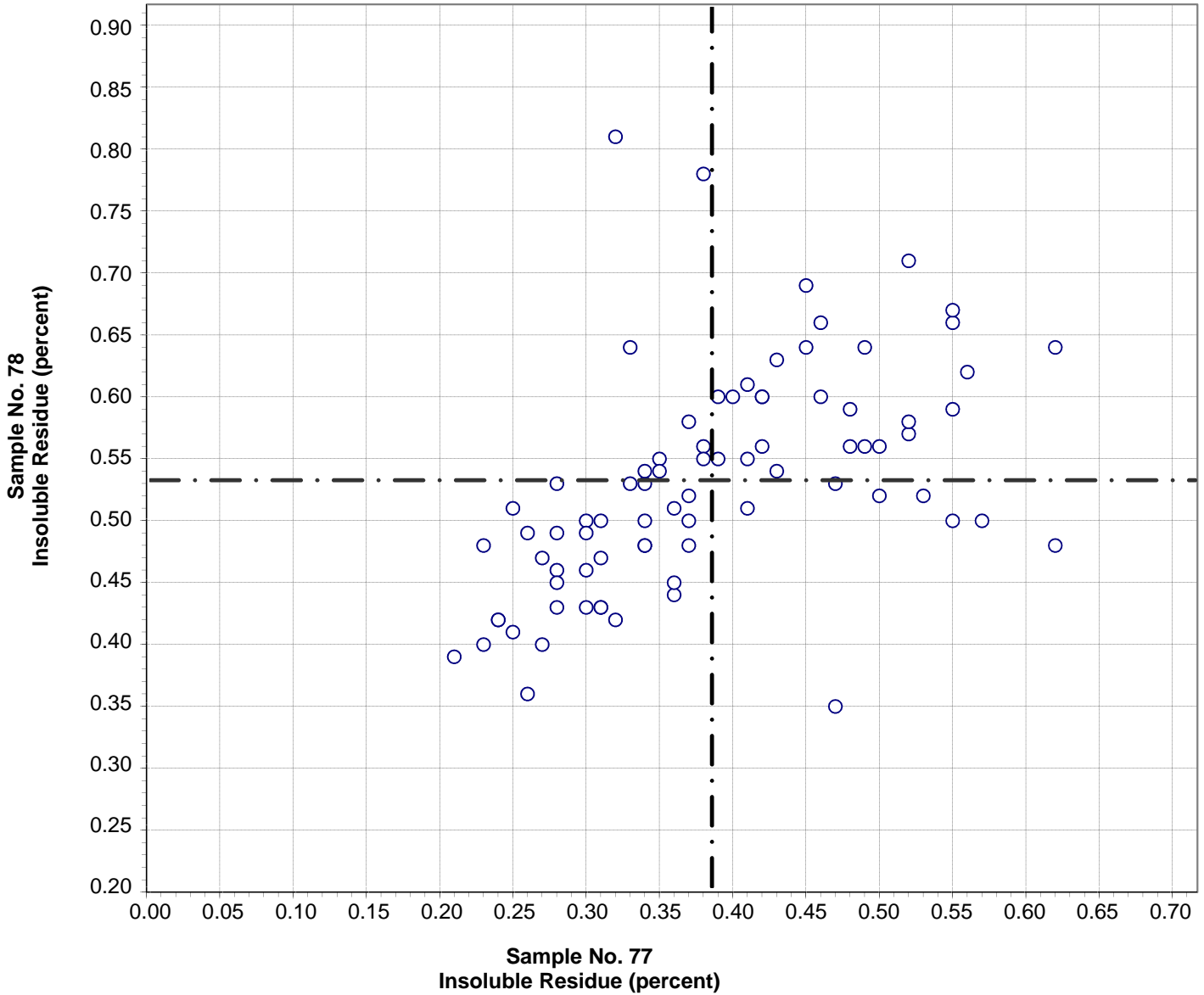


Test No. 104 Chloride 40 Points

Sample No. 77	Ave 0.013	S.D. 0.006	C.V. 49
Sample No. 78	Ave 0.005	S.D. 0.003	C.V. 60

Labs Eliminated: 105, 1435, 3250

**CCRL Proficiency Sample Program  
Insoluble Residue  
BLENDED CEMENT Samples No. 77 and No. 78**

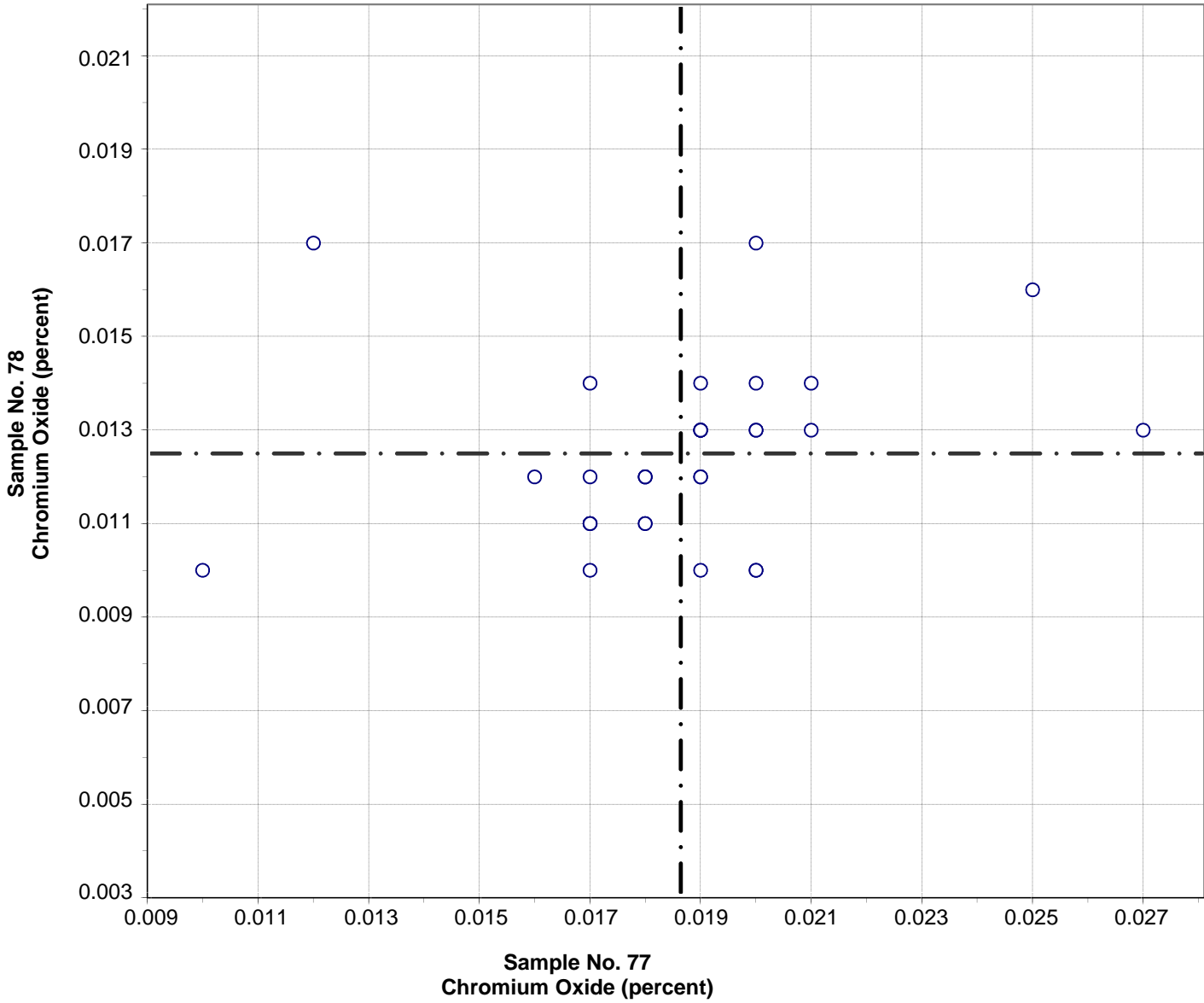


Test No. 80 Insoluble Residue 80 Points

Sample No. 77	Ave 0.39	S.D. 0.10	C.V. 26
Sample No. 78	Ave 0.53	S.D. 0.09	C.V. 17

Labs Eliminated: 24, 121, 441, 2466, 4050

**CCRL Proficiency Sample Program  
Chromium Oxide  
BLENDED CEMENT Samples No. 77 and No. 78**



Test No. 105   Chromium Oxide   32 Points

Sample No. 77	Ave 0.019	S.D. 0.003	C.V. 16
Sample No. 78	Ave 0.012	S.D. 0.002	C.V. 15

Labs Eliminated: 2463

**CCRL PROFICIENCY SAMPLE PROGRAM**  
Blended Cement Proficiency Samples No. 77 and No. 78

Final Report – Physical Results  
May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Normal Consistency - % Water (percent)</b>							
	106	26.0	2.7	10.2	25.8	2.6	10.3
	*104	26.2	0.5	1.9	26.0	0.5	1.8
	* Labs Eliminated - 24, 2477						
<b>Vicat Time of Set - Initial (min)</b>							
	106	123	11	9.3	121	18	14.9
	*104	122	12	9.4	119	11	9.2
	* Labs Eliminated - 74, 3912						
<b>Vicat Time of Set - Final (min)</b>							
	104	216	32	15	212	29	14
	*101	217	29	13	211	28	13
	* Labs Eliminated - 14, 74, 3912						
<b>Autoclave Expansion (percent)</b>							
	95	-0.01	0.03	170	0.00	0.02	255
	*92	-0.02	0.02	101	0.00	0.02	186
	* Labs Eliminated - 124, 246, 2352						
<b>Air Content % (percent)</b>							
	92	9.0	1.5	16	6.3	1.5	23
	*90	9.0	1.3	14	6.3	1.4	22
	* Labs Eliminated - 19, 474						
<b>Air Content - % Water (percent)</b>							
	90	65.6	14.1	21.5	67.1	14.3	21.2
	*83	68.1	2.7	4.0	70.0	2.7	3.9
	* Labs Eliminated - 34, 121, 474, 2466, 2490, 3235, 4098						
<b>Air Content - Flow (percent)</b>							
	90	89	5.1	5.8	86	5.5	6.5
	*84	89	3.3	3.7	85	3.1	3.6
	* Labs Eliminated - 23, 50, 121, 2490, 3235, 4098						



**CCRL PROFICIENCY SAMPLE PROGRAM**  
Blended Cement Proficiency Samples No. 77 and No. 78

Final Report – Physical Results  
May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Specific Gravity</b>							
	92	3.08	0.08	2.5	3.08	0.13	4.2
	*88	3.09	0.04	1.2	3.10	0.03	1.0
	* Labs Eliminated - 23, 2490, 3233, 3662						
<b>Compressive Strength - 3 day (psi)</b>							
	107	4488	354	7.9	4310	310	7.2
	*105	4510	321	7.1	4331	273	6.3
	* Labs Eliminated - 23, 4098						
<b>Compressive Strength - 7 day (psi)</b>							
	107	5293	392	7.4	5353	417	7.8
	*104	5328	337	6.3	5398	324	6.0
	* Labs Eliminated - 23, 25, 46						
<b>Compressive Strength - 28 day (psi)</b>							
	100	6216	480	7.7	6667	473	7.1
	*99	6232	456	7.3	6685	440	6.6
	* Labs Eliminated - 23						
<b>Compressive Strength - % Water (percent)</b>							
	102	46.9	8.2	17.5	47.6	8.4	17.6
	*97	48.2	1.1	2.2	48.9	1.2	2.5
	* Labs Eliminated - 24, 42, 1657, 3503, 4098						
<b>Compressive Strength - Flow (percent)</b>							
	105	110	4.2	3.8	108	3.6	3.3
	*99	111	2.7	2.4	109	2.2	2.1
	* Labs Eliminated - 3, 38, 40, 47, 124, 958						
<b>Fineness - Air Permeability (m<sup>2</sup>/kg)</b>							
	102	513	31	6.0	513	31	6.1
	*96	519	20	3.9	517	19	3.7
	* Labs Eliminated - 23, 51, 169, 2360, 2490, 3912						

**CCRL PROFICIENCY SAMPLE PROGRAM**  
 Blended Cement Proficiency Samples No. 77 and No. 78

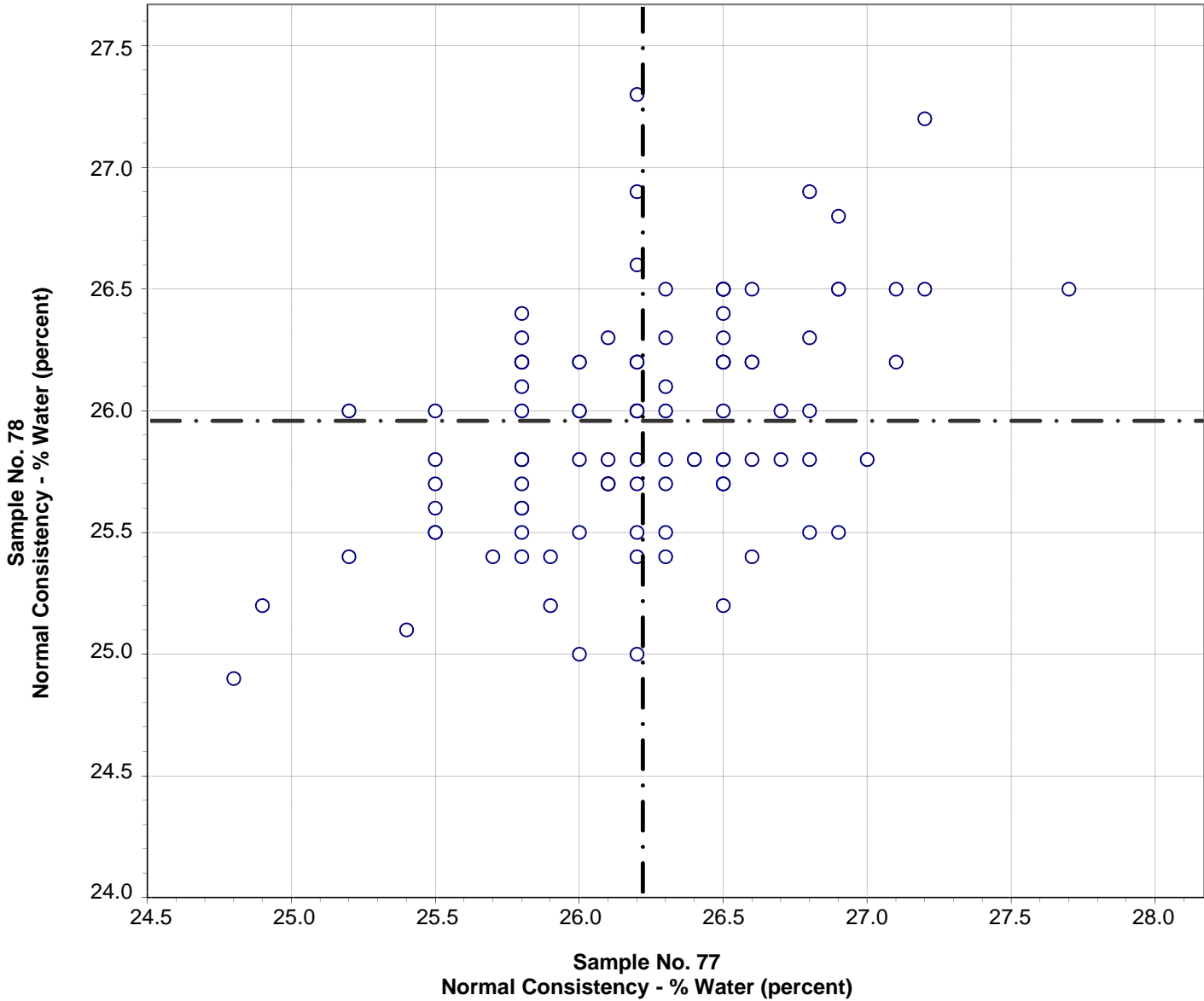
Final Report – Physical Results  
 May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Fineness - 45µm % Passing (percent)</b>							
	104	95.36	10.58	11.10	96.64	10.79	11.16
	*93	97.16	0.35	0.36	98.52	0.21	0.21

\* Labs Eliminated - 7, 22, 34, 51, 74, 413, 474, 3247, 3249, 3431, 3661

**CCRL Proficiency Sample Program  
Normal Consistency - % Water  
BLENDED CEMENT Samples No. 77 and No. 78**

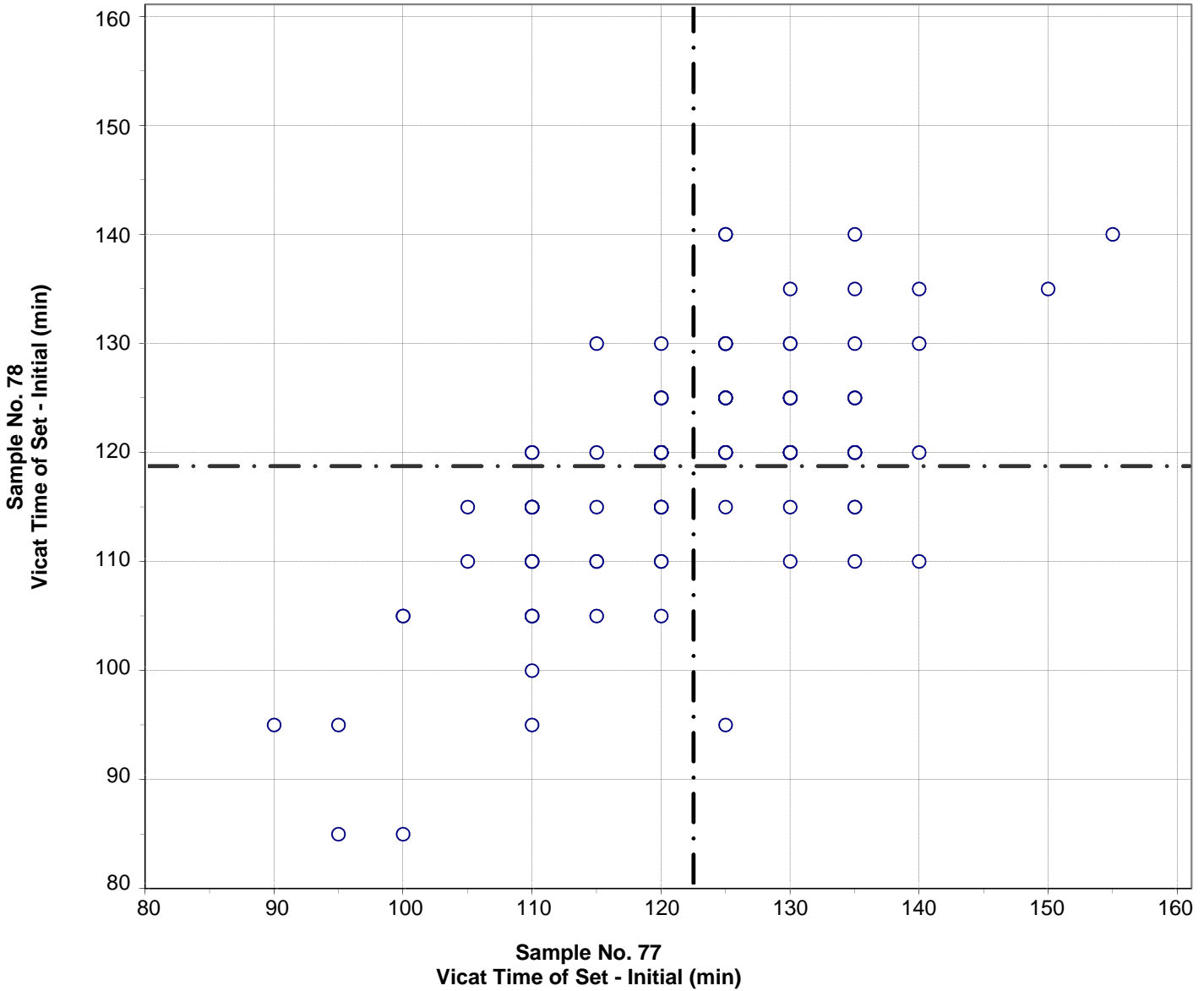


Test No. 110 Normal Consistency - % Water 104 Points

Sample No. 77	Ave 26.2	S.D. 0.5	C.V. 1.9
Sample No. 78	Ave 26.0	S.D. 0.5	C.V. 1.8

Labs Eliminated: 24, 2477

**CCRL Proficiency Sample Program  
Vicac Time of Set - Initial  
BLENDED CEMENT Samples No. 77 and No. 78**

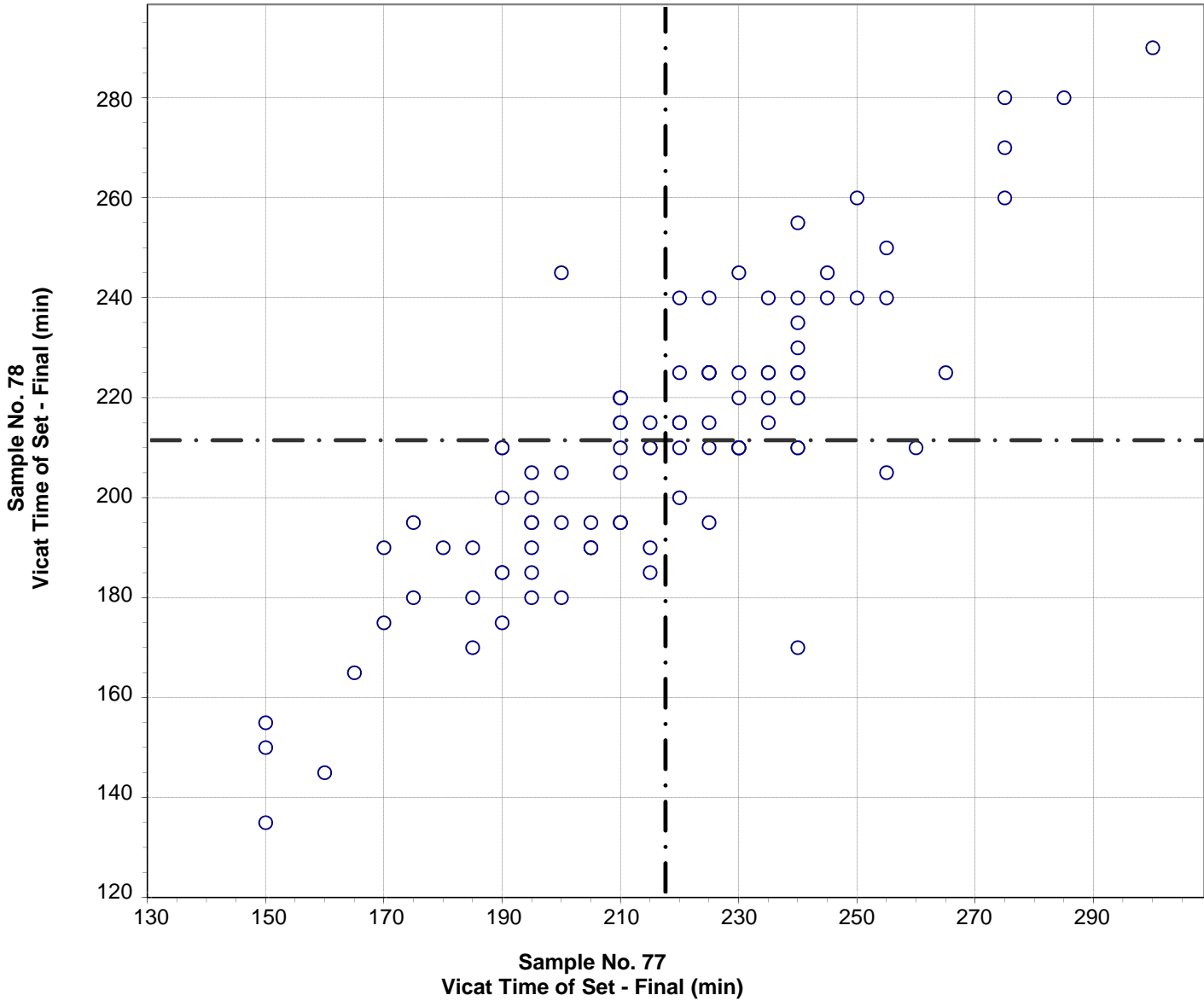


Test No. 120 Vicat Time of Set - Initial 104 Points

Sample No. 77	Ave 122	S.D. 12	C.V. 9.4
Sample No. 78	Ave 119	S.D. 11	C.V. 9.2

Labs Eliminated: 74, 3912

**CCRL Proficiency Sample Program**  
**Vicat Time of Set - Final**  
**BLENDED CEMENT Samples No. 77 and No. 78**

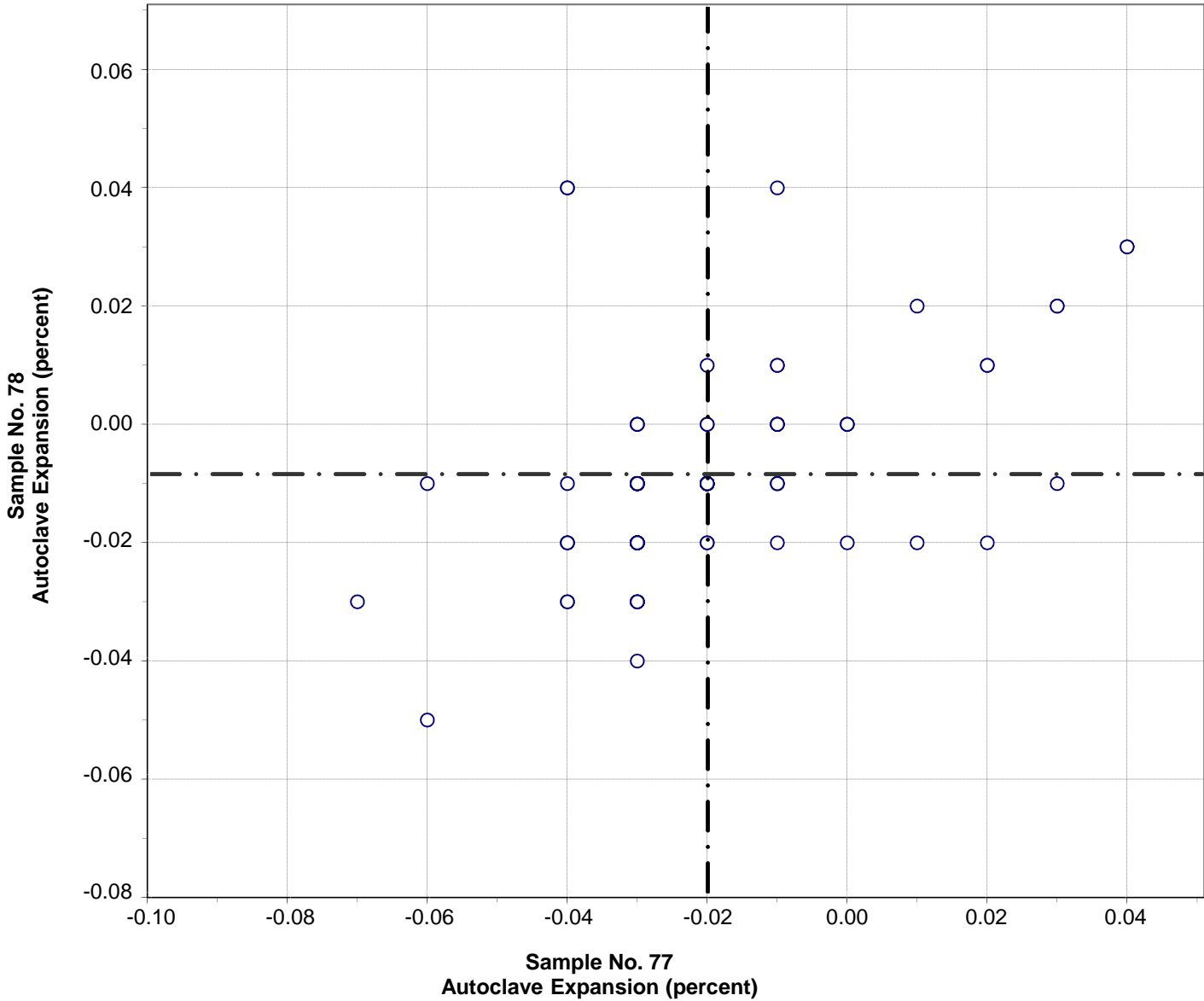


Test No. 121 Vicat Time of Set - Final 101 Points

Sample No. 77	Ave 217	S.D. 29	C.V. 13
Sample No. 78	Ave 211	S.D. 28	C.V. 13

Labs Eliminated: 14, 74, 3912

**CCRL Proficiency Sample Program  
Autoclave Expansion  
BLENDED CEMENT Samples No. 77 and No. 78**

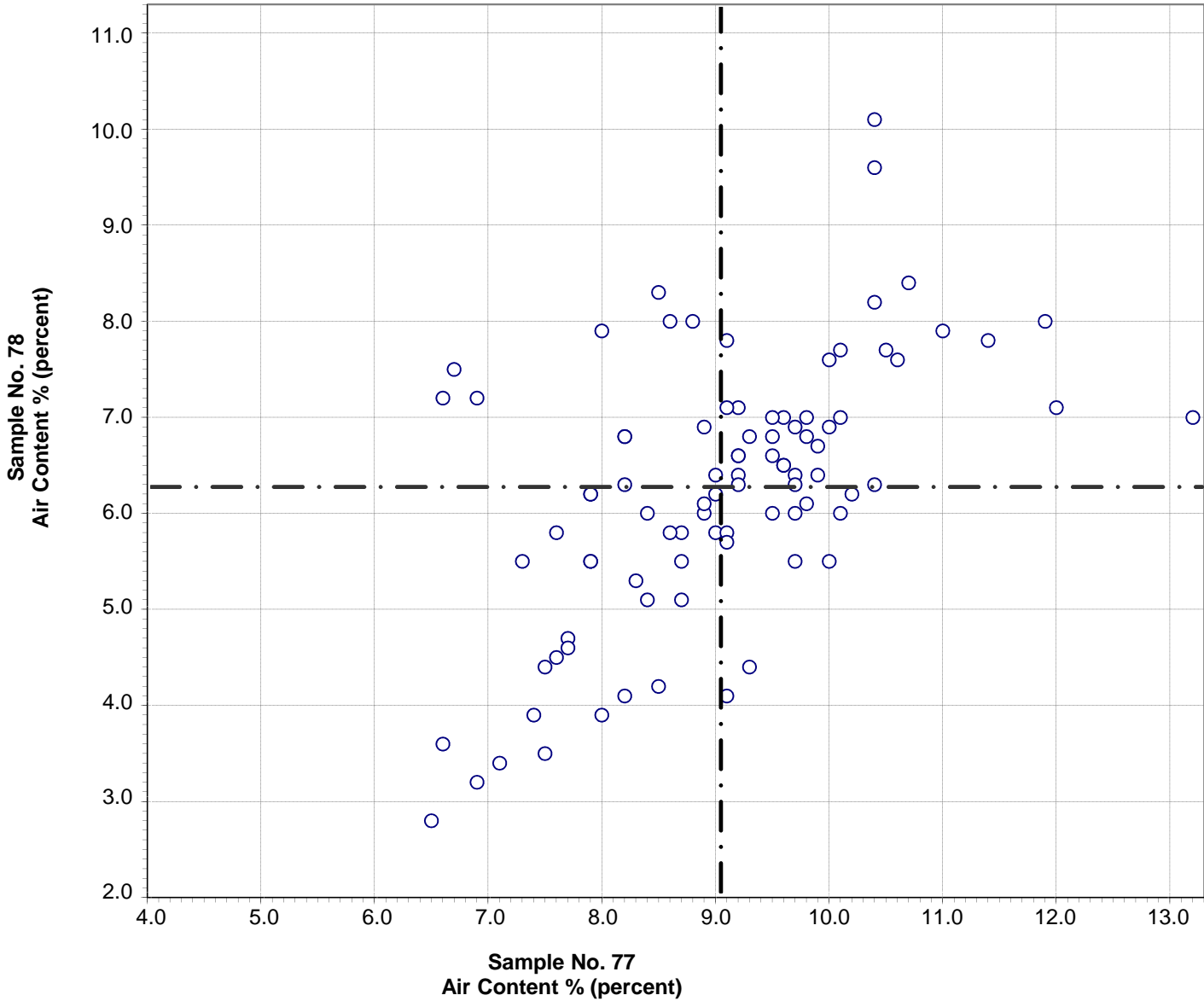


Test No. 160 Autoclave Expansion 92 Points

Sample No. 77	Ave -0.02	S.D. 0.02	C.V. 101
Sample No. 78	Ave 0.00	S.D. 0.02	C.V. 186

Labs Eliminated: 124, 246, 2352

**CCRL Proficiency Sample Program**  
**Air Content %**  
**BLENDED CEMENT Samples No. 77 and No. 78**

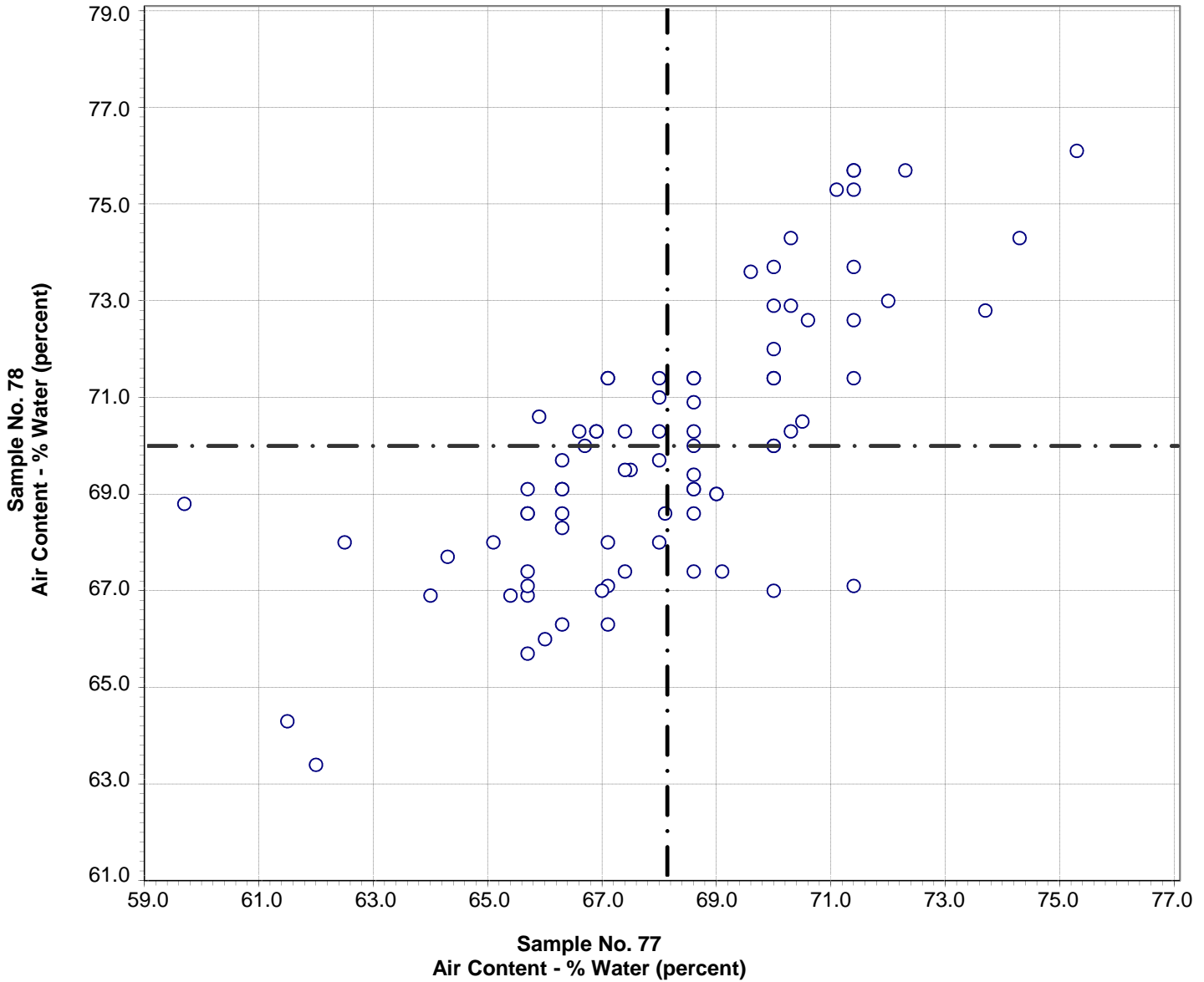


Test No. 170    Air Content %    90 Points

Sample No. 77	Ave 9.0	S.D. 1.3	C.V. 14
Sample No. 78	Ave 6.3	S.D. 1.4	C.V. 22

Labs Eliminated: 19, 474

**CCRL Proficiency Sample Program**  
**Air Content - % Water**  
**BLENDED CEMENT Samples No. 77 and No. 78**



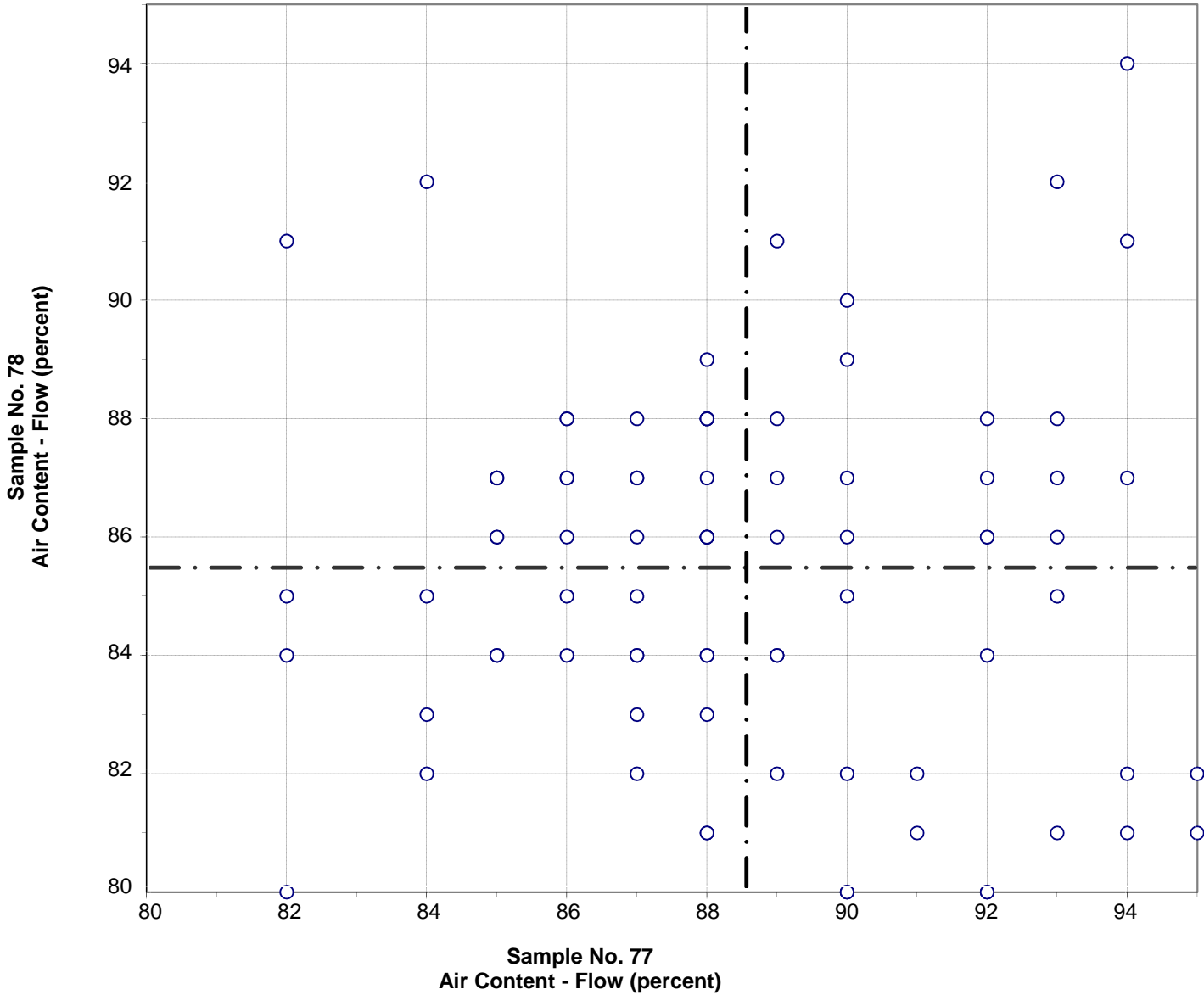
Test No. 180   Air Content - % Water   83 Points

Sample No. 77	Ave 68.1	S.D. 2.7	C.V. 4.0
Sample No. 78	Ave 70.0	S.D. 2.7	C.V. 3.9

Labs Eliminated: 34, 121, 474, 2466, 2490, 3235, 4098



**CCRL Proficiency Sample Program**  
**Air Content - Flow**  
**BLENDED CEMENT Samples No. 77 and No. 78**

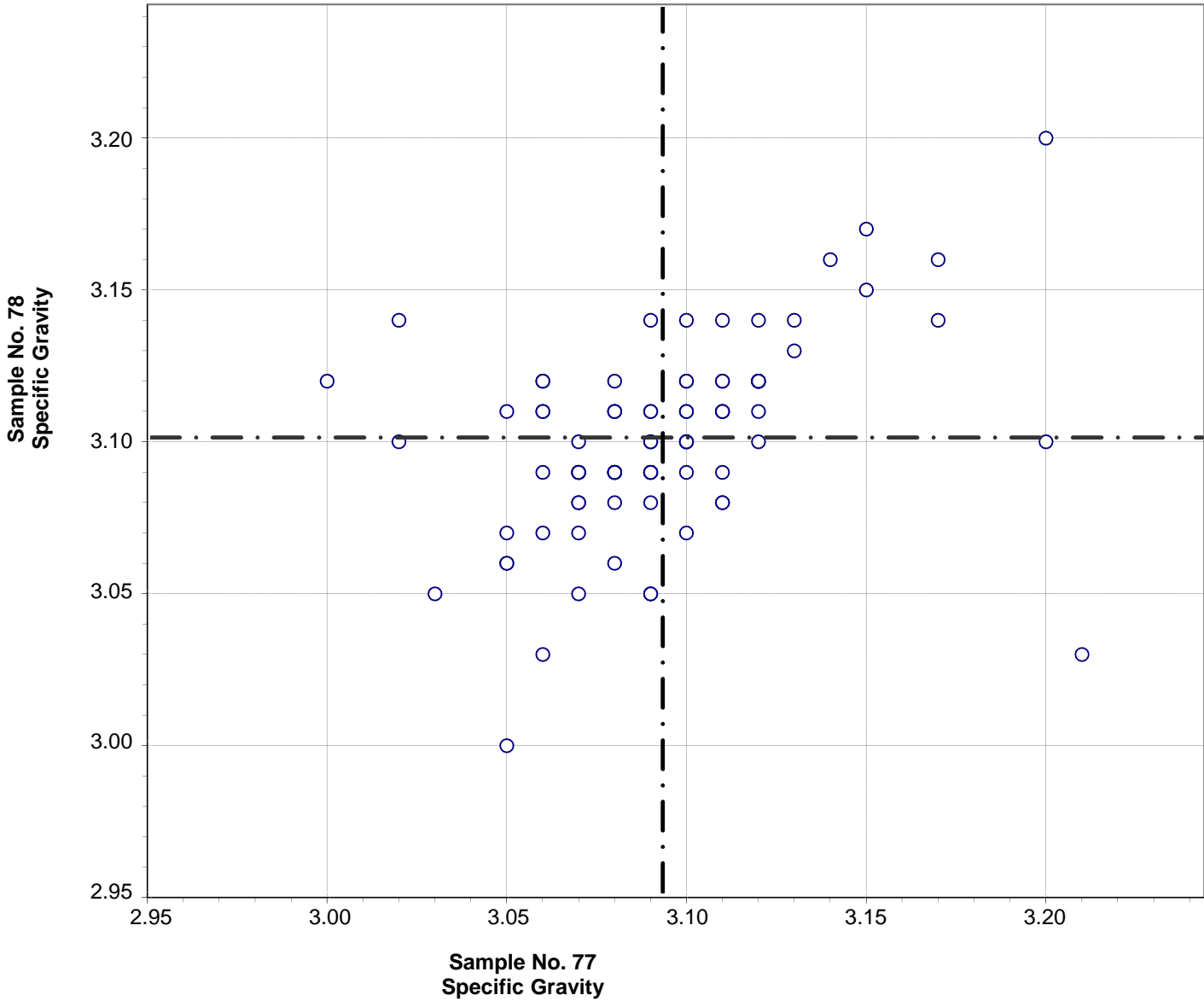


Test No. 190 Air Content - Flow 84 Points

Sample No. 77 Ave 89 S.D. 3.3 C.V. 3.7  
 Sample No. 78 Ave 85 S.D. 3.1 C.V. 3.6

Labs Eliminated: 23, 50, 121, 2490, 3235, 4098

**CCRL Proficiency Sample Program  
Specific Gravity  
BLENDED CEMENT Samples No. 77 and No. 78**

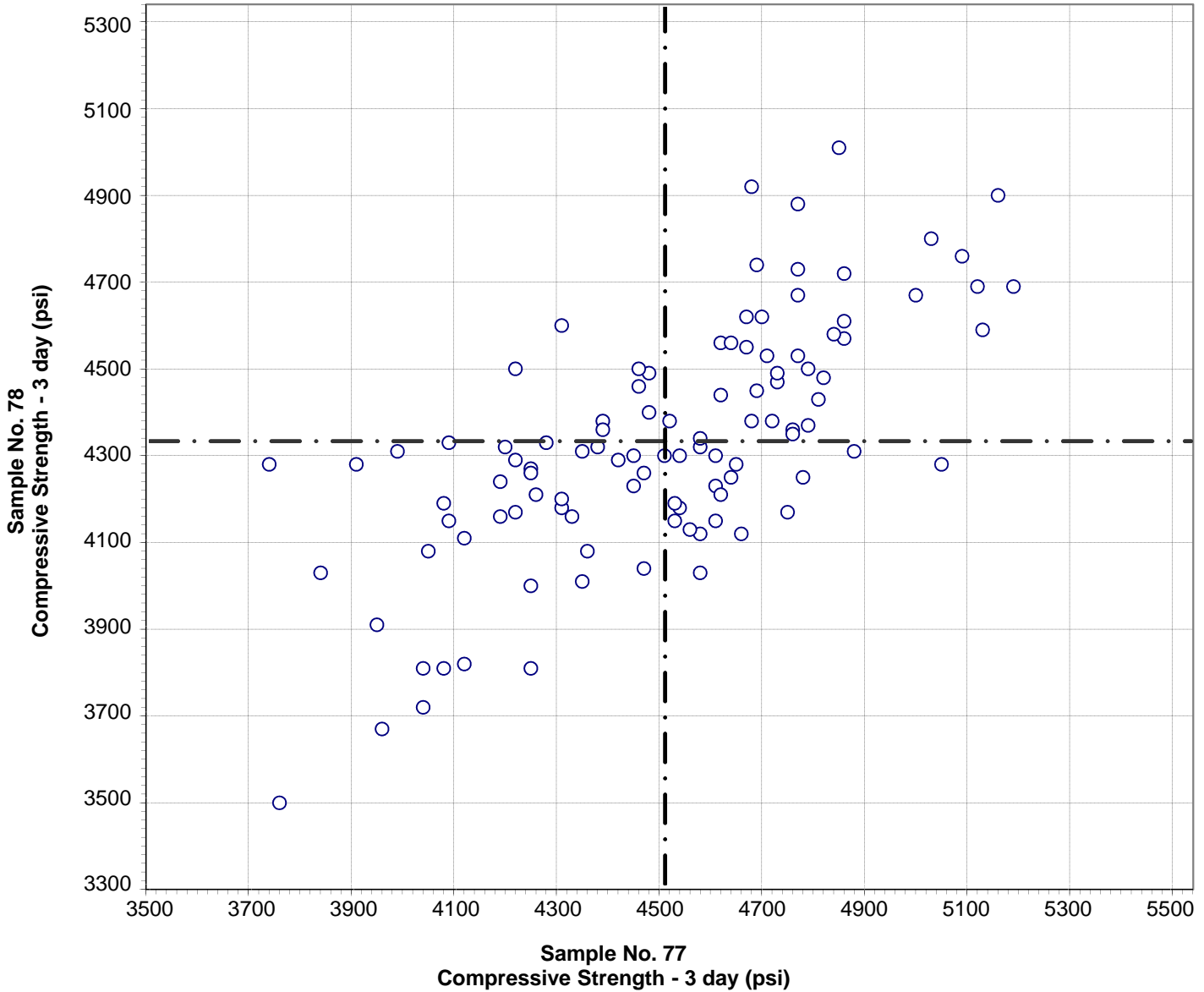


Test No. 310    Specific Gravity    88 Points

Sample No. 77	Ave 3.09	S.D. 0.04	C.V. 1.2
Sample No. 78	Ave 3.10	S.D. 0.03	C.V. 1.0

Labs Eliminated: 23, 2490, 3233, 3662

**CCRL Proficiency Sample Program  
Compressive Strength - 3 day  
BLENDED CEMENT Samples No. 77 and No. 78**

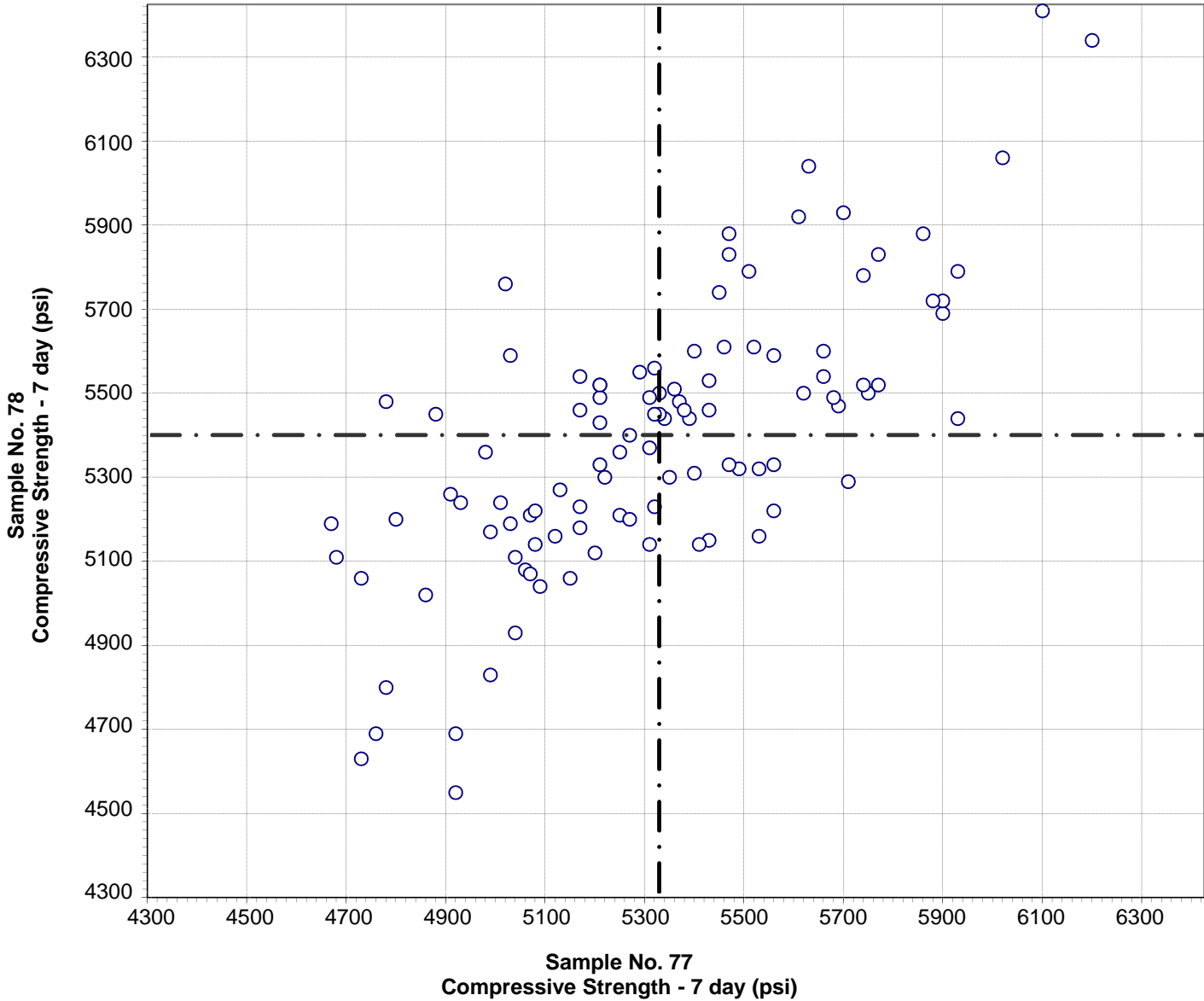


Test No. 200    Compressive Strength - 3 day    105 Points

Sample No. 77	Ave 4510	S.D. 321	C.V. 7.1
Sample No. 78	Ave 4331	S.D. 273	C.V. 6.3

Labs Eliminated: 23, 4098

**CCRL Proficiency Sample Program  
Compressive Strength - 7 day  
BLENDED CEMENT Samples No. 77 and No. 78**

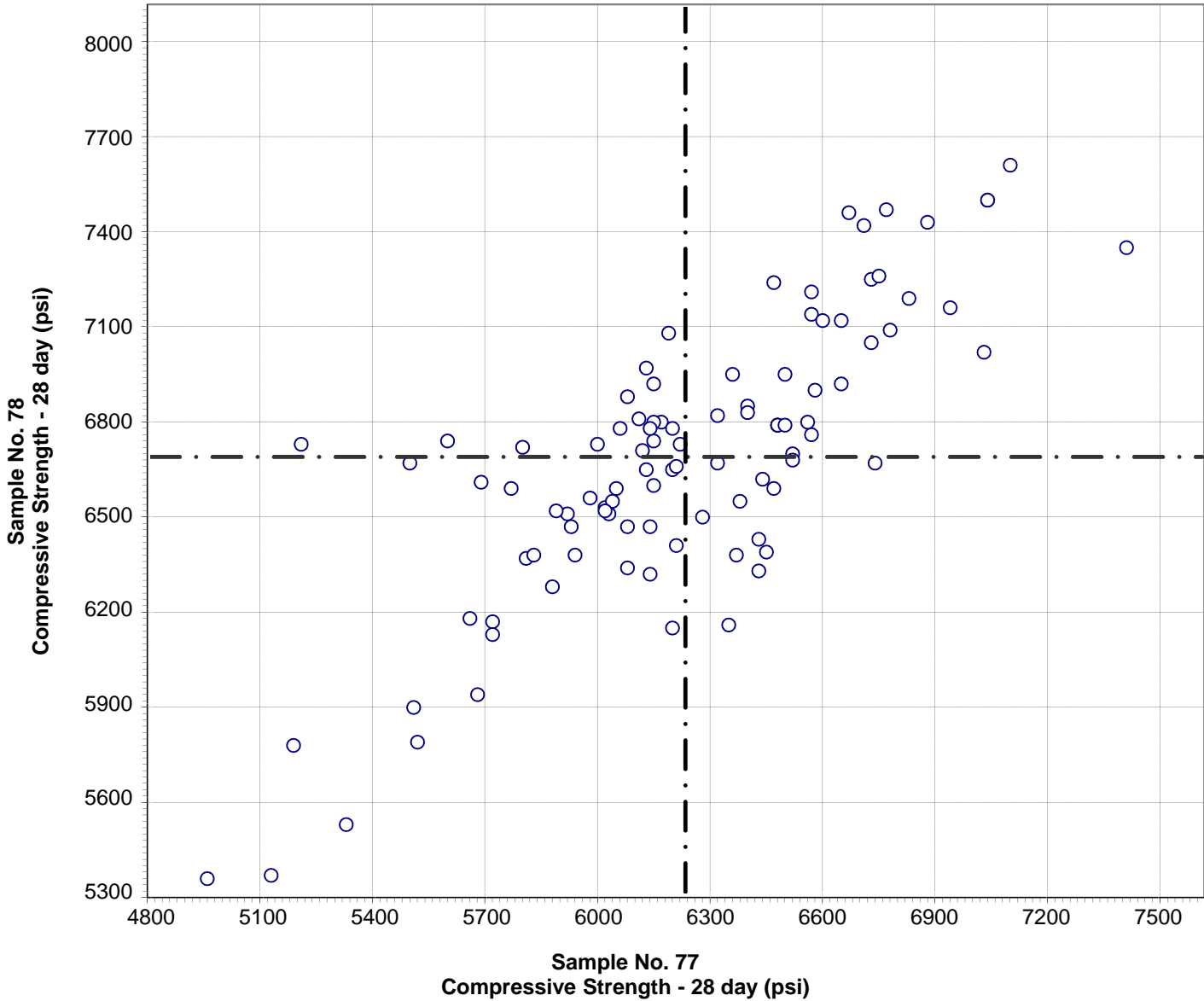


Test No. 210    Compressive Strength - 7 day    104 Points

Sample No. 77	Ave 5328	S.D. 337	C.V. 6.3
Sample No. 78	Ave 5398	S.D. 324	C.V. 6.0

Labs Eliminated: 23, 25, 46

**CCRL Proficiency Sample Program  
Compressive Strength - 28 day  
BLENDED CEMENT Samples No. 77 and No. 78**

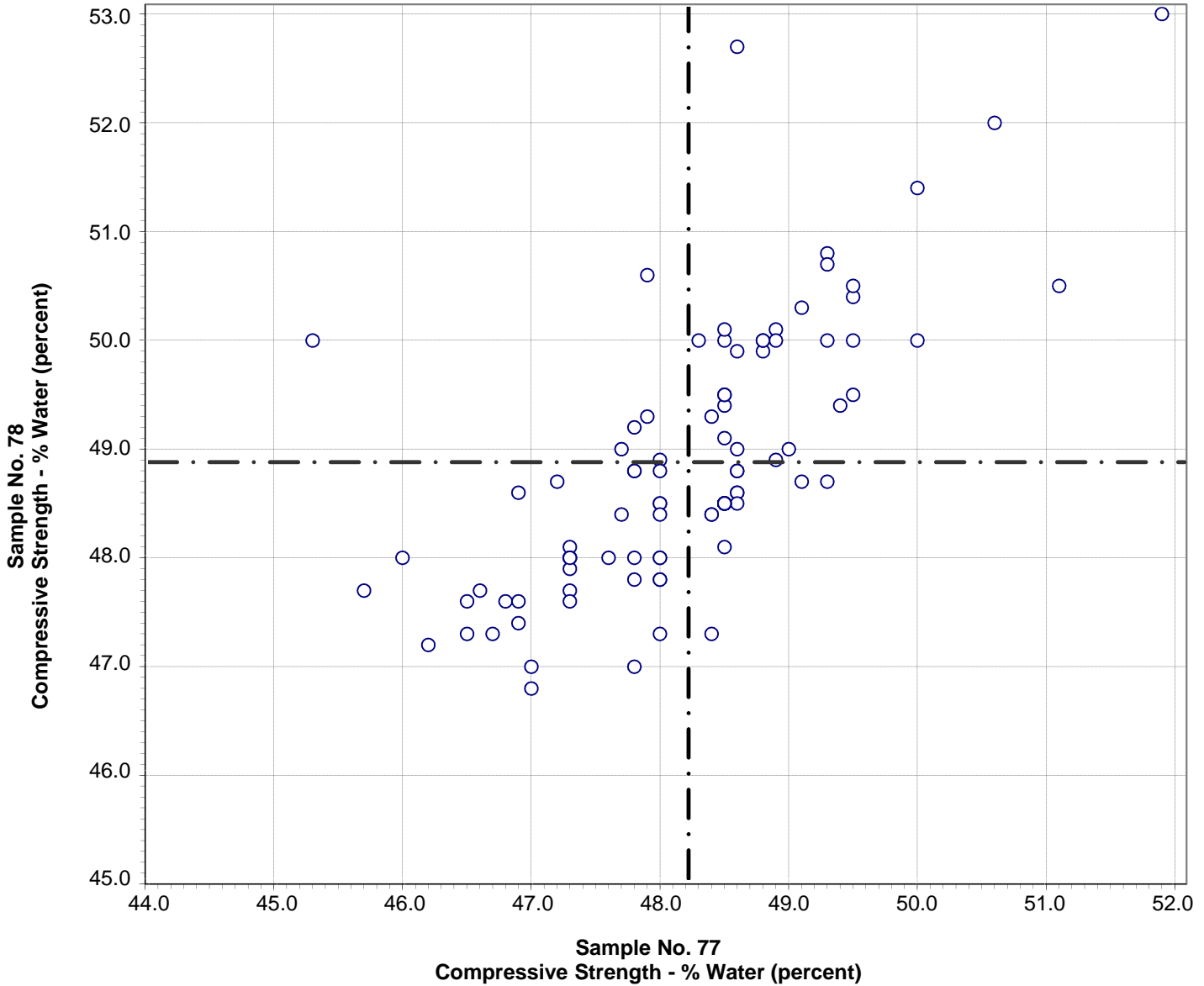


**Test No. 211    Compressive Strength - 28 day    99 Points**

Sample No. 77	Ave 6232	S.D. 456	C.V. 7.3
Sample No. 78	Ave 6685	S.D. 440	C.V. 6.6

Labs Eliminated: 23

**CCRL Proficiency Sample Program  
Compressive Strength - % Water  
BLENDED CEMENT Samples No. 77 and No. 78**

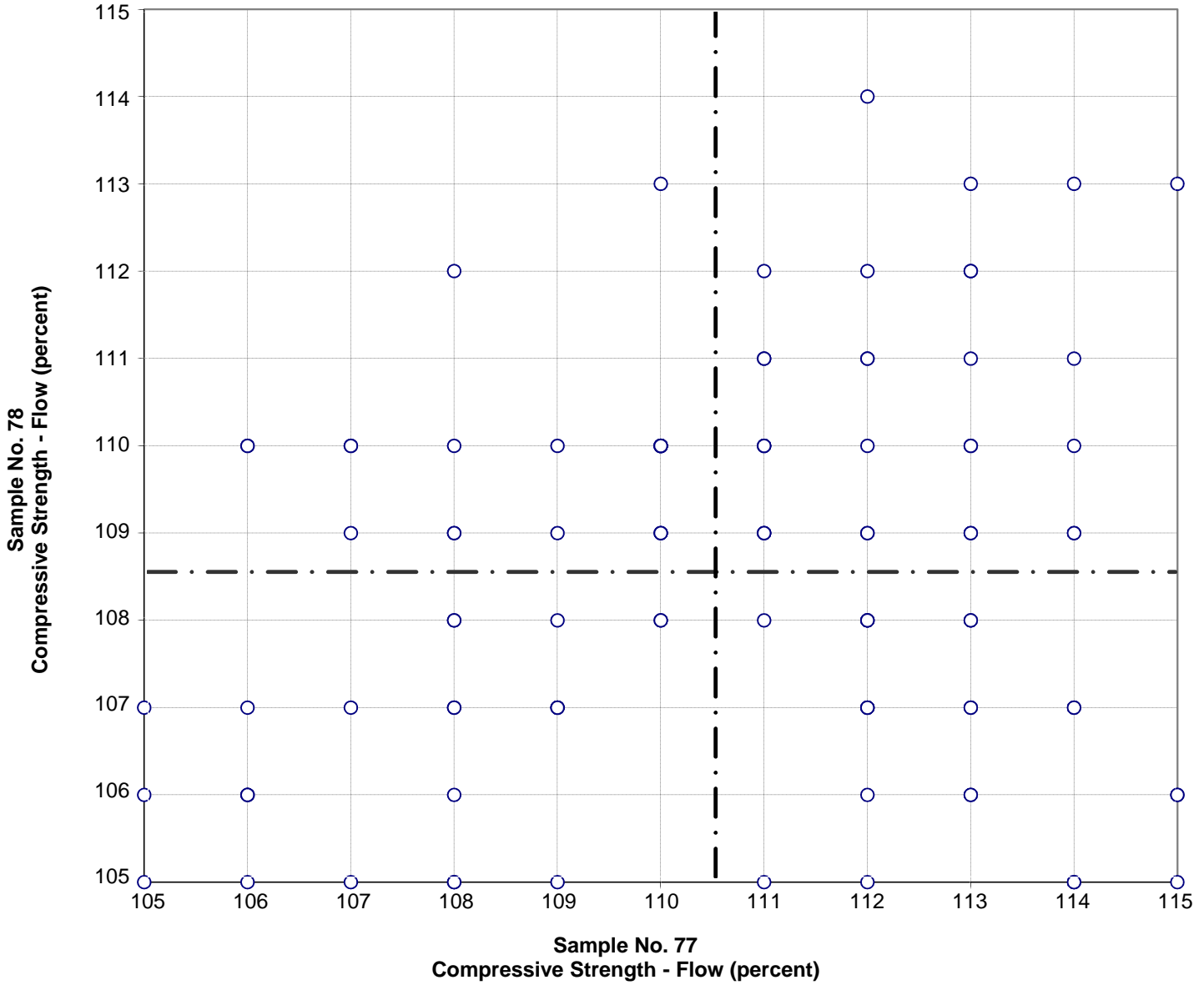


**Test No. 220 Compressive Strength - % Water 97 Points**

Sample No. 77	Ave 48.2	S.D. 1.1	C.V. 2.2
Sample No. 78	Ave 48.9	S.D. 1.2	C.V. 2.5

Labs Eliminated: 24, 42, 1657, 3503, 4098

**CCRL Proficiency Sample Program  
Compressive Strength - Flow  
BLENDED CEMENT Samples No. 77 and No. 78**

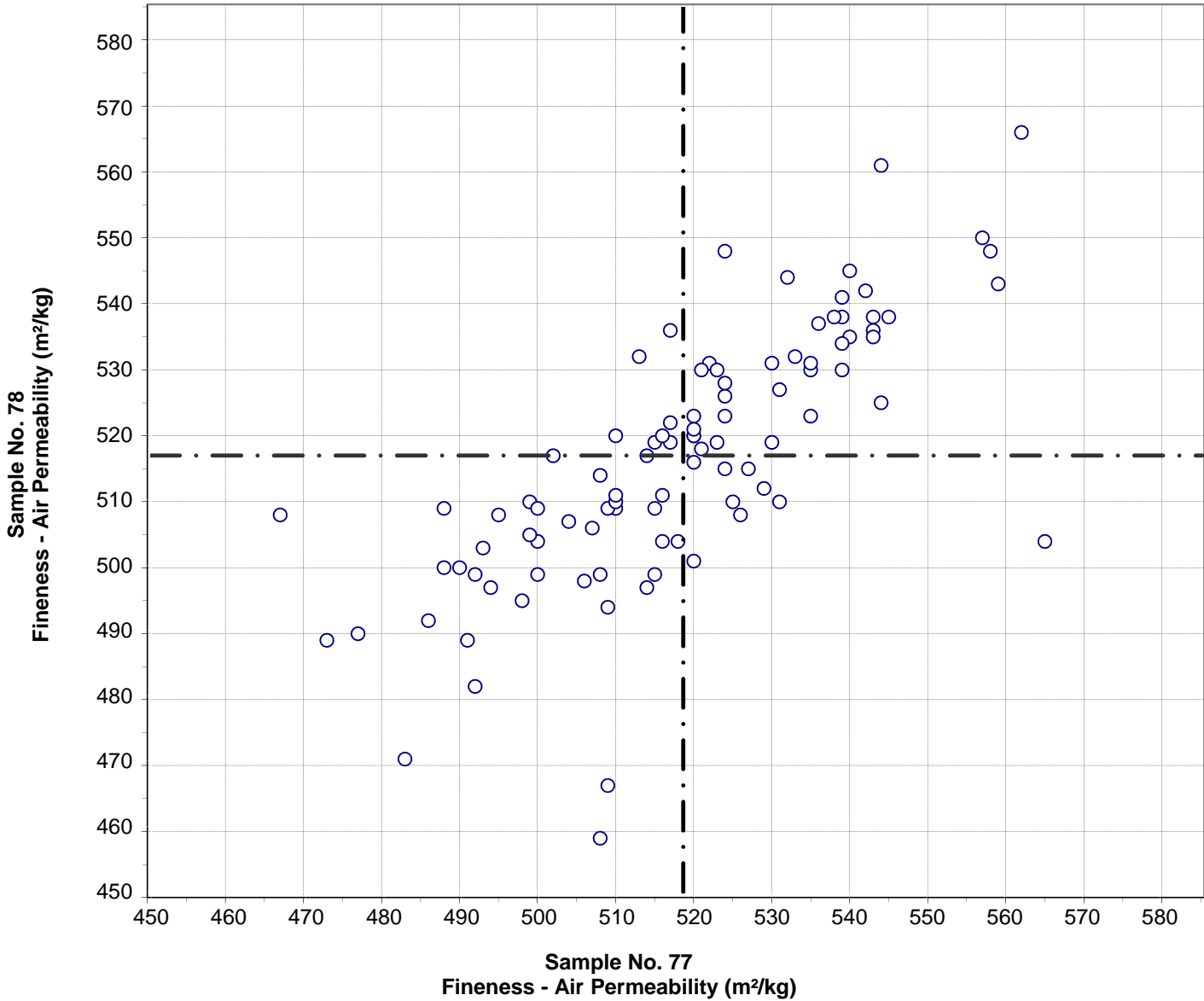


Test No. 230 Compressive Strength - Flow 99 Points

Sample No. 77	Ave 111	S.D. 2.7	C.V. 2.4
Sample No. 78	Ave 109	S.D. 2.2	C.V. 2.1

Labs Eliminated: 3, 38, 40, 47, 124, 958

**CCRL Proficiency Sample Program  
Fineness - Air Permeability  
BLENDED CEMENT Samples No. 77 and No. 78**



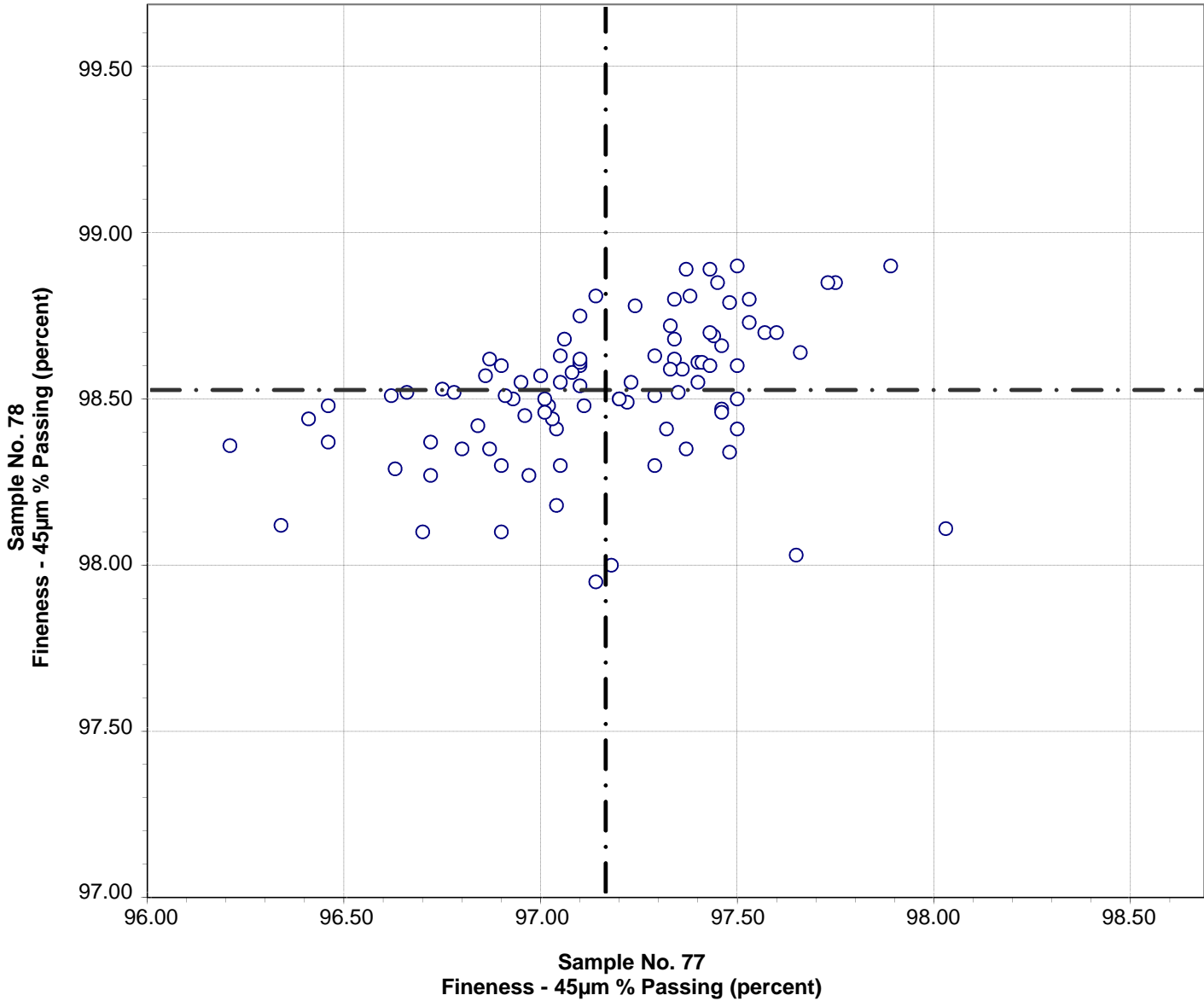
**Test No. 270 Fineness - Air Permeability 96 Points**

Sample No. 77	Ave 519	S.D. 20	C.V. 3.9
Sample No. 78	Ave 517	S.D. 19	C.V. 3.7

Labs Eliminated: 23, 51, 169, 2360, 2490, 3912



**CCRL Proficiency Sample Program**  
**Fineness - 45 $\mu$ m % Passing**  
**BLENDED CEMENT Samples No. 77 and No. 78**



Test No. 281    Fineness - 45 $\mu$ m % Passing    93 Points

Sample No. 77	Ave 97.16	S.D. 0.35	C.V. 0.36
Sample No. 78	Ave 98.52	S.D. 0.21	C.V. 0.21

Labs Eliminated: 7, 22, 34, 51, 74, 413, 474, 3247, 3249, 3431, 3661

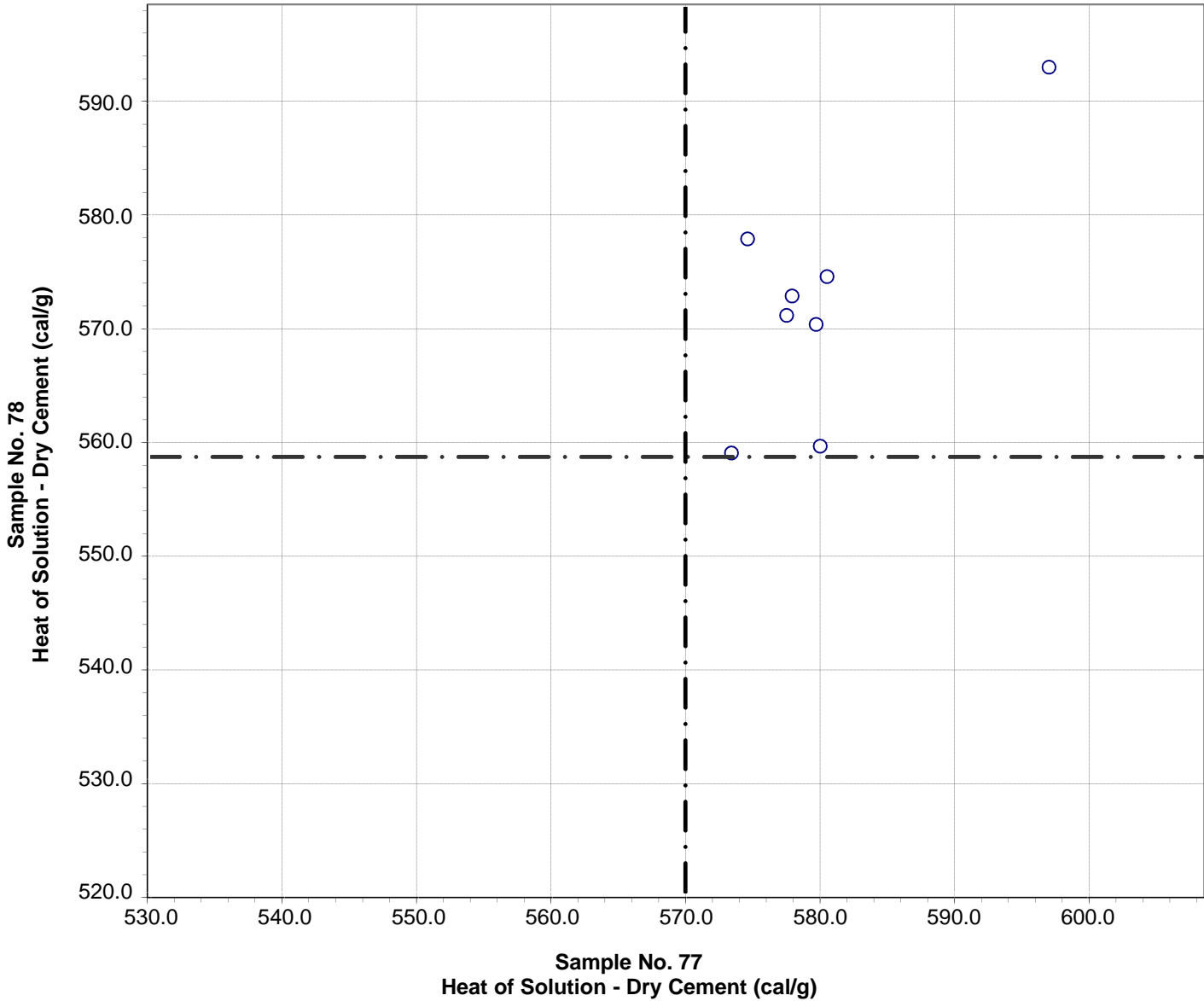
**CCRL PROFICIENCY SAMPLE PROGRAM**  
Blended Cement Proficiency Samples No. 77 and No. 78

Final Report – Heat of Hydration Results  
May 26, 2016

SUMMARY OF RESULTS

Test (unit)	Sample No.77				Sample No. 78		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
<b>Heat of Solution - Dry Cement (cal/g)</b>							
	10	522.9	151.5	29.0	512.8	150.4	29.3
	*9	569.9	31.2	5.5	558.6	42.4	7.6
	* Labs Eliminated - 3503						
<b>Heat of Solution - 7 day (cal/g)</b>							
	11	462.9	120.5	26.0	459.1	119.4	26.0
	*10	499.2	6.5	1.3	495.0	10.1	2.0
	* Labs Eliminated - 3503						
<b>Heat of Solution - 28 day (cal/g)</b>							
	9	492.2	7.7	1.6	488.1	12.6	2.6
	No Labs Eliminated for This Test						
<b>Heat of Hydration - 7 day (cal/g)</b>							
	11	75.6	18.7	24.7	73.8	18.6	25.2
	*10	81.2	3.5	4.3	79.2	5.8	7.3
	* Labs Eliminated - 3503						
<b>Heat of Hydration - 28 day (cal/g)</b>							
	10	87.5	6.8	7.8	85.7	8.7	10.2
	No Labs Eliminated for This Test						

**CCRL Proficiency Sample Program  
Heat of Solution - Dry Cement  
BLENDED CEMENT Samples No. 77 and No. 78**



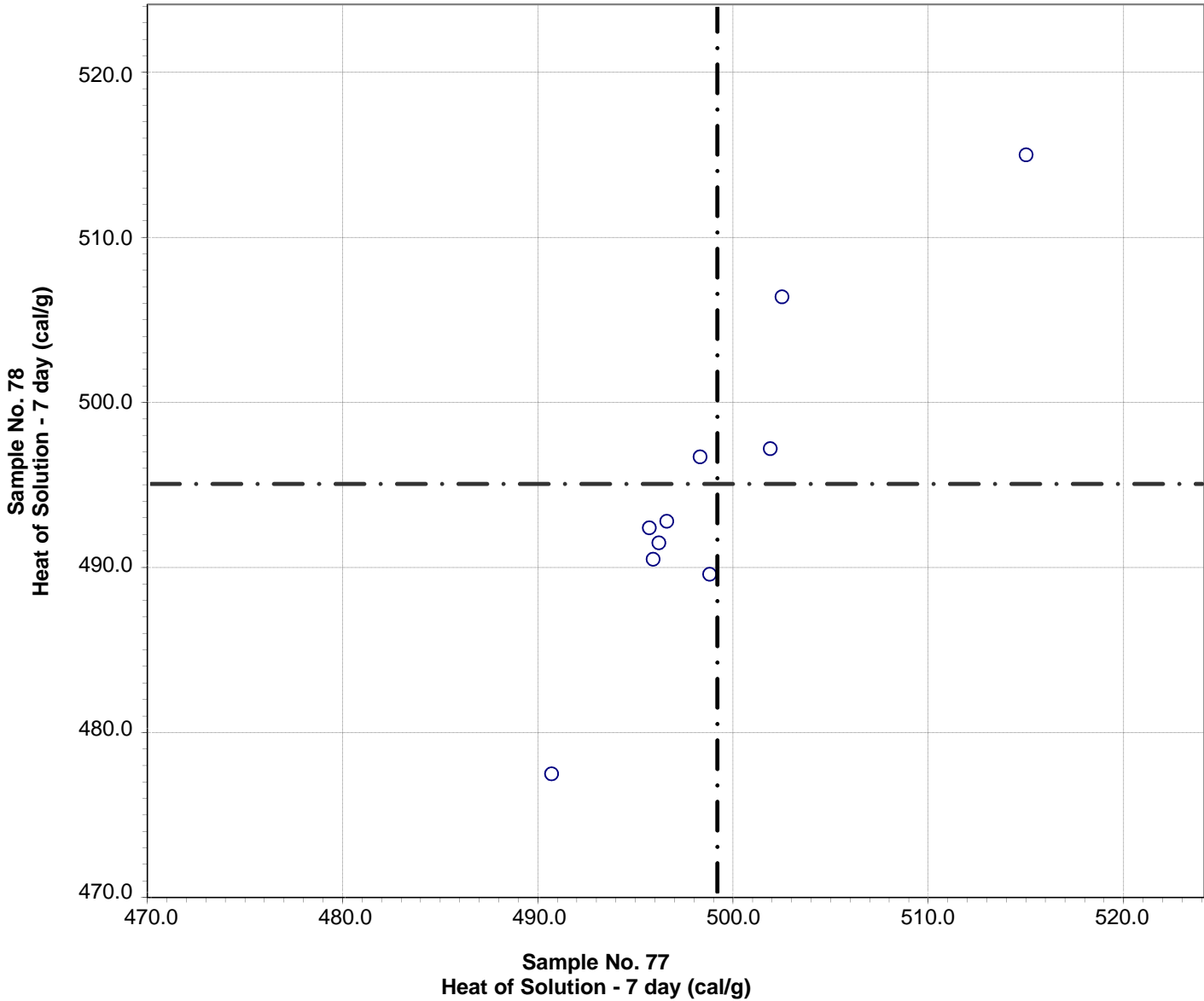
Test No. 291 Heat of Solution - Dry Cement 8 Points

Sample No. 77	Ave 569.9	S.D. 31.2	C.V. 5.5
Sample No. 78	Ave 558.6	S.D. 42.4	C.V. 7.6

Labs Eliminated: 3503

Labs off Diagram: 975

**CCRL Proficiency Sample Program**  
**Heat of Solution - 7 day**  
**BLENDED CEMENT Samples No. 77 and No. 78**

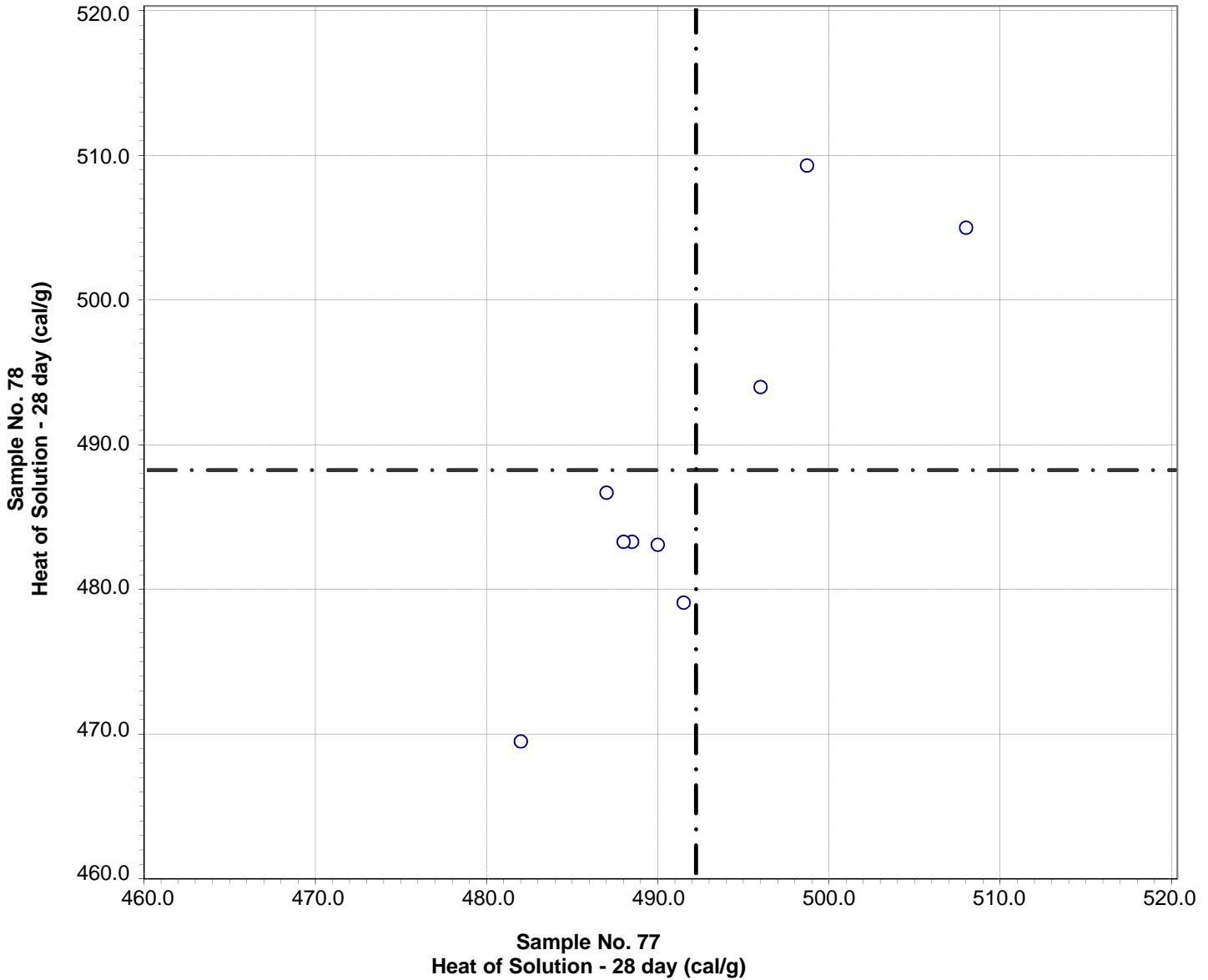


Test No. 292 Heat of Solution - 7 day 10 Points

Sample No. 77	Ave 499.2	S.D. 6.5	C.V. 1.3
Sample No. 78	Ave 495.0	S.D. 10.1	C.V. 2.0

Labs Eliminated: 3503

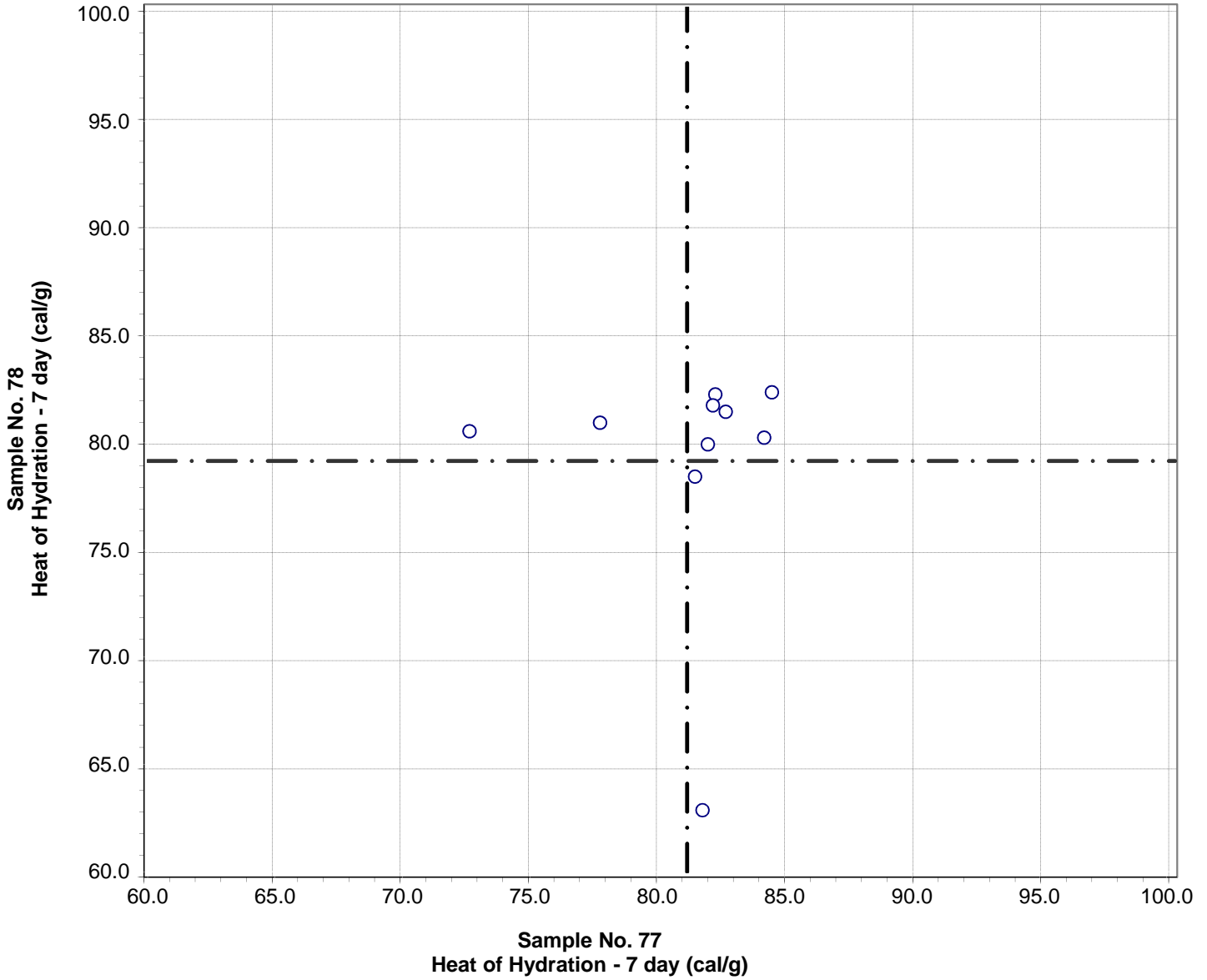
**CCRL Proficiency Sample Program**  
**Heat of Solution - 28 day**  
**BLENDED CEMENT Samples No. 77 and No. 78**



Test No. 301 Heat of Solution - 28 day 9 Points

Sample No. 77	Ave 492.2	S.D. 7.7	C.V. 1.6
Sample No. 78	Ave 488.1	S.D. 12.6	C.V. 2.6

**CCRL Proficiency Sample Program**  
**Heat of Hydration - 7 day**  
**BLENDED CEMENT Samples No. 77 and No. 78**

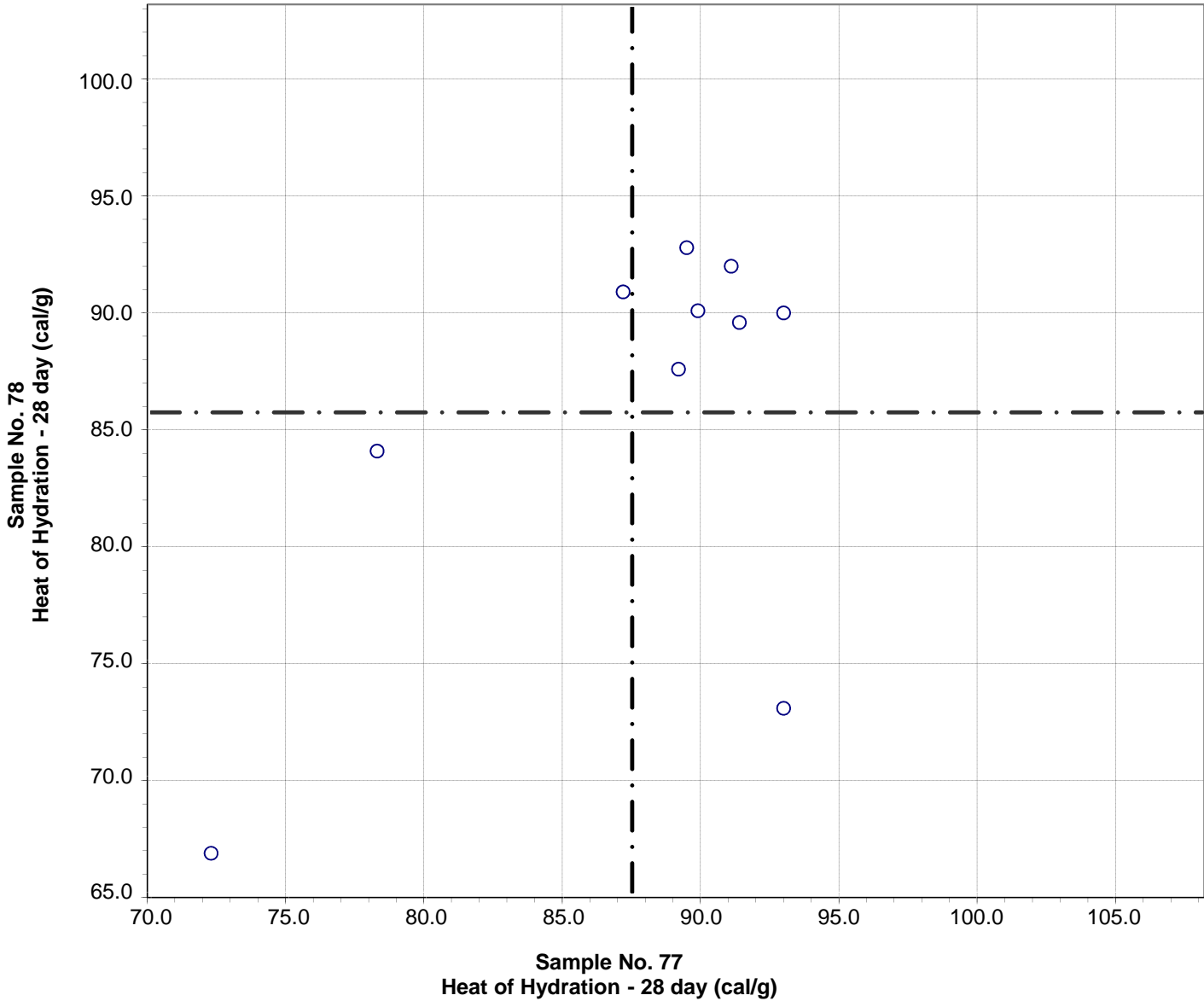


Test No. 290 Heat of Hydration - 7 day 10 Points

Sample No. 77	Ave 81.2	S.D. 3.5	C.V. 4.3
Sample No. 78	Ave 79.2	S.D. 5.8	C.V. 7.3

Labs Eliminated: 3503

**CCRL Proficiency Sample Program**  
**Heat of Hydration - 28 day**  
**BLENDED CEMENT Samples No. 77 and No. 78**



Test No. 300 Heat of Hydration - 28 day 10 Points

Sample No. 77	Ave 87.5	S.D. 6.8	C.V. 7.8
Sample No. 78	Ave 85.7	S.D. 8.7	C.V. 10.2