

CEMENT AND CONCRETE REFERENCE LABORATORY
PROFICIENCY SAMPLE PROGRAM

Final Report
Pozzolan Proficiency Samples
Number 45 and Number 46

October 2009



CCRL CEMENT AND CONCRETE
REFERENCE LABORATORY





October 16, 2009

To: Participants in the CCRL Pozzolan Proficiency Sample Program

SUBJECT: Pozzolan Proficiency Samples No. 45 and No. 46

Following is the final report for the pair of CCRL **Pozzolan** Proficiency Samples which were distributed in July 2009. Both samples were a Class C fly ash.

This report consists of two parts and each part must be downloaded from our website located at: <http://www.ccrl.us/>. One part contains general information that consists of a statistical Summary of Results, a set of Scatter Diagrams, and other associated information. The second part is laboratory specific information that consists of the Table of Results containing test results and ratings for your laboratory.

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 samples 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 Pozzolan Proficiency Samples will be distributed in July 2010.

Sincerely,

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

To: Participants in the CCRL Pozzolan Proficiency Sample Program

FROM: Robin K. Haupt, Supervisor, PSP

**SUBJECT: Explanation of Final Report on Results of Tests on Pozzolan Proficiency
Samples No. 45 and No. 46**

This memo and the material included with it constitute the final report and summary of results for the current pair of Pozzolan Proficiency Samples, which were distributed in July 2009. This material includes a Table of Results for individual laboratory data, a statistical Summary of Results, and a set of 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.

Table of Results - Laboratory Ratings

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.

The ratings for the individual laboratory were determined in the manner described by Crandall and Blaine using a rating scale 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.

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

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, which 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 test results reported, and then with one or more outlying test results omitted. Sometimes, two or more recalculations with laboratories omitted, have been performed 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 participation in chemical and/or physical tests.

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 may indicate strong evidence of bias in many cases.

CCRL PROFICIENCY SAMPLE PROGRAM
Pozzolan Proficiency Samples No. 45 and No. 46
Final Report - Chemical Results
October 16, 2009

SUMMARY OF RESULTS

Test		#Labs	Sample No. 45			Sample No. 46		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Moisture Content	prcnt	67	0.18	0.08	43.4	0.09	0.08	88.7
Moisture Content	prcnt *	61	0.17	0.06	35.1	0.07	0.04	58.4
Silicon Dioxide	prcnt	58	35.97	1.89	5.3	34.31	1.74	5.1
Silicon Dioxide	prcnt *	56	35.97	1.31	3.6	34.28	1.12	3.3
Al ₂ O ₃ w/minor ¹	prcnt	22	23.03	3.24	14.1	23.72	2.55	10.8
Al ₂ O ₃ w/minor ¹	prcnt *	21	22.39	1.19	5.3	23.22	1.13	4.9
¹ (P ₂ O ₃ & TiO ₂ included)								
Al ₂ O ₃ wo/minor ²	prcnt	53	19.50	0.77	3.9	20.62	0.82	4.0
Al ₂ O ₃ wo/minor ²	prcnt *	50	19.46	0.56	2.9	20.57	0.57	2.8
² (P ₂ O ₃ & TiO ₂ not included)								
Ferric Oxide	prcnt	57	5.57	0.53	9.6	7.39	0.66	8.9
Ferric Oxide	prcnt *	52	5.58	0.33	5.9	7.49	0.38	5.1
CaO w/minor ³	prcnt	26	25.10	1.25	5.0	24.25	1.05	4.3
CaO w/minor ³	prcnt *	24	25.35	0.71	2.8	24.49	0.62	2.5
³ (SrO & BaO included)								
CaO wo/minor ⁴	prcnt	46	24.79	1.09	4.4	24.05	0.97	4.0
CaO wo/minor ⁴	prcnt *	44	24.96	0.73	2.9	24.22	0.60	2.5
⁴ (SrO & BaO not included)								

CONTINUED ON NEXT PAGE

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

Moisture Content	19 35 605 1251 1799 3135
Silicon Dioxide	20 125
Al ₂ O ₃ w/minor	2295
Al ₂ O ₃ wo/minor	3 53 126
Ferric Oxide	605 48 125 1799 2522
CaO w/minor	176 3457
CaO wo/minor	125 158

CCRL PROFICIENCY SAMPLE PROGRAM
 Pozzolan Proficiency Samples No. 45 and No. 46
 Final Report - Chemical Results
 October 16, 2009

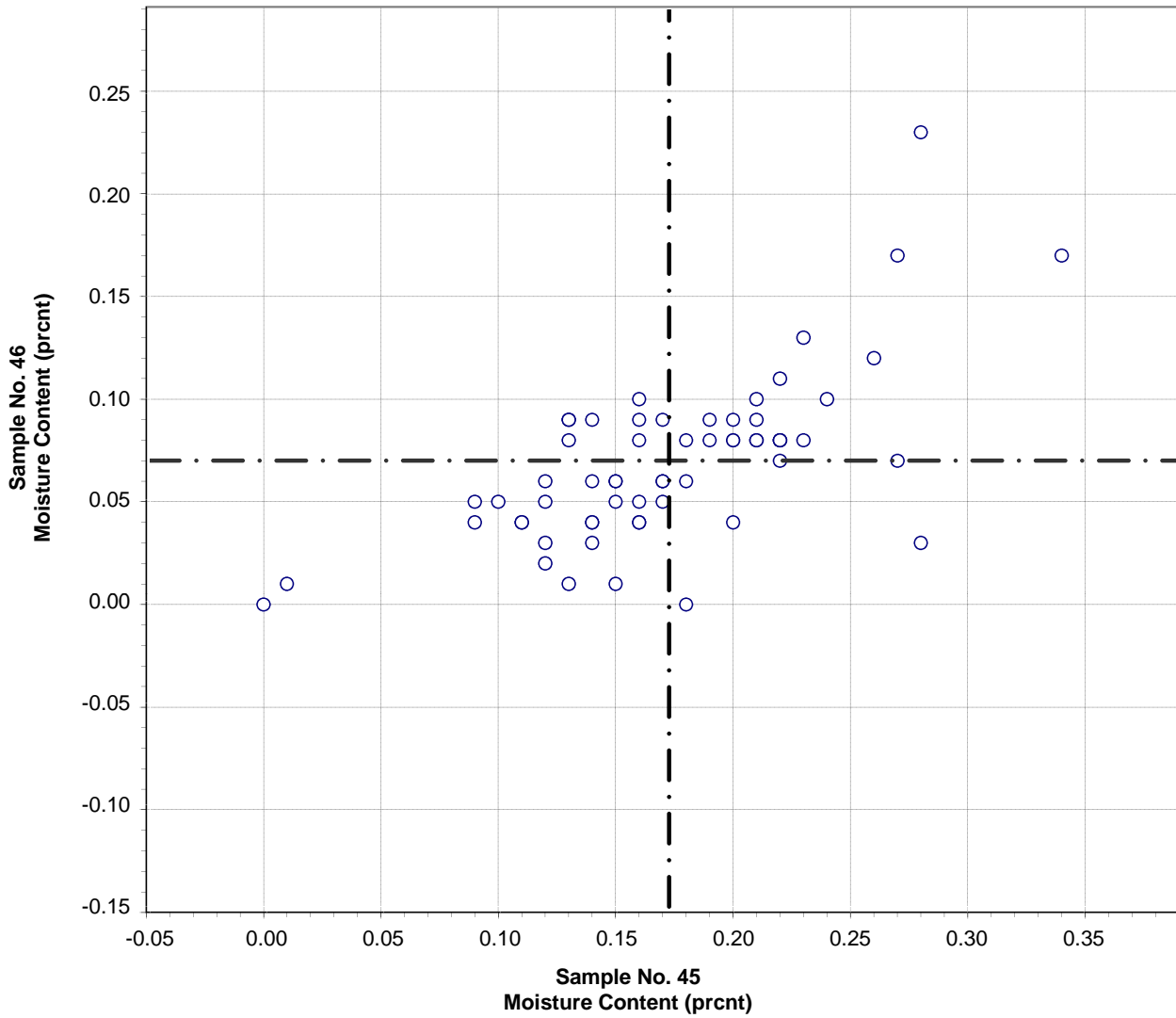
SUMMARY OF RESULTS

Test		Sample No. 45			Sample No. 46			
		#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Magnesium Oxide	prcnt	63	4.46	0.28	6.2	4.52	0.29	6.4
Magnesium Oxide	prcnt *	60	4.48	0.22	4.9	4.53	0.23	5.0
Sulfur Trioxide	prcnt	65	2.35	0.32	13.6	2.05	0.32	15.7
Sulfur Trioxide	prcnt *	62	2.31	0.17	7.4	1.99	0.16	7.9
Loss on Ignition	prcnt	75	0.72	0.76	106	0.47	0.74	159
Loss on Ignition	prcnt *	70	0.62	0.08	13.6	0.37	0.07	18.4
Sodium Oxide	prcnt	59	1.48	0.30	20.6	1.81	0.38	20.8
Sodium Oxide	prcnt *	54	1.49	0.20	13.5	1.80	0.17	9.6
Potassium Oxide	prcnt	60	0.44	0.07	15.7	0.43	0.06	13.5
Potassium Oxide	prcnt *	53	0.43	0.02	4.2	0.43	0.02	4.0
Available Na ₂ O	prcnt	23	0.86	0.32	36.7	1.23	0.35	28.2
Available K ₂ O	prcnt	24	0.24	0.12	50.6	0.31	0.11	35.9
Available K ₂ O	prcnt *	23	0.22	0.08	36.6	0.30	0.09	28.9
Available Alkali	prcnt	19	1.02	0.37	36.5	1.43	0.30	21.2

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

Sulfur Trioxide 53 2295 2476
 Loss on Ignition 53 125 19 605 2295
 Sodium Oxide 1799 24 2295 2476 3135
 Potassium Oxide 3 24 2295 125 126 25 2476
 Magnesium Oxide 20 22 3135
 Available K₂O 2476

**CCRL Proficiency Sample Program
Moisture Content
POZZOLAN Samples No. 45 and No. 46**

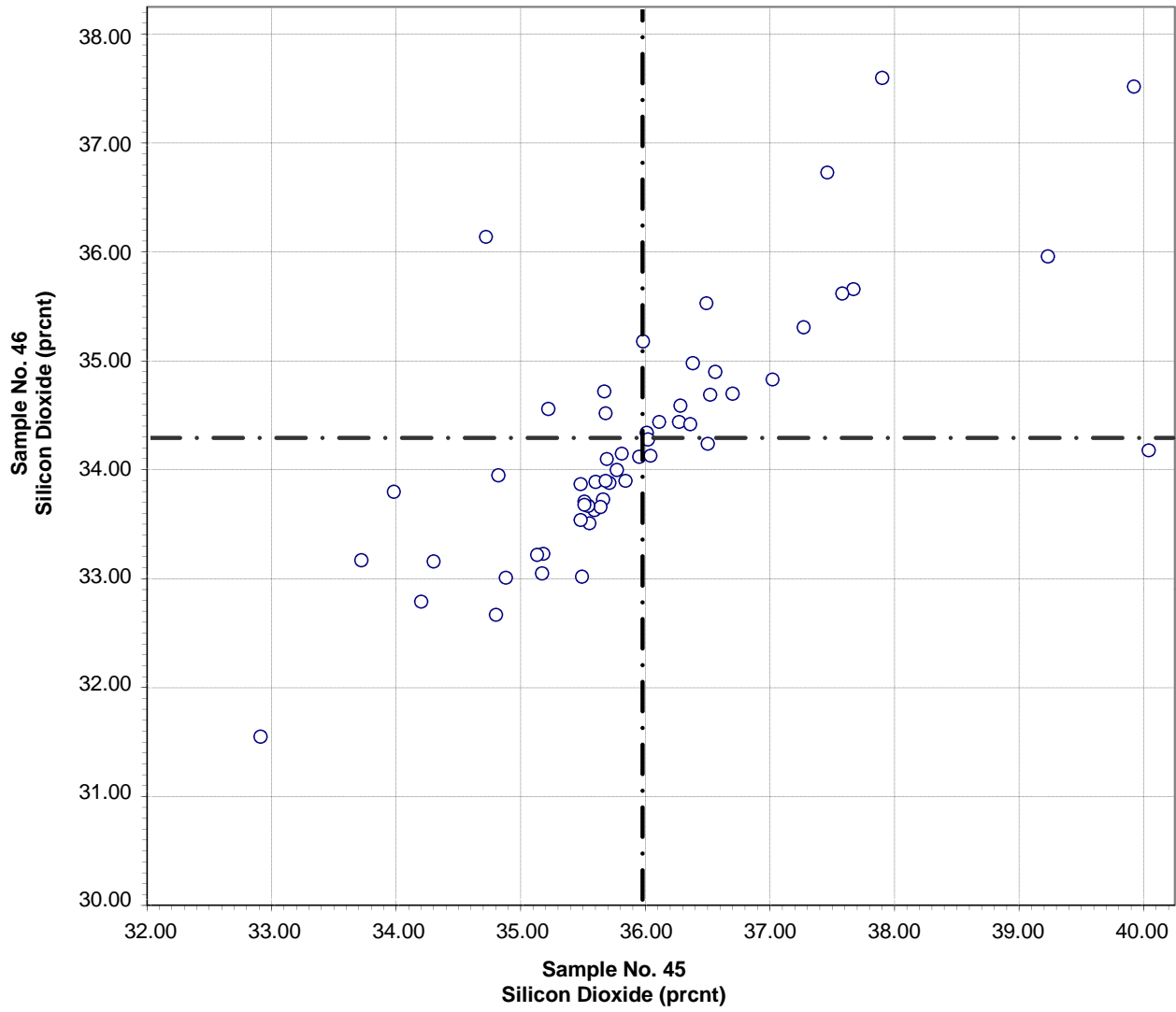


Test No. 5 Moisture Content 61 Points

Sample No. 45	Ave 0.17	S.D. 0.06	C.V. 35.1
Sample No. 46	Ave 0.07	S.D. 0.04	C.V. 58.5

Labs eliminated: 19, 35, 605, 1251, 1799, 3135

**CCRL Proficiency Sample Program
Silicon Dioxide
POZZOLAN Samples No. 45 and No. 46**

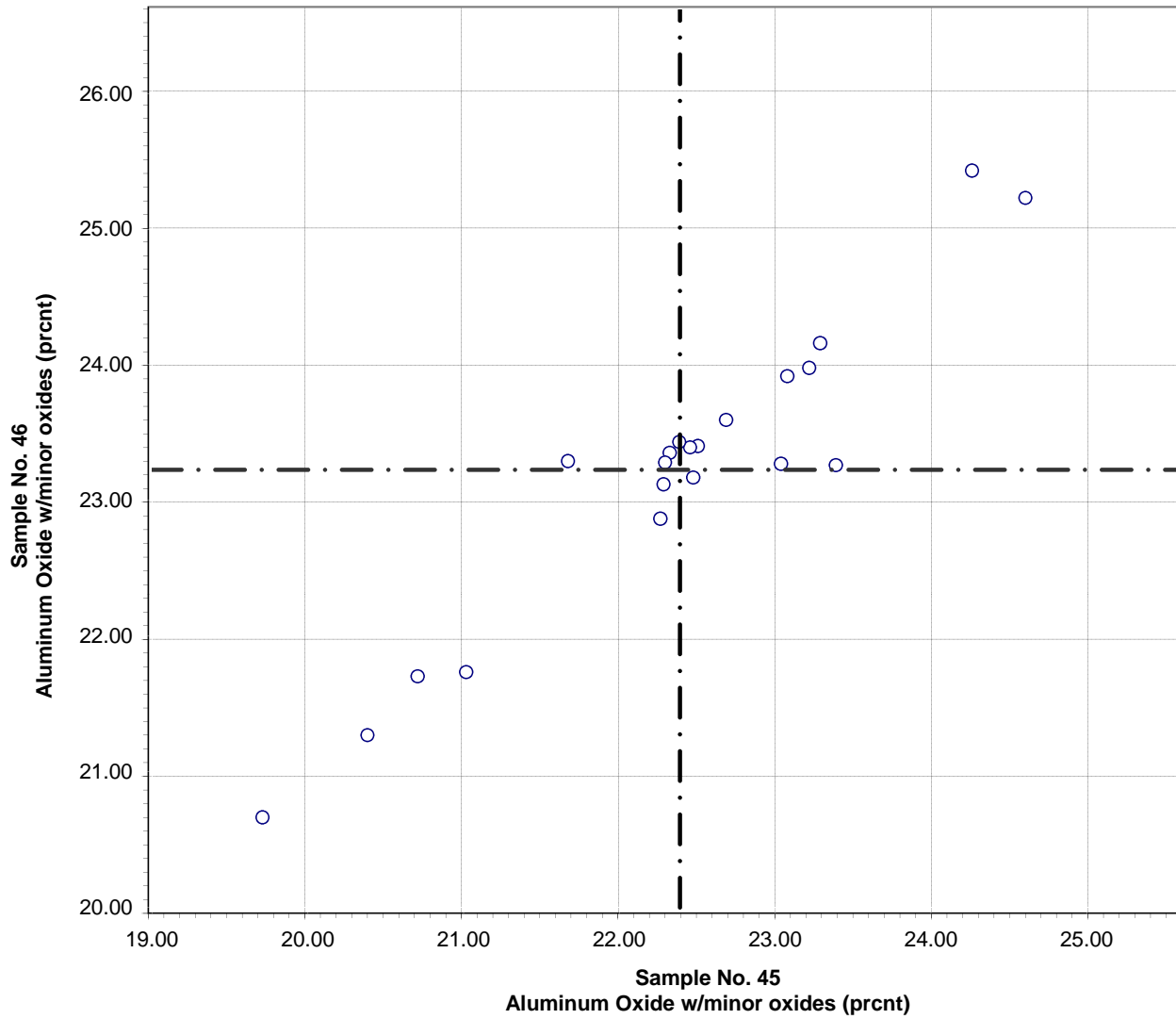


Test No. 10 Silicon Dioxide 56 Points

Sample No. 45	Ave 35.97	S.D. 1.31	C.V. 3.6
Sample No. 46	Ave 34.28	S.D. 1.12	C.V. 3.3

Labs eliminated: 20, 125

**CCRL Proficiency Sample Program
Aluminum Oxide (minor oxides included)
POZZOLAN Samples No. 45 and No. 46**



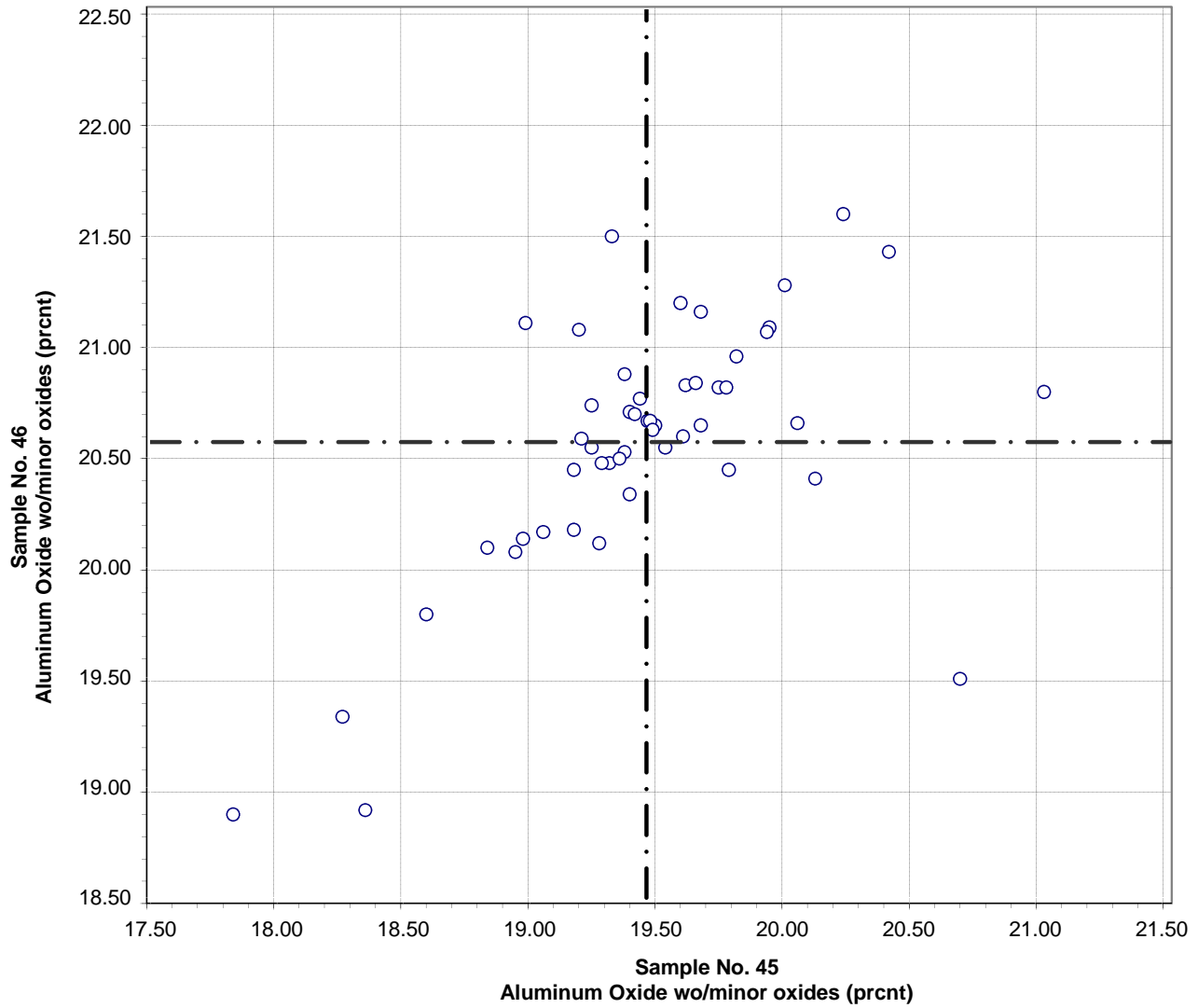
Test No. 20 Aluminum Oxide (minor oxides included) 21 Points

Sample No. 45 Ave 22.39 S.D. 1.19 C.V. 5.3

Sample No. 46 Ave 23.23 S.D. 1.13 C.V. 4.9

Labs eliminated: 2295

**CCRL Proficiency Sample Program
Aluminum Oxide (minor oxides excluded)
POZZOLAN Samples No. 45 and No. 46**



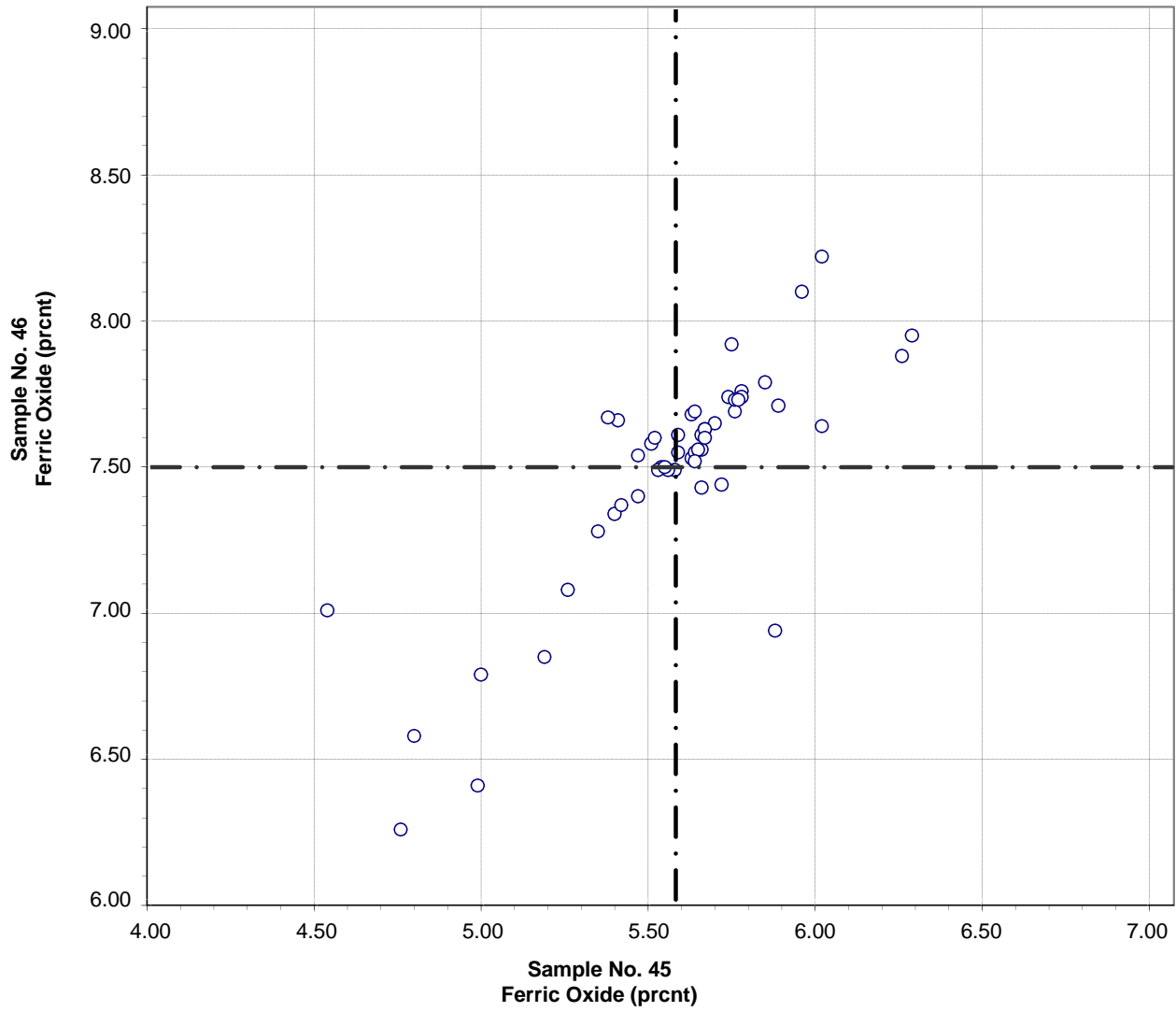
Test No. 21 Aluminum Oxide (minor oxides excluded) 50 Points

Sample No. 45 Ave 19.46 S.D. 0.56 C.V. 2.9

Sample No. 46 Ave 20.57 S.D. 0.57 C.V. 2.8

Labs eliminated: 3, 53, 126

CCRL Proficiency Sample Program
Ferric Oxide
POZZOLAN Samples No. 45 and No. 46

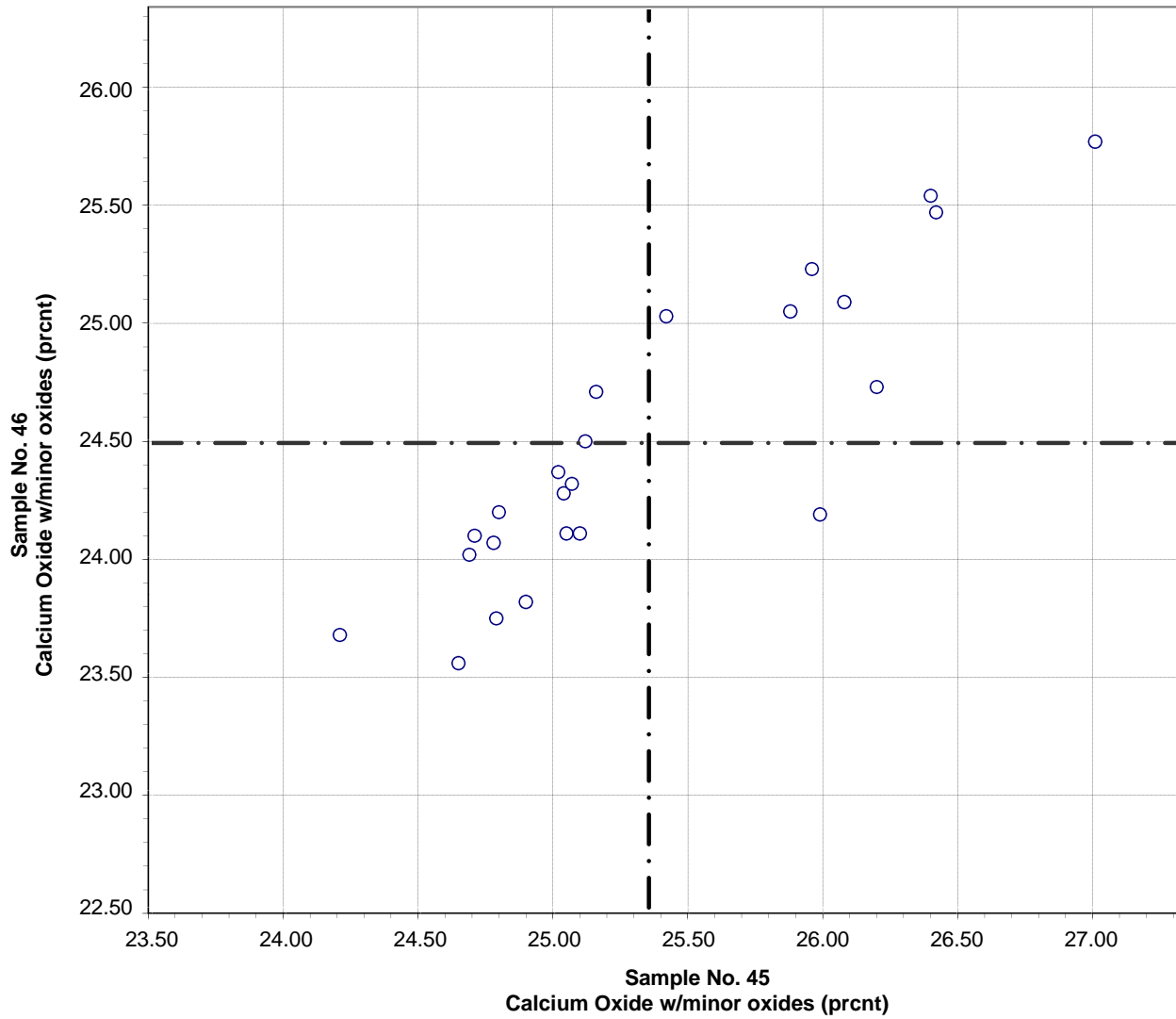


Test No. 30 Ferric Oxide 52 Points

Sample No. 45 Ave 5.58 S.D. 0.33 C.V. 5.9
Sample No. 46 Ave 7.49 S.D. 0.38 C.V. 5.1

Labs eliminated: 605, 48, 125, 1799, 2522

**CCRL Proficiency Sample Program
 Calcium Oxide (minor oxides included)
 POZZOLAN Samples No. 45 and No. 46**



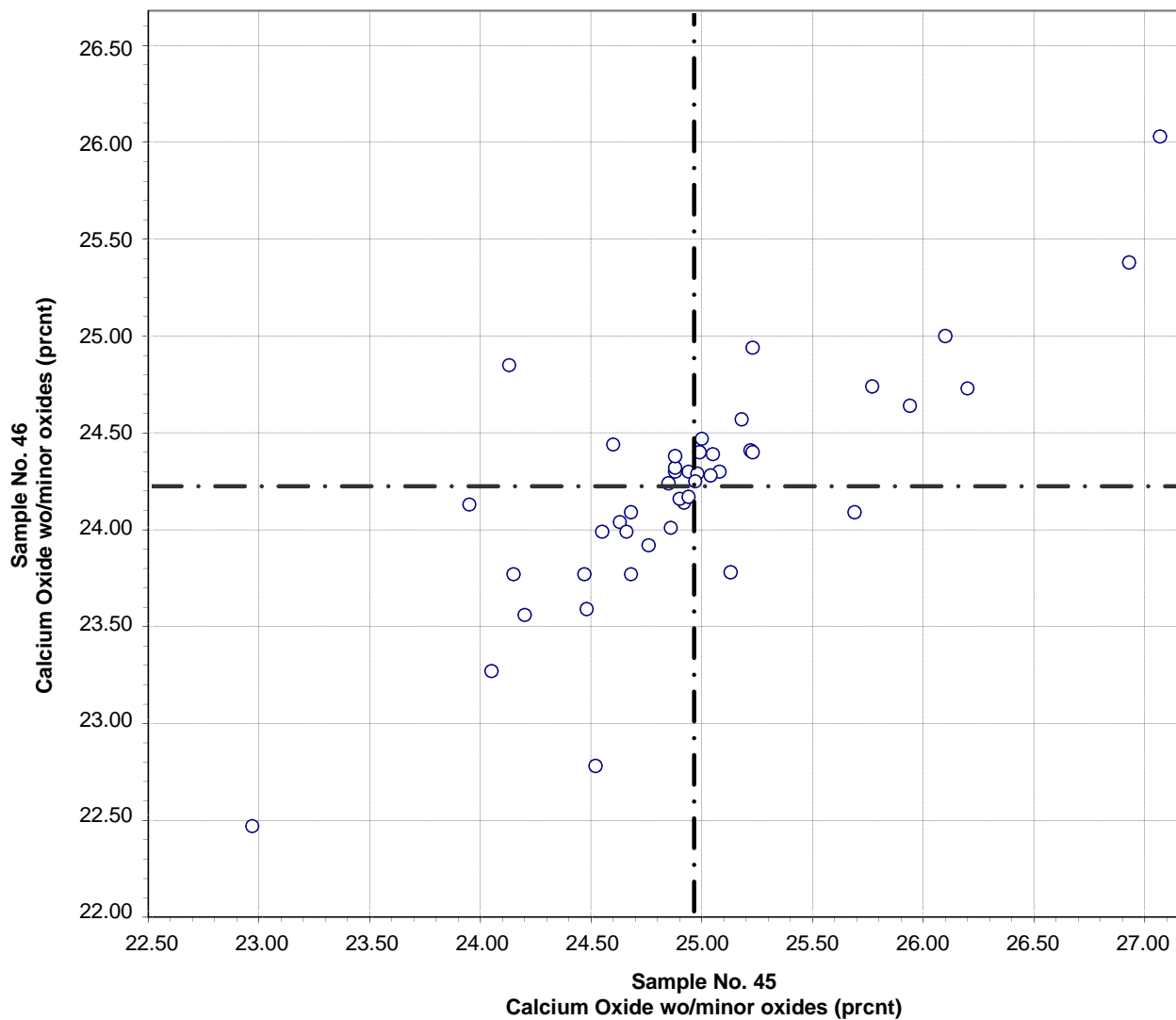
Test No. 40 Calcium Oxide (minor oxides included) 24 Points

Sample No. 45 Ave 25.35 S.D. 0.71 C.V. 2.8

Sample No. 46 Ave 24.49 S.D. 0.62 C.V. 2.5

Labs eliminated: 176, 3457

**CCRL Proficiency Sample Program
 Calcium Oxide (minor oxides excluded)
 POZZOLAN Samples No. 45 and No. 46**



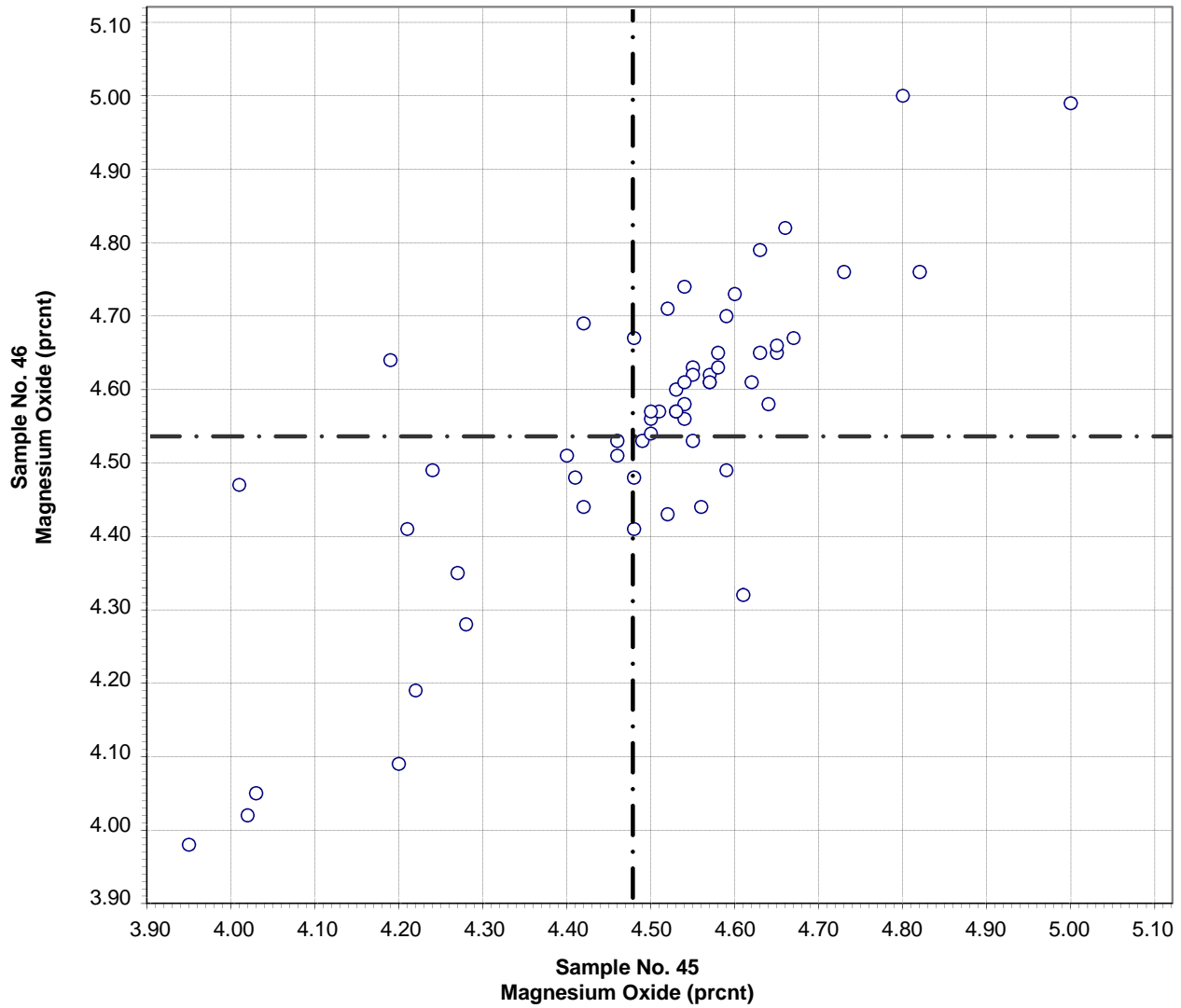
Test No. 42 Calcium Oxide (minor oxides excluded) 44 Points

Sample No. 45 Ave 24.96 S.D. 0.73 C.V. 2.9

Sample No. 46 Ave 24.22 S.D. 0.60 C.V. 2.5

Labs eliminated: 125, 158

**CCRL Proficiency Sample Program
Magnesium Oxide
POZZOLAN Samples No. 45 and No. 46**



Test No. 50 Magnesium Oxide 59 Points

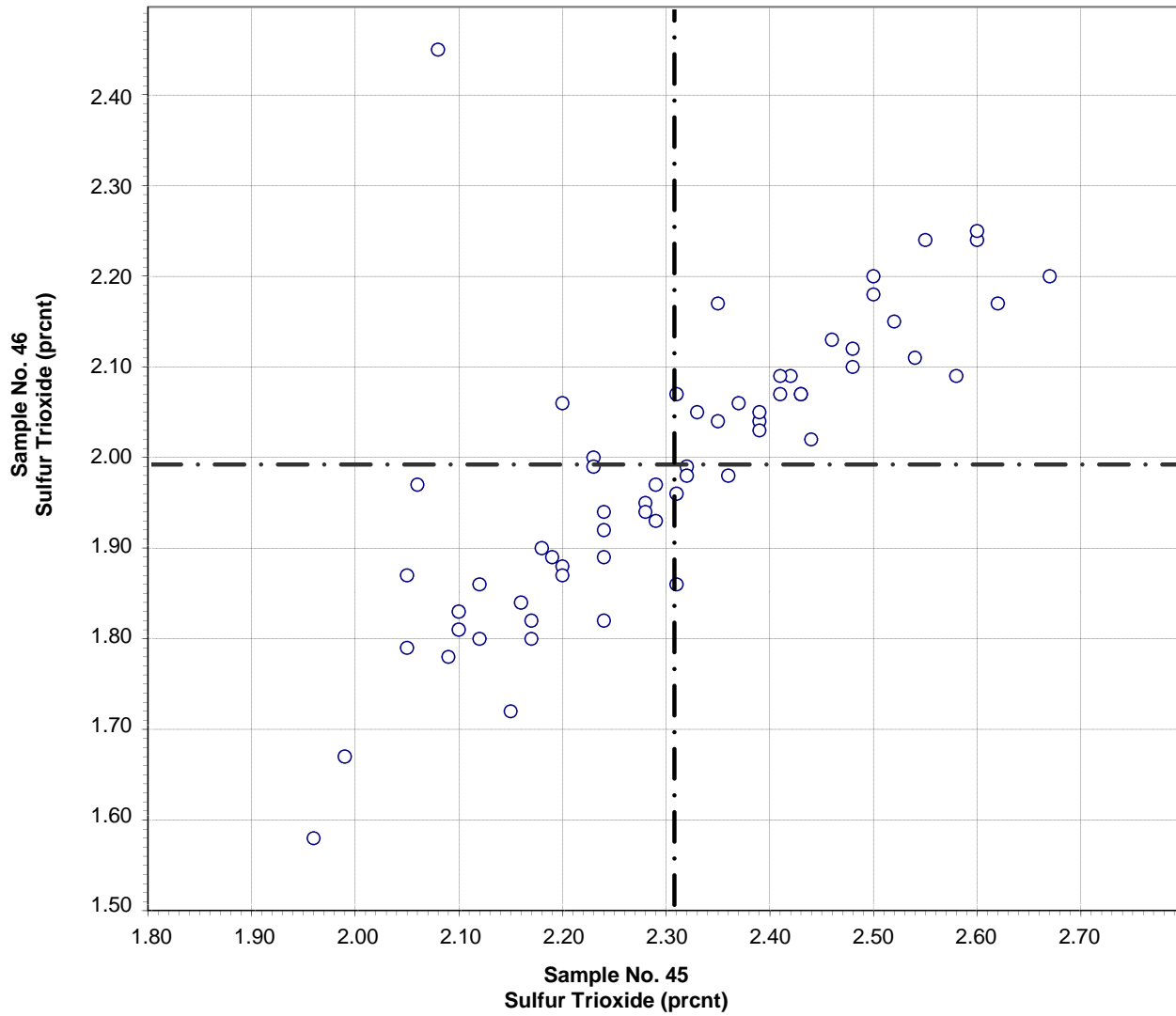
Sample No. 45 Ave 4.48 S.D. 0.22 C.V. 4.9

Sample No. 46 Ave 4.53 S.D. 0.23 C.V. 5.0

Labs eliminated: 20, 22, 3135

Labs off Diagram: 169

**CCRL Proficiency Sample Program
Sulfur Trioxide
POZZOLAN Samples No. 45 and No. 46**

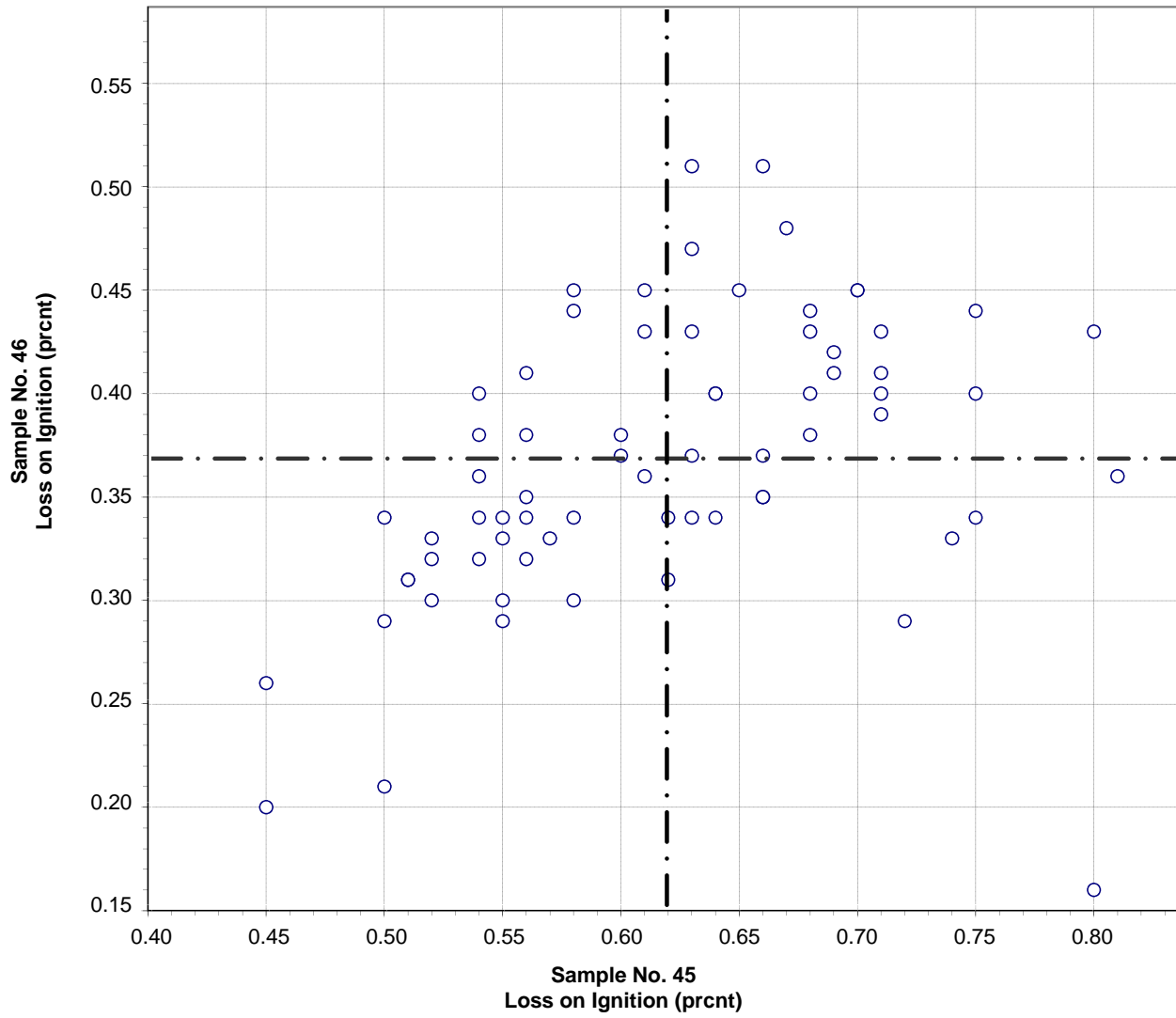


Test No. 60 Sulfur Trioxide 62 Points

Sample No. 45	Ave 2.31	S.D. 0.17	C.V. 7.4
Sample No. 46	Ave 1.99	S.D. 0.16	C.V. 7.9

Labs eliminated: 53, 2295, 2476

**CCRL Proficiency Sample Program
Loss on Ignition
POZZOLAN Samples No. 45 and No. 46**

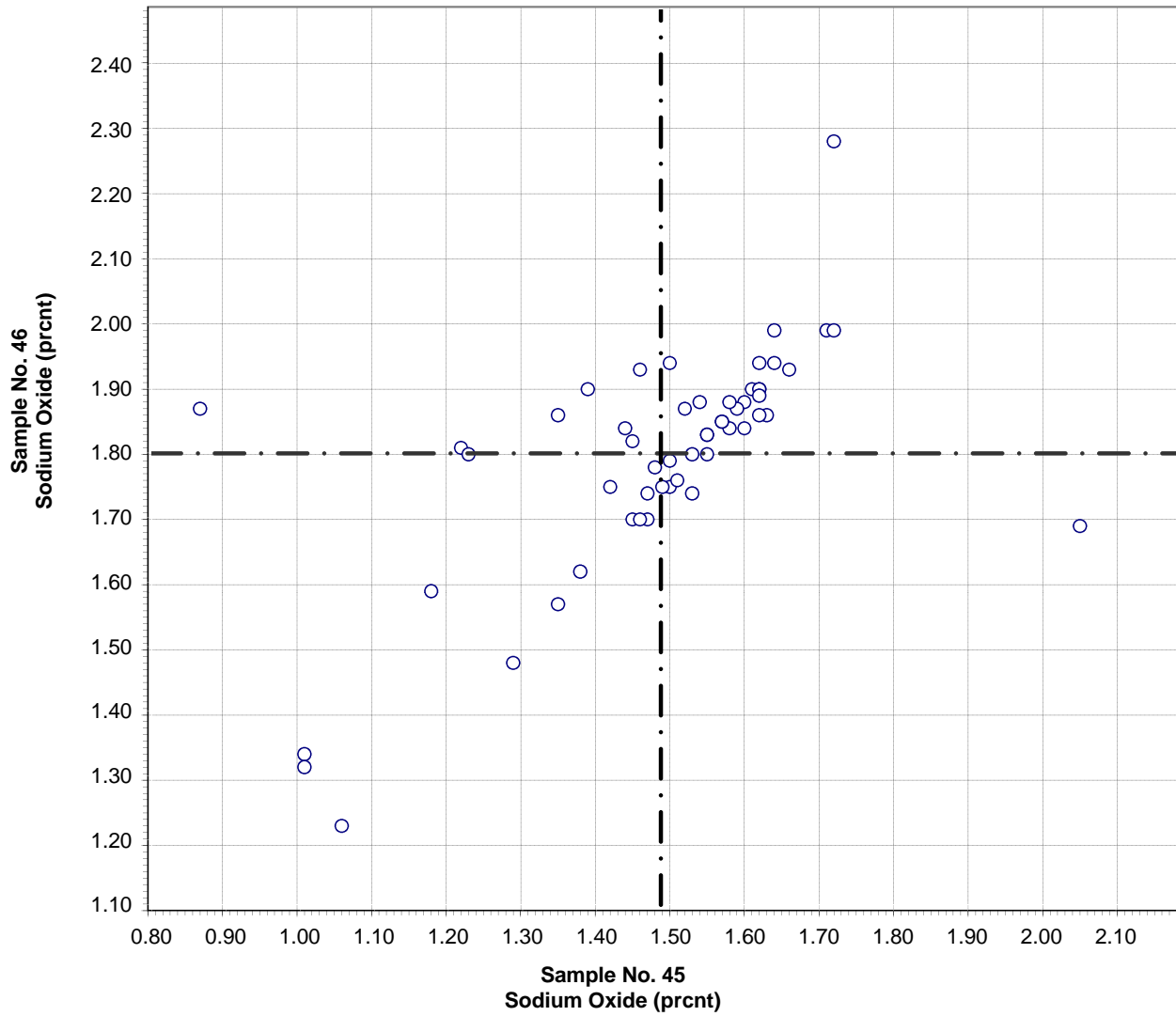


Test No. 70 Loss on Ignition 70 Points

Sample No. 45	Ave 0.62	S.D. 0.08	C.V. 13.6
Sample No. 46	Ave 0.37	S.D. 0.07	C.V. 18.5

Labs eliminated: 53, 125, 19, 605, 2295

**CCRL Proficiency Sample Program
Sodium Oxide
POZZOLAN Samples No. 45 and No. 46**

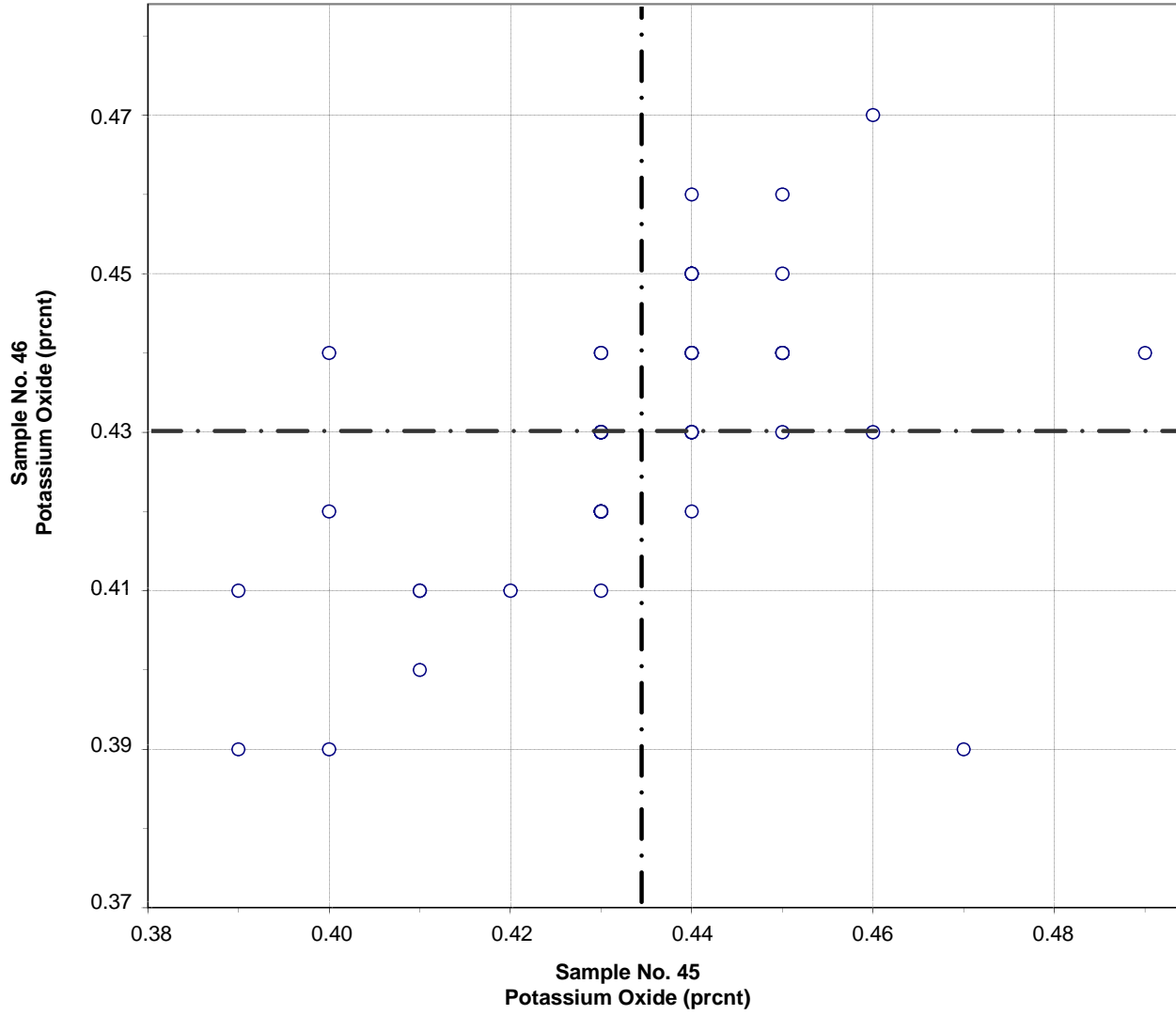


Test No. 90 Sodium Oxide 54 Points

Sample No. 45	Ave 1.49	S.D. 0.20	C.V. 13.5
Sample No. 46	Ave 1.80	S.D. 0.17	C.V. 9.6

Labs eliminated: 1799, 24, 2295, 2476, 3135

**CCRL Proficiency Sample Program
Potassium Oxide
POZZOLAN Samples No. 45 and No. 46**



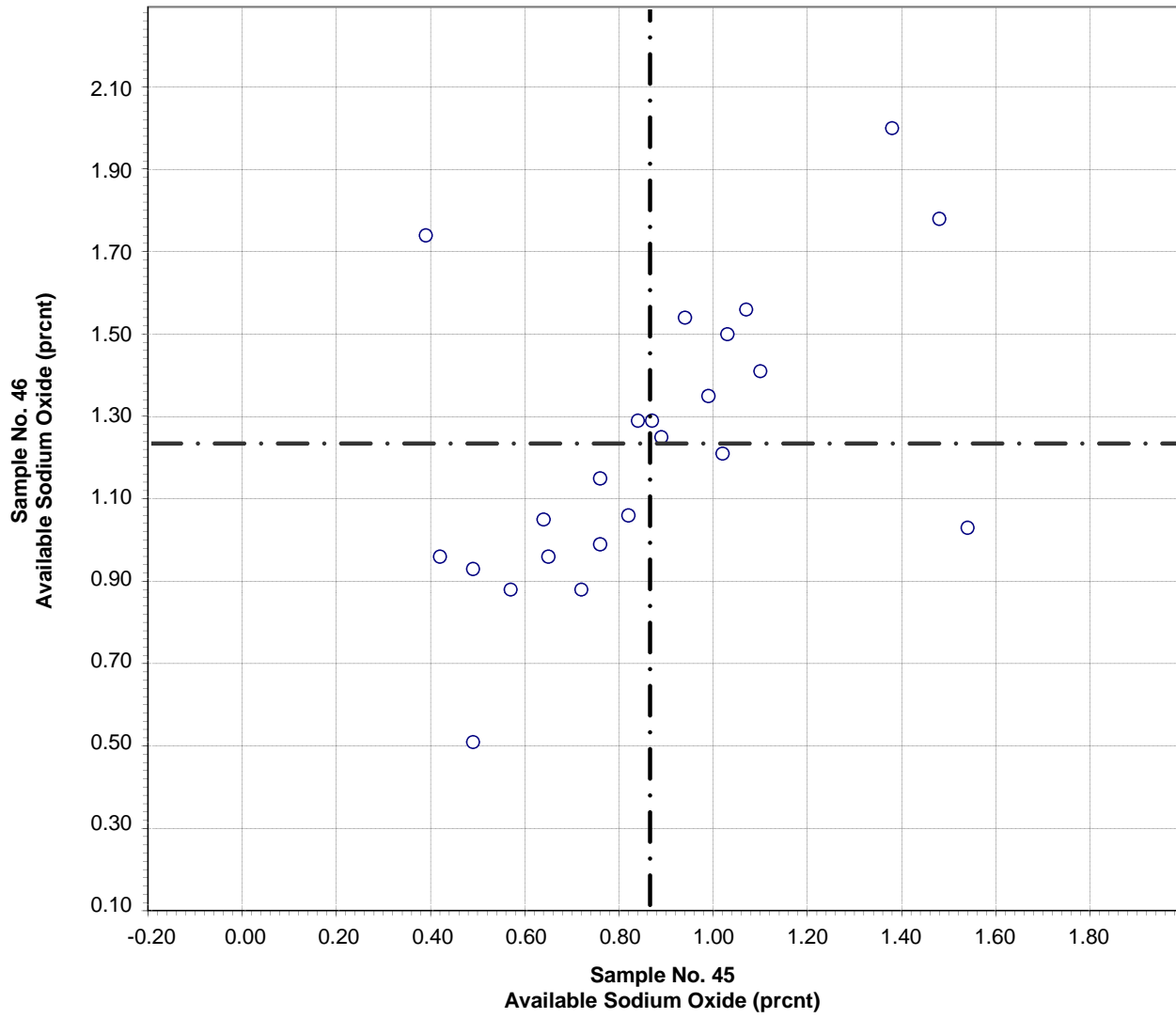
Test No. 100 Potassium Oxide 53 Points

Sample No. 45 Ave 0.43 S.D. 0.02 C.V. 4.2

Sample No. 46 Ave 0.43 S.D. 0.02 C.V. 4.0

Labs eliminated: 3, 24, 2295, 125, 126, 25, 2476

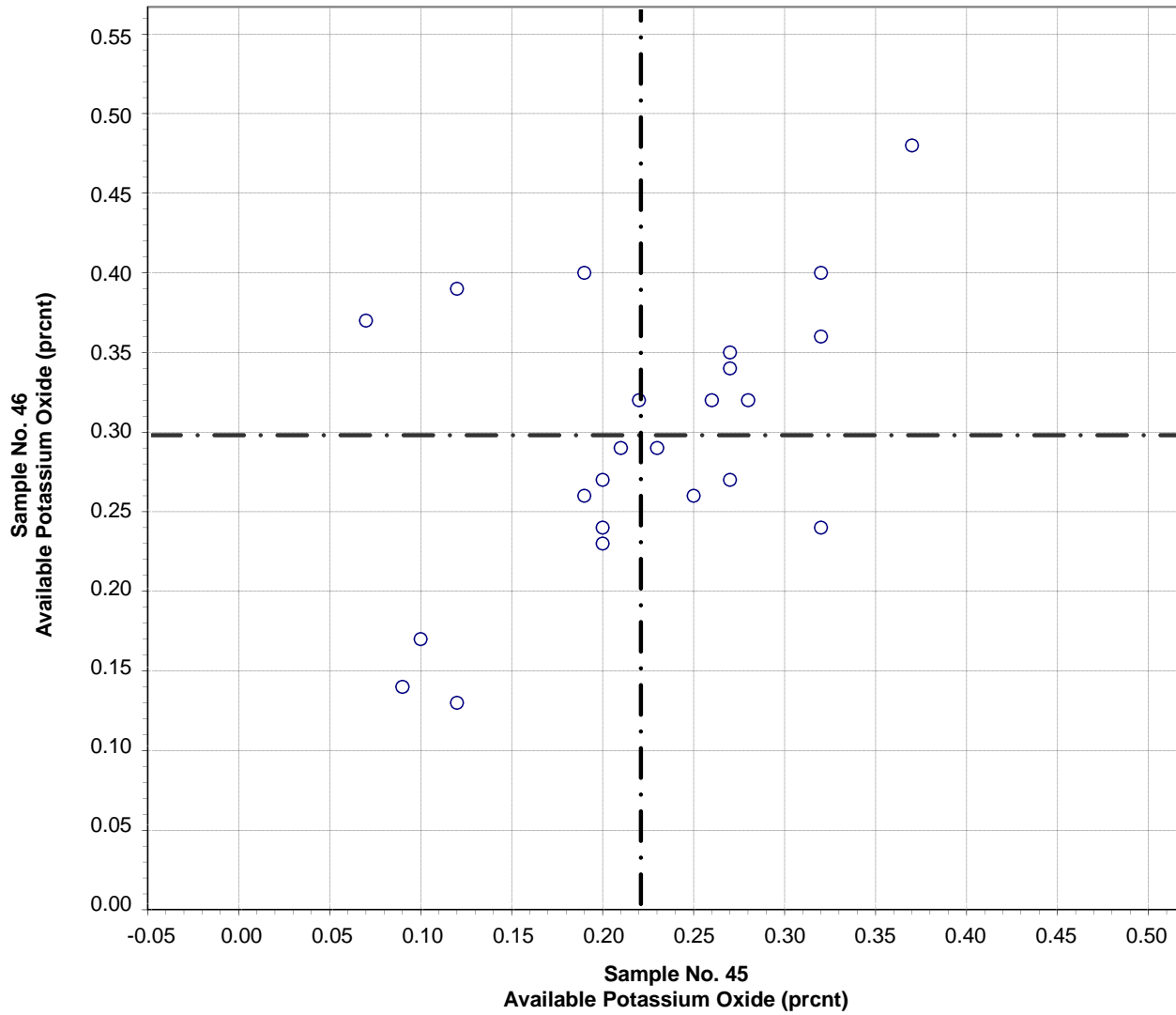
CCRL Proficiency Sample Program
Available Sodium Oxide
POZZOLAN Samples No. 45 and No. 46



Test No. 91 Available Sodium Oxide 23 Points

Sample No. 45	Ave 0.86	S.D. 0.32	C.V. 36.7
Sample No. 46	Ave 1.23	S.D. 0.35	C.V. 28.2

**CCRL Proficiency Sample Program
Available Potassium Oxide
POZZOLAN Samples No. 45 and No. 46**

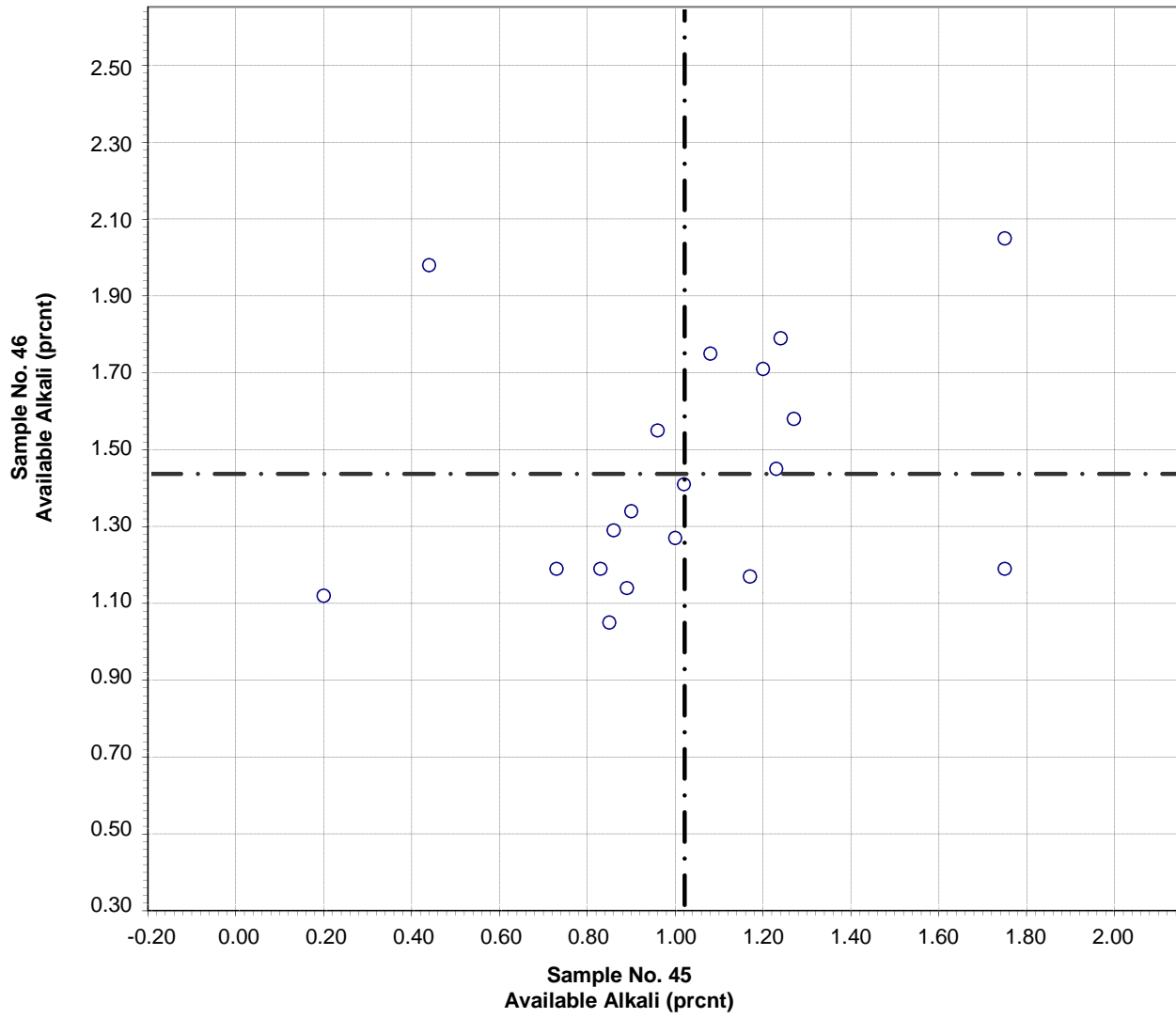


Test No. 93 Available Potassium Oxide 23 Points

Sample No. 45	Ave 0.22	S.D. 0.08	C.V. 36.6
Sample No. 46	Ave 0.30	S.D. 0.09	C.V. 28.9

Labs eliminated: 2476

**CCRL Proficiency Sample Program
Available Alkali
POZZOLAN Samples No. 45 and No. 46**



Test No. 95 Available Alkali 19 Points

Sample No. 45	Ave 1.02	S.D. 0.37	C.V. 36.5
Sample No. 46	Ave 1.43	S.D. 0.30	C.V. 21.2

CCRL PROFICIENCY SAMPLE PROGRAM
Pozzolan Proficiency Sample No. 45 and No. 46
Final Report - Physical Results
October 16, 2009

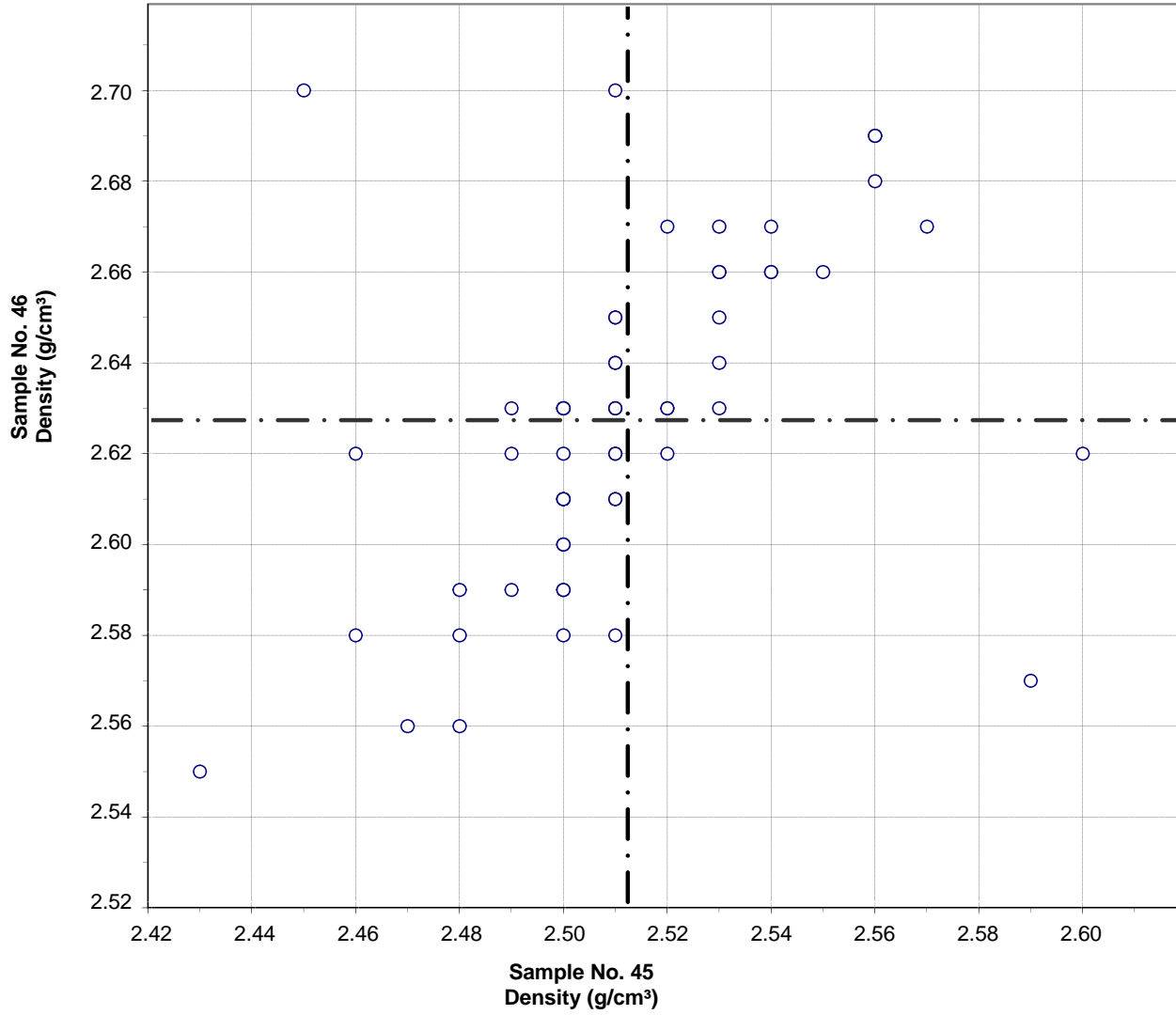
SUMMARY OF RESULTS

		Sample No. 45				Sample No. 46		
Test		#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.
Density	g/cm ³	58	2.52	0.07	2.8	2.64	0.08	2.9
Density	g/cm ³	* 56	2.51	0.03	1.2	2.63	0.04	1.4
45µm Sieve	prcnt	76	12.28	3.25	26.5	12.30	2.46	20.0
45µm Sieve	prcnt	* 70	12.00	0.90	7.5	12.41	0.81	6.6
Drying Shrinkage	prcnt	21	0.021	0.051	238	0.016	0.050	307
Drying Shrinkage	prcnt	* 18	0.009	0.008	89.9	0.008	0.009	105.1
Autoclave Expan	prcnt	55	0.09	0.12	128	0.10	0.12	124
Autoclave Expan	prcnt	* 53	0.08	0.02	29.9	0.09	0.03	29.2
N.C. Water	prcnt	57	24.7	2.2	8.8	24.4	2.1	8.8
N.C. Water	prcnt	* 55	24.9	0.4	1.6	24.6	0.4	1.7
Air Entrainment	prcnt	10	0.049	0.067	137	0.050	0.062	124
STRENGTH ACTIVITY INDEX (SAI) WITH PORTLAND CEMENT								
SAI 7 day	prcnt	66	93	8.1	8.7	92	8.1	8.8
SAI 7 day	prcnt	* 62	94	4.8	5.2	92	5.7	6.2
SAI 28 day	prcnt	59	100	6.5	6.5	100	7.3	7.3
SAI 28 day	prcnt	* 58	101	5.0	4.9	100	6.8	6.8
SAI Water	prcnt	65	95	1.7	1.8	94	1.5	1.6
SAI Water	prcnt	* 64	95	1.5	1.6	95	1.5	1.6
EFFECTIVENESS OF MINERAL ADMIXTURES IN CONTROLLING ALKALI-SILICA REACTIONS (ASR)								
Reduction Expan	prcnt	13	22	38.8	173	13	65.0	512
Reduction Expan	prcnt	* 12	31	24.7	79.7	29	30.8	107.0

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

Density	17 1799
Fineness - 45µm Sieve	14 25 1323 1715 1799 3135
Drying Shrinkage	46 125 207
Autoclave Expansion	39 3365
N. C. Water	958 1038
SAI 7 day	4 39 823 1323
SAI 28 day	1323
SAI Water Requirement	4
ASR Expansion	2292

CCRL Proficiency Sample Program
Density
POZZOLAN Samples No. 45 and No. 46

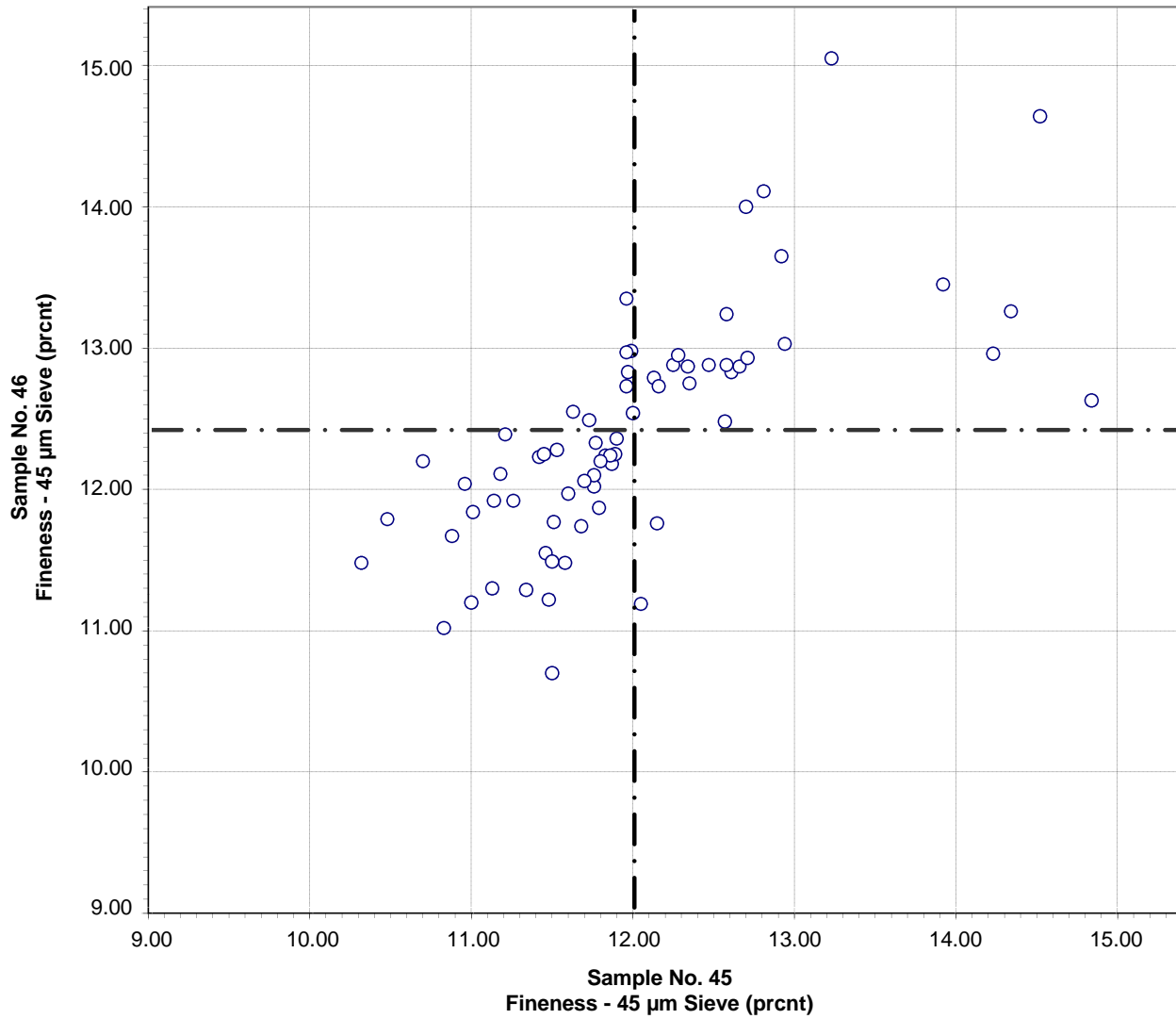


Test No. 310 Density 56 Points

Sample No. 45	Ave 2.51	S.D. 0.03	C.V. 1.2
Sample No. 46	Ave 2.63	S.D. 0.04	C.V. 1.4

Labs eliminated: 17, 1799

**CCRL Proficiency Sample Program
 Fineness - 45 μ m Sieve Retained
 POZZOLAN Samples No. 45 and No. 46**

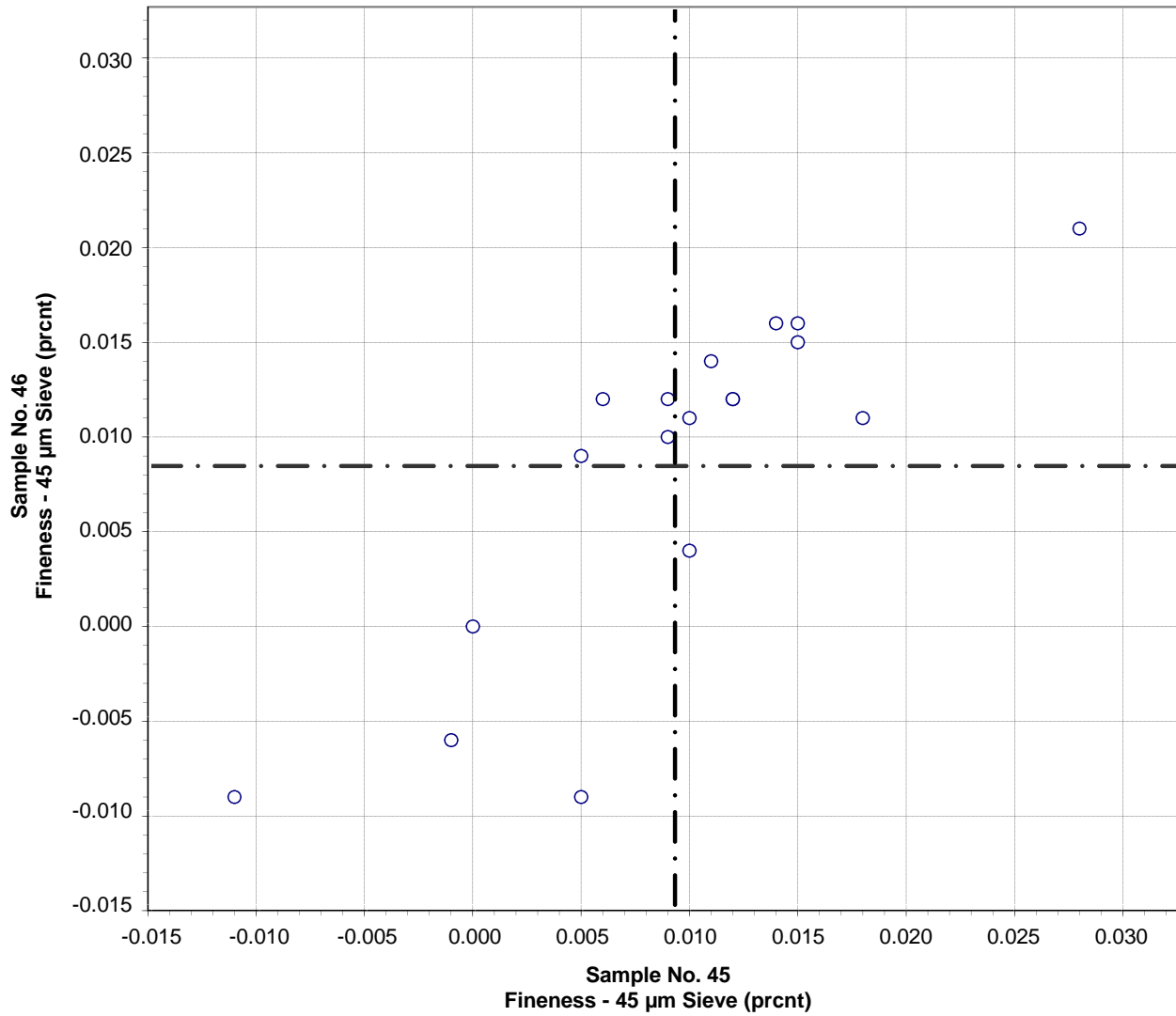


Test No. 281 Fineness - 45 μ m Sieve Retained 70 Points

Sample No. 45 Ave 12.00 S.D. 0.90 C.V. 7.5
 Sample No. 46 Ave 12.41 S.D. 0.81 C.V. 6.6

Labs eliminated: 14, 25, 1323, 1715, 1799, 3135

**CCRL Proficiency Sample Program
Drying Shrinkage
POZZOLAN Samples No. 45 and No. 46**

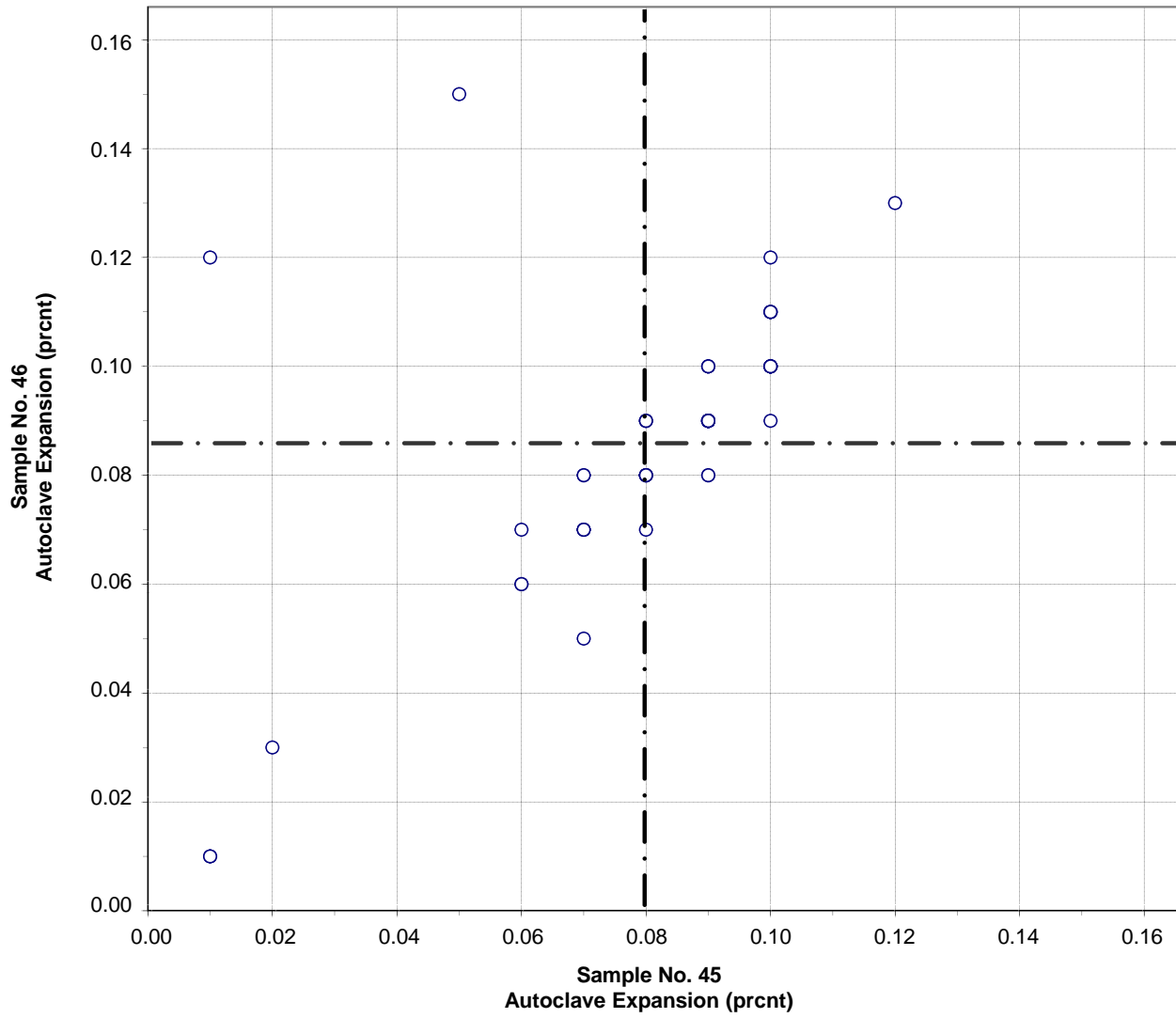


Test No. 340 Drying Shrinkage 18 Points

Sample No. 45	Ave 0.009	S.D. 0.008	C.V. 89.9
Sample No. 46	Ave 0.008	S.D. 0.009	C.V. 105.1

Labs eliminated: 46, 125, 207

**CCRL Proficiency Sample Program
Autoclave Expansion
POZZOLAN Samples No. 45 and No. 46**



Test No. 160

Autoclave Expansion

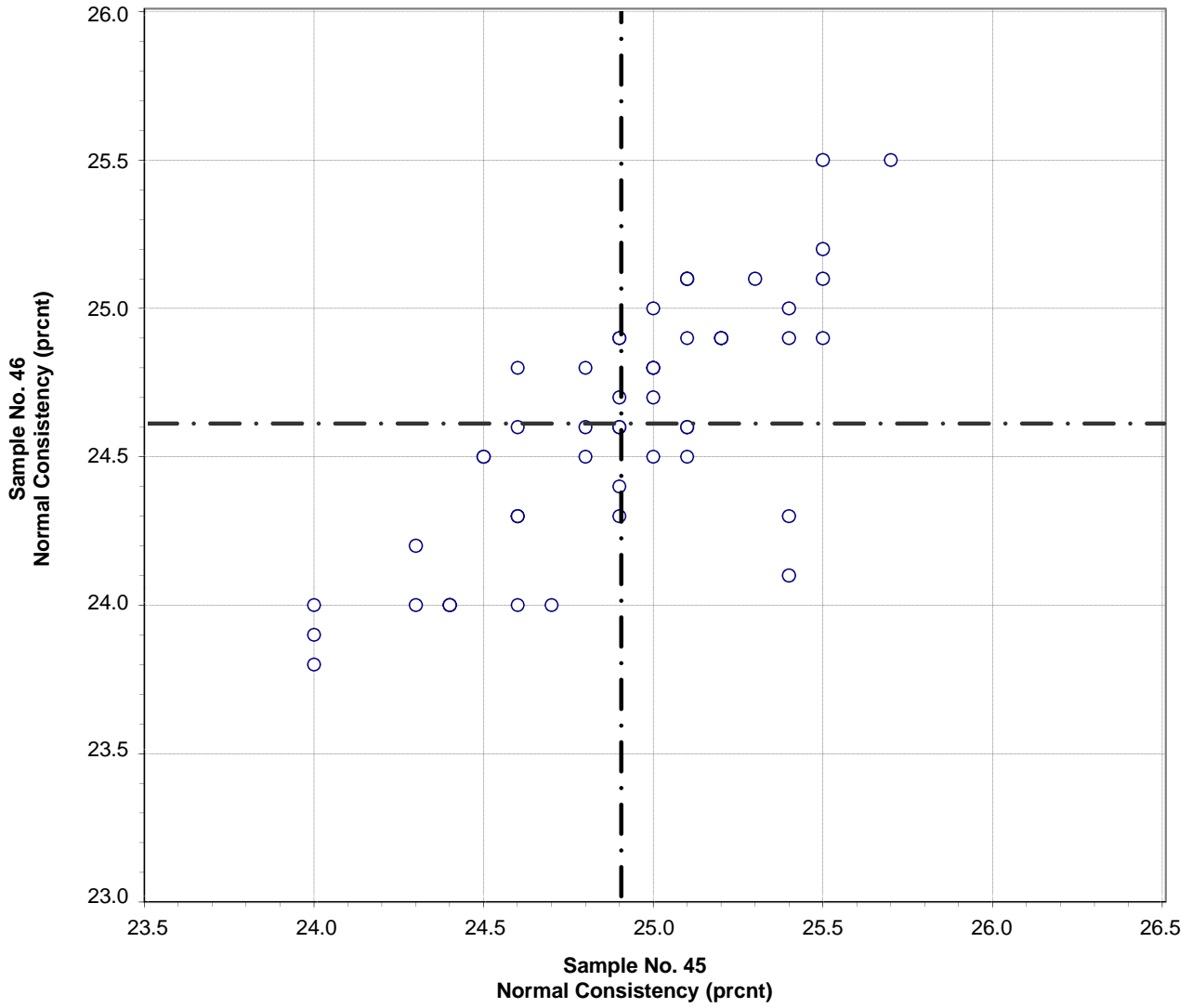
53 Points

Sample No. 45 Ave 0.08 S.D. 0.02 C.V. 29.9

Sample No. 46 Ave 0.09 S.D. 0.03 C.V. 29.2

Labs eliminated: 39, 3365

**CCRL Proficiency Sample Program
Normal Consistency Water
POZZOLAN Samples No. 45 and No. 46**

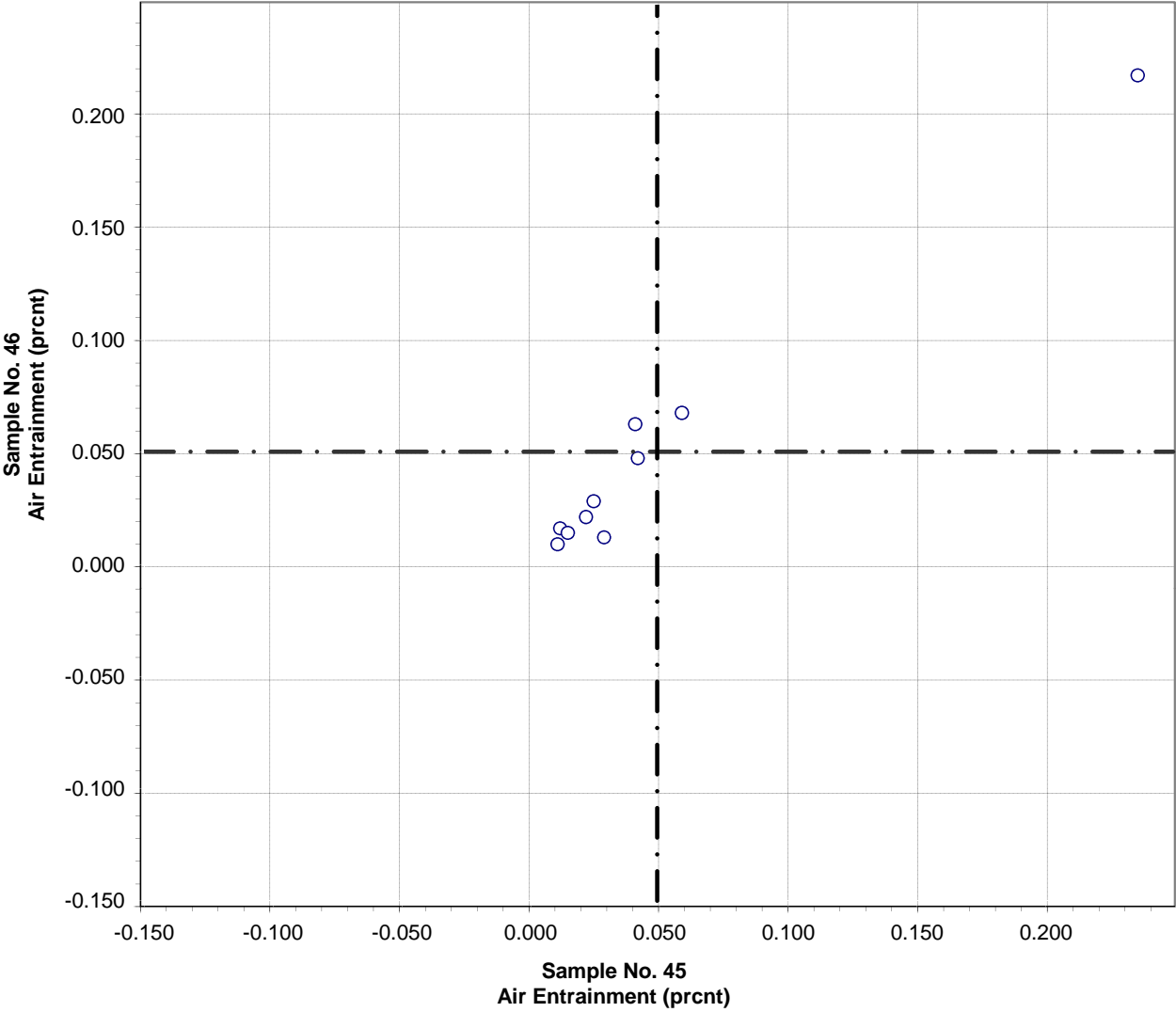


Test No. 110 Normal Consistency Water 55 Points

Sample No. 45 Ave 24.9 S.D. 0.4 C.V. 1.6
 Sample No. 46 Ave 24.6 S.D. 0.4 C.V. 1.7

Labs eliminated: 958, 1038

**CCRL Proficiency Sample Program
Air Entrainment, Vinsol Resin
POZZOLAN Samples No. 45 and No. 46**



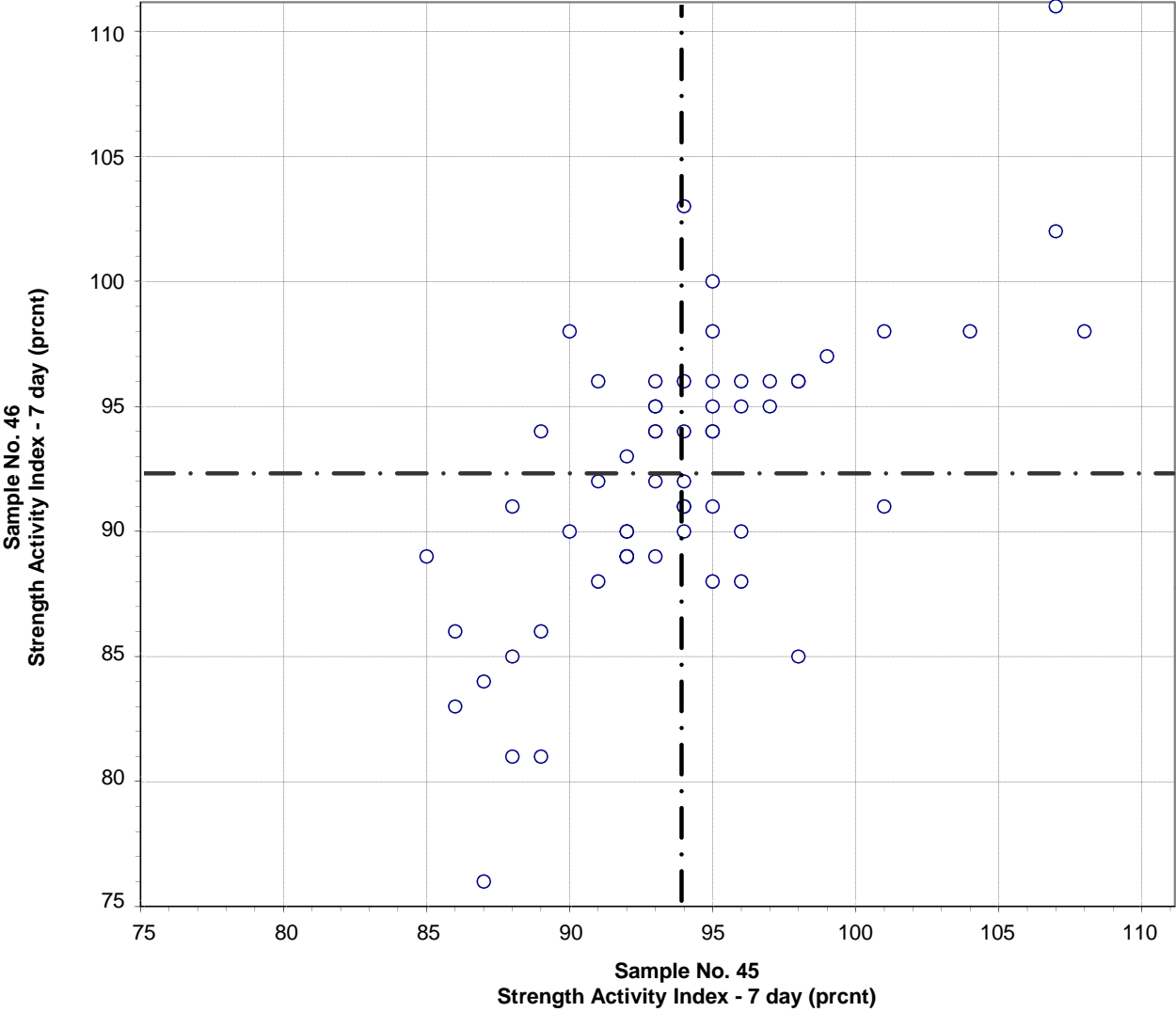
Test No. 350

Air Entrainment, Vinsol Resin

10 Points

Sample No. 45	Ave 0.049	S.D. 0.067	C.V. 136.6
Sample No. 46	Ave 0.050	S.D. 0.062	C.V. 124.0

**CCRL Proficiency Sample Program
Strength Activity Index - 7 day
POZZOLAN Samples No. 45 and No. 46**

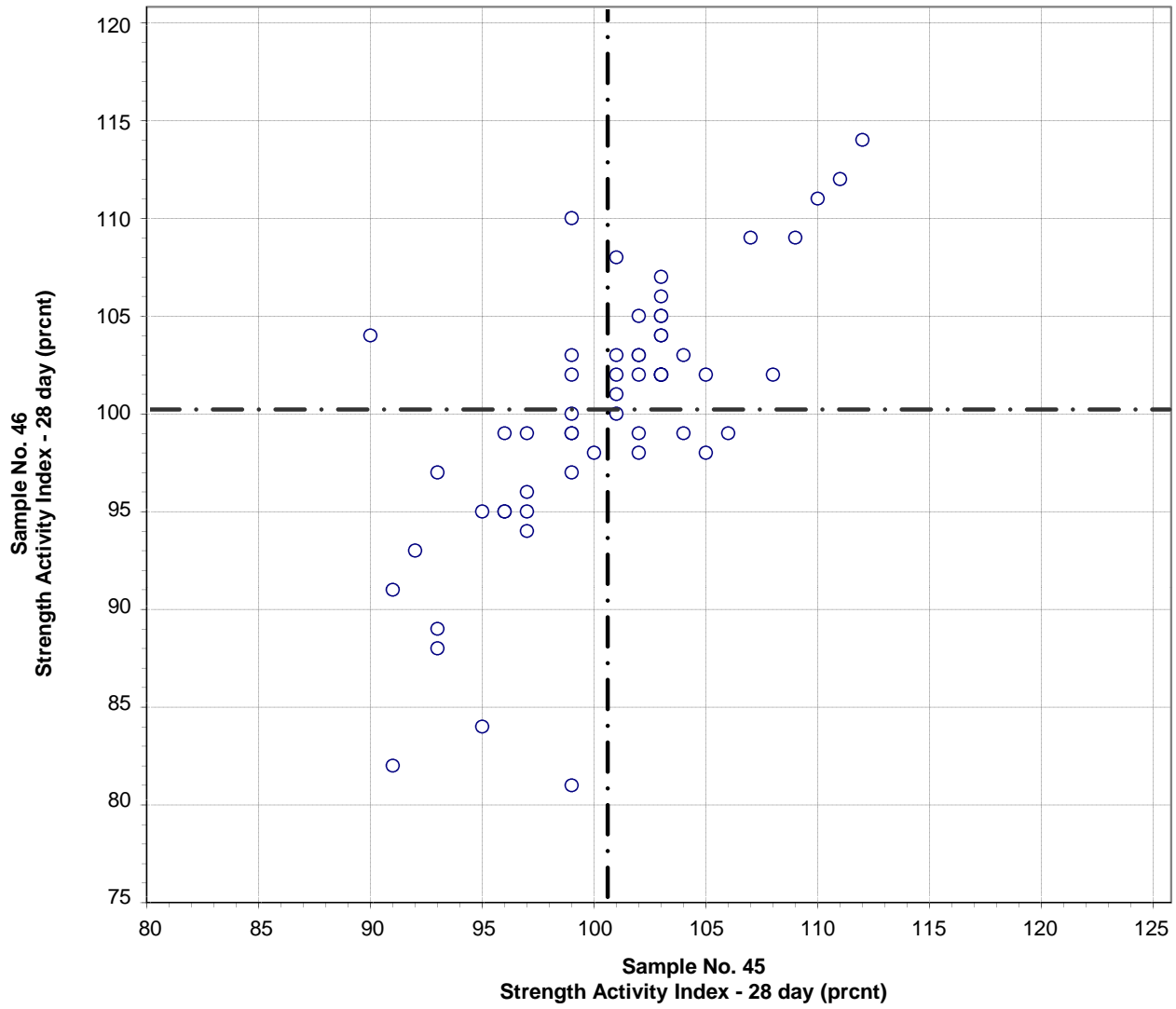


Test No. 359 Strength Activity Index - 7 day 62 Points

Sample No. 45 Ave 94 S.D. 4.8 C.V. 5.2
 Sample No. 46 Ave 92 S.D. 5.7 C.V. 6.2

Labs eliminated: 4, 39, 823, 1323

**CCRL Proficiency Sample Program
Strength Activity Index - 28 day
POZZOLAN Samples No. 45 and No. 46**

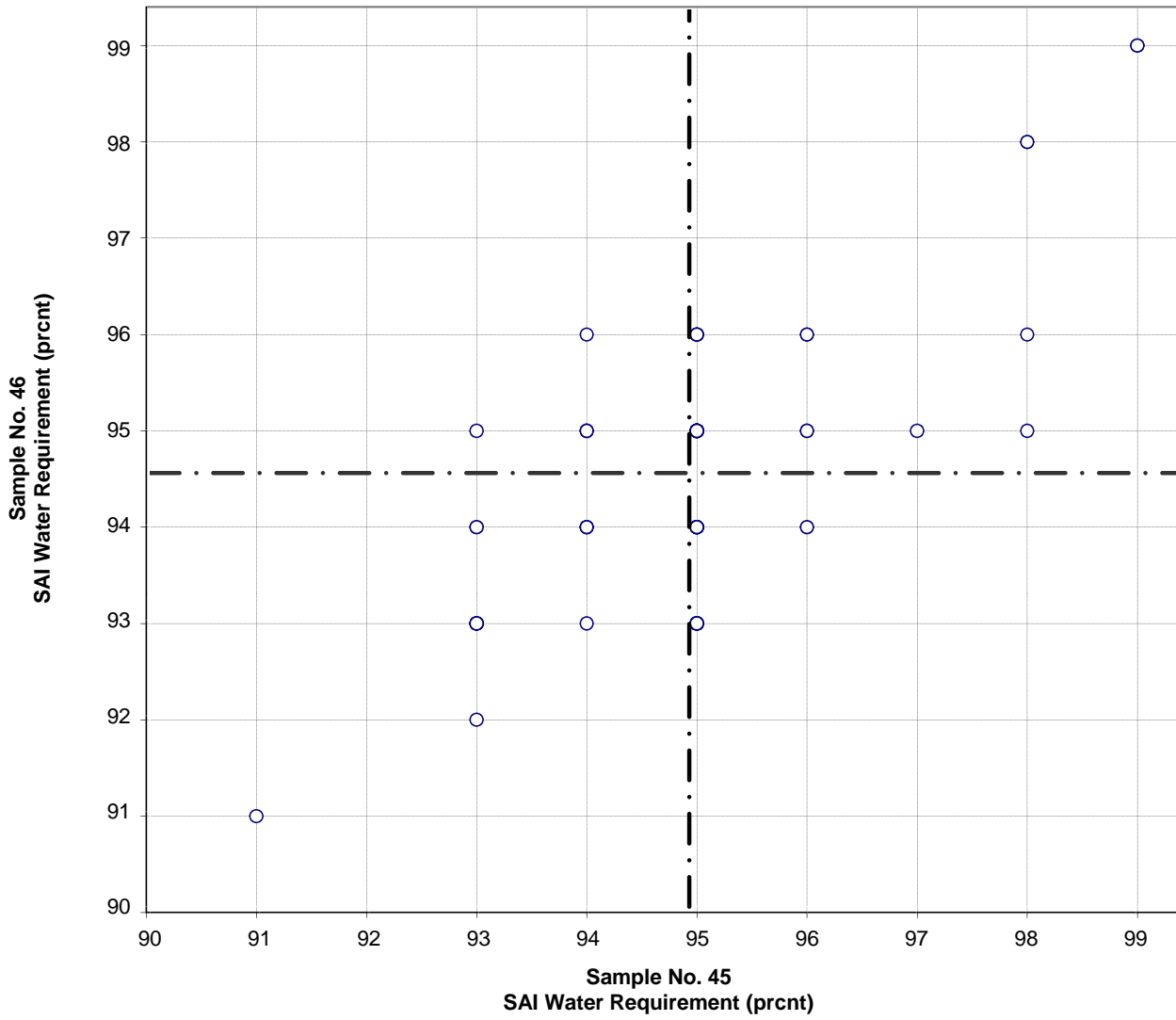


Test No. 360 Strength Activity Index - 28 day 58 Points

Sample No. 45 Ave 101 S.D. 5.0 C.V. 4.9
 Sample No. 46 Ave 100 S.D. 6.8 C.V. 6.8

Labs eliminated: 1323

**CCRL Proficiency Sample Program
SAI Water Requirement
POZZOLAN Samples No. 45 and No. 46**

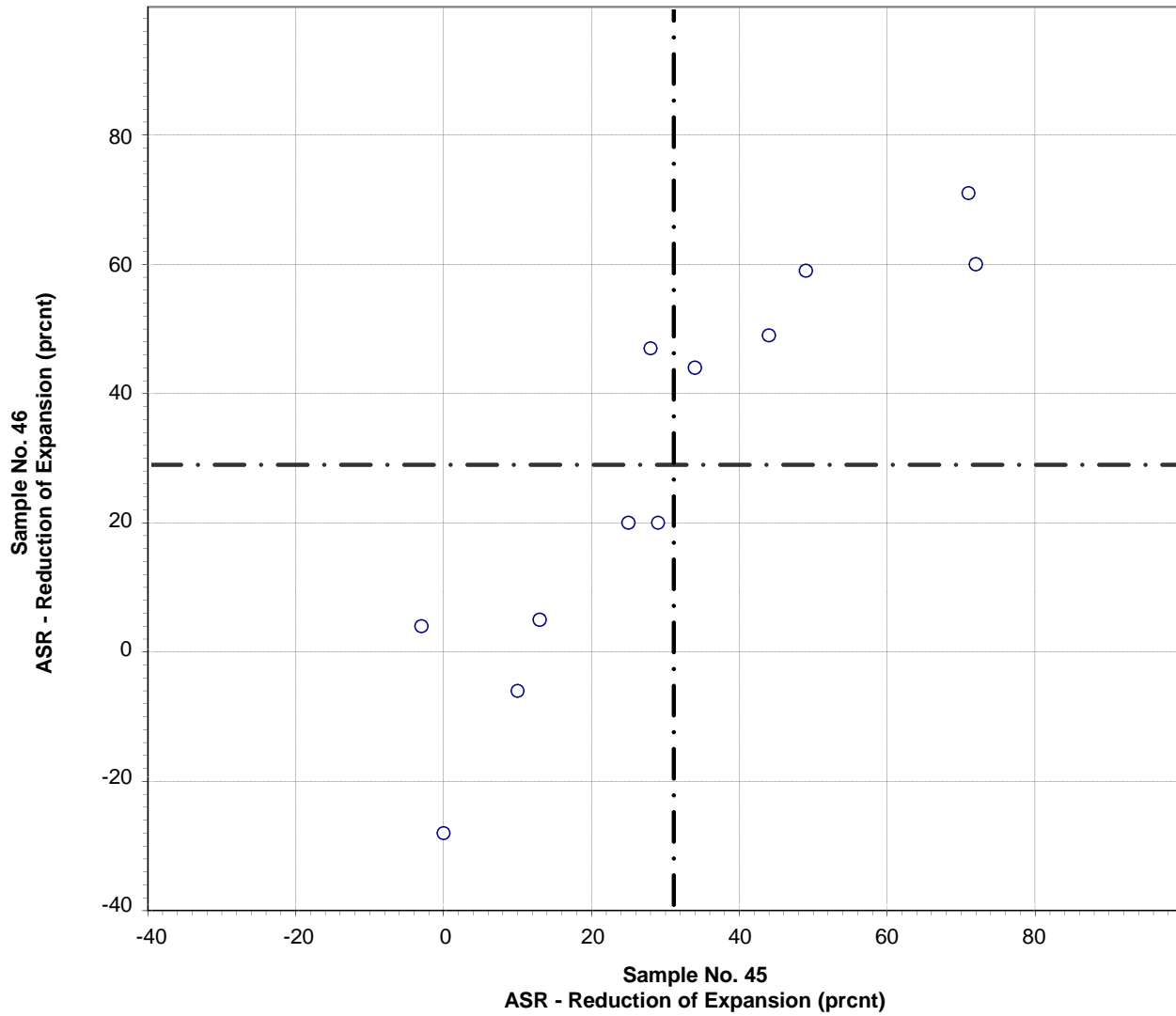


Test No. 370 SAI Water Requirement 64 Points

Sample No. 45	Ave 95	S.D. 1.5	C.V. 1.6
Sample No. 46	Ave 95	S.D. 1.5	C.V. 1.6

Labs eliminated: 4

**CCRL Proficiency Sample Program
Alkali-Silica Reaction - Reduction of Expansion
POZZOLAN Samples No. 45 and No. 46**



Test No. 390 ASR - Reduction of Expansion 12 Points

Sample No. 45 Ave 31 S.D. 24.7 C.V. 79.7
 Sample No. 46 Ave 29 S.D. 30.8 C.V. 107.0

Labs eliminated: 2292