

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

**Final Report**  
**Pozzolan Proficiency Samples**  
**Number 47 and Number 48**

October 2010



**CCRL**

CEMENT AND CONCRETE  
REFERENCE LABORATORY





October 15, 2010

**To: Participants in the CCRL Pozzolan Proficiency Sample Program**

**SUBJECT: Pozzolan Proficiency Samples No. 47 and No. 48**

Following is the final report for the pair of CCRL **Pozzolan** Proficiency Samples which were distributed in July 2010. 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 2011.

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. 47 and No. 48**

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 2010. 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 62<sup>nd</sup> 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.

<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.

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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.*

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  $\pm 1$  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 may indicate strong evidence of bias in many cases.

CCRL PROFICIENCY SAMPLE PROGRAM  
Pozzolan Proficiency Samples No. 47 and No. 48  
Final Report - Chemical Results  
October 15, 2010

SUMMARY OF RESULTS

Test	#Labs	Sample No. 47			Sample No. 48		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Moist Content	% 69	0.08	0.06	78	0.07	0.06	90
Moist Content	% * 66	0.07	0.04	50	0.06	0.04	59
Silicon Dioxide	% 60	30.69	2.00	6.4	35.39	1.60	4.6
Silicon Dioxide	% * 54	30.76	0.65	2.1	35.57	0.74	2.1
Al <sub>2</sub> O <sub>3</sub> w/minor <sup>1</sup>	% 20	19.64	0.87	4.4	21.88	0.91	4.2
Al <sub>2</sub> O <sub>3</sub> w/minor <sup>1</sup>	% * 19	19.79	0.60	3.0	22.05	0.54	2.4
<sup>1</sup> (P <sub>2</sub> O <sub>3</sub> & TiO <sub>2</sub> included)							
Al <sub>2</sub> O <sub>3</sub> wo/minor <sup>2</sup>	% 57	17.51	0.82	4.7	19.35	0.71	3.7
Al <sub>2</sub> O <sub>3</sub> wo/minor <sup>2</sup>	% * 56	17.57	0.67	3.8	19.39	0.65	3.4
<sup>2</sup> (P <sub>2</sub> O <sub>3</sub> & TiO <sub>2</sub> not included)							
Ferric Oxide	% 59	6.01	0.59	9.8	7.43	0.56	7.6
Ferric Oxide	% * 55	5.93	0.38	6.3	7.45	0.39	5.3
CaO w/minor <sup>3</sup>	% 23	29.15	1.02	3.5	25.28	0.80	3.2
<sup>3</sup> (SrO & BaO included)							
CaO wo/minor <sup>4</sup>	% 51	28.16	0.94	3.3	24.54	0.89	3.6
CaO wo/minor <sup>4</sup>	% * 47	28.34	0.68	2.4	24.57	0.48	2.0
<sup>4</sup> (SrO & BaO not included)							

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

Moisture Content	207 605 2476
Silicon Dioxide	20 23 24 52 58 125
Al <sub>2</sub> O <sub>3</sub> w/minor	1479
Al <sub>2</sub> O <sub>3</sub> wo/minor	52
Ferric Oxide	15 23 52 176
CaO wo/minor	23 52 125 2150

CCRL PROFICIENCY SAMPLE PROGRAM  
 Pozzolan Proficiency Samples No. 47 and No. 48  
 Final Report - Chemical Results  
 October 15, 2010

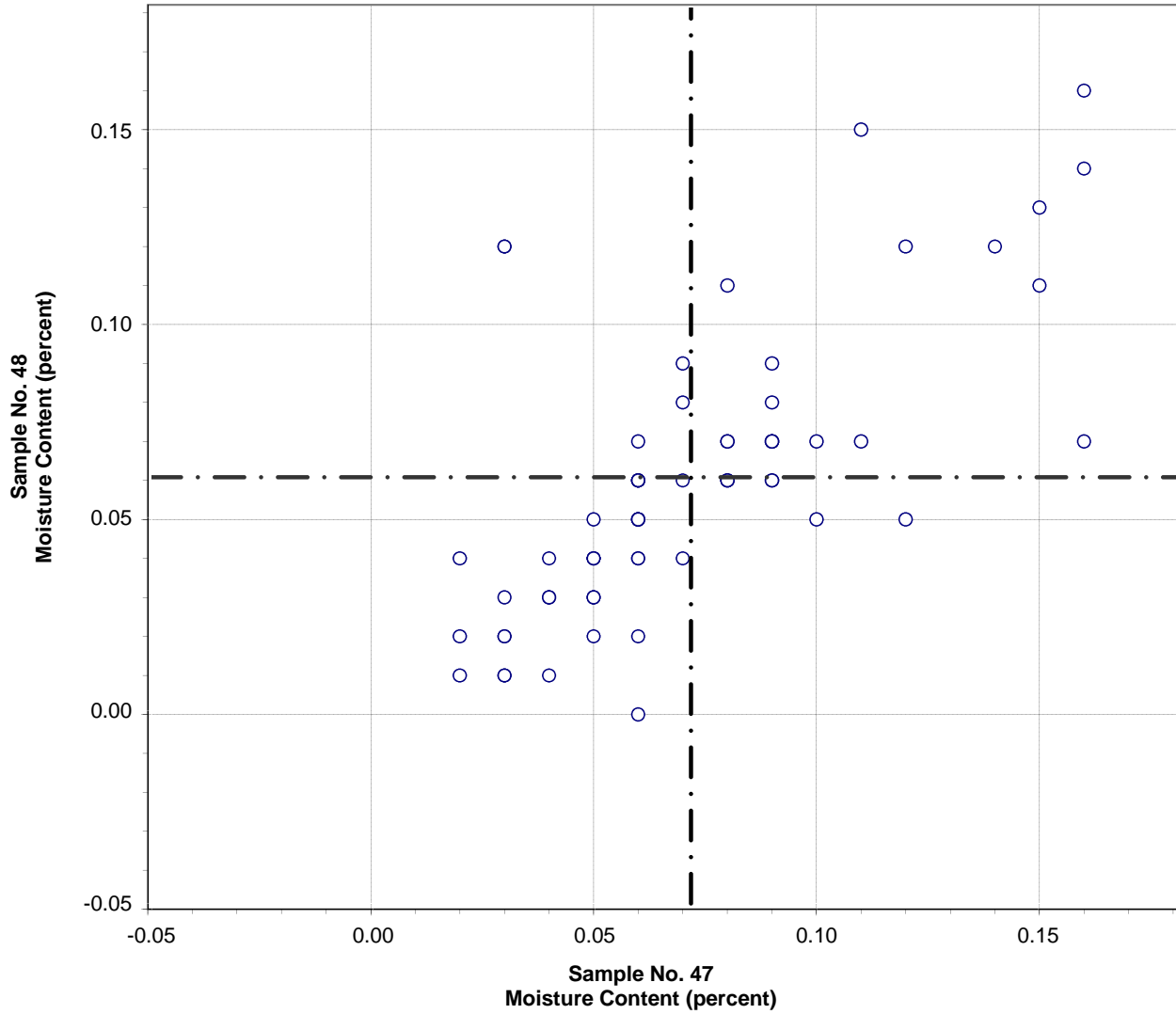
SUMMARY OF RESULTS

Test	#Labs	Sample No. 47			Sample No. 48		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Magnesium Oxide	% 64	7.49	0.70	9.3	4.86	0.49	10
Magnesium Oxide	% * 59	7.63	0.29	3.8	4.85	0.20	4.1
Sulfur Trioxide	% 66	2.86	0.36	13	1.62	0.25	15
Sulfur Trioxide	% * 63	2.86	0.21	7.2	1.59	0.11	6.7
Loss on Ignition	% 75	0.34	0.07	21	0.34	0.09	26
Loss on Ignition	% * 73	0.34	0.07	21	0.33	0.07	21
Sodium Oxide	% 58	2.14	0.26	12	1.62	0.22	14
Sodium Oxide	% * 54	2.19	0.18	8.4	1.64	0.12	7.3
Potassium Oxide	% 60	0.35	0.06	16	0.51	0.05	10
Potassium Oxide	% * 55	0.34	0.02	5.4	0.51	0.02	4.3
Available Na <sub>2</sub> O	% 25	1.36	0.45	33	1.13	0.38	33
Available K <sub>2</sub> O	% 25	0.20	0.15	57	0.38	0.17	45
Available K <sub>2</sub> O	% * 23	0.22	0.05	21	0.35	0.10	28
Available Alkali	% 22	1.54	0.40	26	1.36	0.37	27
Available Alkali	% * 21	1.60	0.29	18	1.41	0.29	20

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

Magnesium Oxide	23 20 22 126 2476
Sulfur Trioxide	23 40 53
Loss on Ignition	958 3365
Sodium Oxide	23 24 53 125
Potassium Oxide	23 24 125 126 176
Available Potassium	24 52
Available Alkali	50

**CCRL Proficiency Sample Program  
Moisture Content  
POZZOLAN Samples No. 47 and No. 48**

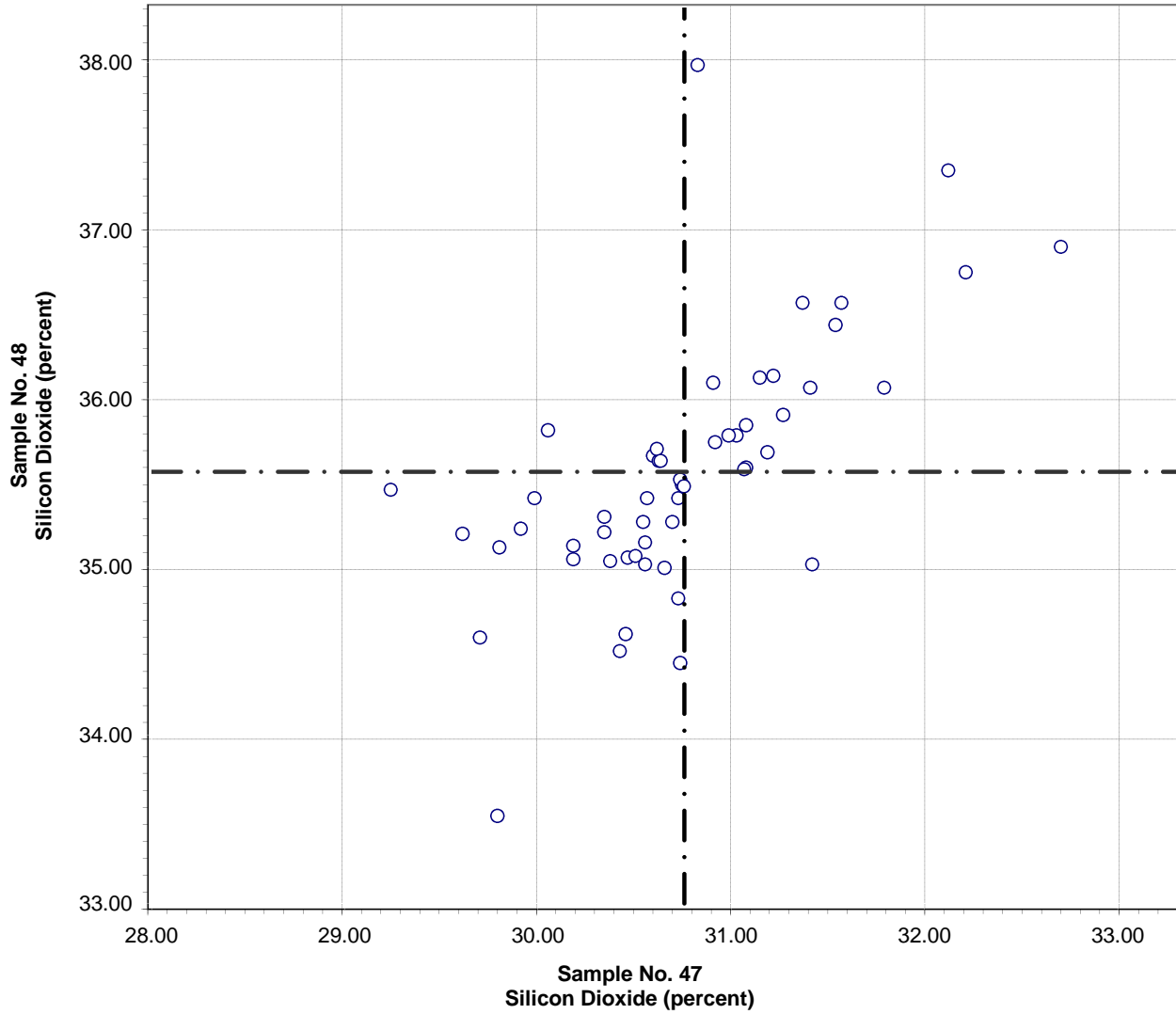


**Test No. 5      Moisture Content      66 Points**

Sample No. 47	Ave 0.07	S.D. 0.04	C.V. 50
Sample No. 48	Ave 0.06	S.D. 0.04	C.V. 59

Labs eliminated: 207, 605, 2476

**CCRL Proficiency Sample Program  
Silicon Dioxide  
POZZOLAN Samples No. 47 and No. 48**



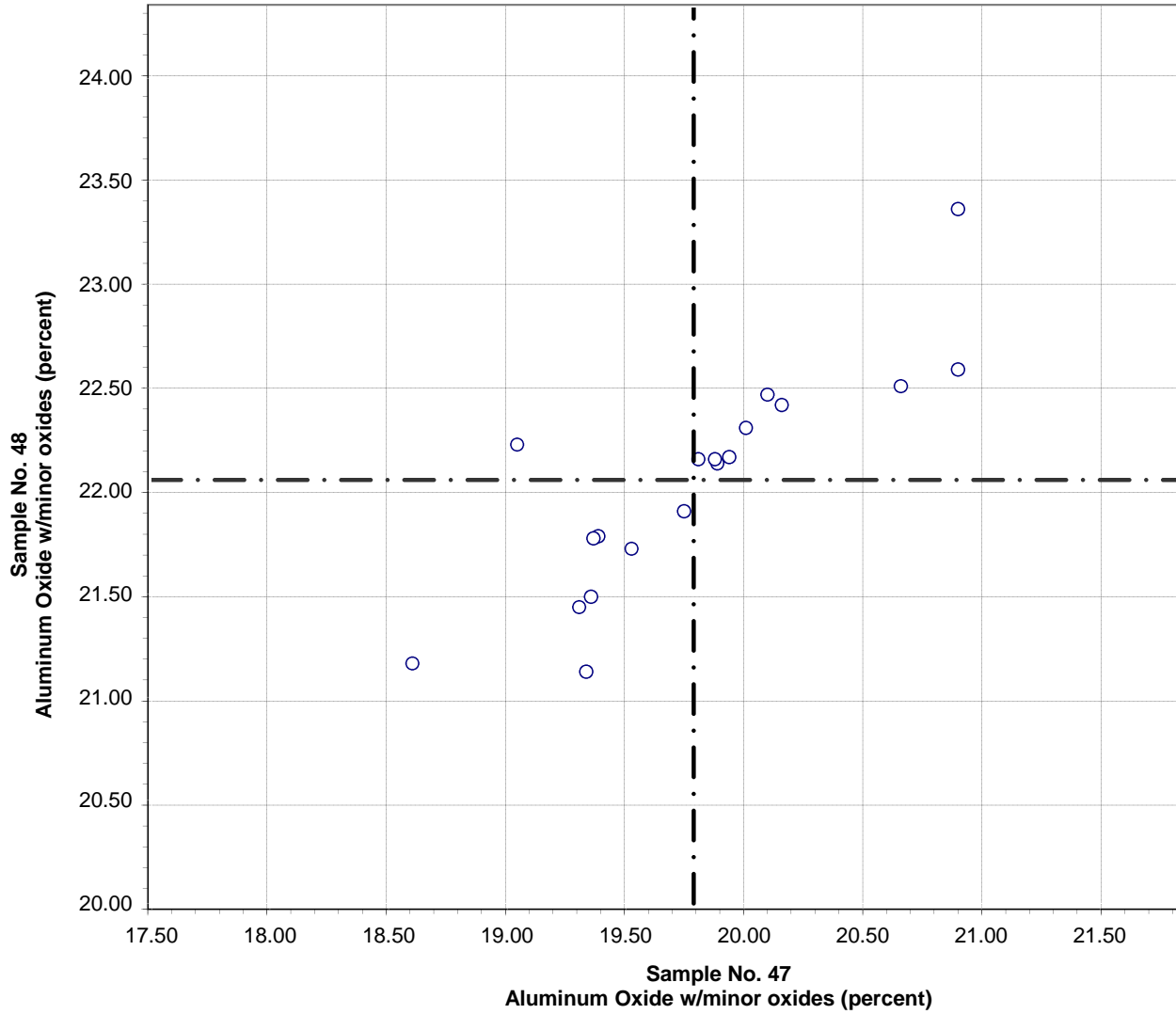
**Test No. 10      Silicon Dioxide      54 Points**

Sample No. 47	Ave 30.76	S.D. 0.65	C.V. 2.1
Sample No. 48	Ave 35.57	S.D. 0.74	C.V. 2.1

Labs eliminated: 20, 23, 24, 52, 58, 125



**CCRL Proficiency Sample Program  
Aluminum Oxide (minor oxides included)  
POZZOLAN Samples No. 47 and No. 48**

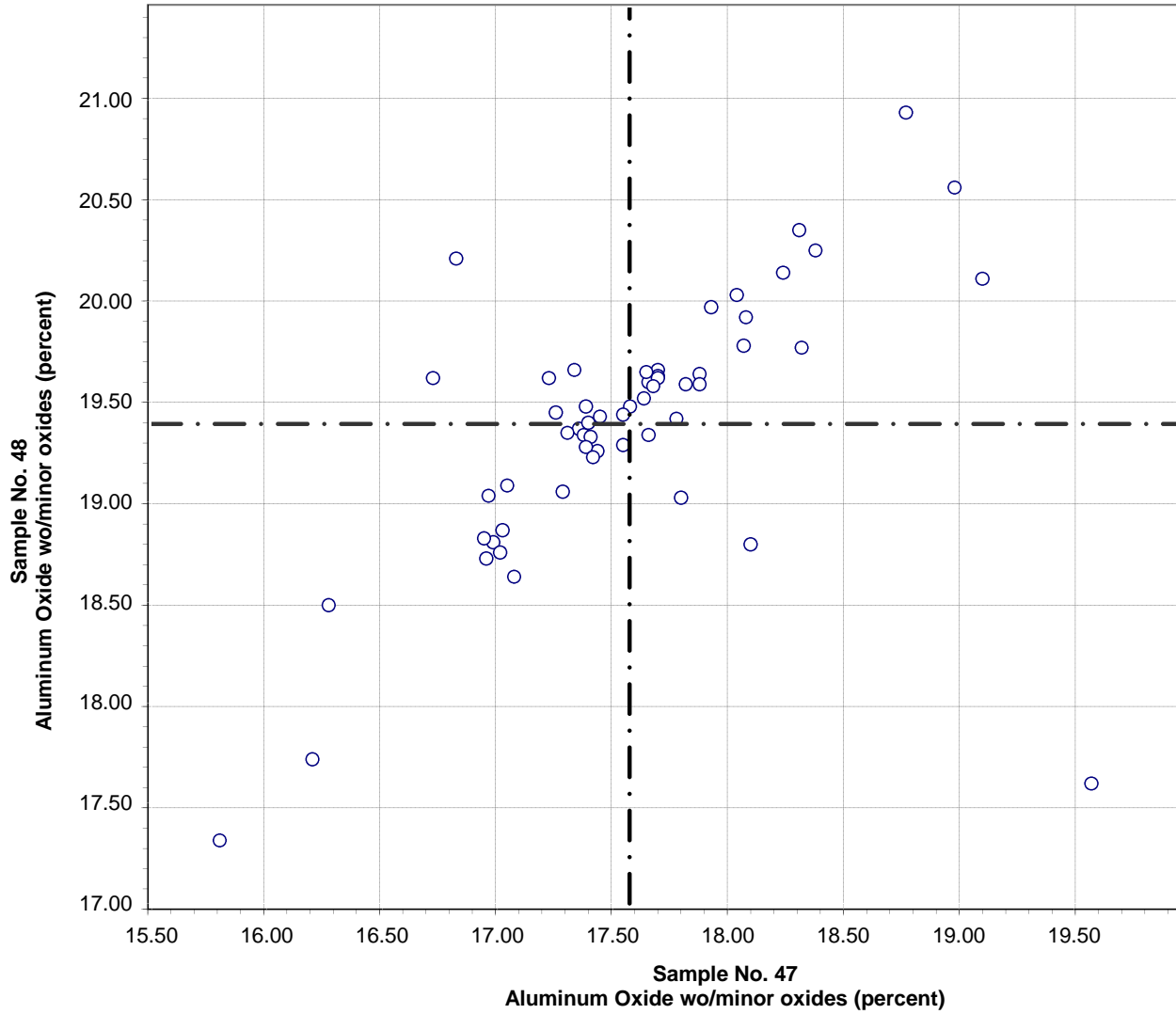


**Test No. 20    Aluminum Oxide (minor oxides included)    19 Points**

Sample No. 47	Ave 19.79	S.D. 0.60	C.V. 3.0
Sample No. 48	Ave 22.05	S.D. 0.54	C.V. 2.4

Labs eliminated: 1479

**CCRL Proficiency Sample Program  
Aluminum Oxide (minor oxides excluded)  
POZZOLAN Samples No. 47 and No. 48**



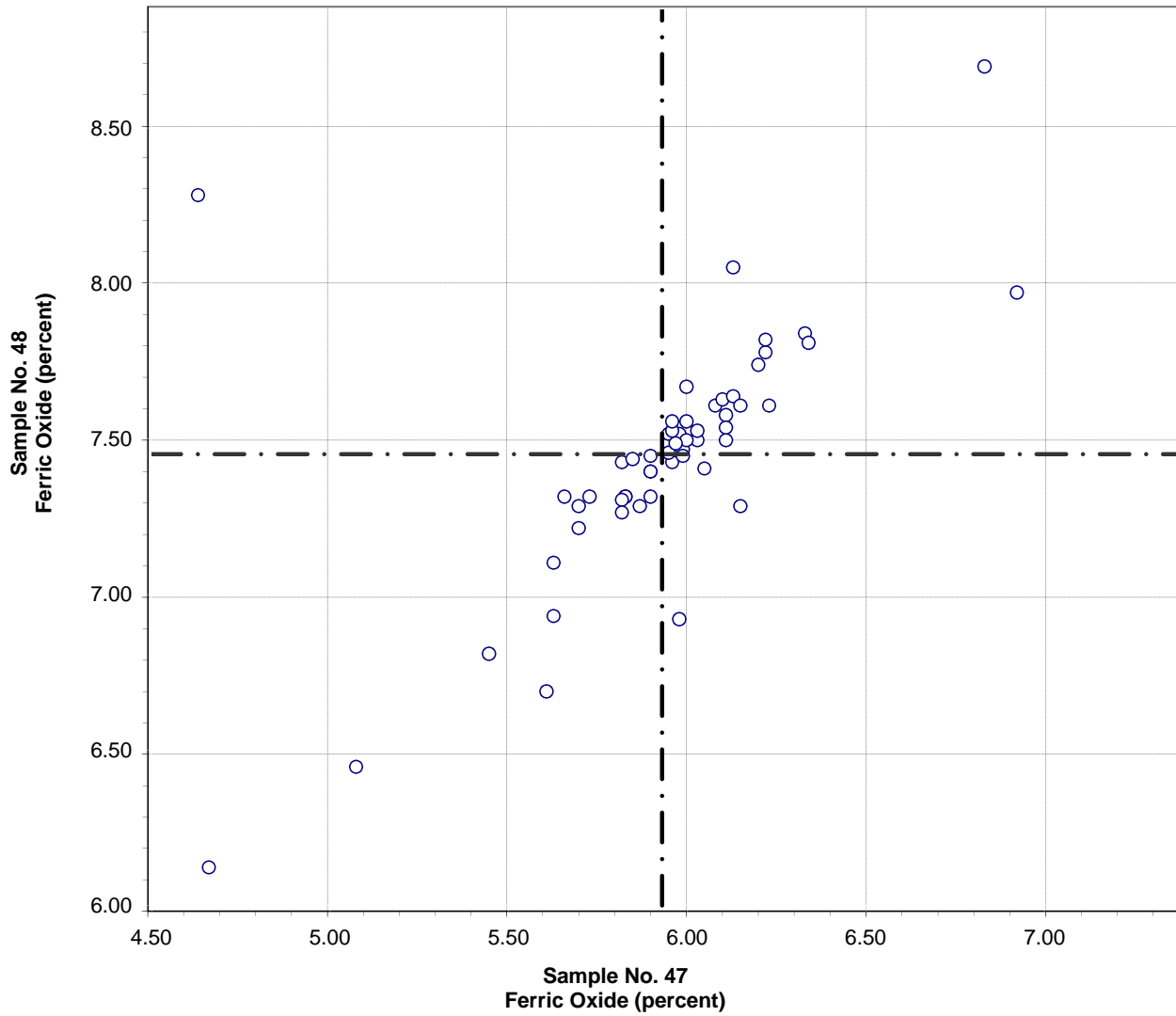
**Test No. 21    Aluminum Oxide (minor oxides excluded)    56 Points**

Sample No. 47    Ave 17.57    S.D. 0.67    C.V. 3.8

Sample No. 48    Ave 19.39    S.D. 0.65    C.V. 3.4

Labs eliminated: 52

**CCRL Proficiency Sample Program  
 Ferric Oxide  
 POZZOLAN Samples No. 47 and No. 48**



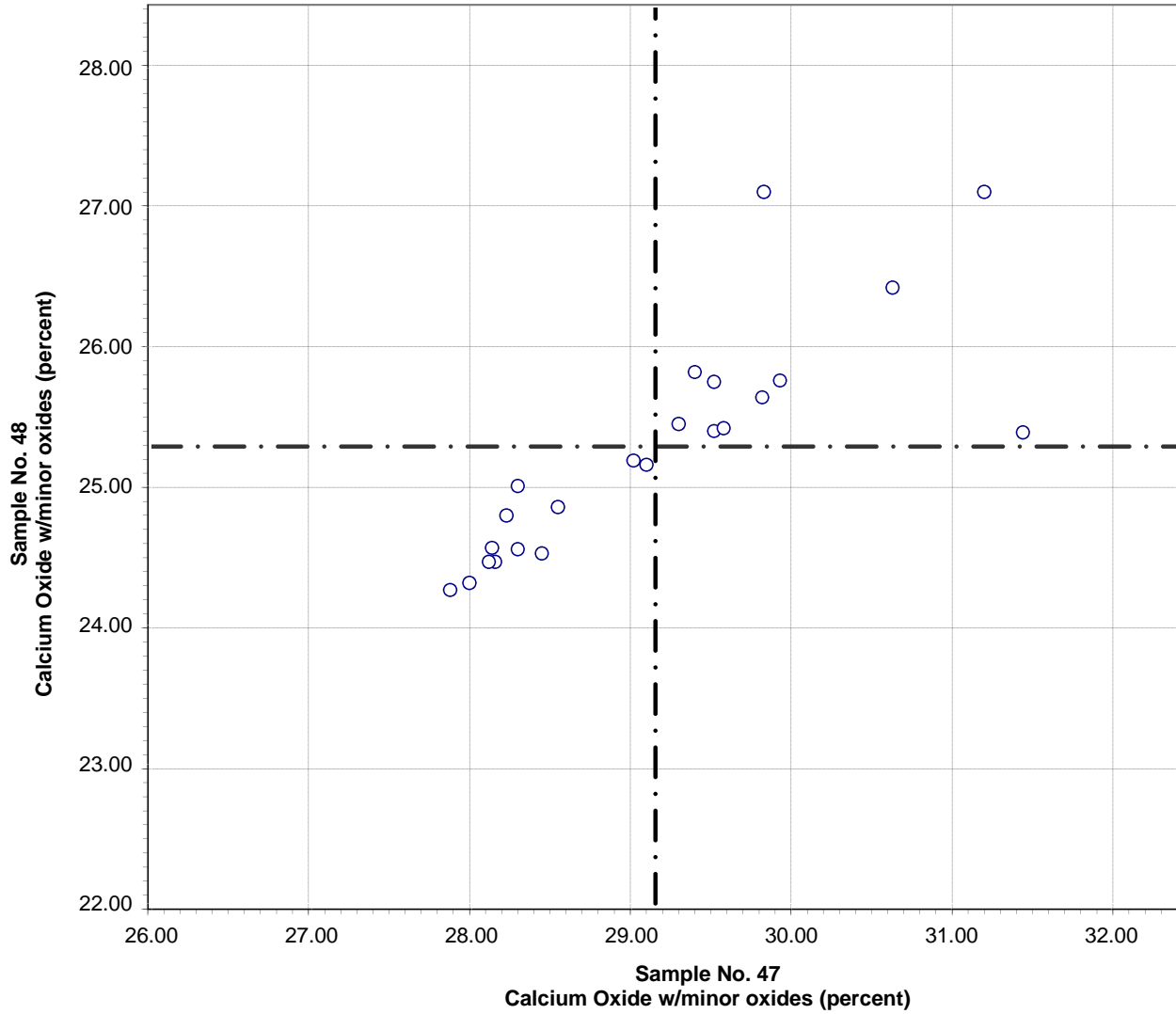
**Test No. 30    Ferric Oxide    55 Points**

Sample No. 47    Ave 5.93    S.D. 0.38    C.V. 6.3

Sample No. 48    Ave 7.45    S.D. 0.39    C.V. 5.3

Labs eliminated: 15, 23, 52, 176

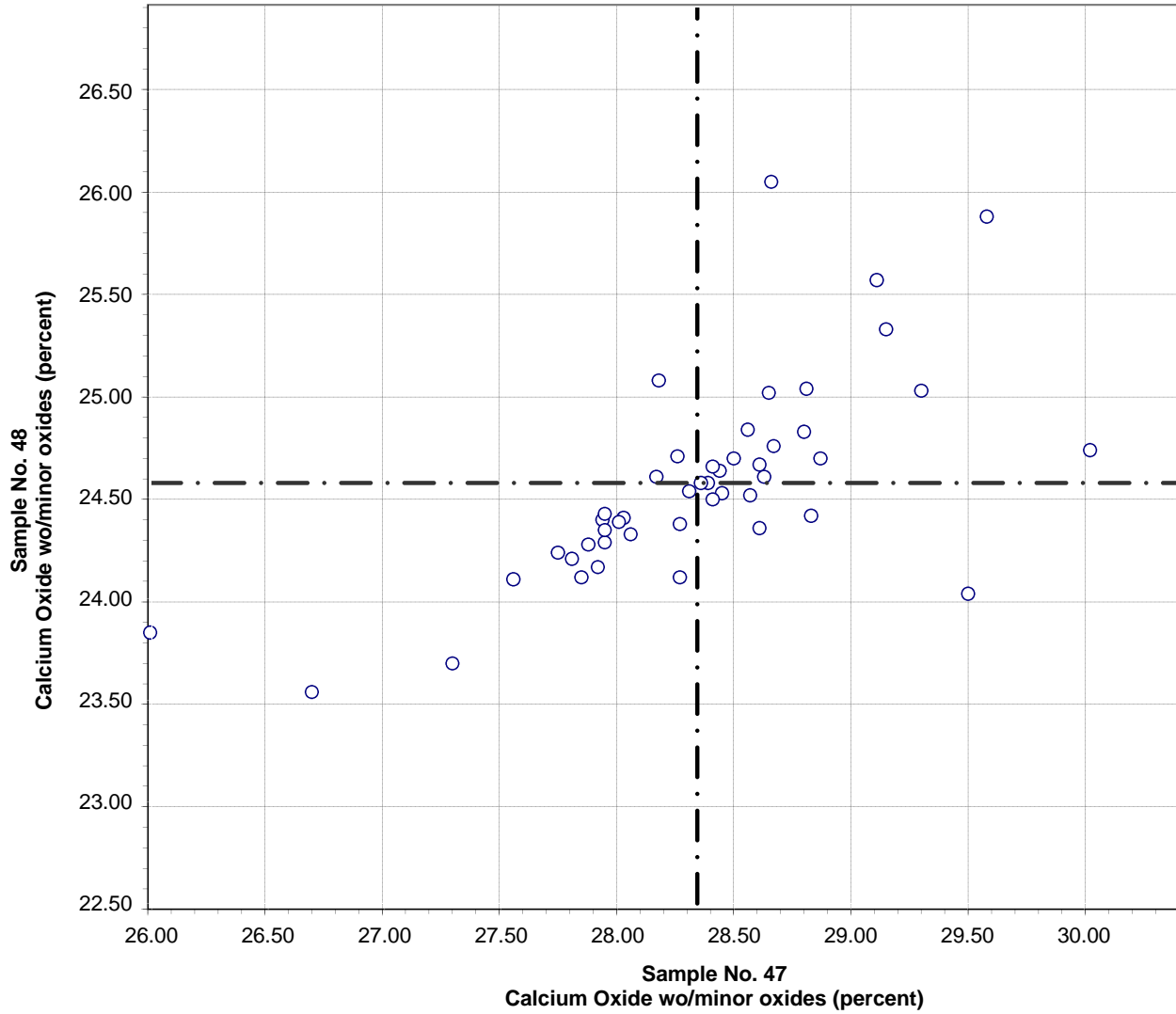
**CCRL Proficiency Sample Program  
 Calcium Oxide (minor oxides included)  
 POZZOLAN Samples No. 47 and No. 48**



**Test No. 40    Calcium Oxide (minor oxides included)    23 Points**

Sample No. 47	Ave 29.15	S.D. 1.02	C.V. 3.5
Sample No. 48	Ave 25.28	S.D. 0.80	C.V. 3.2

**CCRL Proficiency Sample Program  
 Calcium Oxide (minor oxides excluded)  
 POZZOLAN Samples No. 47 and No. 48**

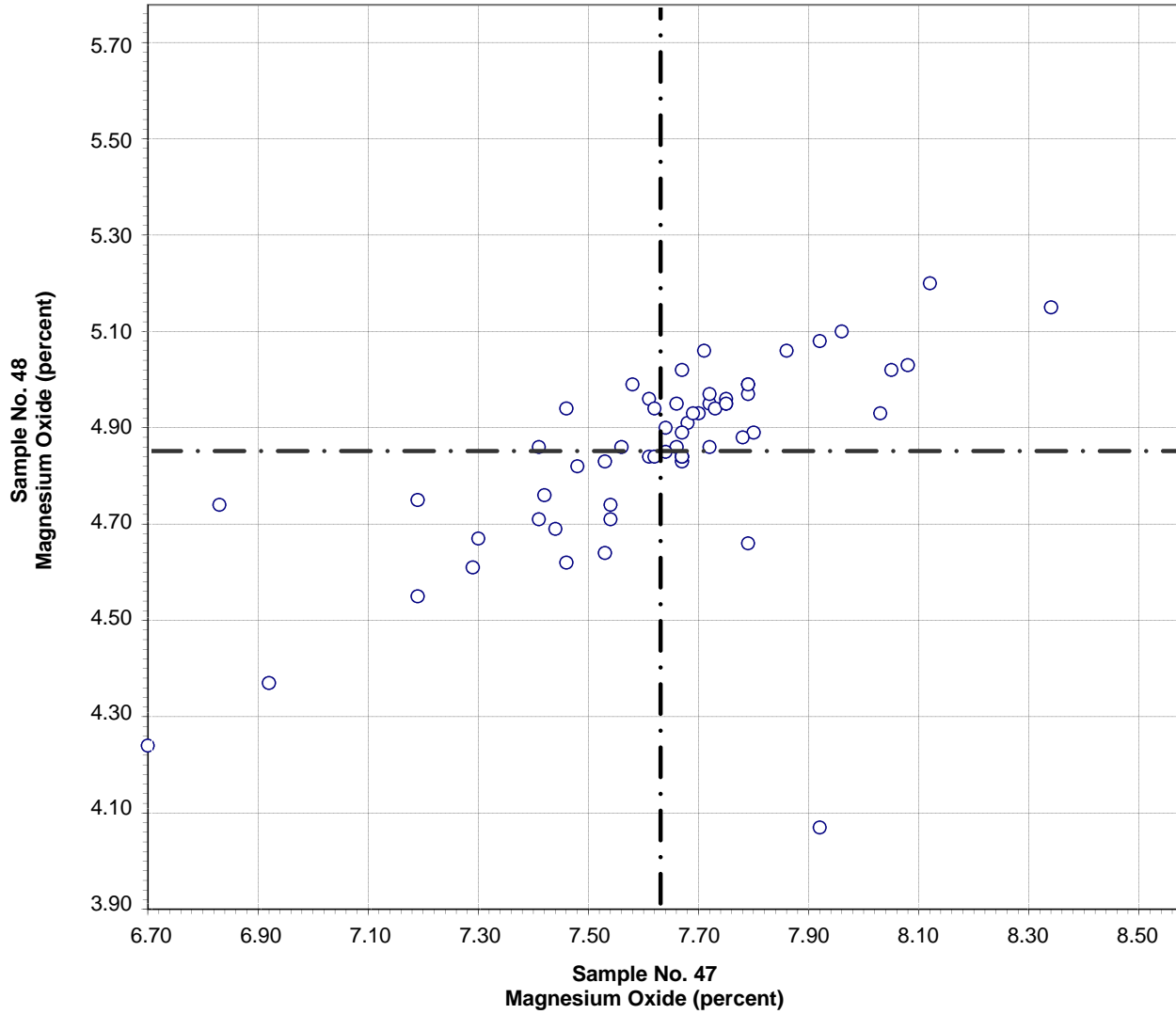


**Test No. 42    Calcium Oxide (minor oxides excluded)    47 Points**

Sample No. 47    Ave 28.34    S.D. 0.68    C.V. 2.4  
 Sample No. 48    Ave 24.57    S.D. 0.48    C.V. 2.0

Labs eliminated: 23, 52, 125, 2150

**CCRL Proficiency Sample Program  
Magnesium Oxide  
POZZOLAN Samples No. 47 and No. 48**



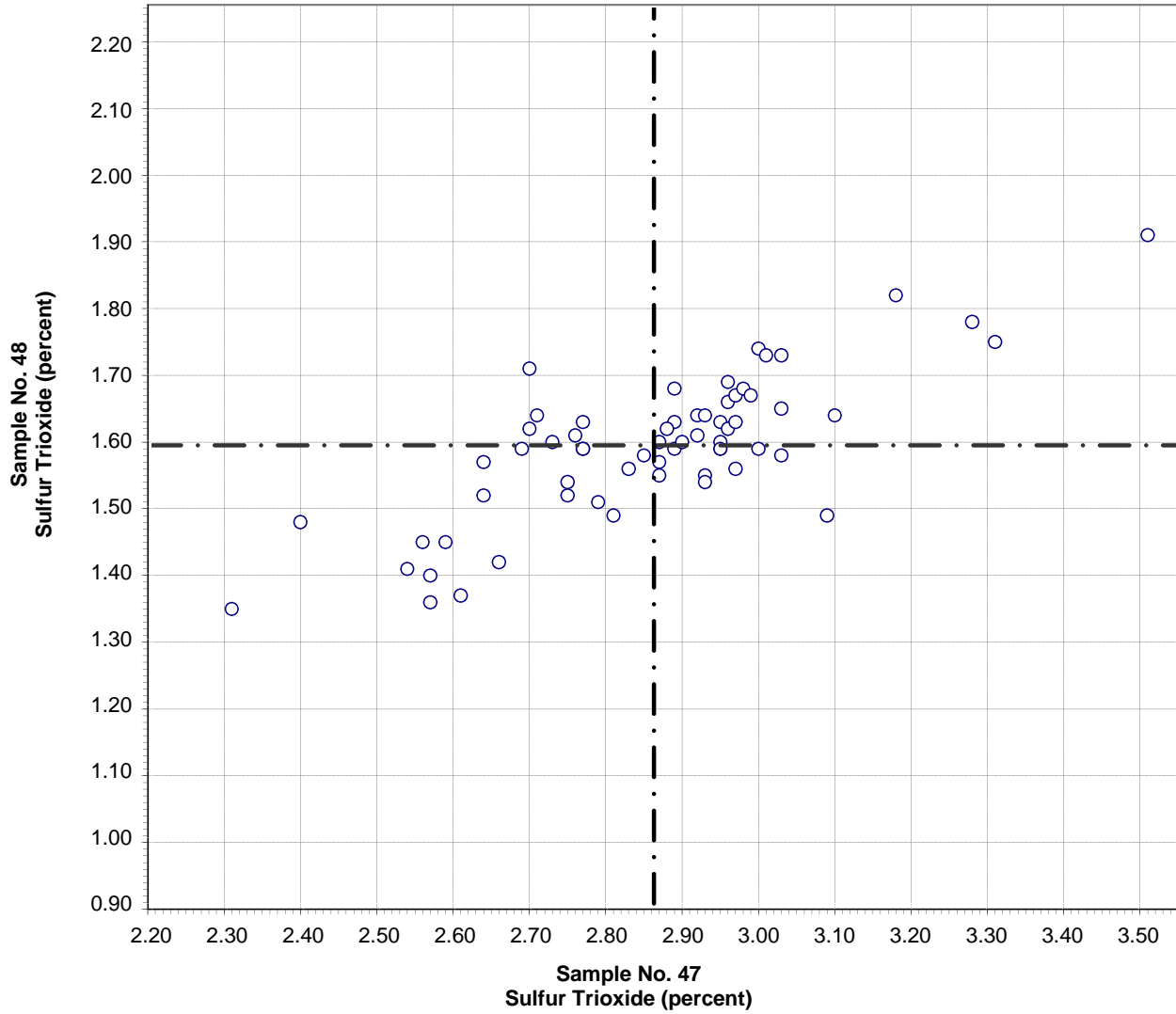
**Test No. 50    Magnesium Oxide    59 Points**

Sample No. 47    Ave 7.63    S.D. 0.29    C.V. 3.8

Sample No. 48    Ave 4.85    S.D. 0.20    C.V. 4.1

Labs eliminated: 23, 20, 22, 126, 2476

**CCRL Proficiency Sample Program  
Sulfur Trioxide  
POZZOLAN Samples No. 47 and No. 48**



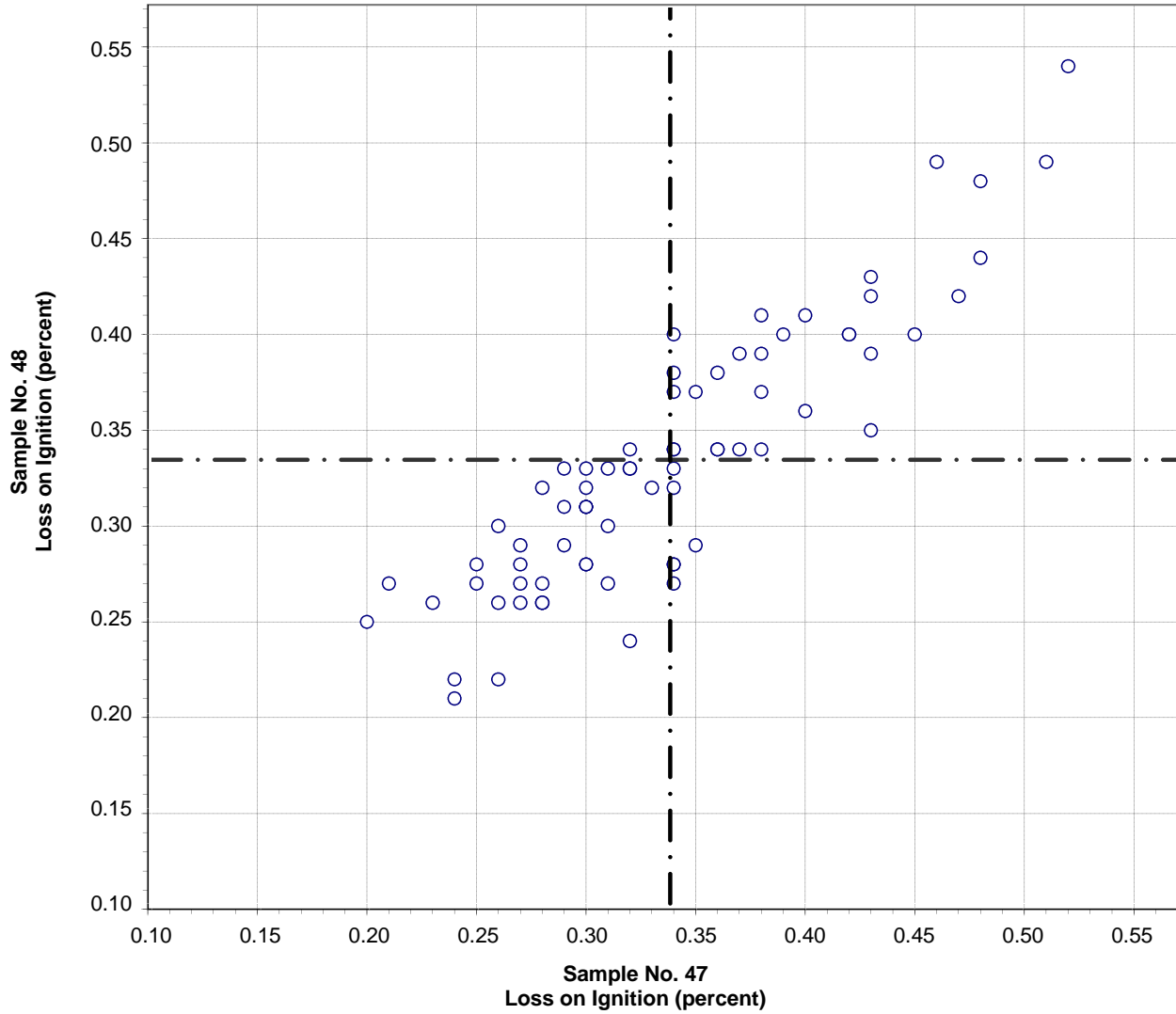
**Test No. 60    Sulfur Trioxide    63 Points**

Sample No. 47    Ave 2.86    S.D. 0.21    C.V. 7.2

Sample No. 48    Ave 1.59    S.D. 0.11    C.V. 6.7

Labs eliminated: 23, 40, 53

**CCRL Proficiency Sample Program  
Loss on Ignition  
POZZOLAN Samples No. 47 and No. 48**



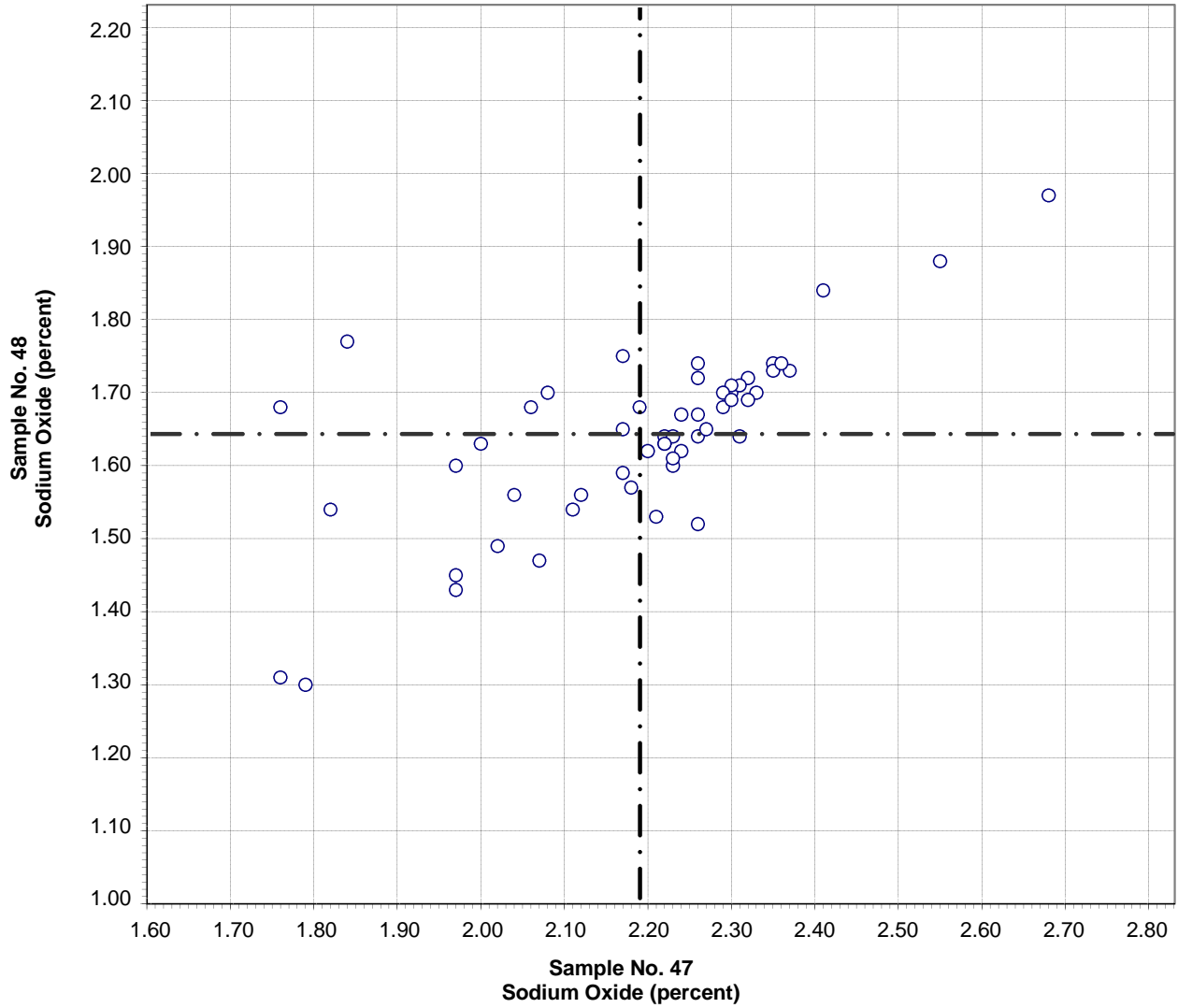
**Test No. 70    Loss on Ignition    73 Points**

Sample No. 47	Ave 0.34	S.D. 0.07	C.V. 21
Sample No. 48	Ave 0.33	S.D. 0.07	C.V. 21

Labs eliminated: 958, 3365



**CCRL Proficiency Sample Program  
Sodium Oxide  
POZZOLAN Samples No. 47 and No. 48**



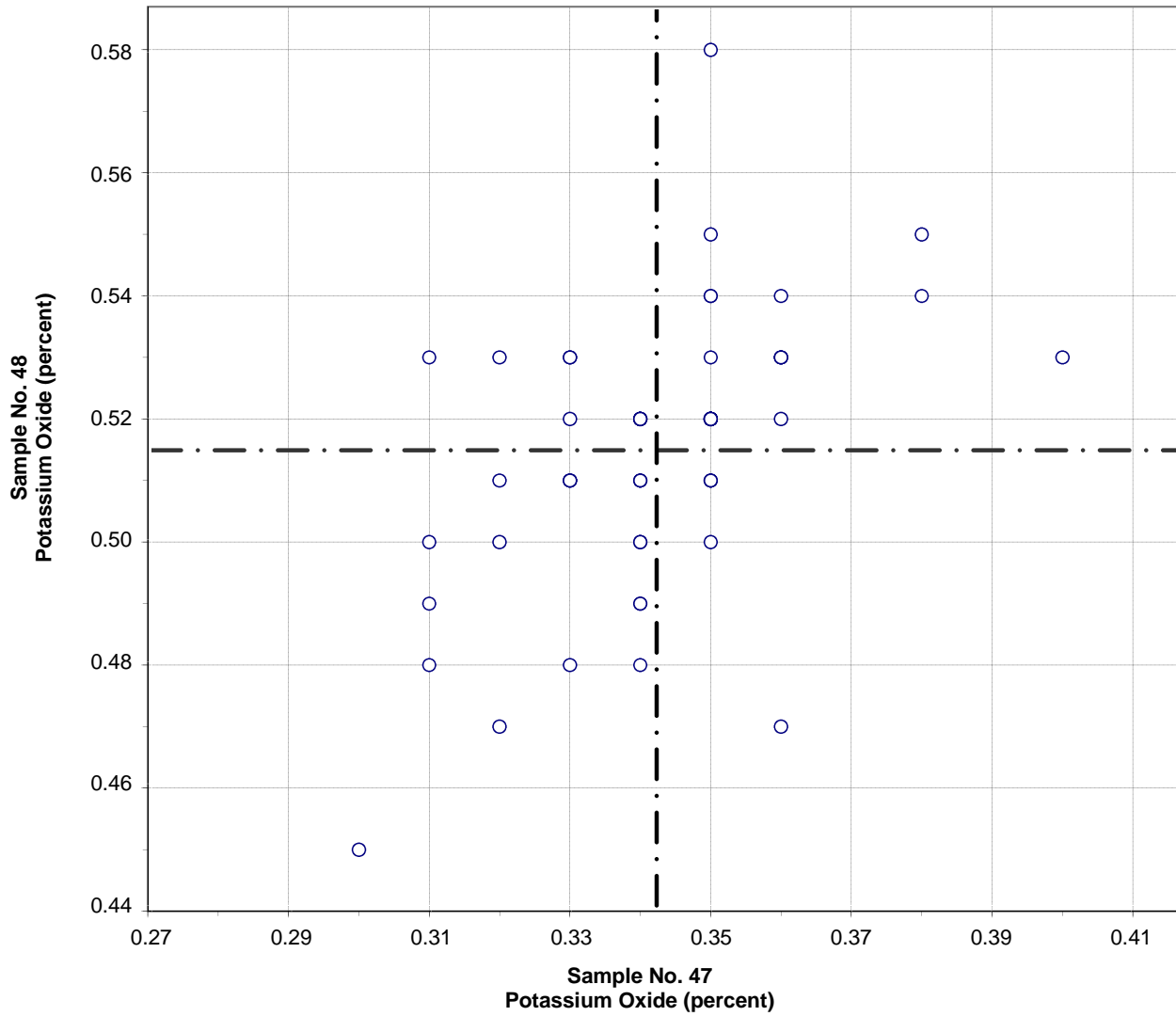
**Test No. 90    Sodium Oxide    54 Points**

Sample No. 47    Ave 2.19    S.D. 0.18    C.V. 8.4

Sample No. 48    Ave 1.64    S.D. 0.12    C.V. 7.3

Labs eliminated: 23, 24, 53, 125

**CCRL Proficiency Sample Program  
Potassium Oxide  
POZZOLAN Samples No. 47 and No. 48**



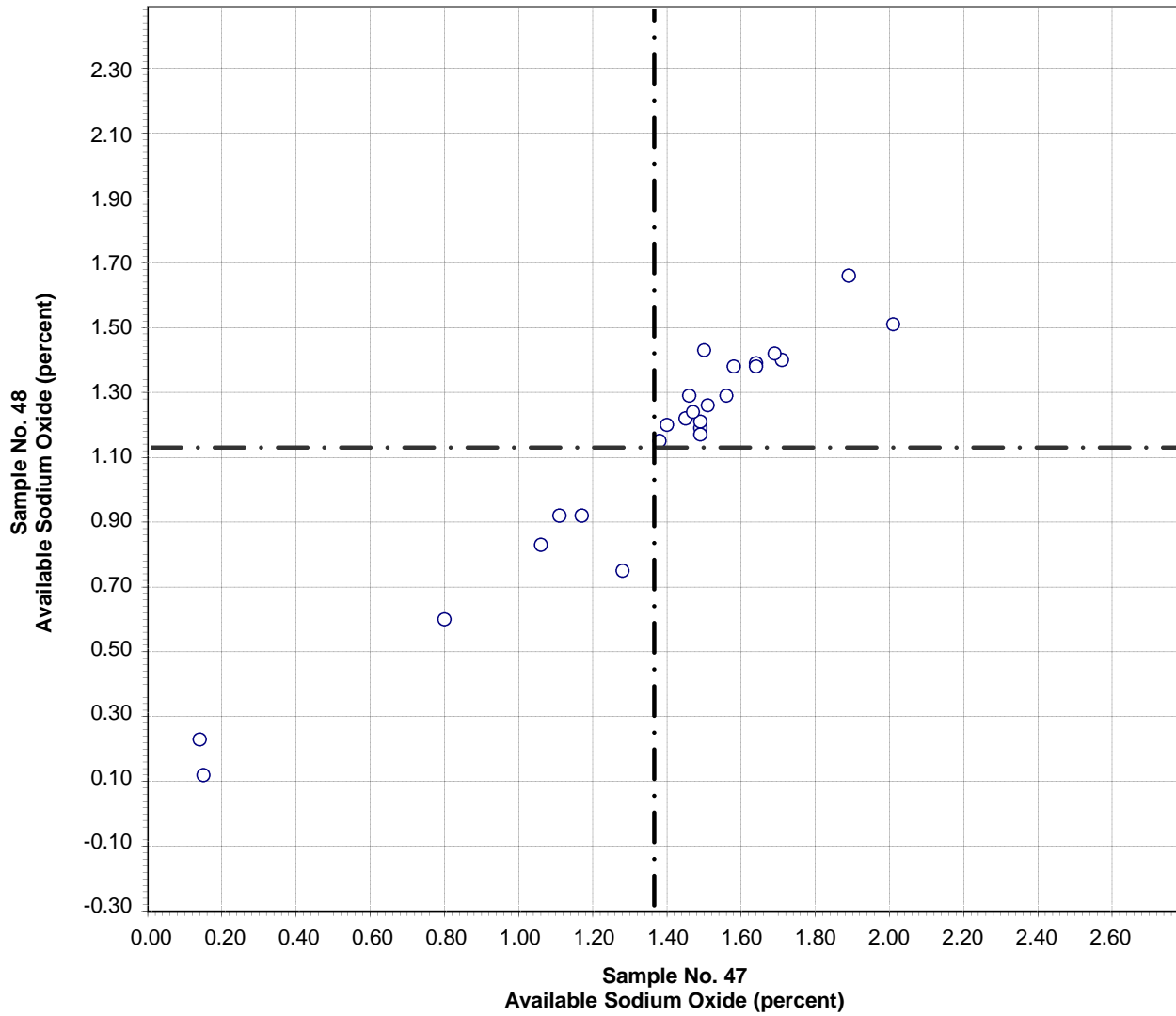
**Test No. 100 Potassium Oxide 55 Points**

Sample No. 47 Ave 0.34 S.D. 0.02 C.V. 5.4

Sample No. 48 Ave 0.51 S.D. 0.02 C.V. 4.3

Labs eliminated: 23, 24, 125, 126, 176

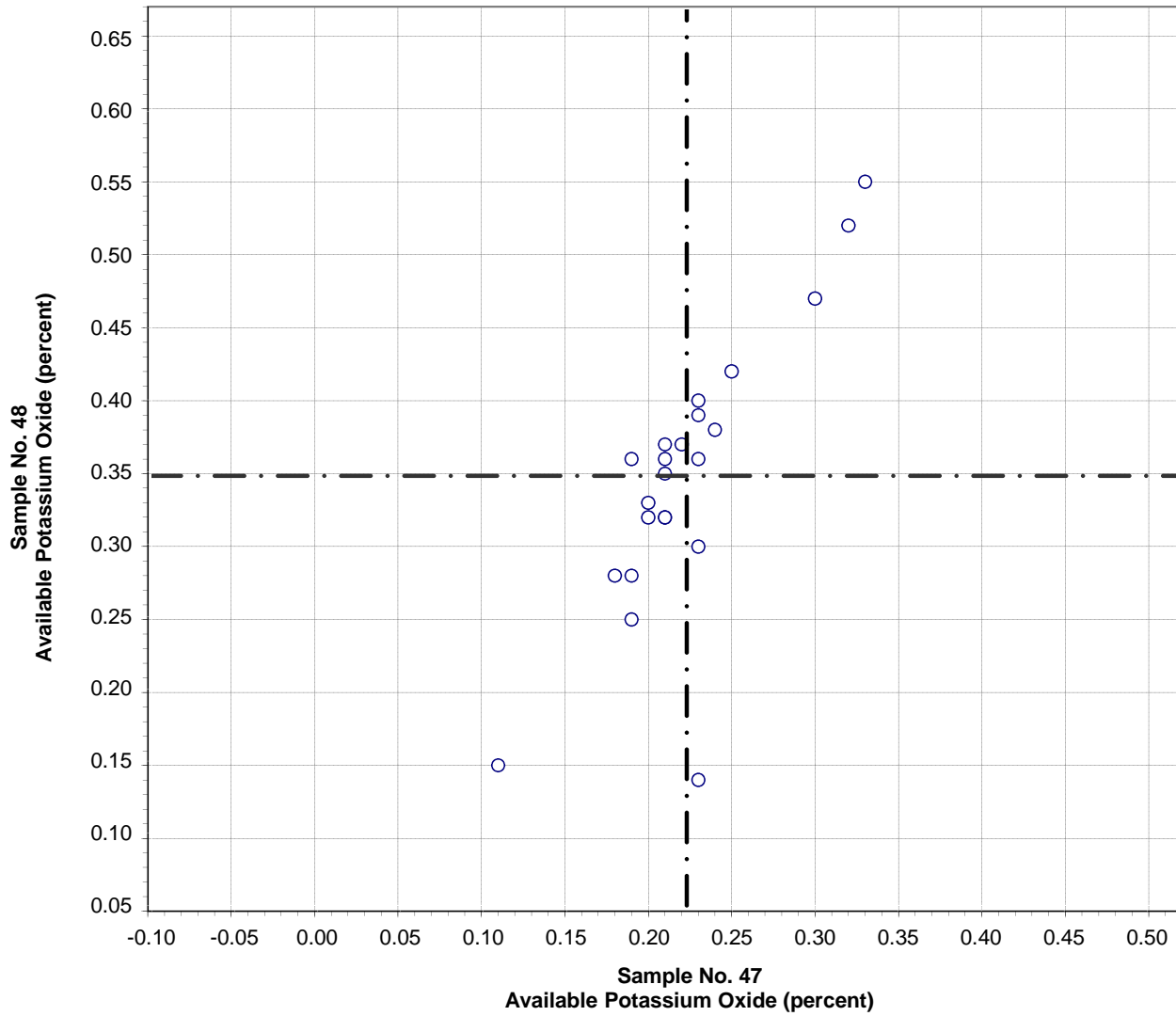
**CCRL Proficiency Sample Program  
Available Sodium Oxide  
POZZOLAN Samples No. 47 and No. 48**



**Test No. 91    Available Sodium Oxide    25 Points**

Sample No. 47	Ave 1.36	S.D. 0.45	C.V. 33
Sample No. 48	Ave 1.13	S.D. 0.38	C.V. 33

**CCRL Proficiency Sample Program**  
**Available Potassium Oxide**  
**POZZOLAN Samples No. 47 and No. 48**

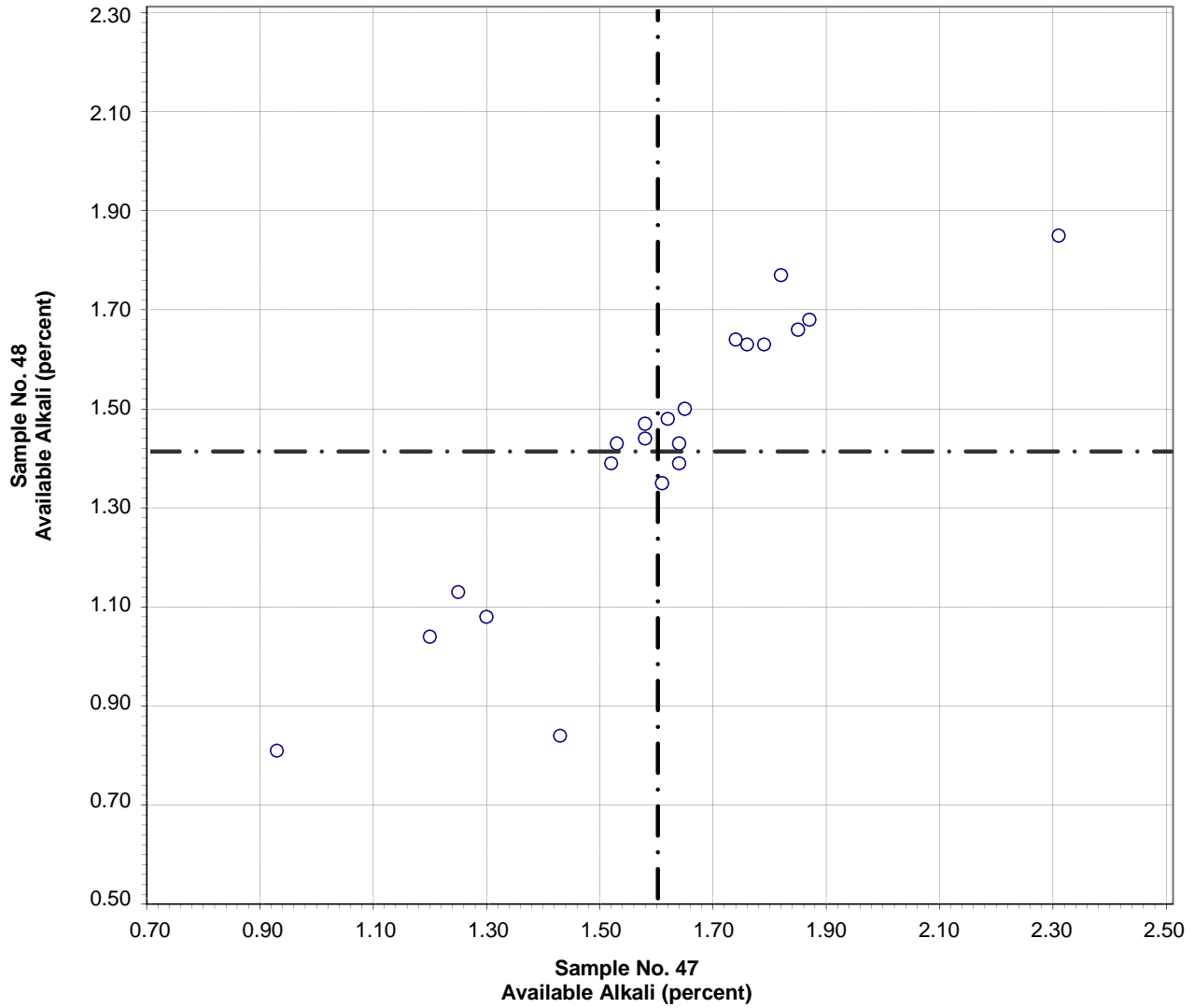


Test No. 93    Available Potassium Oxide    23 Points

Sample No. 47	Ave 0.22	S.D. 0.05	C.V. 21
Sample No. 48	Ave 0.35	S.D. 0.10	C.V. 28

Labs eliminated: 24, 52

**CCRL Proficiency Sample Program  
Available Alkali  
POZZOLAN Samples No. 47 and No. 48**



**Test No. 95    Available Alkali    21 Points**

Sample No. 47	Ave 1.60	S.D. 0.29	C.V. 18
Sample No. 48	Ave 1.41	S.D. 0.29	C.V. 20

Labs eliminated: 50

CCRL PROFICIENCY SAMPLE PROGRAM  
Pozzolan Proficiency Sample No. 47 and No. 48  
Final Report - Physical Results  
October 15, 2010

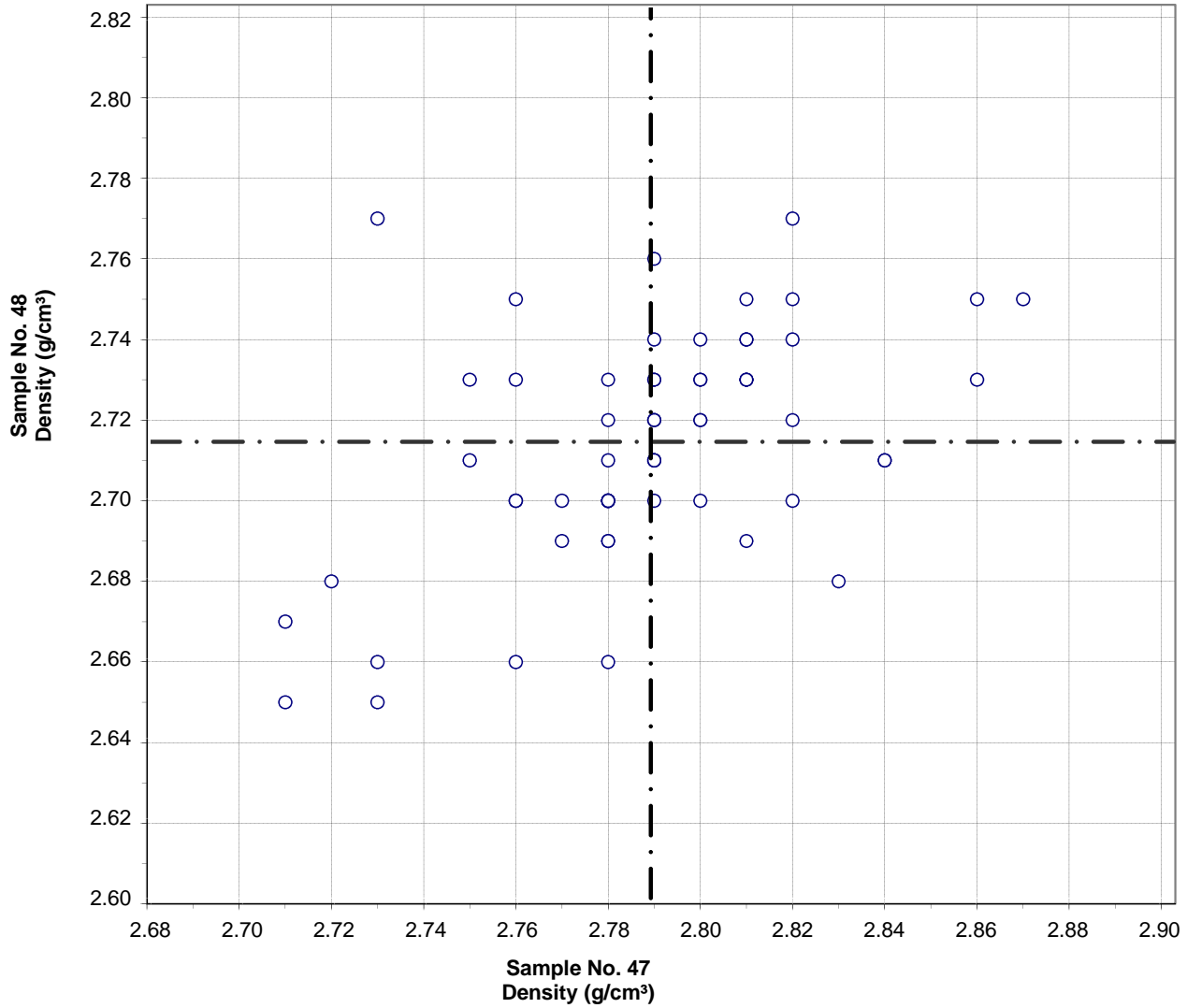
SUMMARY OF RESULTS

Test		#Labs	Sample No. 47			Sample No. 48		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Density	g/cm <sup>3</sup>	66	2.79	0.05	1.7	2.71	0.04	1.4
Density	g/cm <sup>3</sup>	* 63	2.79	0.03	1.2	2.71	0.03	1.0
45µm Sieve	%	78	13.82	2.00	15	9.94	1.20	12
45µm Sieve	%	* 76	14.08	1.20	8.6	10.03	0.90	9.0
Drying Shrinkage	%	17	0.021	0.050	234	0.021	0.050	236
Drying Shrinkage	%	* 15	0.005	0.013	248	0.004	0.013	287
Autoclave Expan	%	60	0.12	0.07	62	0.05	0.04	71
Autoclave Expan	%	* 55	0.13	0.02	16	0.05	0.02	31
N.C. Water	%	62	23.4	2.3	9.8	23.5	1.8	7.6
N.C. Water	%	* 59	23.8	0.3	1.3	23.7	0.3	1.4
Air Entrainment	%	9	0.018	0.007	40	0.022	0.007	29
<b>STRENGTH ACTIVITY INDEX (SAI) WITH PORTLAND CEMENT</b>								
SAI 7 day	%	70	99	4.5	4.6	100	5.8	5.8
SAI 7 day	%	* 69	98	3.8	3.8	100	4.9	5.0
SAI 28 day	%	61	100	5.4	5.4	106	4.8	4.6
SAI 28 day	%	* 59	100	4.1	4.1	106	4.3	4.0
SAI Water	%	69	93	13	14	92	13	14
SAI Water	%	* 67	95	2.1	2.2	94	2.0	2.1
<b>EFFECTIVENESS OF MINERAL ADMIXTURES IN CONTROLLING ALKALI-SILICA REACTIONS (ASR)</b>								
Reduction Expansion	%	11	11	18	168	25	14	55

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

Density	26 116 1435
Fineness - 45µm	176 605
Drying Shrinkage	2522 2621
Autoclave Expansion	2 36 26 605 3365
N. C. Water	565 958 1038
SAI 7 day	4
SAI 28 day	26 37
SAI Water Requirement	1435 2295

**CCRL Proficiency Sample Program  
Density  
POZZOLAN Samples No. 47 and No. 48**

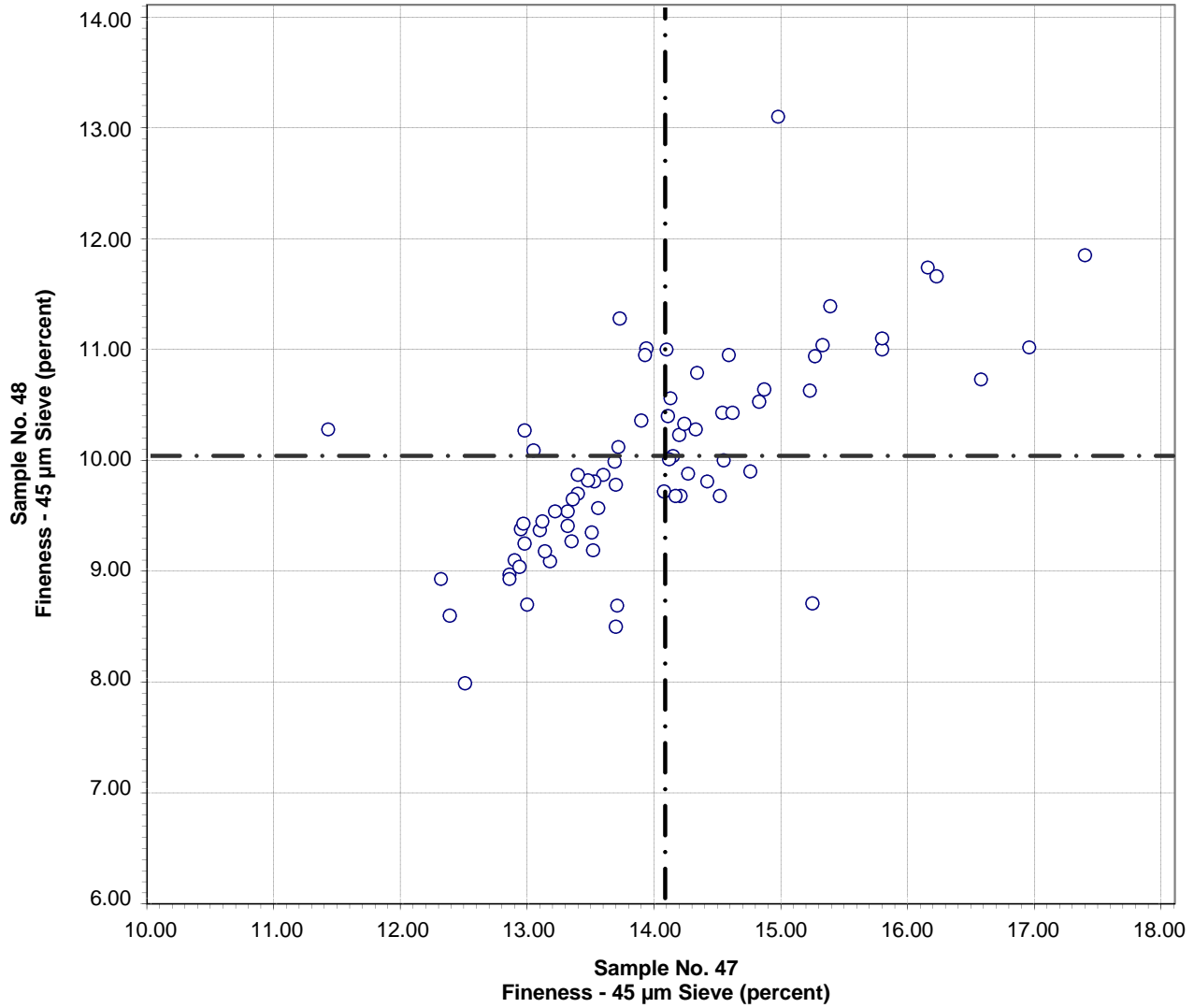


**Test No. 310      Density      63 Points**

Sample No. 47	Ave 2.79	S.D. 0.03	C.V. 1.2
Sample No. 48	Ave 2.71	S.D. 0.03	C.V. 1.0

Labs eliminated: 26, 116, 1435

**CCRL Proficiency Sample Program  
 Fineness - 45  $\mu$ m Sieve Retained  
 POZZOLAN Samples No. 47 and No. 48**



**Test No. 281      Fineness - 45  $\mu$ m Sieve Retained      75 Points**

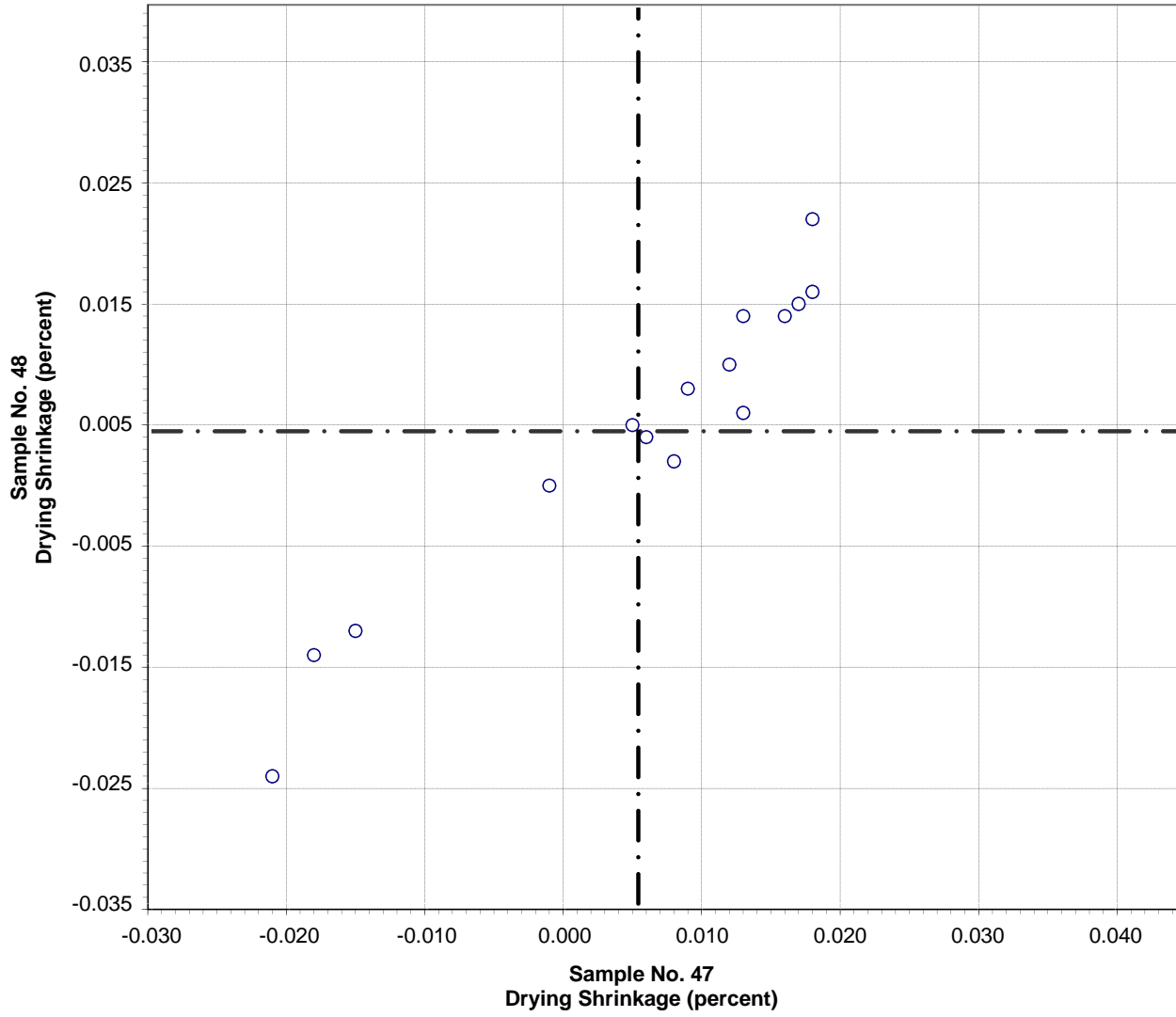
Sample No. 47    Ave 14.08    S.D. 1.20    C.V. 8.5  
 Sample No. 48    Ave 10.03    S.D. 0.90    C.V. 9.0

Labs eliminated: 176, 605

Labs off Diagram: 2476



**CCRL Proficiency Sample Program  
Drying Shrinkage  
POZZOLAN Samples No. 47 and No. 48**

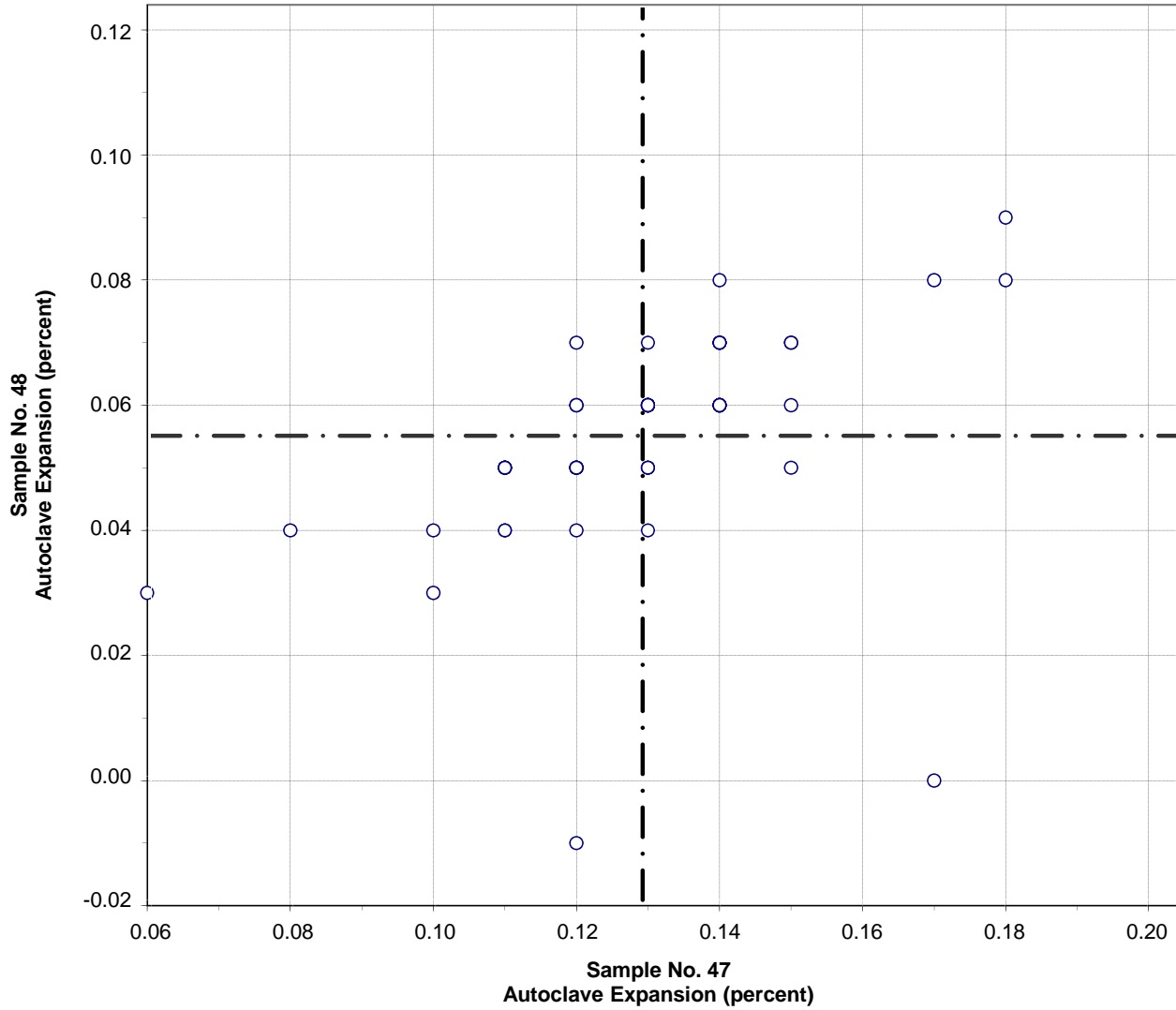


Test No. 340      Drying Shrinkage      15 Points

Sample No. 47	Ave 0.005	S.D. 0.013	C.V. 248
Sample No. 48	Ave 0.004	S.D. 0.013	C.V. 287

Labs eliminated: 2522, 2621

**CCRL Proficiency Sample Program  
Autoclave Expansion  
POZZOLAN Samples No. 47 and No. 48**

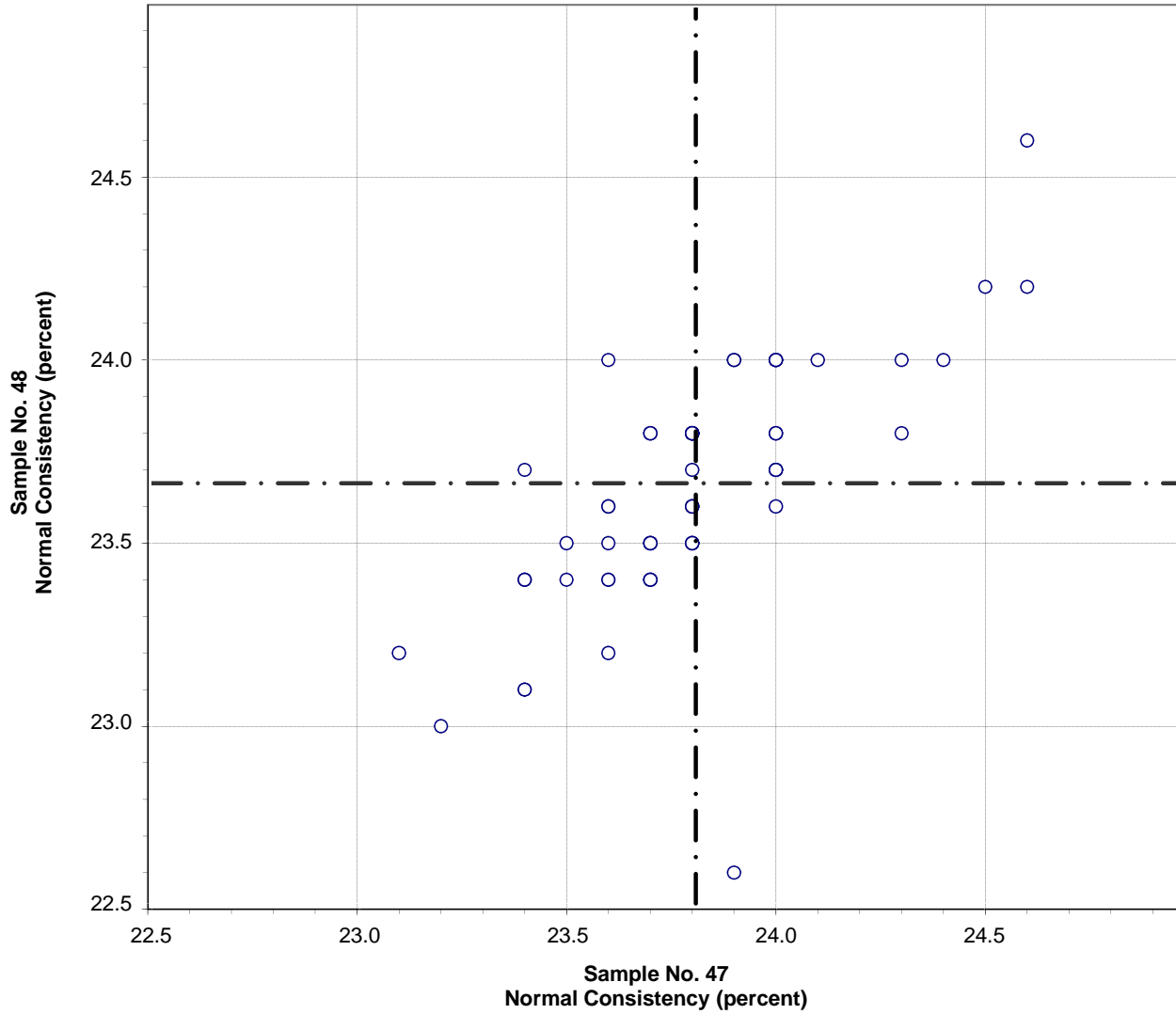


**Test No. 160      Autoclave Expansion      55 Points**

Sample No. 47	Ave 0.13	S.D. 0.02	C.V. 16
Sample No. 48	Ave 0.05	S.D. 0.02	C.V. 31

Labs eliminated: 2, 36, 26, 605, 3365

**CCRL Proficiency Sample Program  
Normal Consistency Water  
POZZOLAN Samples No. 47 and No. 48**



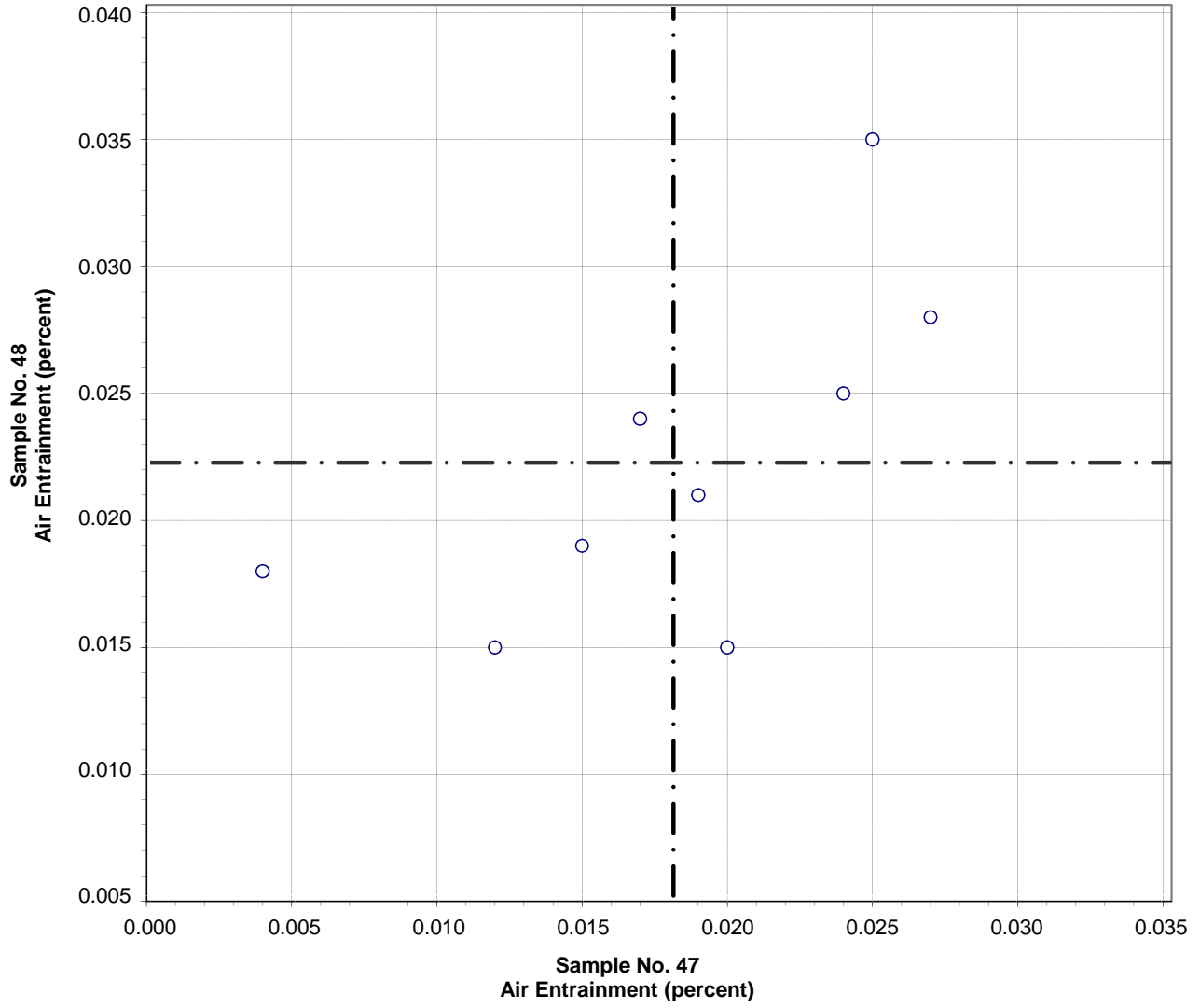
**Test No. 110      Normal Consistency Water      59 Points**

Sample No. 47    Ave 23.8    S.D. 0.3    C.V. 1.3

Sample No. 48    Ave 23.7    S.D. 0.3    C.V. 1.4

Labs eliminated: 565, 958, 1038

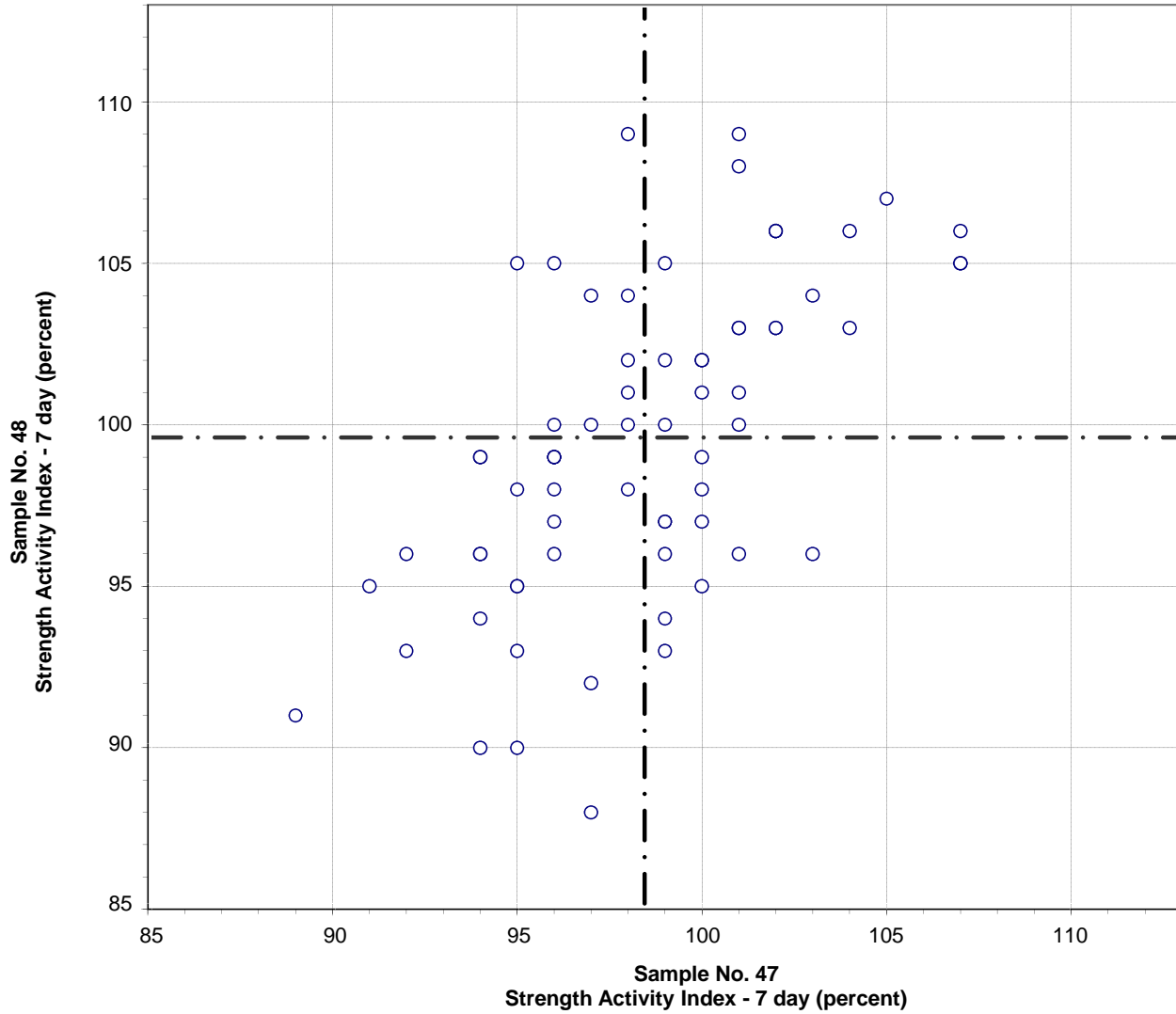
**CCRL Proficiency Sample Program  
Air Entrainment  
POZZOLAN Samples No. 47 and No. 48**



**Test No. 350      Air Entrainment      9 Points**

Sample No. 47	Ave 0.018	S.D. 0.007	C.V. 40
Sample No. 48	Ave 0.022	S.D. 0.007	C.V. 29

**CCRL Proficiency Sample Program  
Strength Activity Index - 7 day  
POZZOLAN Samples No. 47 and No. 48**

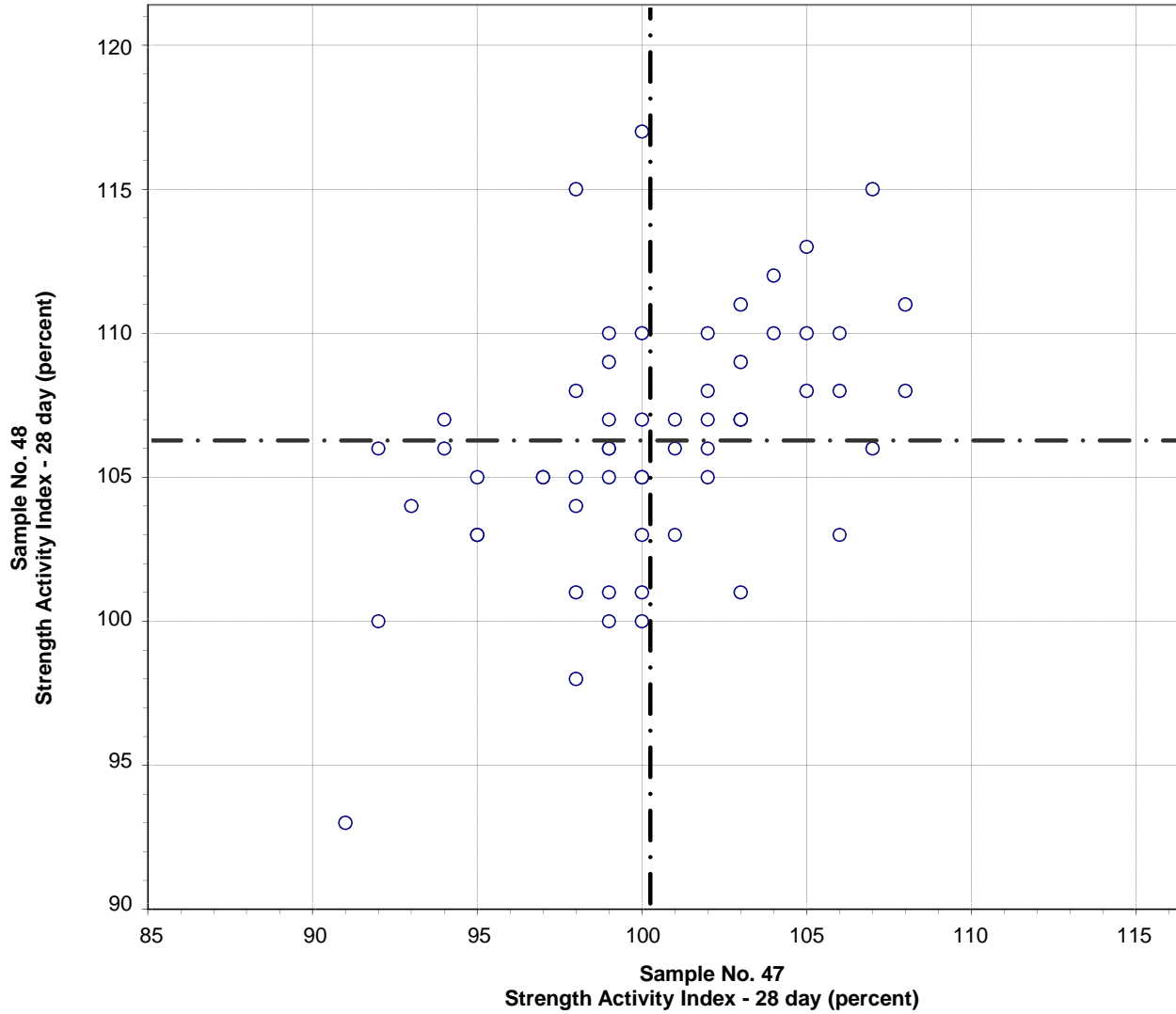


Test No. 359      Strength Activity Index - 7 day      69 Points

Sample No. 47    Ave 98    S.D. 3.8    C.V. 3.8  
 Sample No. 48    Ave 100    S.D. 4.9    C.V. 5.0

Labs eliminated: 4

**CCRL Proficiency Sample Program  
Strength Activity Index - 28 day  
POZZOLAN Samples No. 47 and No. 48**

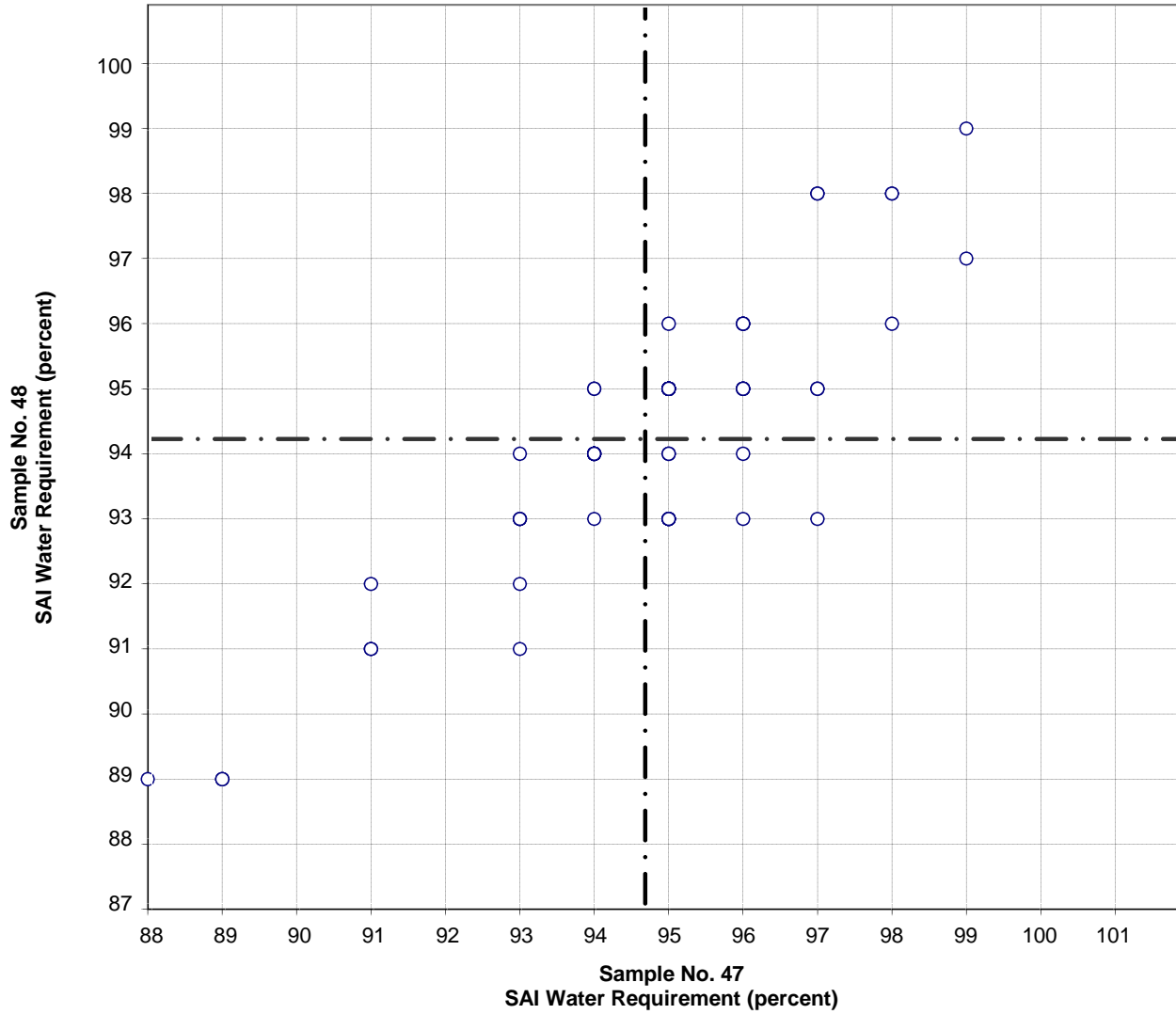


**Test No. 360      Strength Activity Index - 28 day      59 Points**

Sample No. 47    Ave 100    S.D. 4.1    C.V. 4.1  
 Sample No. 48    Ave 106    S.D. 4.3    C.V. 4.0

Labs eliminated: 26, 37

**CCRL Proficiency Sample Program  
SAI Water Requirement  
POZZOLAN Samples No. 47 and No. 48**

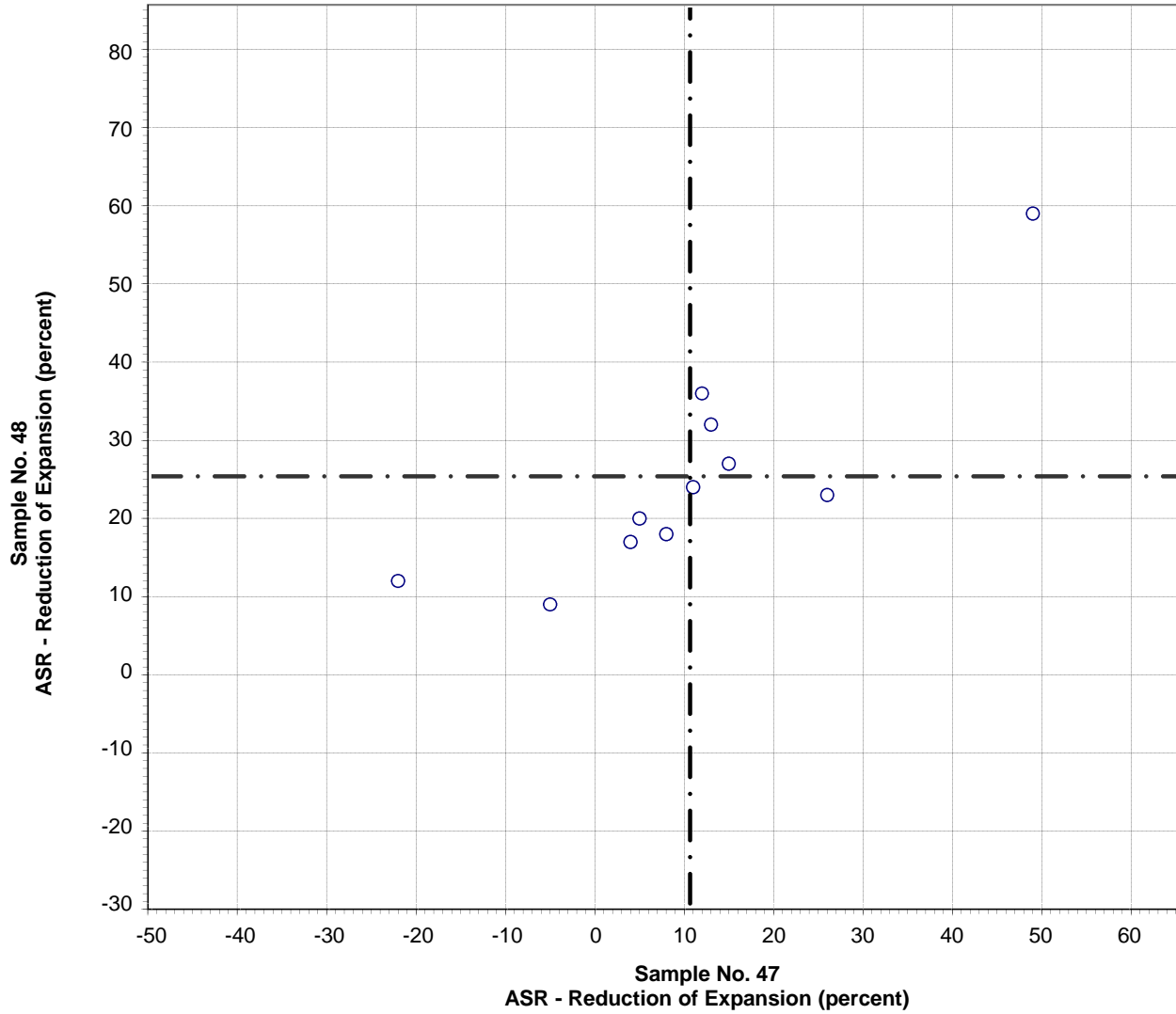


**Test No. 370      SAI Water Requirement      67 Points**

Sample No. 47	Ave 95	S.D. 2.1	C.V. 2.2
Sample No. 48	Ave 94	S.D. 2.0	C.V. 2.1

Labs eliminated: 1435, 2295

**CCRL Proficiency Sample Program  
Alkali-Silica Reaction - Reduction of Expansion  
POZZOLAN Samples No. 47 and No. 48**



Test No. 390      ASR - Reduction of Expansion      11 Points

Sample No. 47   Ave 11   S.D. 18   C.V. 168  
 Sample No. 48   Ave 25   S.D. 14   C.V. 55