

CEMENT AND CONCRETE REFERENCE LABORATORY
PROFICIENCY SAMPLE PROGRAM

Final Report
Pozzolan Proficiency Samples
Number 35 and Number 36

November 2004

CEMENT AND CONCRETE REFERENCE LABORATORY

AT THE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
GAITHERSBURG, MARYLAND 20899
(301) 975-6704

SPONSORED BY
COMMITTEE C-1 ON CEMENT
COMMITTEE C-9 ON CONCRETE AND
CONCRETE AGGREGATES
AMERICAN SOCIETY FOR TESTING AND MATERIALS

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November 24, 2004

To: Participants in the CCRL Pozzolan Proficiency Sample Program

SUBJECT: Pozzolan Proficiency Samples No. 35 and No. 36

Enclosed is your copy of the final report on the test results for the CCRL **Pozzolan** Proficiency Samples which were distributed in August 2004.

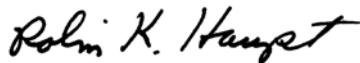
This report consists of a statistical Summary of Results, a set of general Scatter Diagrams, and associated detailed information. The Table of Results with test results and ratings for your laboratory can be downloaded at our website located at: <http://ccrl.us/psp/pspdata.htm>.

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 use.

Additional samples of these two cement 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 August 2005.

Sincerely,



Robin K. Haupt
Supervisor, Proficiency Sample Programs
Cement and Concrete Reference Laboratory
Materials and Construction Research Division
Building and Fire Research Laboratory

Enclosure

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. 35 and No. 36**

This letter, 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 August 2004. 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.

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. (See reverse for an explanation of the scatter diagrams.)

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. 33 and No. 34
 Final Report - Chemical Results
 November 24, 2004

SUMMARY OF RESULTS

Test		#Labs	Sample No. 35			Sample No. 36		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Moisture Content	prcnt	55	0.13	0.070	52.8	0.11	0.053	47.6
Moisture Content	prcnt *	53	0.12	0.046	37.4	0.10	0.041	39.1
Silicon Dioxide	prcnt	49	56.10	4.4	7.77	52.75	2.9	5.47
Silicon Dioxide	prcnt *	45	56.76	1.9	3.43	53.00	1.5	2.87
Al ₂ O ₃ w/minor ¹	prcnt	24	29.55	3.1	10.4	25.18	3.0	11.9
Al ₂ O ₃ w/minor ¹	prcnt *	22	30.06	1.8	5.91	25.33	1.6	6.39
¹ (P ₂ O ₃ & TiO ₂ included)								
Al ₂ O ₃ wo/minor ²	prcnt	38	27.29	3.1	11.22	23.20	2.1	9.02
Al ₂ O ₃ wo/minor ²	prcnt *	36	27.87	1.17	4.19	23.51	0.94	4.00
² (P ₂ O ₃ & TiO ₂ not included)								
Ferric Oxide	prcnt	47	5.26	0.74	14.1	4.02	0.42	10.5
Ferric Oxide	prcnt *	43	5.42	0.45	8.38	4.05	0.31	7.67
Calcium Oxide	prcnt	48	0.80	0.26	32.77	12.11	0.57	4.69
Calcium Oxide	prcnt *	46	0.82	0.23	28.51	12.16	0.51	4.16

CONTINUED ON NEXT PAGE

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

Moisture Content	126 1251
Silicon Dioxide	15 23 205 930
Al ₂ O ₃ w/minor oxides	45 930
Al ₂ O ₃ wo/minor oxides	23 25
Ferric Oxide	25 29 50 2150
Calcium Oxide	23 930

CCRL PROFICIENCY SAMPLE PROGRAM
Pozzolan Proficiency Samples No. 35 and No. 36
Final Report - Chemical Results
November 24, 2004

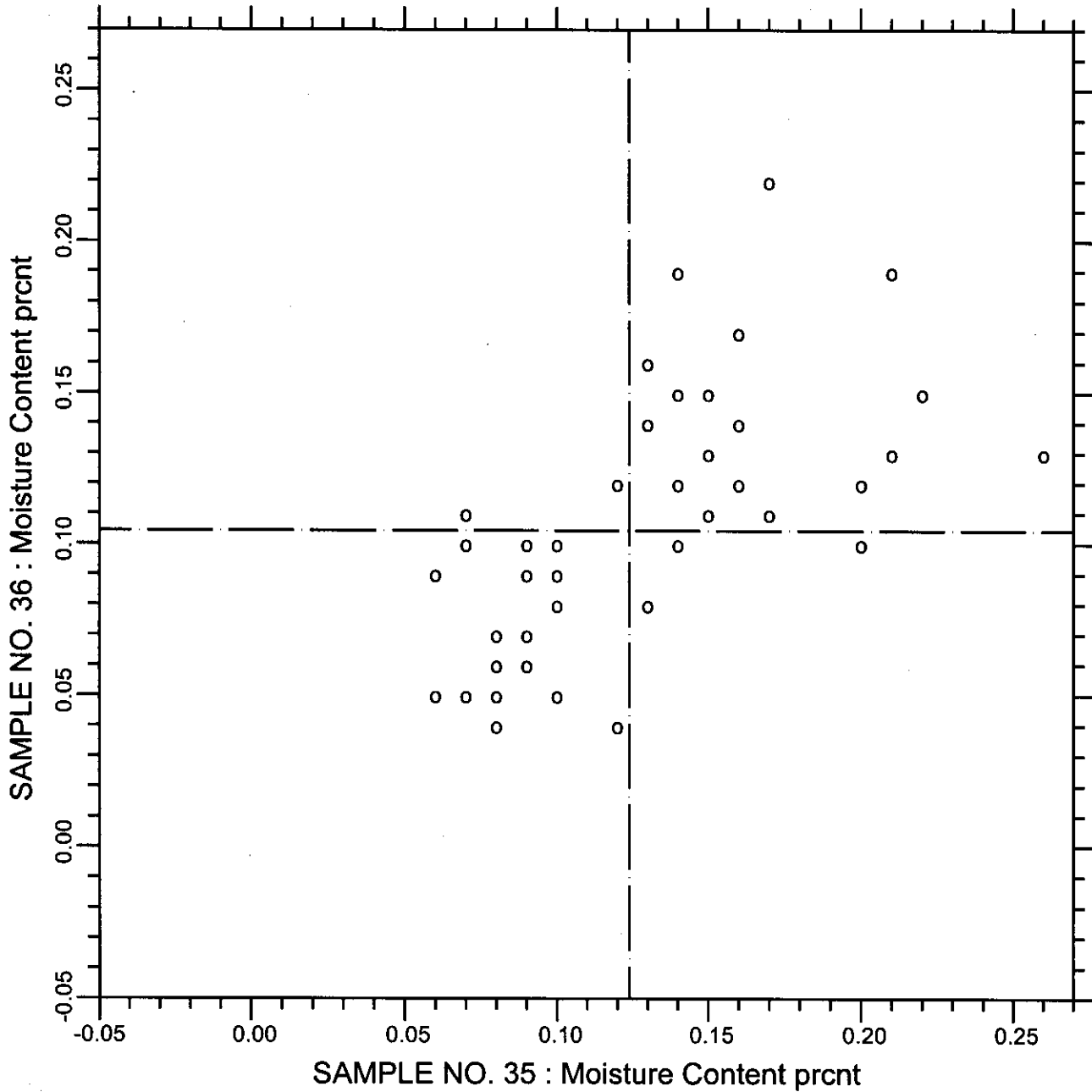
SUMMARY OF RESULTS

Test	#Labs	Sample No. 35			Sample No. 36		
		Average	S.D.	C.V.	Average	S.D.	C.V.
Magnesium Oxide	prcnt 48	0.82	0.40	48.4	2.07	0.25	12.2
Magnesium Oxide	prcnt * 46	0.76	0.16	20.7	2.04	0.21	10.4
Sulfur Trioxide	prcnt 50	0.17	0.094	53.9	0.59	0.126	21.5
Sulfur Trioxide	prcnt * 48	0.17	0.090	53.1	0.56	0.071	12.6
Loss on Ignition	prcnt 58	2.51	0.12	4.77	0.64	0.14	22.29
Loss on Ignition	prcnt * 54	2.49	0.077	3.11	0.61	0.089	14.61
Sodium Oxide	prcnt 44	0.20	0.084	41.9	0.28	0.090	31.6
Potassium Oxide	prcnt 42	2.25	0.22	9.95	0.79	0.15	19.32
Potassium Oxide	prcnt * 36	2.25	0.130	5.78	0.77	0.050	6.51
Available Na ₂ O	prcnt 27	0.09	0.12	132.8	0.15	0.12	82.2
Available Na ₂ O	prcnt * 23	0.06	0.027	44.5	0.12	0.024	20.2
Available K ₂ O	prcnt 27	0.49	0.177	36.2	0.24	0.081	33.3
Available K ₂ O	prcnt * 25	0.48	0.085	17.9	0.23	0.039	17.3
Available Alkali	prcnt 27	0.43	0.20	47.4	0.32	0.17	52.8
Available Alkali	prcnt * 25	0.38	0.091	24.2	0.27	0.047	17.3

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

Magnesium Oxide	40 205
Sulfur Trioxide	47 1940
Loss on Ignition	19 52 126 158
Potassium Oxide	25 40 52 46 205 2116
Available Na ₂ O	44 52 46 2522
Available K ₂ O	40 44
Available Alkali	44 2522

CCRL PROFICIENCY SAMPLE PROGRAM
Moisture Content
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.5

Moisture Content

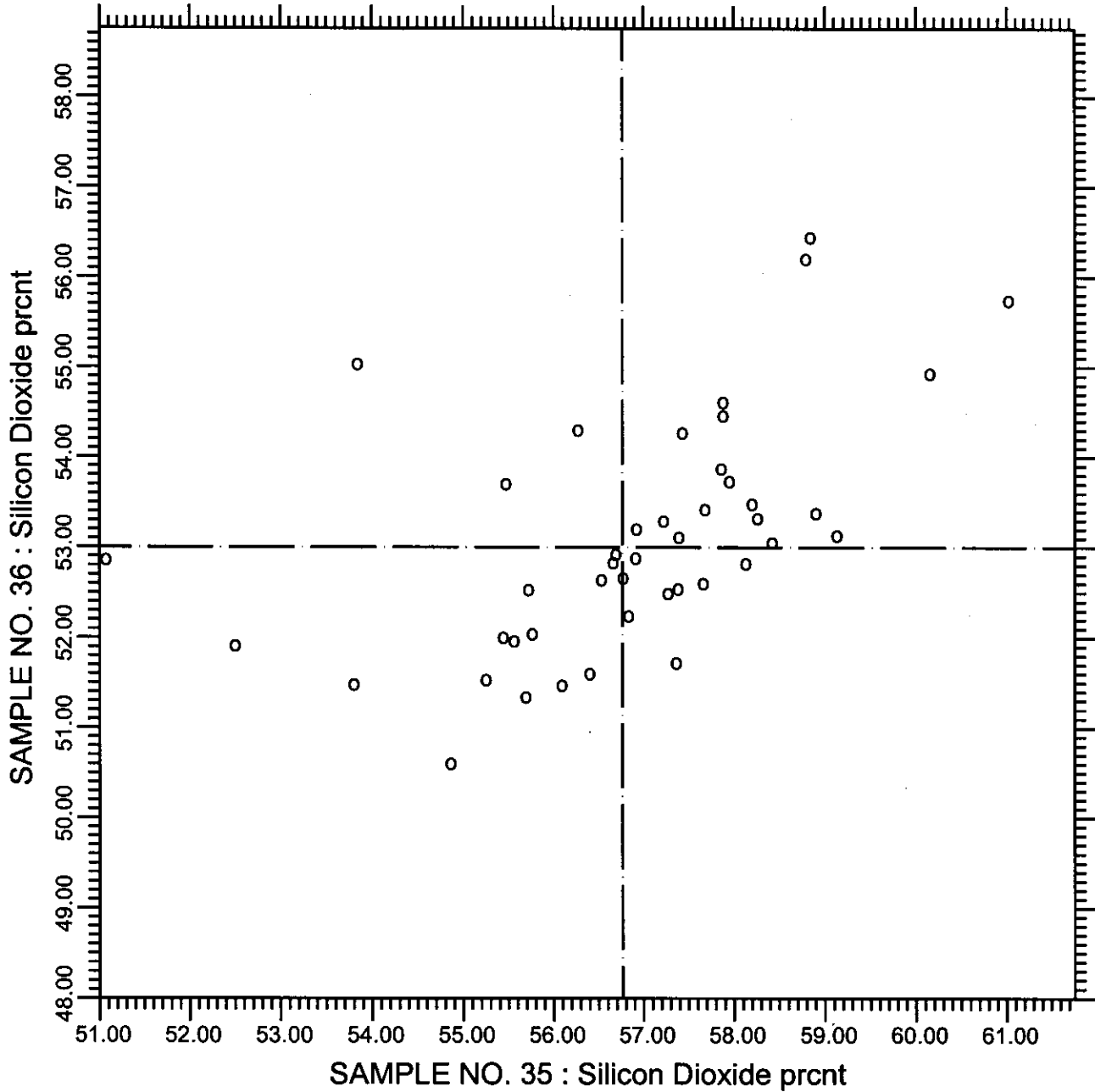
53 POINTS

SAMPLE NO. 35 AVE 0.1240 S.D. 0.046 C.V. 37.4

SAMPLE NO. 36 AVE 0.1043 S.D. 0.041 C.V. 39.1

LABS ELIMINATED 126 1251

CCRL PROFICIENCY SAMPLE PROGRAM
 Silicon Dioxide
 POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.10

Silicon Dioxide

44 POINTS

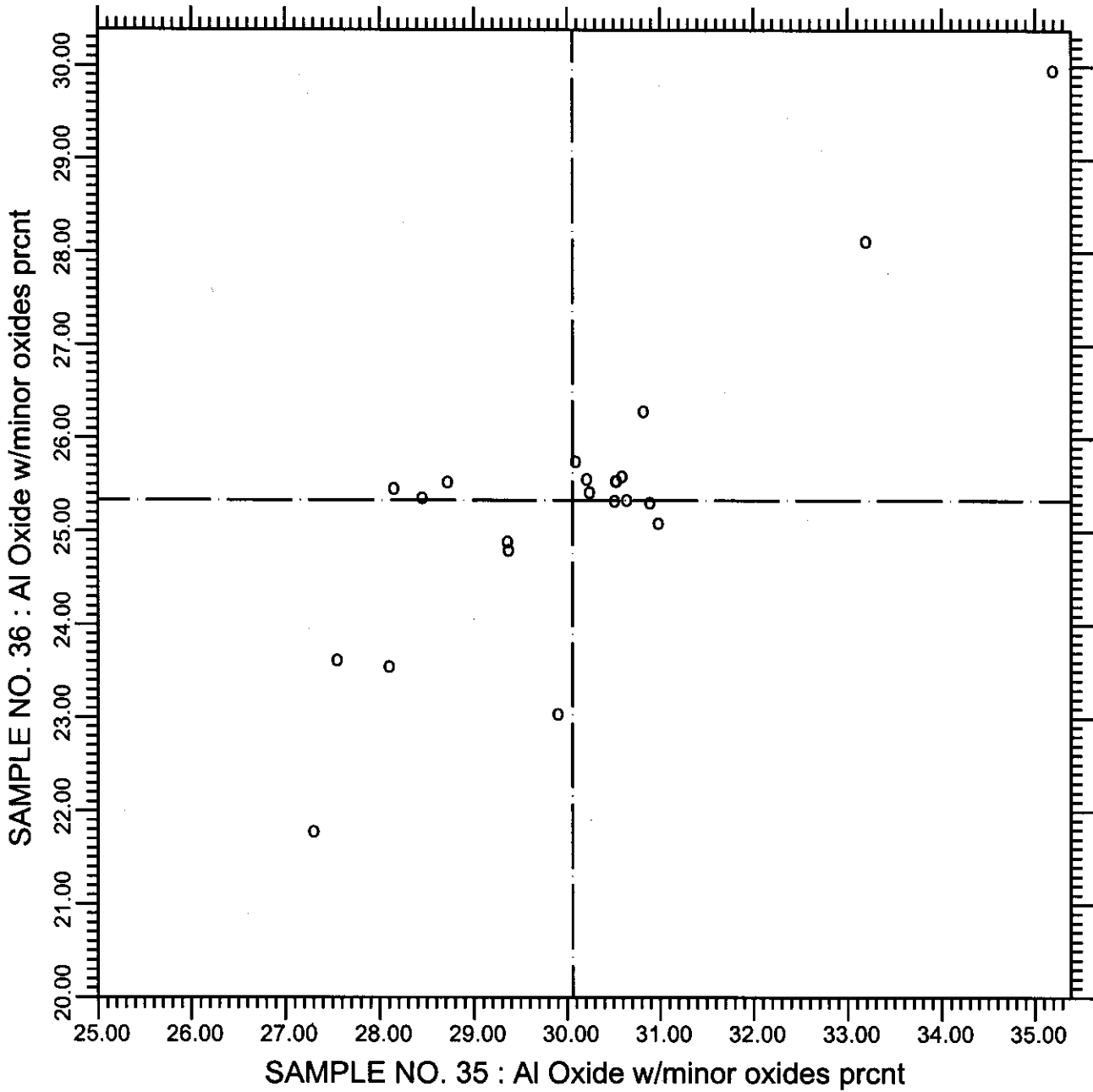
SAMPLE NO. 35 AVE 56.76 S.D. 1.9 C.V. 3.43

SAMPLE NO. 36 AVE 53.00 S.D. 1.5 C.V. 2.87

LABS ELIMINATED 15 23 205 930

LABS OFF DIAGRAM 2150

CCRL PROFICIENCY SAMPLE PROGRAM
Aluminum Oxide (minor oxides included)
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.20

Al Oxide w/minor oxides

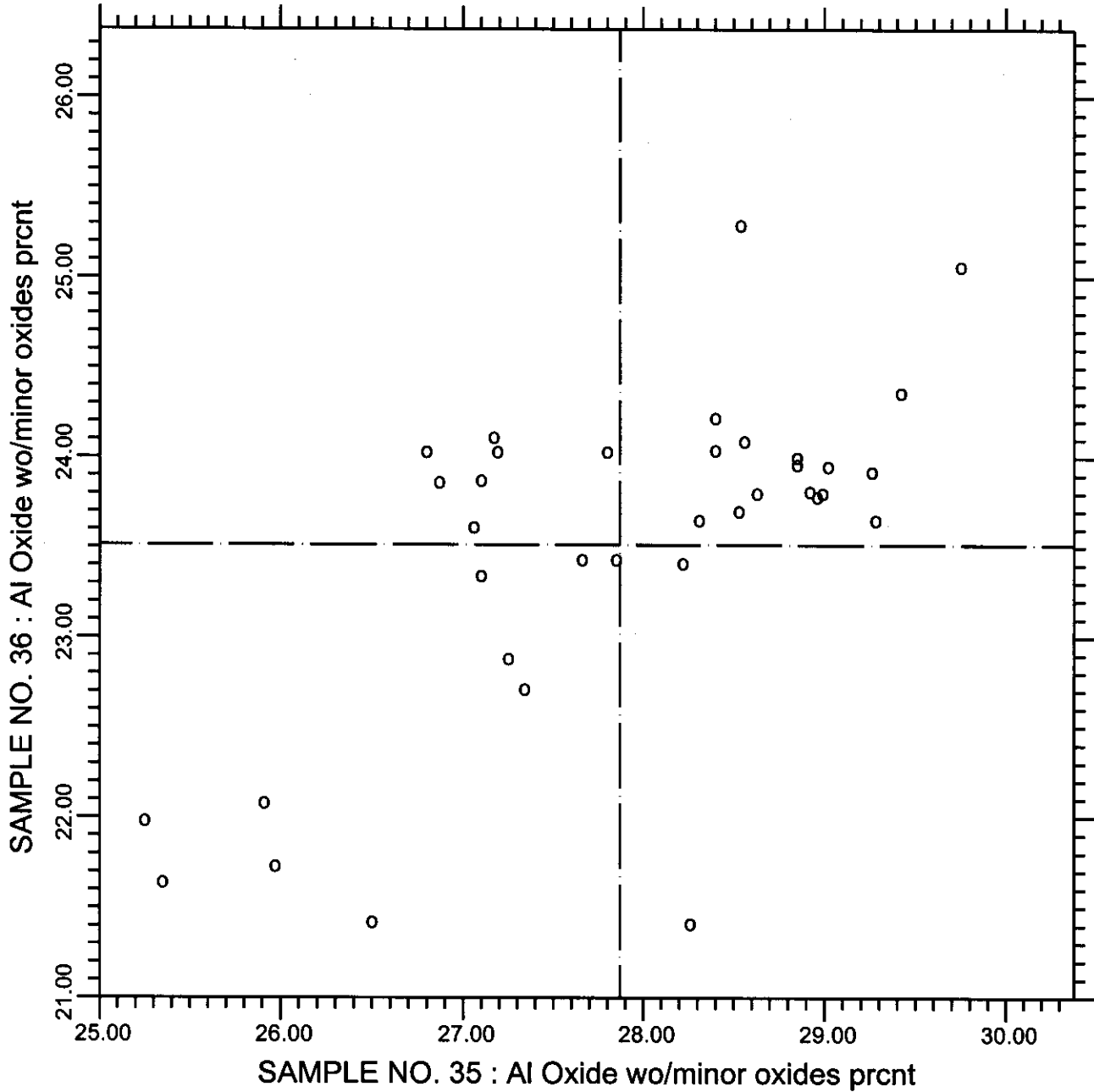
22 POINTS

SAMPLE NO. 35 AVE 30.06 S.D. 1.8 C.V. 5.91

SAMPLE NO. 36 AVE 25.33 S.D. 1.6 C.V. 6.39

LABS ELIMINATED 45 930

CCRL PROFICIENCY SAMPLE PROGRAM
 Aluminum Oxide (minor oxides excluded)
 POZZOLAN SAMPLES NO. 35 & NO. 36



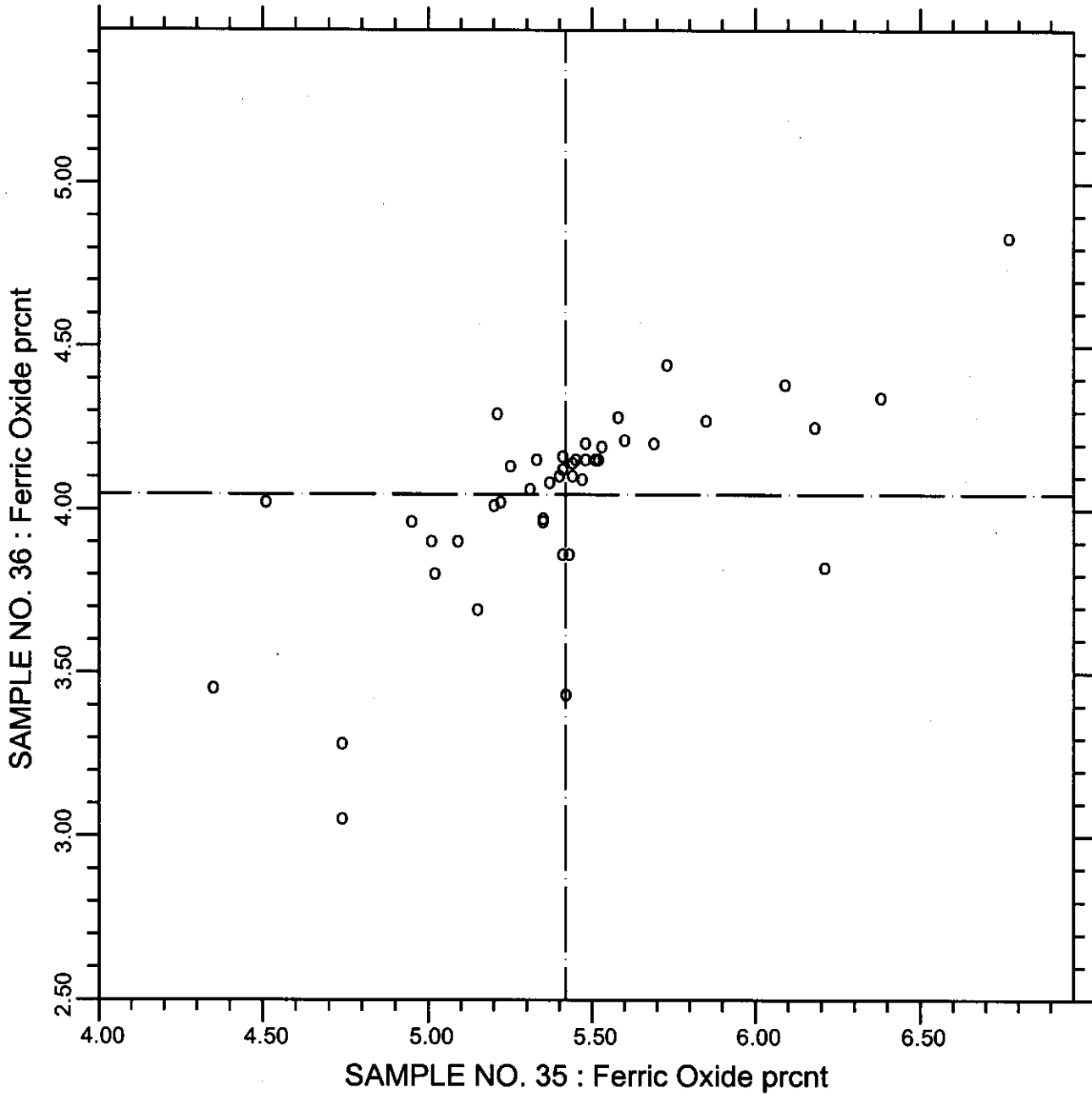
TEST NO.21 Al Oxide wo/minor oxides 36 POINTS

SAMPLE NO. 35 AVE 27.87 S.D. 1.17 C.V. 4.19

SAMPLE NO. 36 AVE 23.51 S.D. 0.94 C.V. 4.00

LABS ELIMINATED 23 25

CCRL PROFICIENCY SAMPLE PROGRAM
Ferric Oxide
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.30

Ferric Oxide

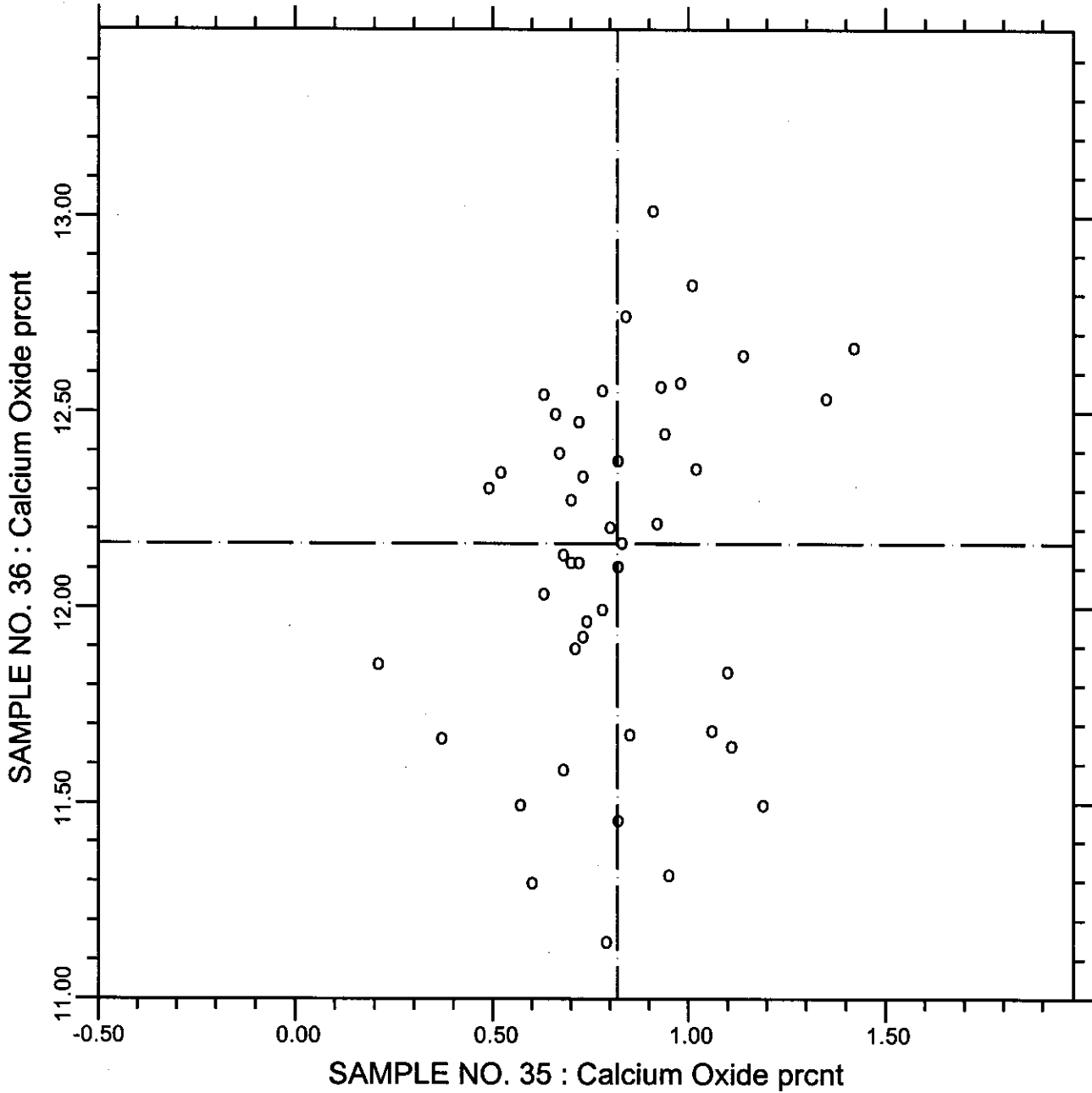
43 POINTS

SAMPLE NO. 35 AVE 5.419 S.D. 0.45 C.V. 8.38

SAMPLE NO. 36 AVE 4.047 S.D. 0.31 C.V. 7.67

LABS ELIMINATED 25 29 50 2150

CCRL PROFICIENCY SAMPLE PROGRAM
 Calcium Oxide
 POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.40

Calcium Oxide

45 POINTS

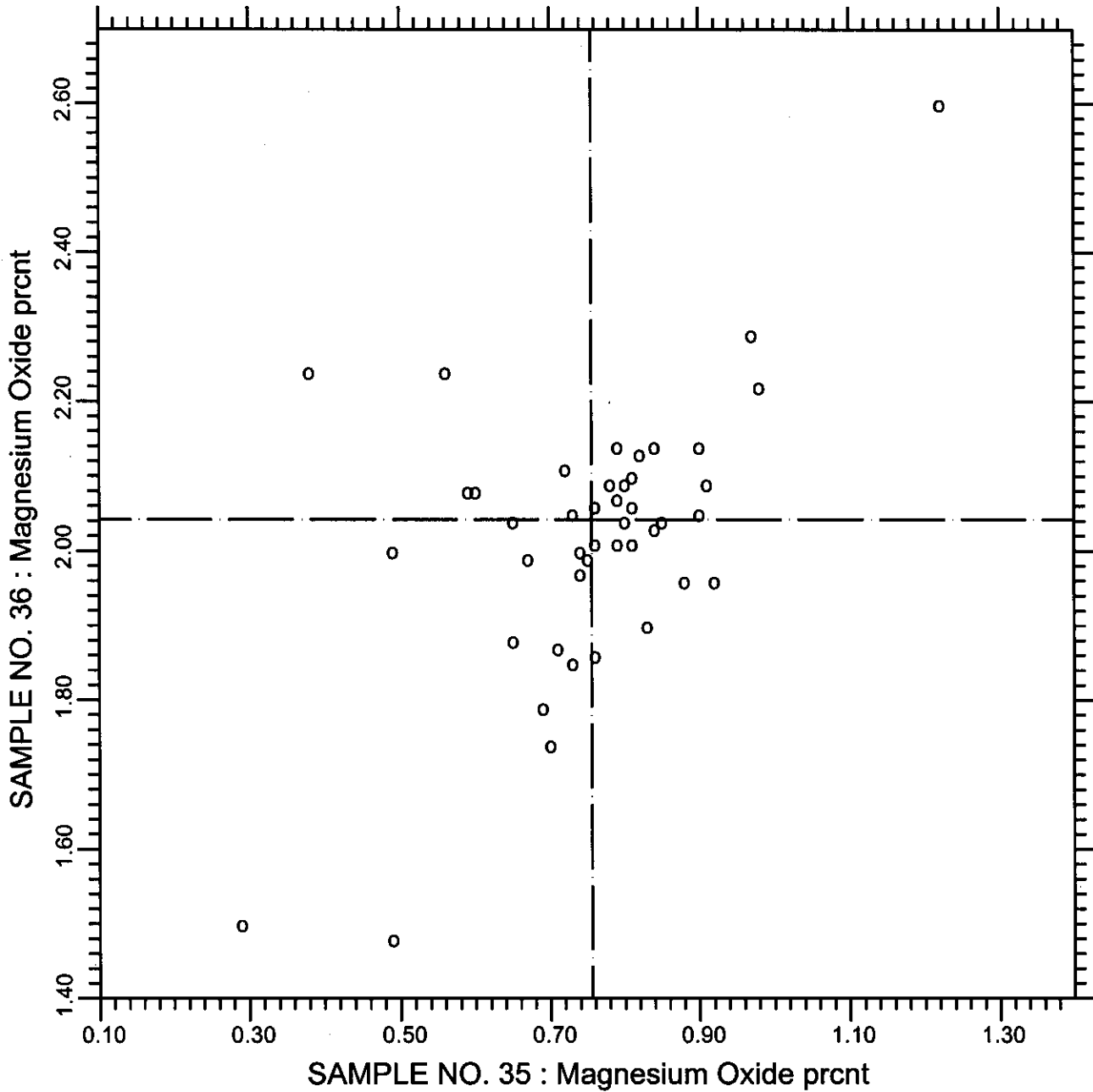
SAMPLE NO. 35 AVE 0.819 S.D. 0.23 C.V. 28.51

SAMPLE NO. 36 AVE 12.163 S.D. 0.51 C.V. 4.16

LABS ELIMINATED 23 930

LABS OFF DIAGRAM 1

CCRL PROFICIENCY SAMPLE PROGRAM
Magnesium Oxide
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.50

Magnesium Oxide

45 POINTS

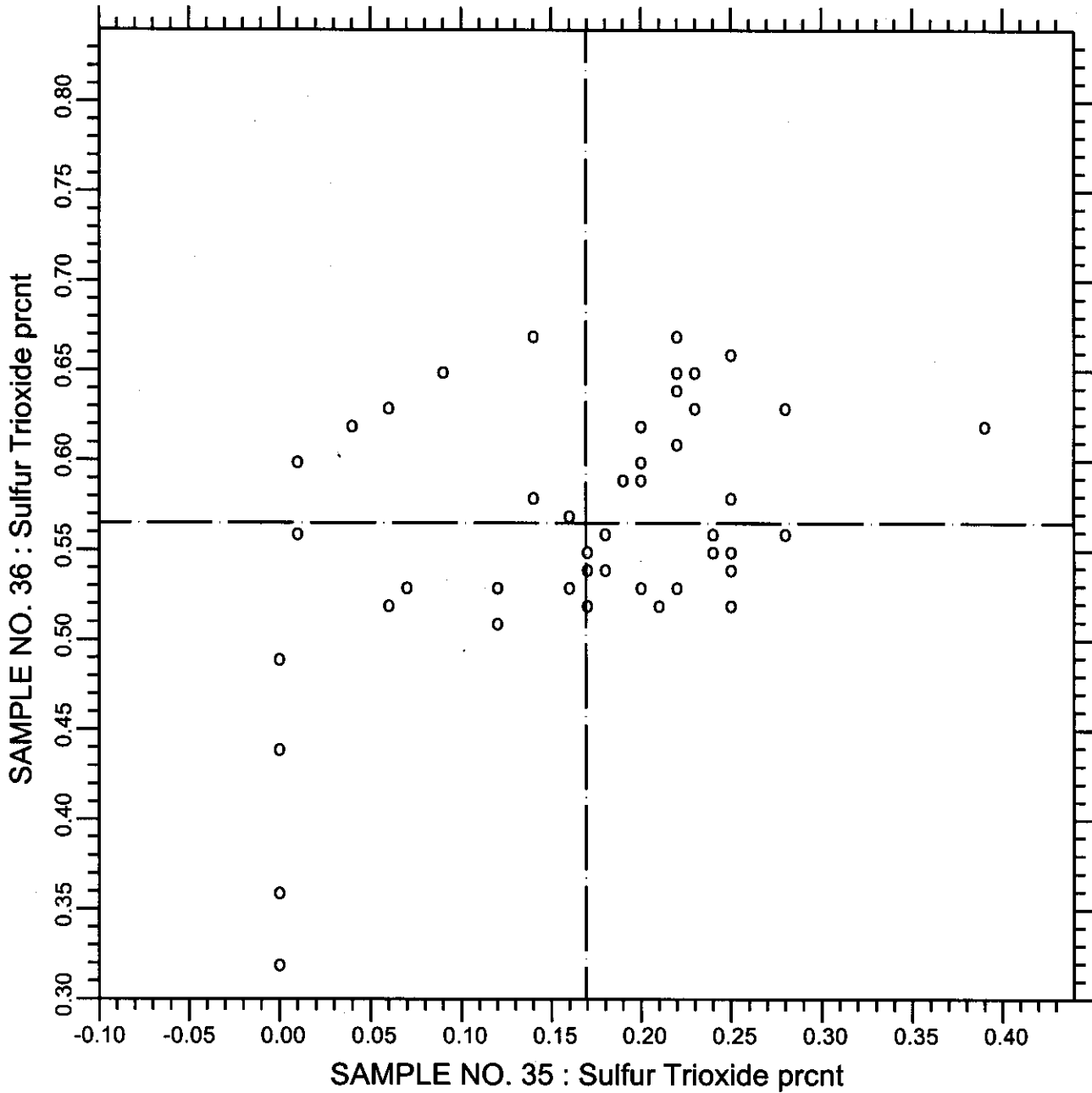
SAMPLE NO. 35 AVE 0.756 S.D. 0.16 C.V. 20.7

SAMPLE NO. 36 AVE 2.042 S.D. 0.21 C.V. 10.4

LABS ELIMINATED 40 205

LABS OFF DIAGRAM 45

CCRL PROFICIENCY SAMPLE PROGRAM
Sulfur Trioxide
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.60

Sulfur Trioxide

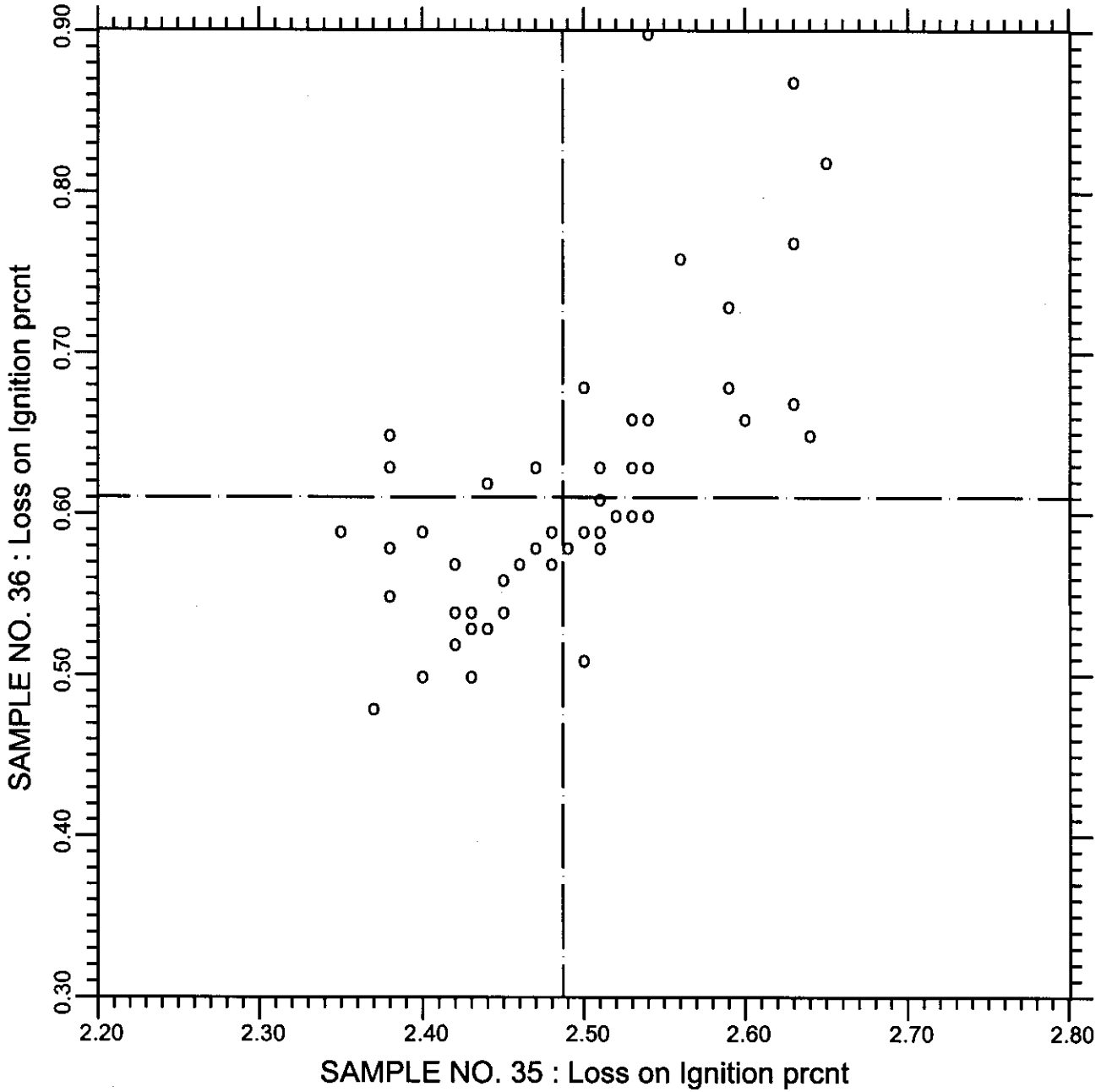
48 POINTS

SAMPLE NO. 35 AVE 0.169 S.D. 0.090 C.V. 53.1

SAMPLE NO. 36 AVE 0.565 S.D. 0.071 C.V. 12.6

LABS ELIMINATED 47 1940

CCRL PROFICIENCY SAMPLE PROGRAM
Loss on Ignition
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.70

Loss on Ignition

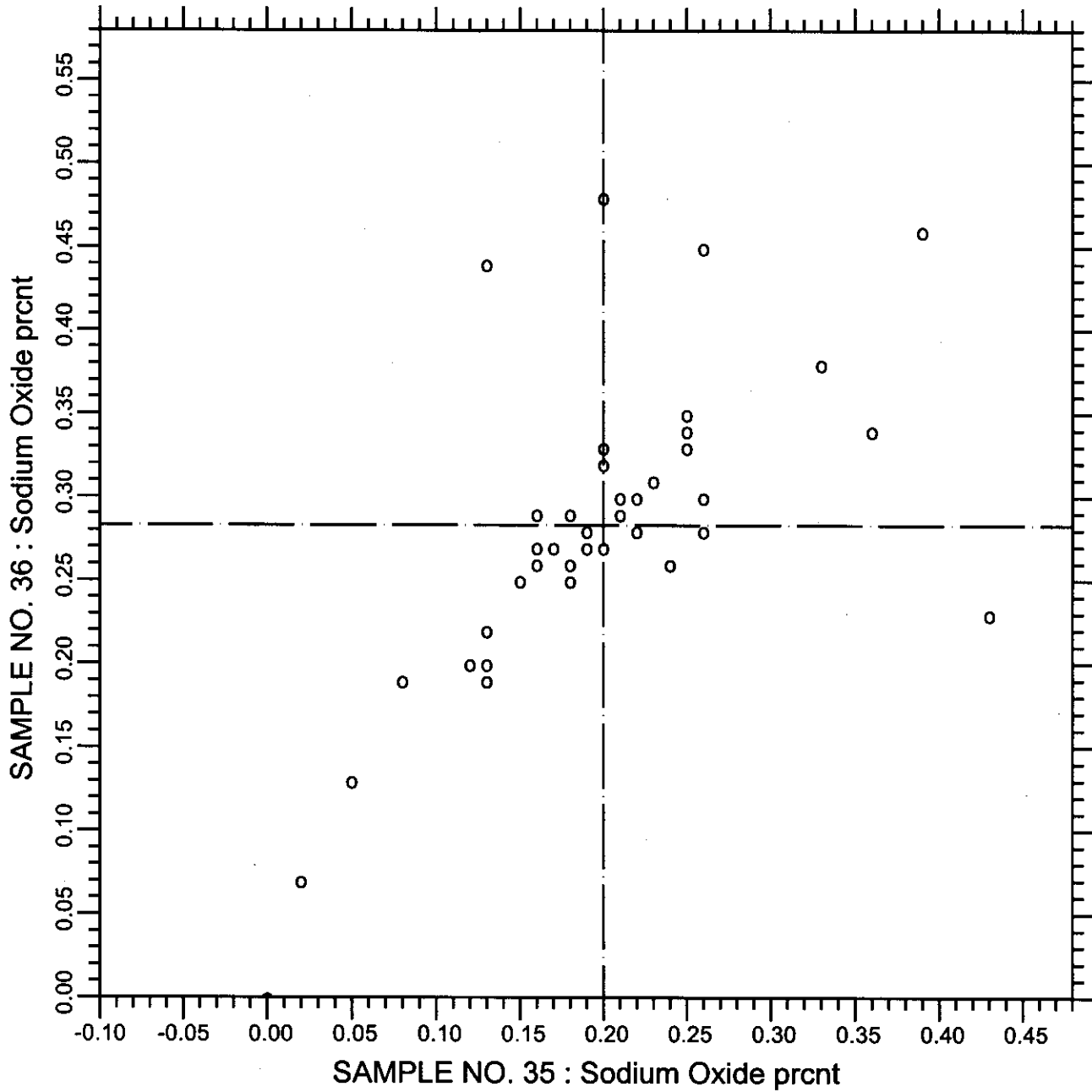
54 POINTS

SAMPLE NO. 35 AVE 2.487 S.D. 0.077 C.V. 3.11

SAMPLE NO. 36 AVE 0.610 S.D. 0.089 C.V. 14.61

LABS ELIMINATED 19 52 126 158

CCRL PROFICIENCY SAMPLE PROGRAM
Sodium Oxide
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.90

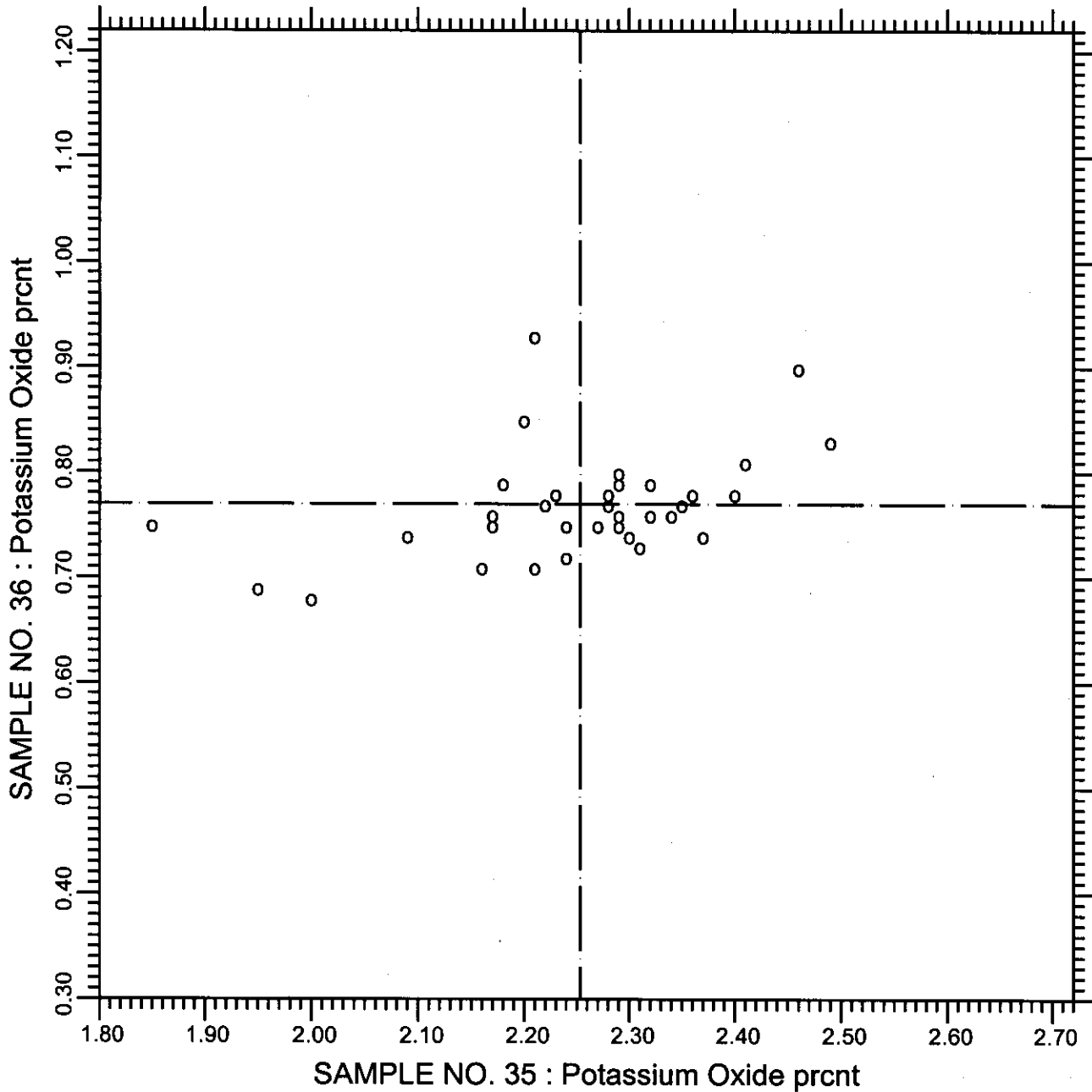
Sodium Oxide

44 POINTS

SAMPLE NO. 35 AVE 0.200 S.D. 0.084 C.V. 41.9

SAMPLE NO. 36 AVE 0.283 S.D. 0.090 C.V. 31.6

CCRL PROFICIENCY SAMPLE PROGRAM
Potassium Oxide
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.100

Potassium Oxide

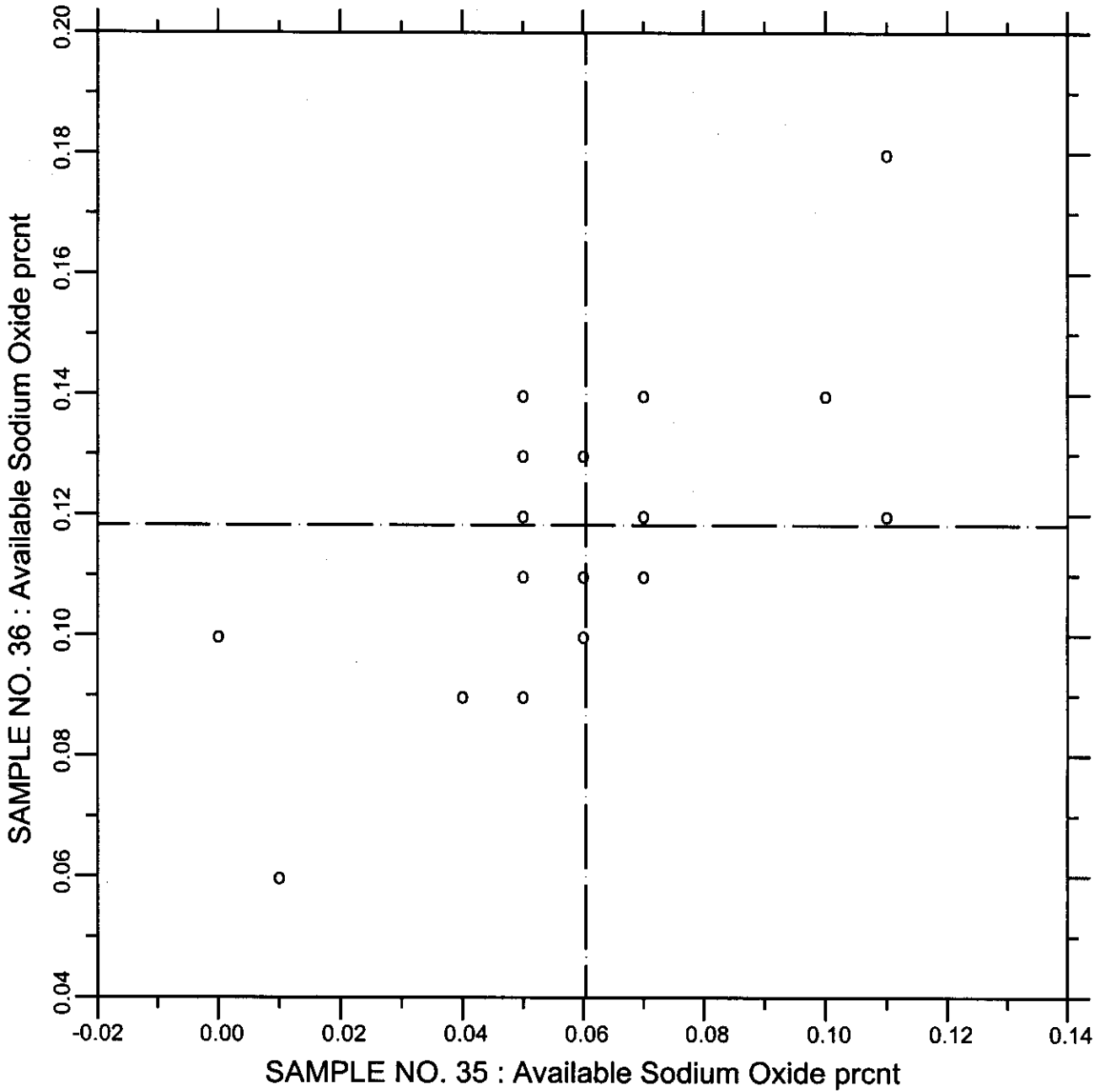
36 POINTS

SAMPLE NO. 35 AVE 2.2533 S.D. 0.130 C.V. 5.78

SAMPLE NO. 36 AVE 0.7700 S.D. 0.050 C.V. 6.51

LABS ELIMINATED 25 40 52 46 205 2116

CCRL PROFICIENCY SAMPLE PROGRAM
Available Sodium Oxide
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.91 Available Sodium Oxide 23 POINTS

SAMPLE NO. 35 AVE 0.0604 S.D. 0.027 C.V. 44.5

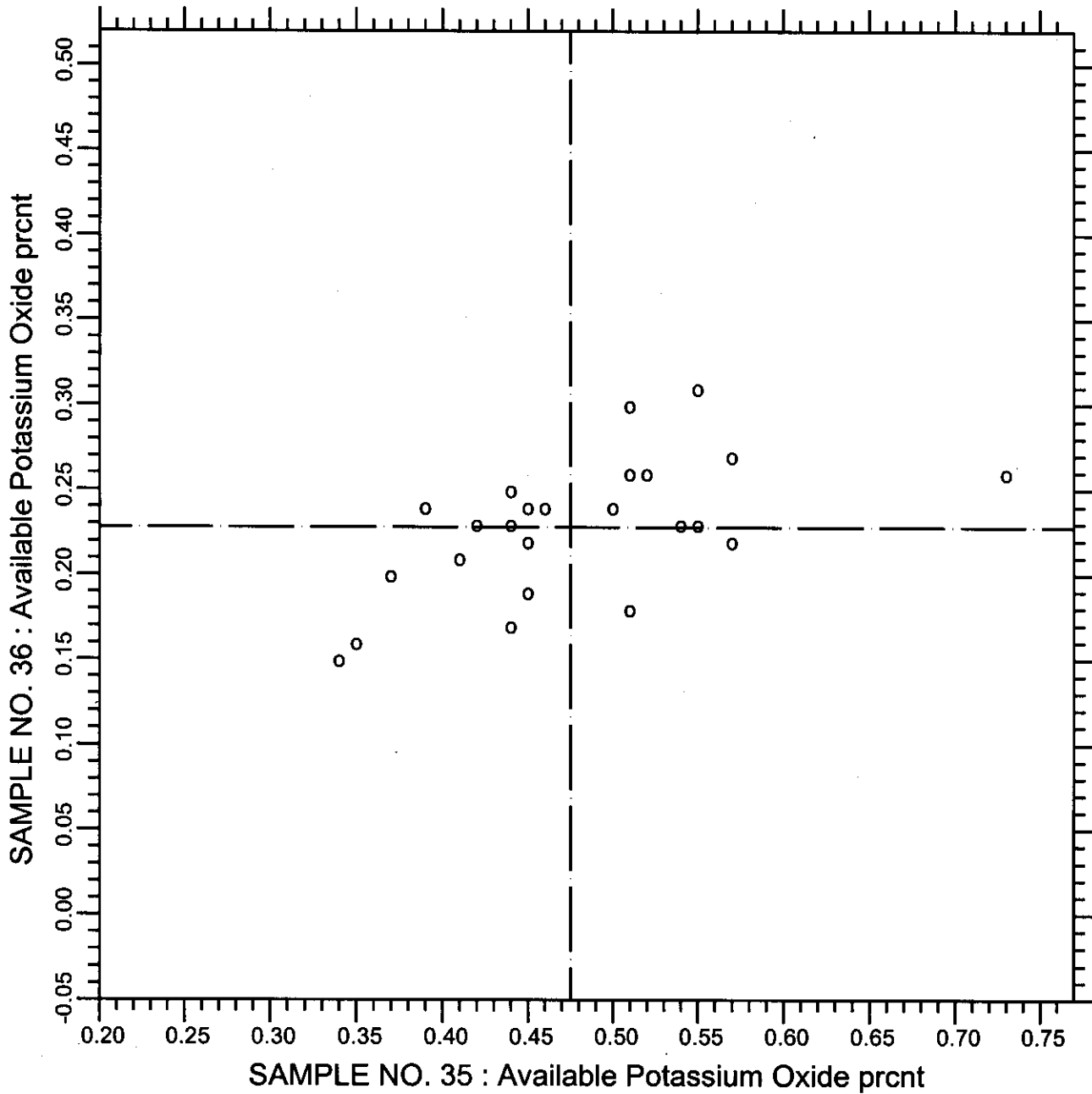
SAMPLE NO. 36 AVE 0.1183 S.D. 0.024 C.V. 20.2

LABS ELIMINATED 44 52 46 2522

CCRL PROFICIENCY SAMPLE PROGRAM

Available Potassium Oxide

POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.93

Available Potassium Oxide

25 POINTS

SAMPLE NO. 35 AVE 0.4752 S.D. 0.085 C.V. 17.9

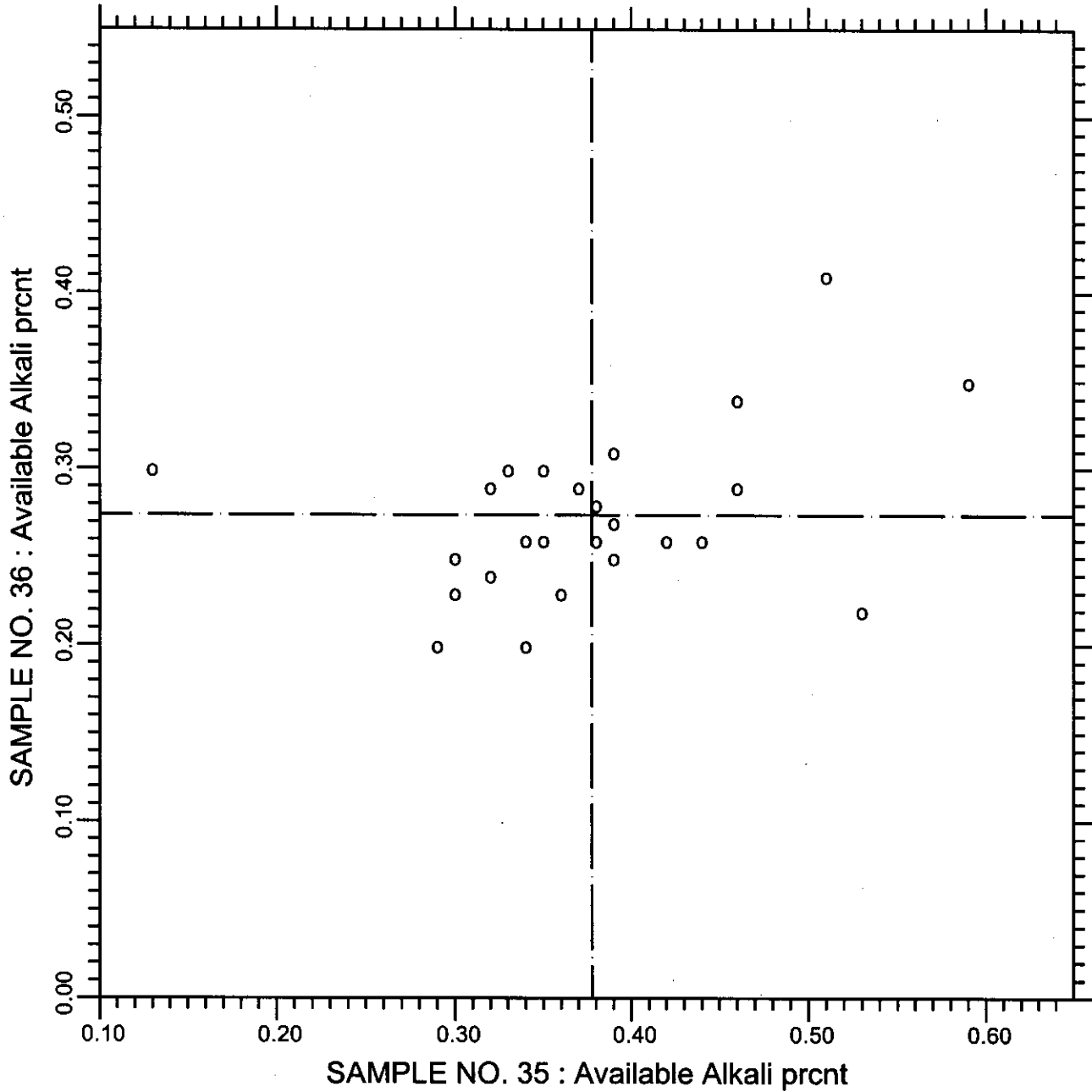
SAMPLE NO. 36 AVE 0.2280 S.D. 0.039 C.V. 17.3

LABS ELIMINATED 40 44

CCRL PROFICIENCY SAMPLE PROGRAM

Available Alkali

POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.95

Available Alkali

25 POINTS

SAMPLE NO. 35 AVE 0.3776 S.D. 0.091 C.V. 24.2

SAMPLE NO. 36 AVE 0.2740 S.D. 0.047 C.V. 17.3

LABS ELIMINATED 44 2522

CCRL PROFICIENCY SAMPLE PROGRAM
Pozzolan Proficiency Sample No. 35 and No. 36
Final Report - Physical Results
November 24, 2004

SUMMARY OF RESULTS

Test		#Labs	Sample No. 35			Sample No. 36		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Density	g/cm ³	57	2.26	0.14	6.21	2.34	0.15	6.56
Density	g/cm ³	* 55	2.23	0.037	1.67	2.32	0.047	2.02
45µm Sieve	prcnt	64	31.02	5.1	16.6	20.58	4.2	20.4
45µm Sieve	prcnt	* 60	31.55	2.8	9.05	21.02	1.7	8.19
Drying Shrinkage	prcnt	13	0.016	0.039	240	0.009	0.045	503
Autoclave Expan	prcnt	48	0.02	0.035	149	0.01	0.063	491
Autoclave Expan	prcnt	* 45	0.02	0.018	78.4	0.02	0.019	88.7
N.C. Water	prcnt	50	26.2	0.82	3.14	24.9	0.82	3.30
Air Entrainment	prcnt	7	0.347	0.82	236	0.352	0.83	235
STRENGTH ACTIVITY INDEX (SAI) WITH PORTLAND CEMENT								
SAI 7 day	prcnt	* 52	77	5.7	7.43	85	4.8	5.58
SAI 28 day	prcnt	49	84	8.3	9.86	98	8.9	9.11
SAI 28 day	prcnt	* 47	83	4.7	5.66	96	4.8	4.99
SAI Water	prcnt	54	98	9.9	10.13	96	9.4	9.85
SAI Water	prcnt	* 52	100	2.1	2.14	98	1.8	1.88
EFFECTIVENESS OF MINERAL ADMIXTURES IN CONTROLLING ALKALI-SILICA REACTIONS (ASR)								
Reduction Expan	prcnt	9	56	9.8	17.6	60	13.6	22.7

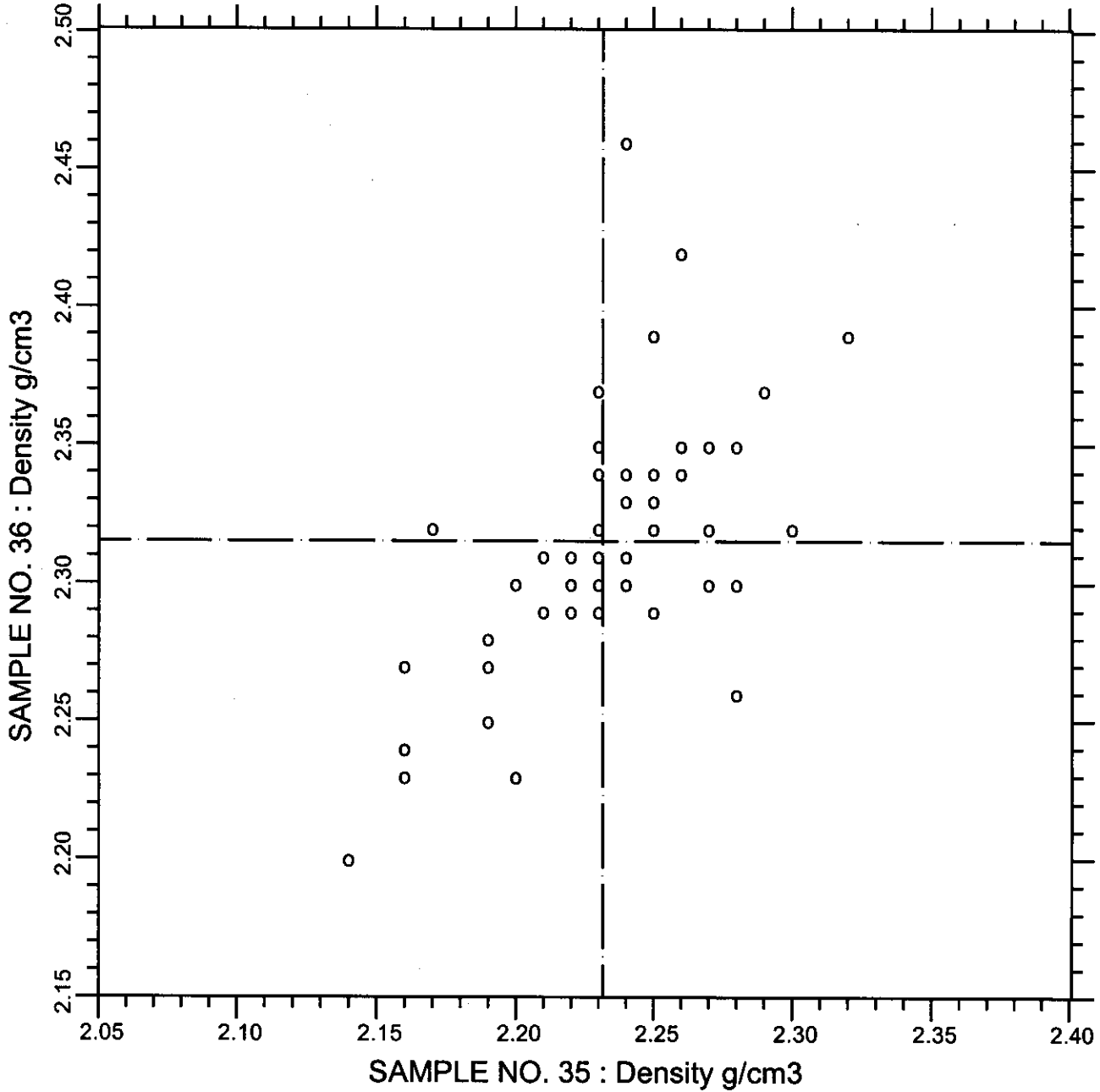
* ELIMINATED LABS: Data over three S.D. from the mean

Density	33 47
45µm Sieve	15 24 26 33
Autoclave Expansion	23 47 126
SAI 7 day	15 1251
SAI 28 day	15 1251
SAI Water	158 1251

CCRL PROFICIENCY SAMPLE PROGRAM

Density

POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.310

Density

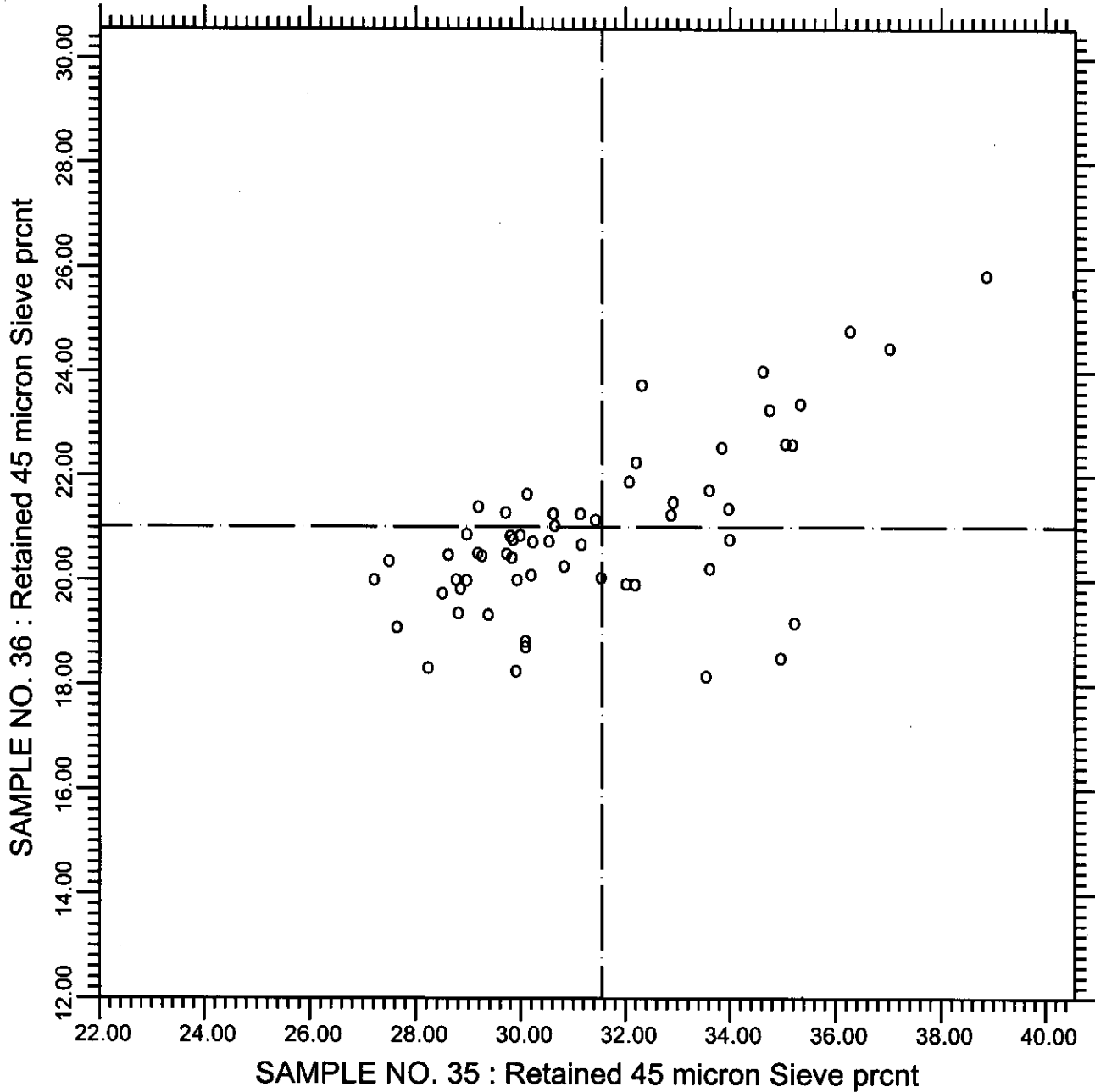
55 POINTS

SAMPLE NO. 35 AVE 2.2316 S.D. 0.037 C.V. 1.67

SAMPLE NO. 36 AVE 2.3153 S.D. 0.047 C.V. 2.02

LABS ELIMINATED 33 47

CCRL PROFICIENCY SAMPLE PROGRAM
Fineness - 45 micron Sieve Retained
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.281 Retained 45 micron Sieve 59 POINTS

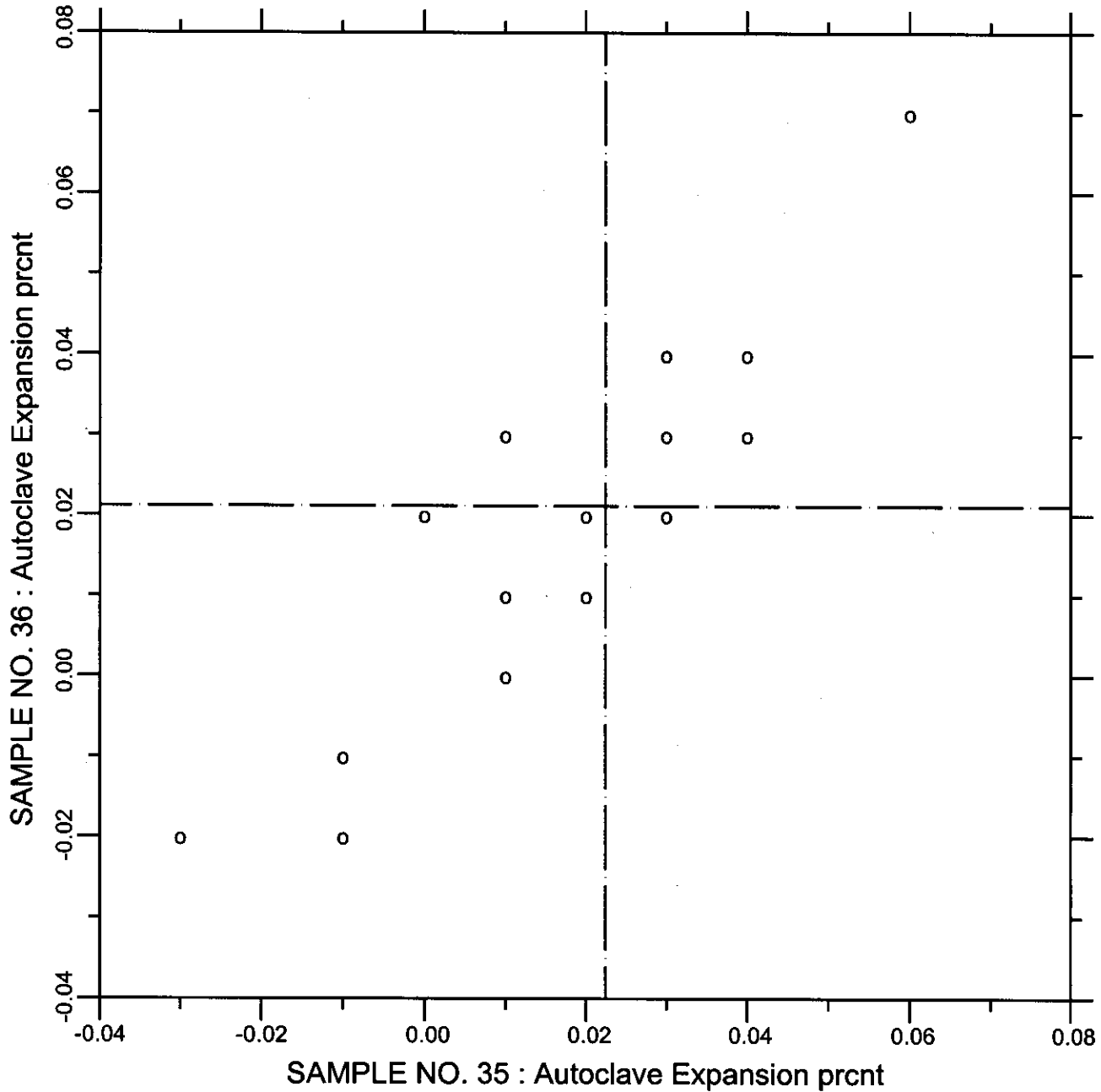
SAMPLE NO. 35 AVE 31.55 S.D. 2.8 C.V. 9.05

SAMPLE NO. 36 AVE 21.02 S.D. 1.7 C.V. 8.19

LABS ELIMINATED 15 24 26 33

LABS OFF DIAGRAM 1773

CCRL PROFICIENCY SAMPLE PROGRAM
Autoclave Expansion
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.160 Autoclave Expansion 43 POINTS

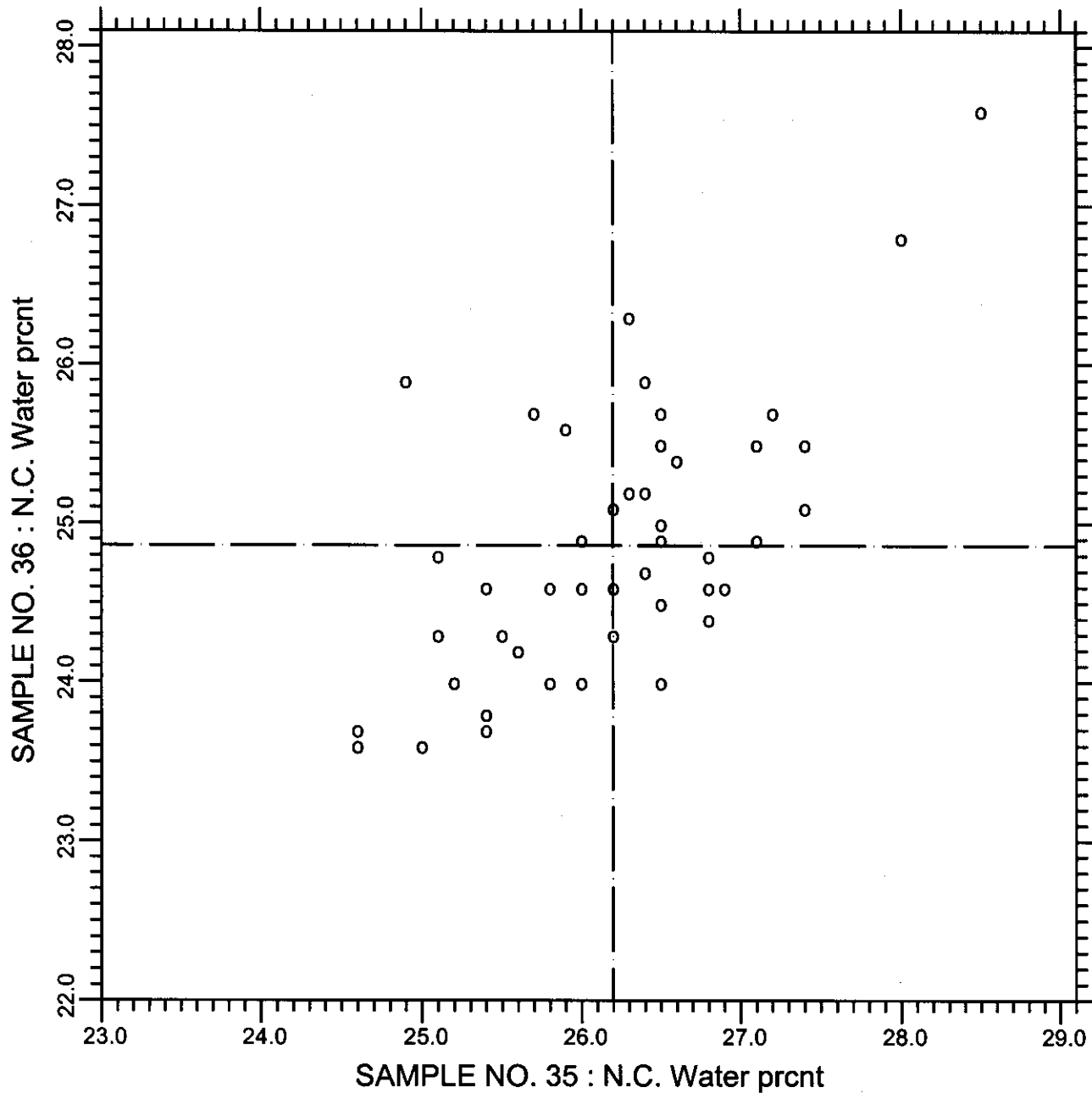
SAMPLE NO. 35 AVE 0.0224 S.D. 0.018 C.V. 78.4

SAMPLE NO. 36 AVE 0.0211 S.D. 0.019 C.V. 88.7

LABS ELIMINATED 23 47 126

LABS OFF DIAGRAM 40 2295

CCRL PROFICIENCY SAMPLE PROGRAM
 Normal Consistency Water
 POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.110

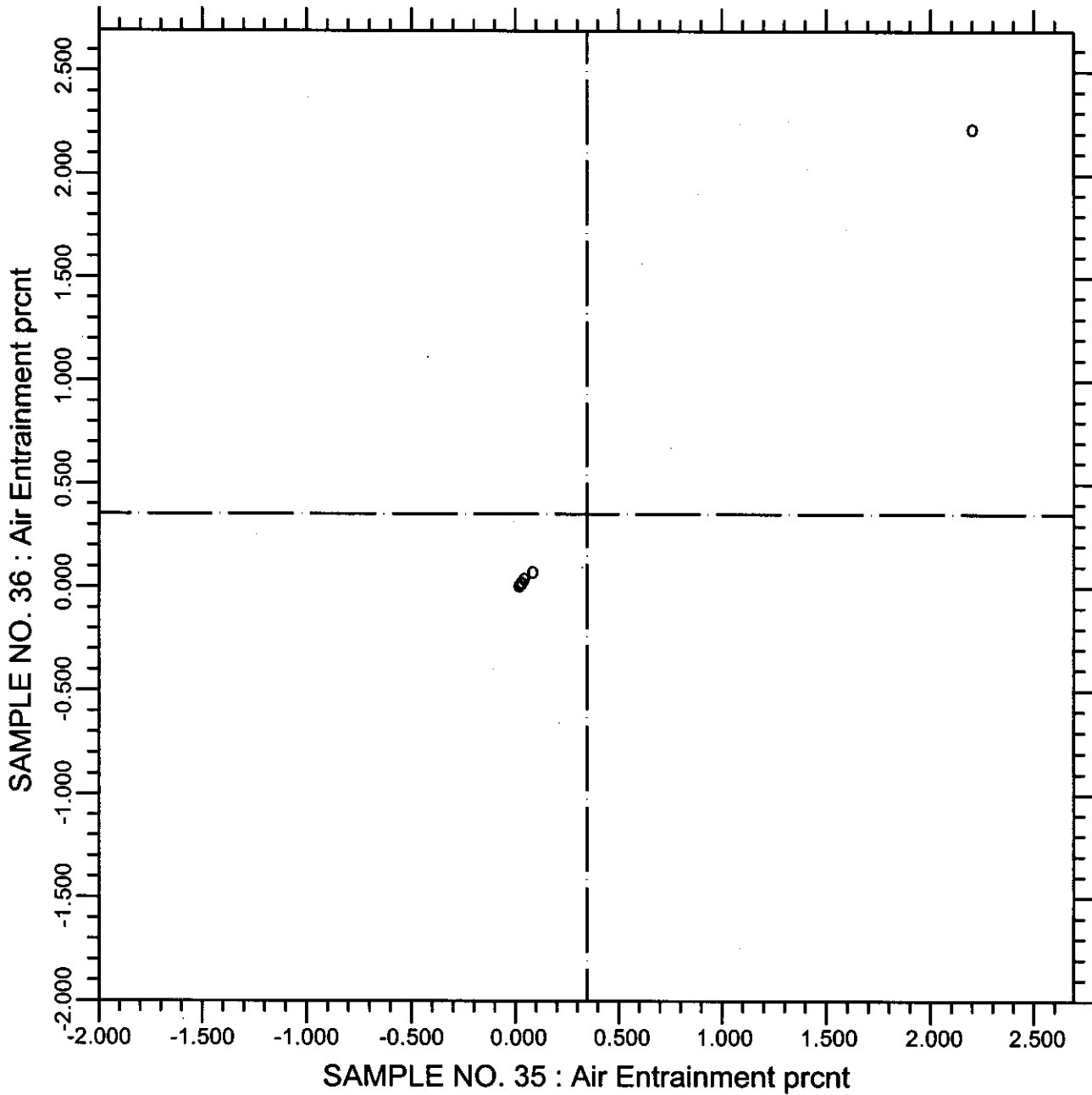
N.C. Water

50 POINTS

SAMPLE NO. 35 AVE 26.20 S.D. 0.82 C.V. 3.14

SAMPLE NO. 36 AVE 24.86 S.D. 0.82 C.V. 3.30

CCRL PROFICIENCY SAMPLE PROGRAM
Air Entrainment
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.350

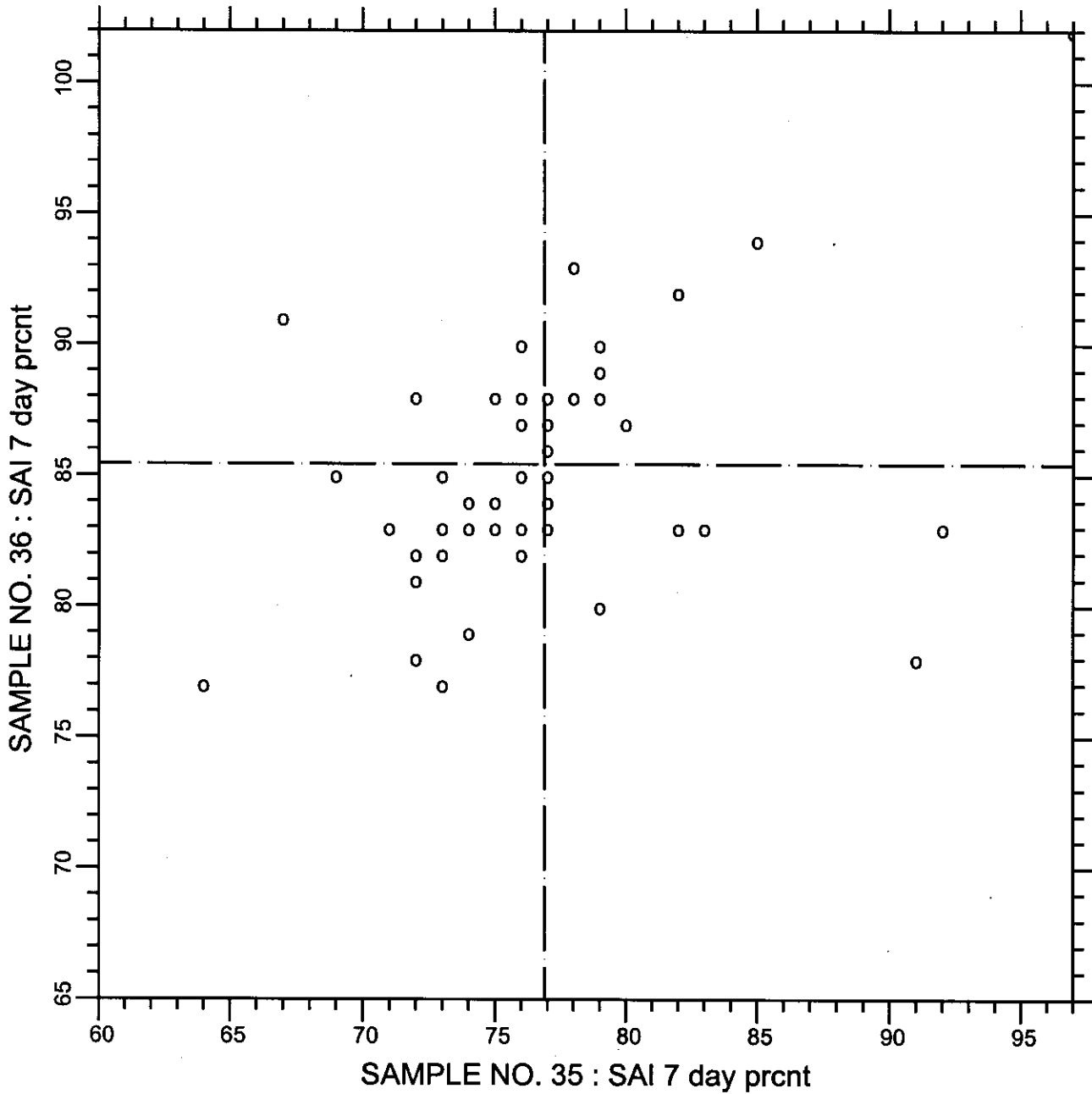
Air Entrainment

7 POINTS

SAMPLE NO. 35 AVE 0.35 S.D. 0.82 C.V. 236

SAMPLE NO. 36 AVE 0.35 S.D. 0.83 C.V. 235

CCRL PROFICIENCY SAMPLE PROGRAM
Strength Activity Index - 7 day
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.359

SAI 7 day

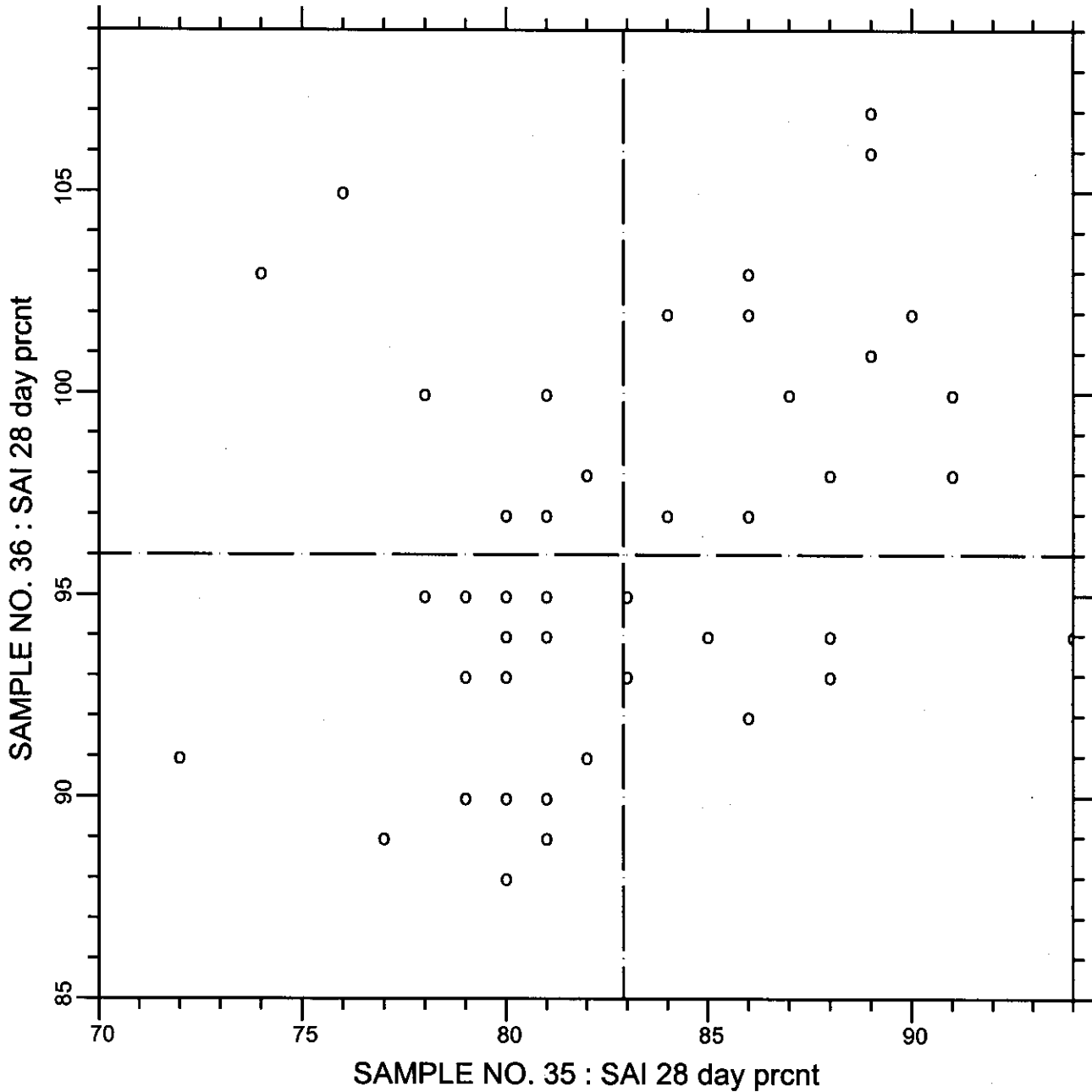
52 POINTS

SAMPLE NO. 35 AVE 76.88 S.D. 5.7 C.V. 7.43

SAMPLE NO. 36 AVE 85.42 S.D. 4.8 C.V. 5.58

LABS ELIMINATED 15 1251

CCRL PROFICIENCY SAMPLE PROGRAM
Strength Activity Index - 28 day
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.360

SAI 28 day

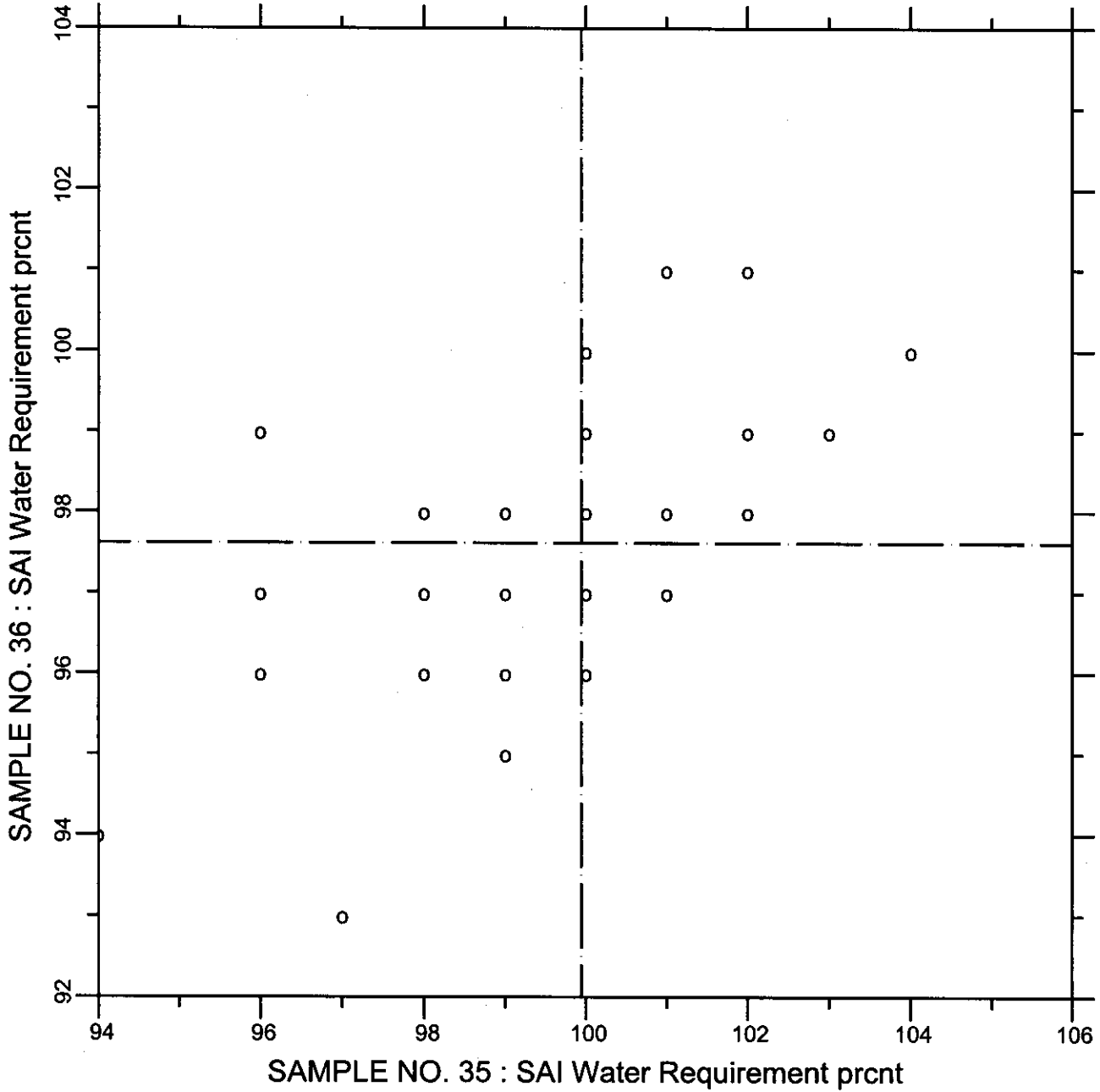
47 POINTS

SAMPLE NO. 35 AVE 82.91 S.D. 4.7 C.V. 5.66

SAMPLE NO. 36 AVE 96.00 S.D. 4.8 C.V. 4.99

LABS ELIMINATED 15 1251

CCRL PROFICIENCY SAMPLE PROGRAM
SAI Water Requirement
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.370 SAI Water Requirement 51 POINTS

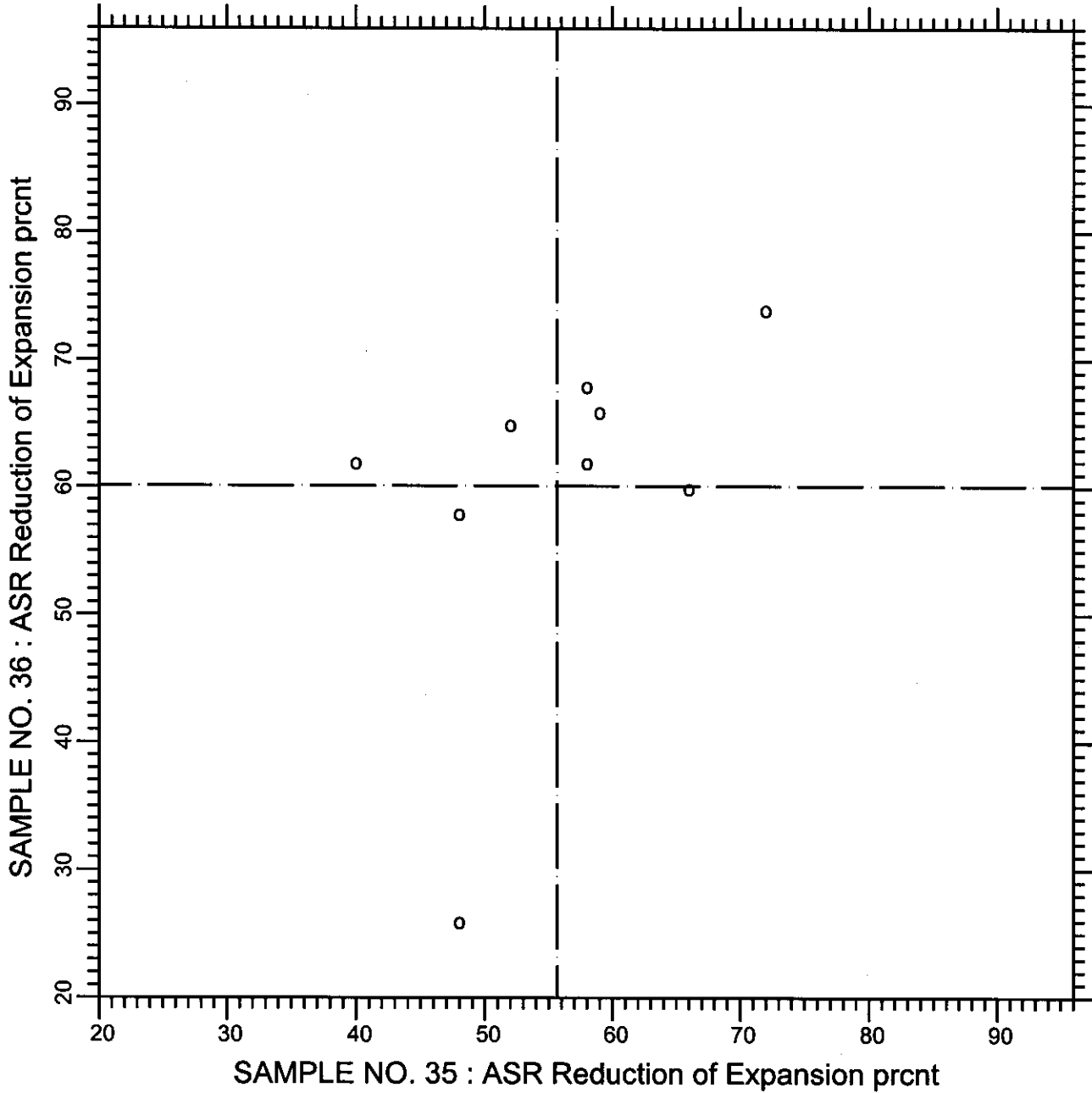
SAMPLE NO. 35 AVE 99.94 S.D. 2.1 C.V. 2.14

SAMPLE NO. 36 AVE 97.62 S.D. 1.8 C.V. 1.88

LABS ELIMINATED 158 1251

LABS OFF DIAGRAM 1940

CCRL PROFICIENCY SAMPLE PROGRAM
Alkali-Silica Reaction - Reduction of Expansion
POZZOLAN SAMPLES NO. 35 & NO. 36



TEST NO.390 ASR Reduction of Expansion 9 POINTS

SAMPLE NO. 35 AVE 55.7 S.D. 9.8 C.V. 17.6

SAMPLE NO. 36 AVE 60.1 S.D. 13.6 C.V. 22.7