

CEMENT AND CONCRETE REFERENCE LABORATORY
PROFICIENCY SAMPLE PROGRAM

Final Report
Portland Cement Proficiency Samples
Number 163 and Number 164

April 2007



CCRL CEMENT AND CONCRETE
REFERENCE LABORATORY



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

100 Bureau Dr., Stop 8618
Fax: 301-975-2243
e-mail: ccrl@nist.gov

April 6, 2007

To: Participants in the CCRL Portland Cement Proficiency Sample Program

SUBJECT: Final Report on Portland Cement Proficiency Samples No. 163 and No. 164

Following is the final report for the current pair of CCRL **Portland Cement** Proficiency Samples which were distributed in January 2007. Portland Cement Sample No 163 was a ASTM C150 Type I and No. 164 was ASTM C150 Type I/II.

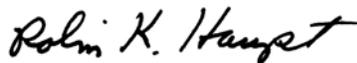
This report consists of a statistical Summary of Results, a set of general Scatter Diagrams, and associated detailed information. The Table of Results with individualized information for participating laboratories can be downloaded at our website located at: <http://ccrl.us/>. Additional information is provided in the following pages.

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.

It is presently anticipated that the next Portland Cement Proficiency Samples will be distributed in June 2007.

Sincerely,



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

Attachment

TO: Participants in the CCRL Portland Cement Proficiency Sample Program

FROM: Robin K. Haupt, Supervisor, PSP

SUBJECT: Explanation of Final Report on Results of Tests for Portland Cement Proficiency Samples No. 163 and No. 164

This letter, and the material included with it, constitute the final report, and summary of results for the current pair of Portland Cement Proficiency Samples, which were distributed in January 2007. This material includes a Table of Results for individual laboratory data, a statistical Summary of Results, and a set of general Scatter Diagrams. Your unique laboratory number is displayed at the top of the individual Table of Results.

An explanation of the program is contained in the paper: "Statistical Evaluation of Interlaboratory Cement Tests" by J. R. Crandall and R. L. Blaine [View document](#), and "Statistical Aspects of the Cement Testing Program" by W.J. Youden [View document](#), which can be found in Volume 59, Proceedings of the 62nd Annual Meeting of the Society, June 25, 1959, American Society for Testing and Materials.

Each laboratory receives an individualized Table of Results. The Table of Results shows the, test title, and the reporting unit in the first two columns. After that it lists in order, the laboratory's results for the odd and even numbered samples, overall averages for the odd and even numbered samples, and the laboratory's ratings for the odd and even samples.

Laboratory ratings, shown in the Table of Results for the individual laboratory, were determined in the manner described by Crandall and Blaine using a rating scale of 1 to 5 instead of 0 to 4. The ratings have no valid standing beyond showing the difference between the individual laboratory result and the average for a particular test.

The following table details the relationship between the ratings and the averages.

Ratings	Range (Number of Standard Deviations)	Number (Per 100) of Laboratories achieving the rating ¹
5	Less than 1	69
4	1 to 1.5	18
3	1.5 to 2	9
2	2 to 2.5	3
1	Greater than 2.5	1

The sign of the rating merely shows whether the result reported was greater or less than the average obtained.

Participants subscribing to the primary chemical analysis portion of this report should note that the statistics were calculated using data obtained by wet methods, and rapid methods of chemical analysis. Participants in the secondary chemical analysis should note that laboratory ratings are assigned using primary chemical statistics.

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

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.*

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.

Statistics for CO₂ and Limestone - Samples No.163 and No. 164 did NOT contain limestone additions, therefore statistics for CO₂ and limestone content were not generated.

Scatter Diagrams

General scatter diagrams are supplied with this report. Crandall and Blaine describe the manner of preparing scatter diagrams, and their interpretation, in the paper published in the 1959 ASTM Proceedings. Each laboratory will receive a complete set of diagrams according to their subscription to the given program.

Using the results received from each laboratory, a scatter diagram is generated for each test method by plotting the value for the odd numbered samples on the X, or horizontal axis, against the value for the even numbered samples on the Y, or vertical axis. To find your point, just plot as you would when plotting any scatter diagram. Vertical and horizontal dashed lines, which divide the diagrams into four sections or quadrants, place the average values for the odd and even numbered samples, respectively. The first line of print under the diagram includes the test number, as given on the data sheet, the test title, and the number of data points on the diagrams. The number of plotted points may not agree with the total number of data pairs included in the analysis because a few points may be off the diagram, and some points may represent several data pairs, which are identical. Laboratories whose points are off the diagram will have a rating of ± 1 for that particular test.

Diagrams for CO₂ and Limestone - Samples No.163 and No. 164 did NOT contain limestone additions, therefore scatter diagrams for CO₂ and limestone content were not printed.

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
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Chemical Results
 April 8, 2007

SUMMARY OF RESULTS

Test		#Labs	Sample No. 163			Sample No. 164		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Silicon Dioxide	prcnt	235	20.59	0.32	1.57	20.22	0.32	1.58
Silicon Dioxide	prcnt *	223	20.59	0.24	1.16	20.20	0.20	1.02
Aluminum Oxide	prcnt	235	4.95	0.20	4.02	5.14	0.18	3.47
Aluminum Oxide	prcnt *	223	4.93	0.13	2.64	5.13	0.11	2.23
Ferric Oxide	prcnt	238	2.77	0.19	6.93	4.23	0.16	3.74
Ferric Oxide	prcnt *	228	2.75	0.053	1.94	4.24	0.089	2.10
Calcium Oxide	prcnt	235	63.95	0.59	0.926	63.62	0.58	0.905
Calcium Oxide	prcnt *	230	63.94	0.44	0.680	63.64	0.48	0.761
Magnesium Oxide	prcnt	237	1.87	0.124	6.66	1.08	0.098	9.15
Magnesium Oxide	prcnt *	222	1.87	0.068	3.63	1.06	0.061	5.74
Sulfur Trioxide	prcnt	239	2.90	0.15	5.16	3.59	0.13	3.75
Sulfur Trioxide	prcnt *	224	2.88	0.083	2.88	3.58	0.094	2.63
Loss on Ignition	prcnt	242	1.46	0.18	12.35	1.09	0.10	9.28
Loss on Ignition	prcnt *	225	1.44	0.091	6.36	1.09	0.069	6.32
Sodium Oxide	prcnt	224	0.193	0.037	19.2	0.063	0.044	69.8
Sodium Oxide	prcnt *	208	0.196	0.024	12.0	0.058	0.022	38.0

CONTINUED ON NEXT PAGE

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

Silicon Dioxide	3 18 22 39 52 126 1940 142 201 853 2305 2466
Aluminum Oxide	22 47 143 201 768 3 8 20 168 305 2466 2484
Ferric Oxide	8 207 918 1715 25 29 51 2466 3125
Calcium Oxide	2 22 30 107 1251
Magnesium Oxide	41 127 201 207 918 1644 1715 2463 8 1251 1523 1676 2466 3127 3135
Sulfur Trioxide	2 107 207 305 697 918 1644 1715 126 203 492 853 1853 2295 2305
Loss on Ignition	19 101 121 137 167 197 244 696 125 221 354 787 1251 1715 2295 2305 2621
Sodium Oxide	30 207 222 354 504 1466 2437 2464 2466 2484 125 197 1657 3125 3127 3135

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Chemical Results
 April 8, 2007

SUMMARY OF RESULTS

Test		#Labs	Sample No. 163			Sample No. 164		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Potassium Oxide	prcnt	229	0.681	0.036	5.25	0.382	0.032	8.28
Potassium Oxide	prcnt *	215	0.682	0.021	3.03	0.383	0.018	4.75
Titanium Dioxide	prcnt	167	0.30	0.029	9.61	0.33	0.023	7.13
Titanium Dioxide	prcnt *	157	0.30	0.012	3.83	0.33	0.013	3.97
Phosphorous Pent	prcnt	159	0.210	0.024	11.4	0.095	0.018	19.6
Phosphorous Pent	prcnt *	136	0.214	0.0086	4.01	0.093	0.0066	7.05
Zinc Oxide	prcnt	83	0.046	0.032	70.4	0.064	0.020	30.8
Zinc Oxide	prcnt *	74	0.042	0.0035	8.17	0.062	0.0053	8.55
Manganic Oxide	prcnt	129	0.048	0.1628	341.3	0.068	0.0097	14.3
Manganic Oxide	prcnt *	120	0.035	0.0054	15.81	0.069	0.0040	5.88
Chloride	prcnt	95	0.008	0.010	124	0.008	0.013	171
Chloride	prcnt *	85	0.006	0.0029	49.6	0.004	0.0029	66.8
Insoluble Residue	prcnt	221	0.27	0.23	83.4	0.20	0.12	61.2
Insoluble Residue	prcnt *	209	0.24	0.086	36.7	0.18	0.082	45.0
Free Calcium Oxid	prcnt	192	0.65	0.24	37.2	0.63	0.33	52.7
Free Calcium Oxid	prcnt *	188	0.63	0.18	27.8	0.61	0.18	30.6

CONTINUED ON NEXT PAGE

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

Potassium Oxide	3 8 22 207 698 883 52 73 95 169 206 2463 2484 2492
Titanium Dioxide	20 26 86 504 22 54 130 2292 2412 2466
Phosphorus Pentoxide	54 86 207 413 493 504 1196 95 127 201 205 687 1799 2295 2466 9 56 166 181 497 2412 2462 3125
Zinc Oxide	19 30 39 92 130 95 1466 2412 2484
Manganic Oxide	20 695 45 54 124 1466 2437 2462 3135
Chloride	246 870 2482 92 244 1644 2363 54 255 3057
Insoluble Residue	270 501 697 1799 2491 3009 121 175 918 2477 3057
Free Calcium Oxide	107 1799 2308 2463

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Chemical Results
 April 8, 2007

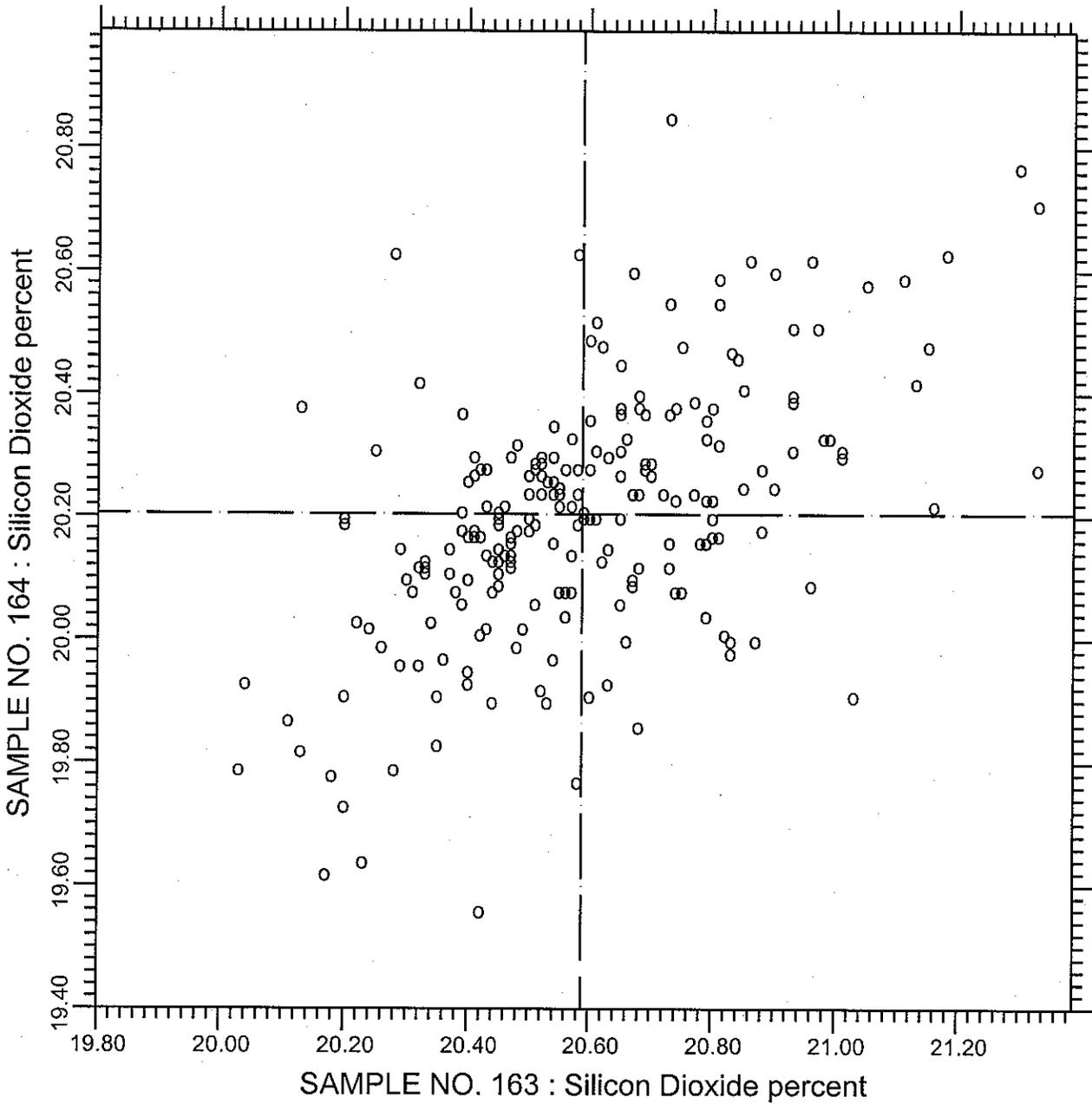
SUMMARY OF RESULTS

Test	Sample No. 163					Sample No. 164		
	#Labs	Average	S.D.	C.V.	Average	S.D.	C.V.	
Carbon Dioxide	Not Determined for Samples 163 & 164 - Cements did not Contain Limestone Additions							
Limestone	Not Determined for Samples 163 & 164 - Cements did not Contain Limestone Additions							
Chromium Oxide	prcnt	79	0.015	0.010	70.5	0.016	0.014	87.5
Chromium Oxide	prcnt *	74	0.013	0.0041	32.1	0.013	0.0050	38.4
Tricalcium Silicate	prcnt	199	58.7	3.1	5.25	54.9	3.3	6.05
Tricalcium Silicate	prcnt *	193	58.5	2.7	4.58	54.7	2.6	4.81
Dicalcium Silicate	prcnt	197	14.8	2.7	18.2	16.5	2.9	17.5
Tricalc Aluminate	prcnt	200	8.4	0.55	6.55	6.48	0.62	9.50
Tricalc Aluminate	prcnt *	195	8.4	0.42	4.98	6.41	0.36	5.56
Tetracalc Alumino	prcnt	194	8.4	0.45	5.39	12.9	0.52	4.04
Tetracalc Alumino	prcnt *	188	8.4	0.17	2.01	12.9	0.28	2.16

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

Chromium Oxide	20 36 30 2934 3135
Tricalcium Silicate	30 158 1196 1379 1940 2305
Tricalcium Aluminate	47 143 175 1715 2466
Tetracalcium Aluminoferrite	8 458 1715 29 2466 3125

CCRL PROFICIENCY SAMPLE PROGRAM
 Silicon Dioxide
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.10

Silicon Dioxide

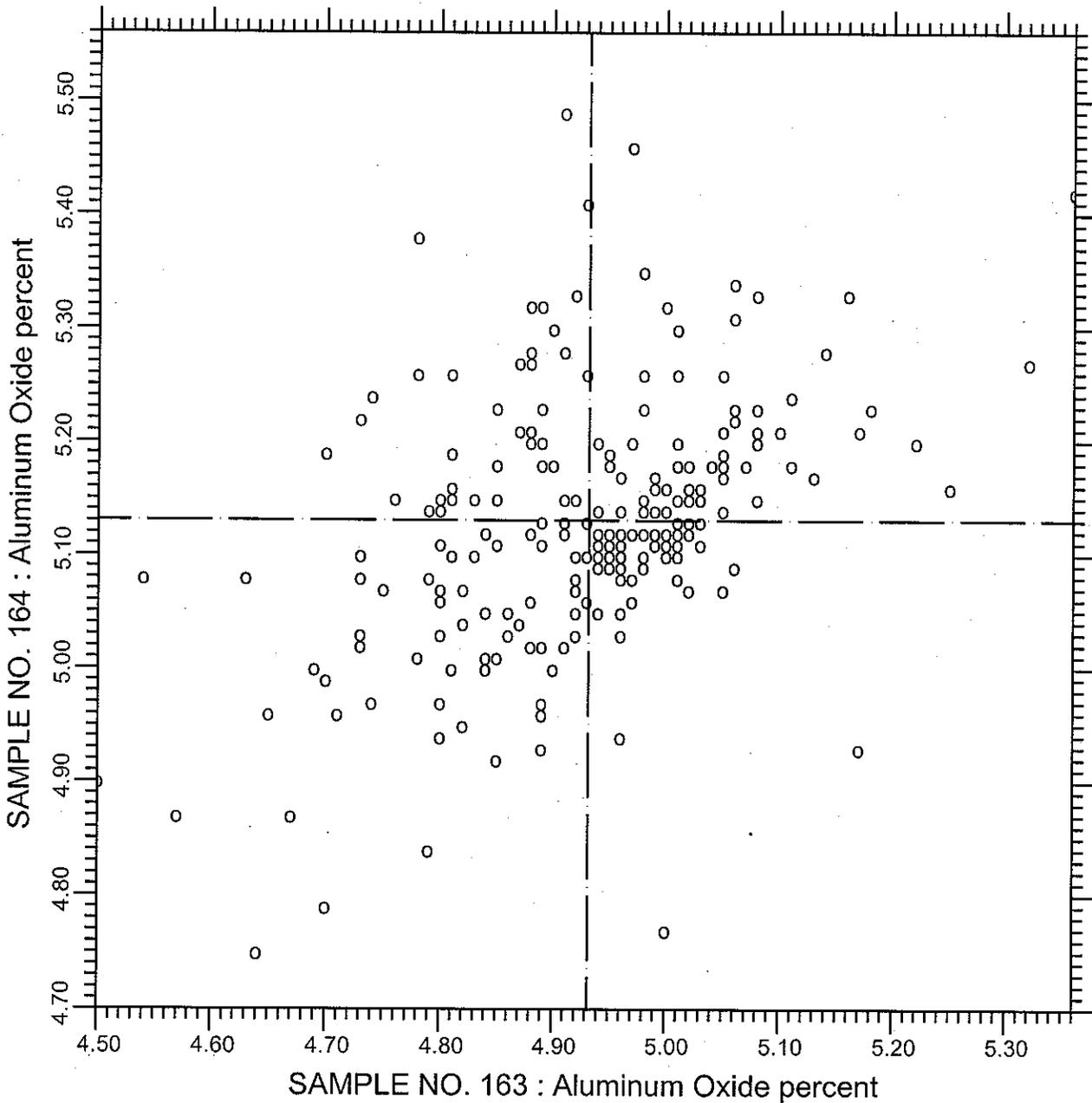
223 POINTS

SAMPLE NO. 163 AVE 20.588 S.D. 0.24 C.V. 1.16

SAMPLE NO. 164 AVE 20.204 S.D. 0.20 C.V. 1.02

LABS ELIMINATED 3 18 22 39 52 126 1940 142 201 853 2305 2466

CCRL PROFICIENCY SAMPLE PROGRAM
Aluminum Oxide - wo/minor oxides
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.21

Aluminum Oxide

222 POINTS

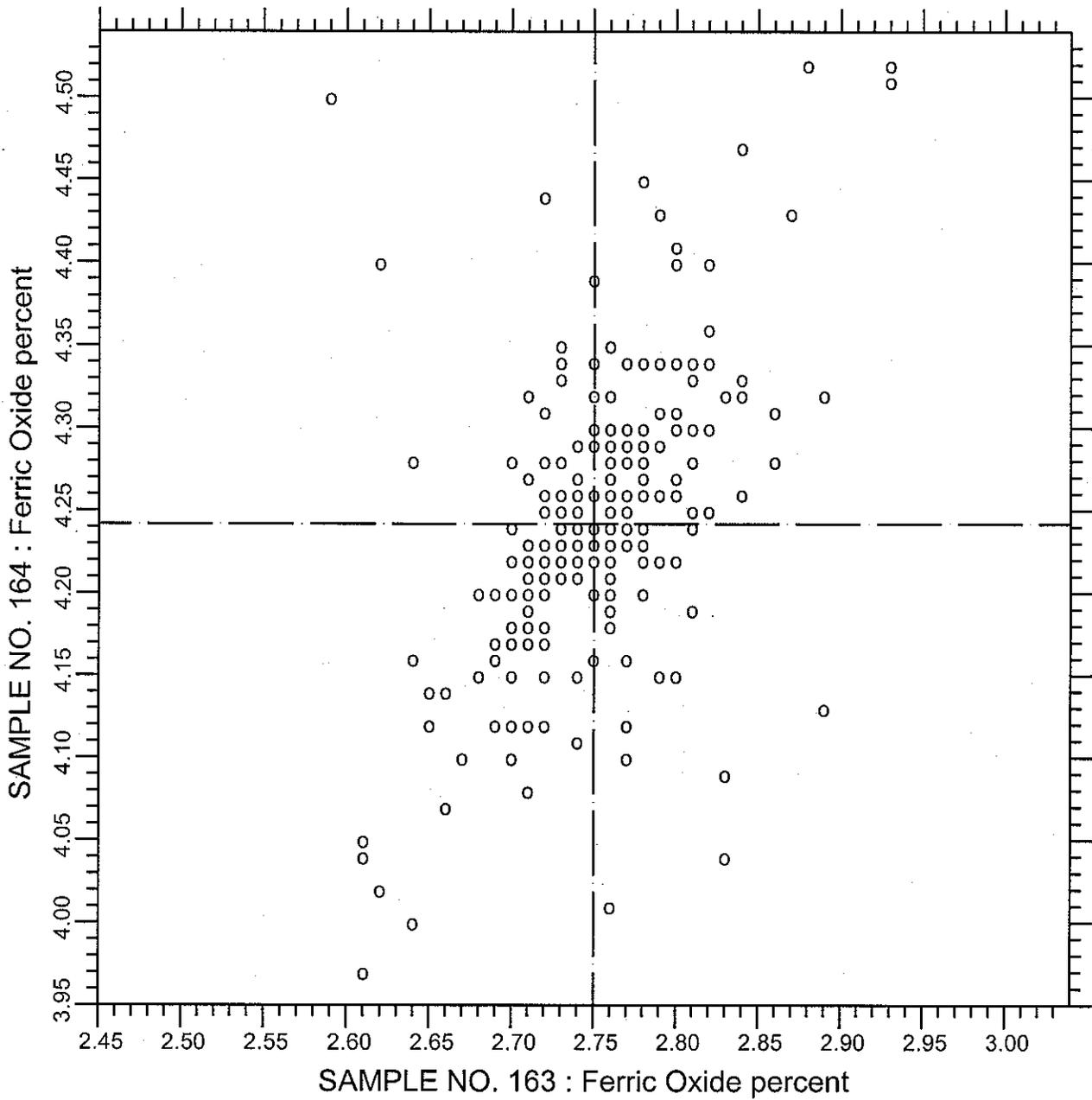
SAMPLE NO. 163 AVE 4.9322 S.D. 0.13 C.V. 2.64

SAMPLE NO. 164 AVE 5.1307 S.D. 0.11 C.V. 2.23

LABS ELIMINATED 22 47 143 201 768 3 8 20 168 305 2466 2484

LABS OFF DIAGRAM 207

CCRL PROFICIENCY SAMPLE PROGRAM
Ferric Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.30

Ferric Oxide

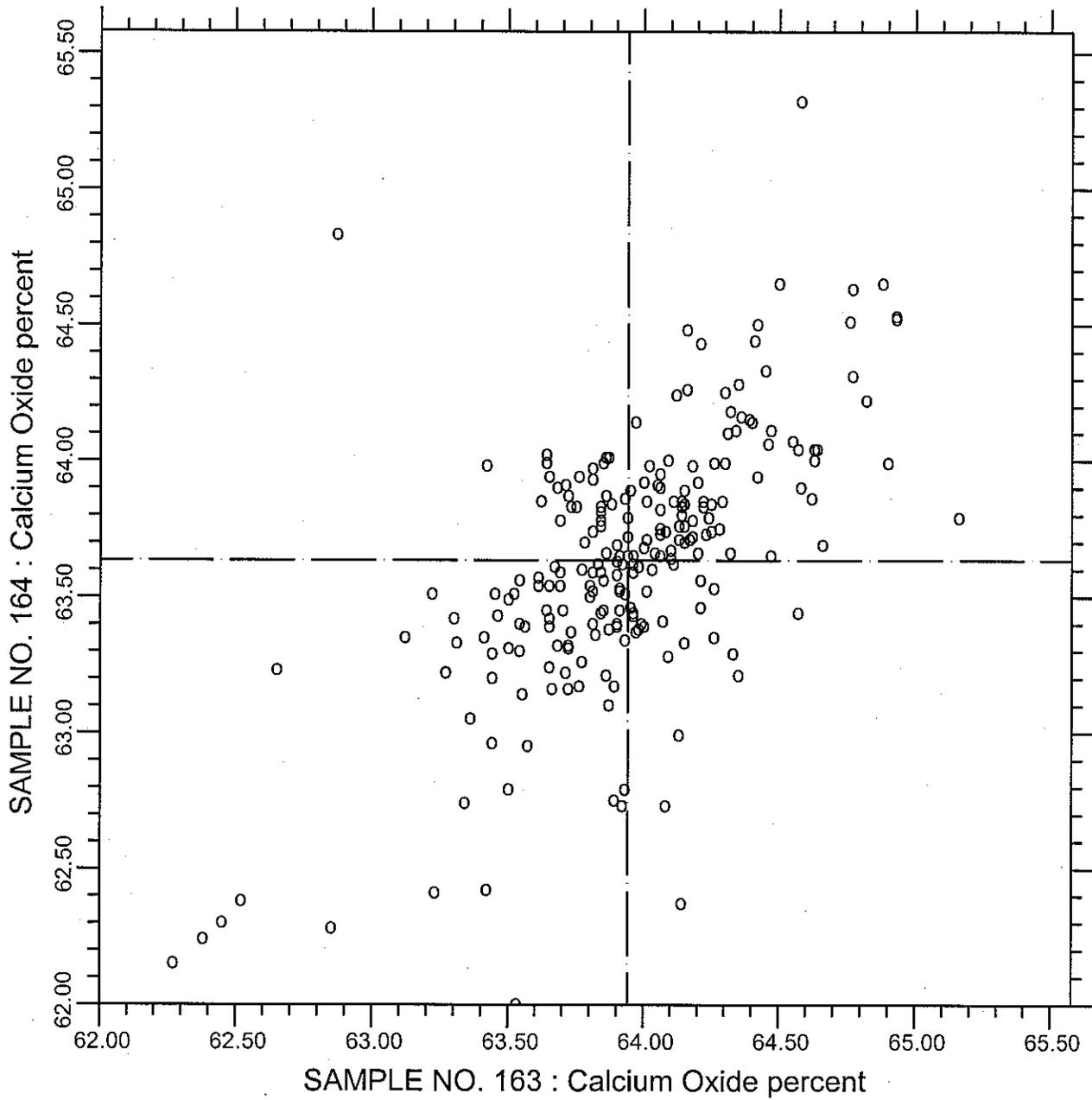
228 POINTS

SAMPLE NO. 163 AVE 2.7503 S.D. 0.053 C.V. 1.94

SAMPLE NO. 164 AVE 4.2417 S.D. 0.089 C.V. 2.10

LABS ELIMINATED 8 207 918 1715 25 29 51 768 2466 3125

CCRL PROFICIENCY SAMPLE PROGRAM
Calcium Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.40

Calcium Oxide

229 POINTS

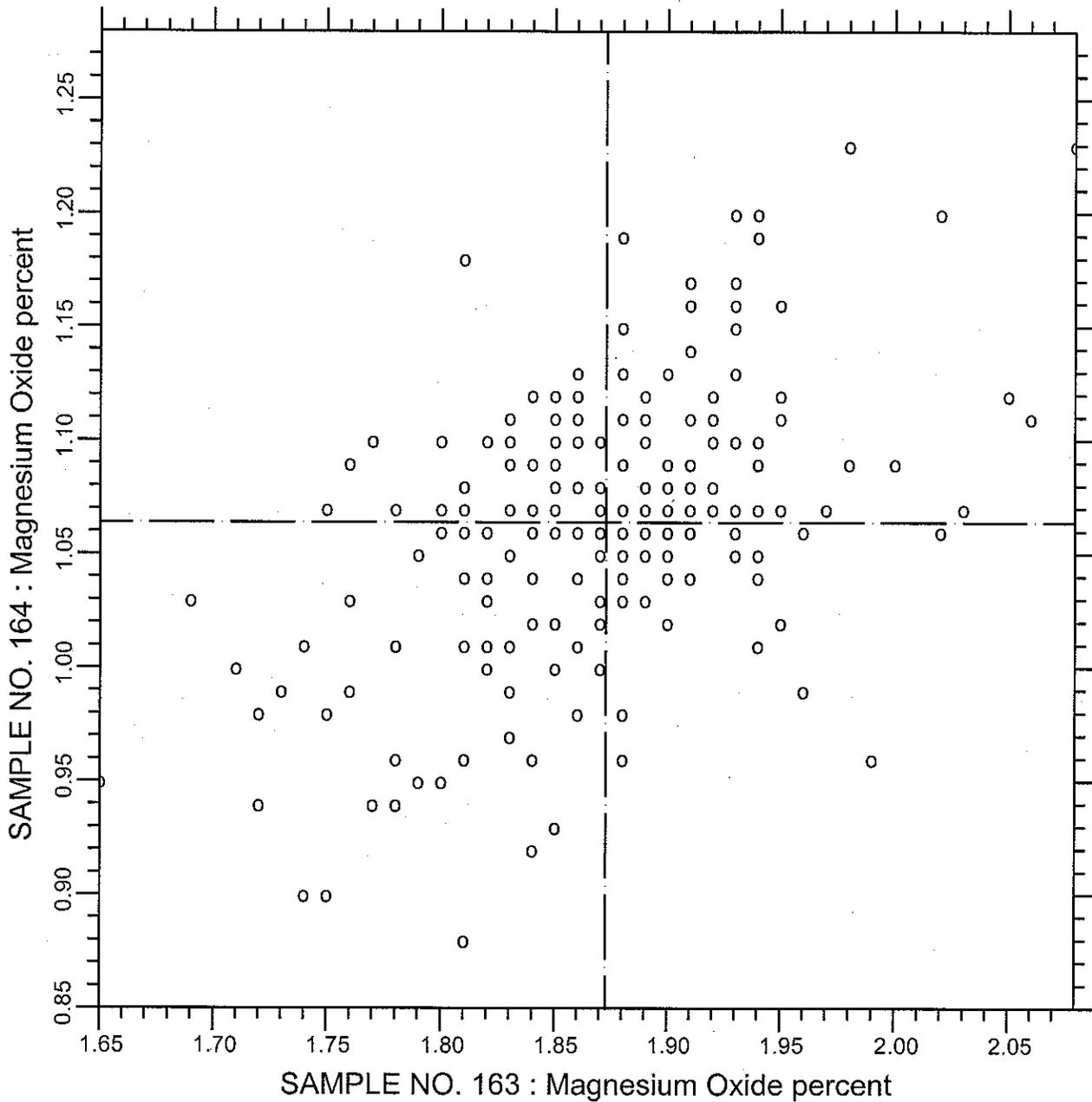
SAMPLE NO. 163 AVE 63.942 S.D. 0.44 C.V. 0.680

SAMPLE NO. 164 AVE 63.636 S.D. 0.48 C.V. 0.761

LABS ELIMINATED 2 22 30 107 1251

LABS OFF DIAGRAM 176

CCRL PROFICIENCY SAMPLE PROGRAM
Magnesium Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.50

Magnesium Oxide

220 POINTS

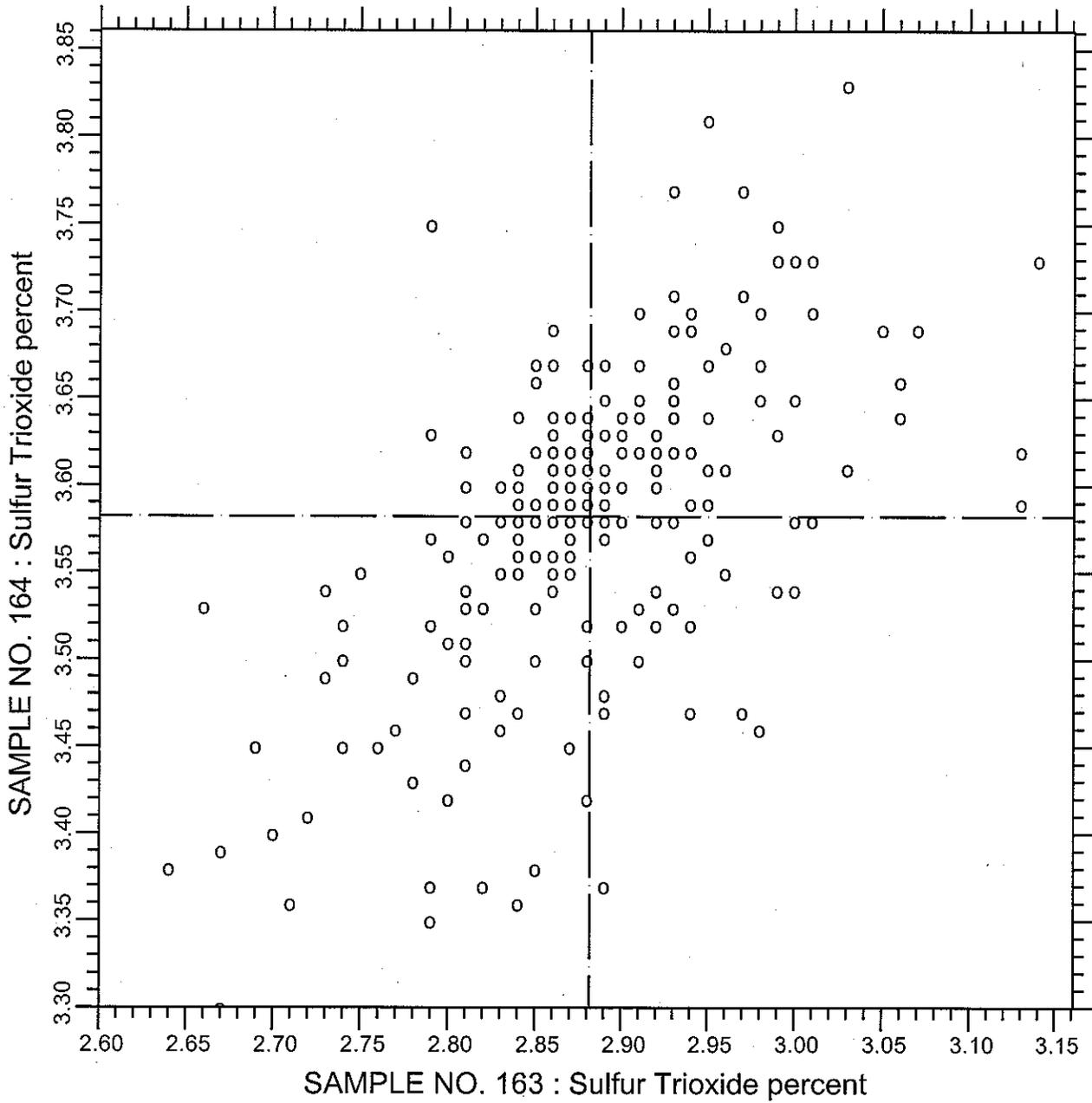
SAMPLE NO. 163 AVE 1.8727 S.D. 0.068 C.V. 3.63

SAMPLE NO. 164 AVE 1.0638 S.D. 0.061 C.V. 5.74

LABS ELIMINATED 41 127 201 207 918 1644 1715 2463 8 1251 1523 1676
2466 3127 3135

LABS OFF DIAGRAM 3 29

CCRL PROFICIENCY SAMPLE PROGRAM
Sulfur Trioxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.60

Sulfur Trioxide

222 POINTS

SAMPLE NO. 163 AVE 2.8818 S.D. 0.083 C.V. 2.88

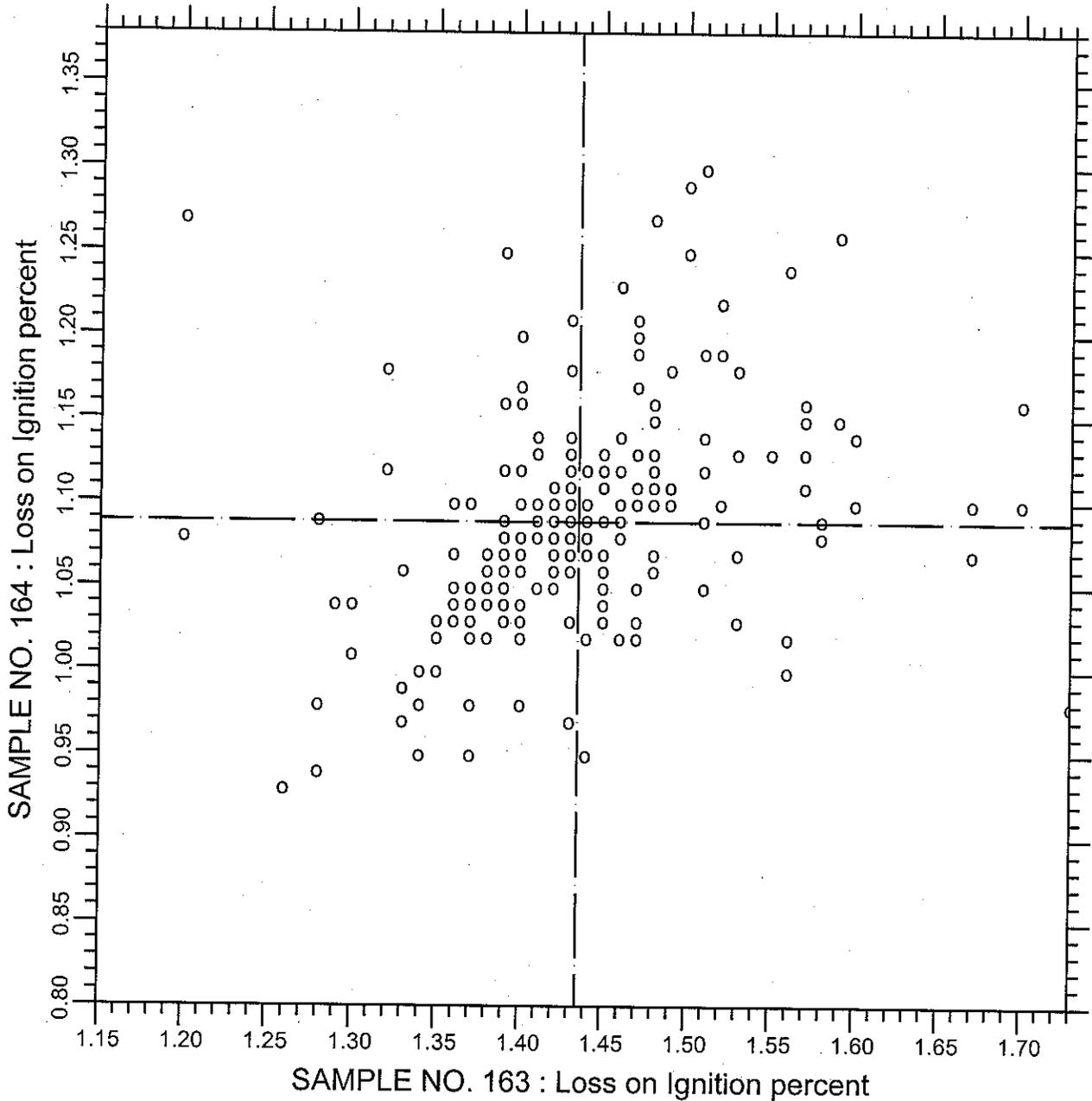
SAMPLE NO. 164 AVE 3.5820 S.D. 0.094 C.V. 2.63

LABS ELIMINATED 2 107 207 305 697 918 1644 1715 126 203 492 853

1853 2295 2305

LABS OFF DIAGRAM 1054 2463

CCRL PROFICIENCY SAMPLE PROGRAM
 Loss on Ignition
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.70

Loss on Ignition

220 POINTS

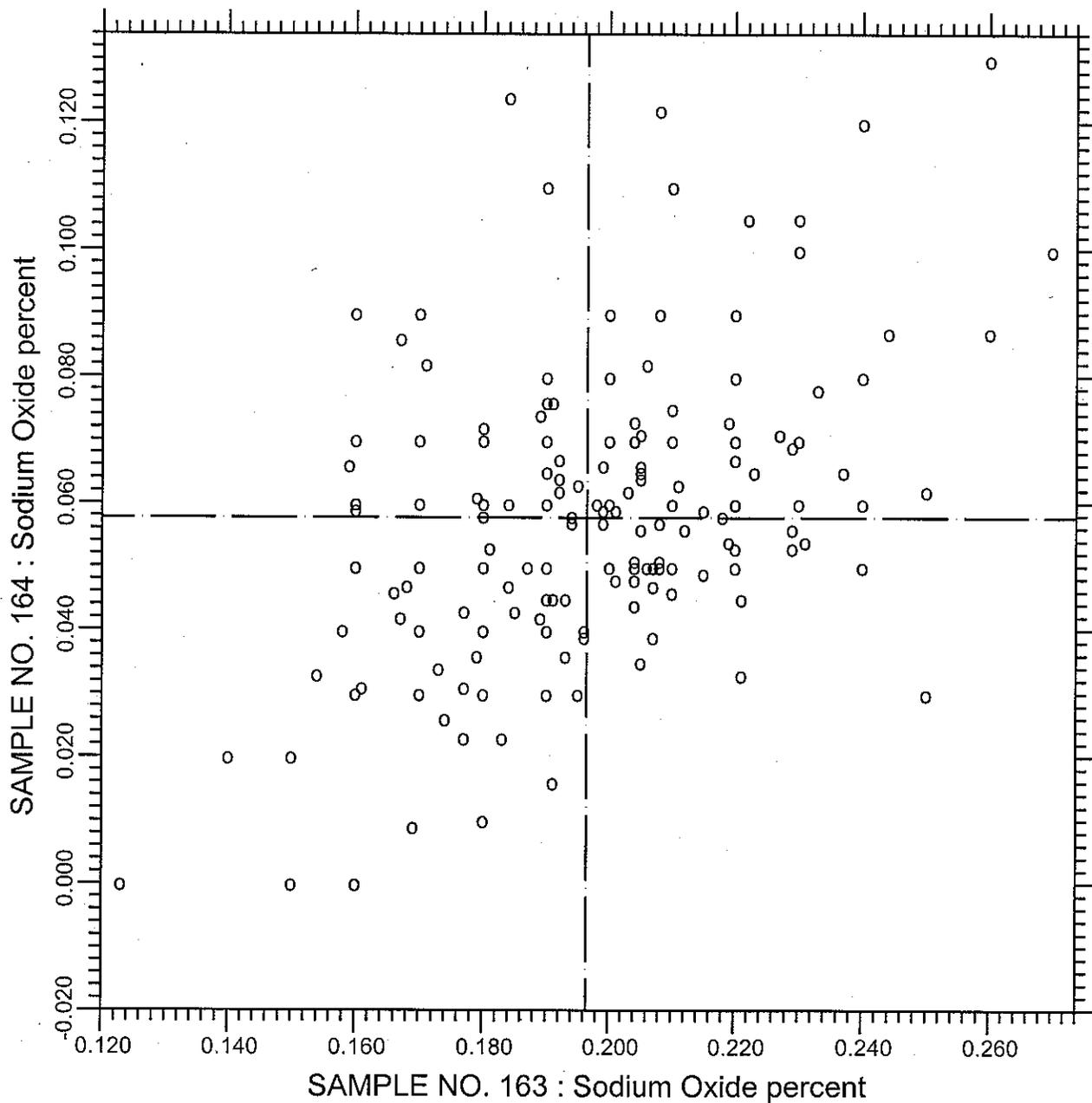
SAMPLE NO. 163 AVE 1.4352 S.D. 0.091 C.V. 6.36

SAMPLE NO. 164 AVE 1.0885 S.D. 0.069 C.V. 6.32

LABS ELIMINATED 19 101 121 137 167 197 244 696 125 221 354 787 1251
 1715 2295 2305 2621

LABS OFF DIAGRAM 207 853 918 2466 3126

CCRL PROFICIENCY SAMPLE PROGRAM
Sodium Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.90

Sodium Oxide

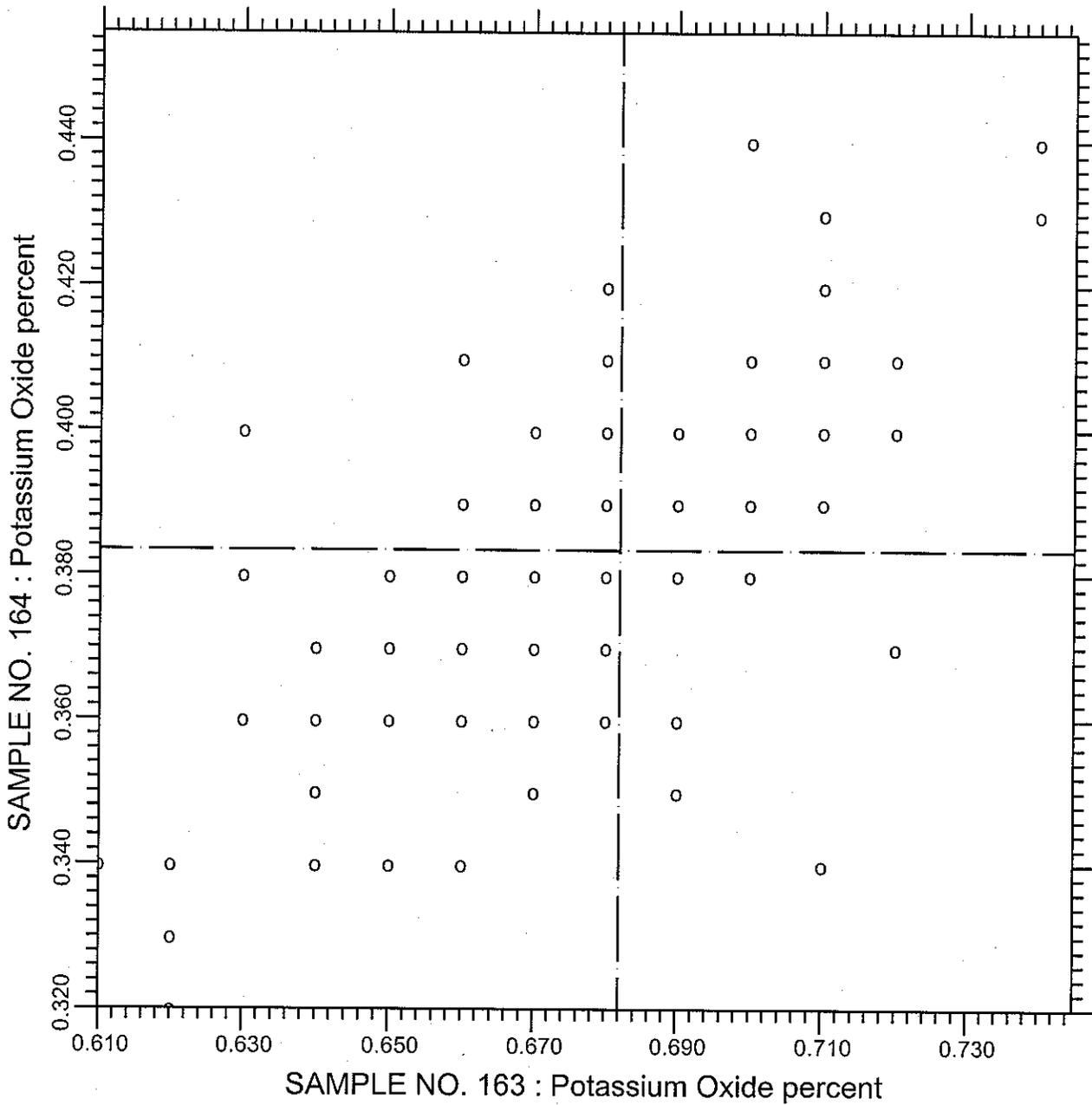
208 POINTS

SAMPLE NO. 163 AVE 0.1964 S.D. 0.024 C.V. 12.0

SAMPLE NO. 164 AVE 0.0577 S.D. 0.022 C.V. 38.0

LABS ELIMINATED 30 207 222 354 504 1466 2437 2464 2466 2484 125 197
1657 3125 3127 3135

CCRL PROFICIENCY SAMPLE PROGRAM
Potassium Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.100

Potassium Oxide

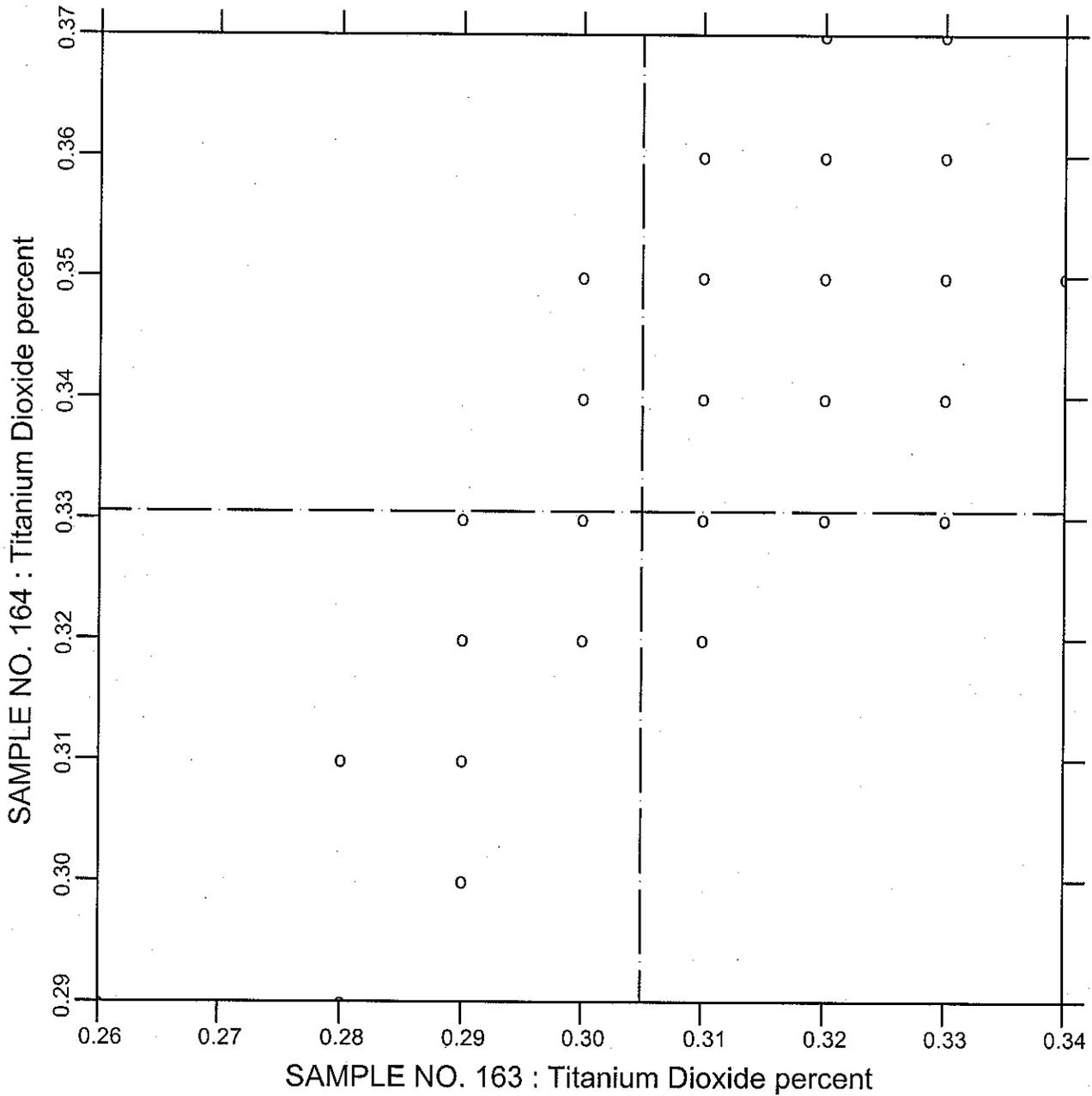
215 POINTS

SAMPLE NO. 163 AVE 0.6820 S.D. 0.021 C.V. 3.03

SAMPLE NO. 164 AVE 0.3834 S.D. 0.018 C.V. 4.75

LABS ELIMINATED 3 8 22 207 698 883 52 73 95 169 206 2463 2484 2492

CCRL PROFICIENCY SAMPLE PROGRAM
Titanium Dioxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



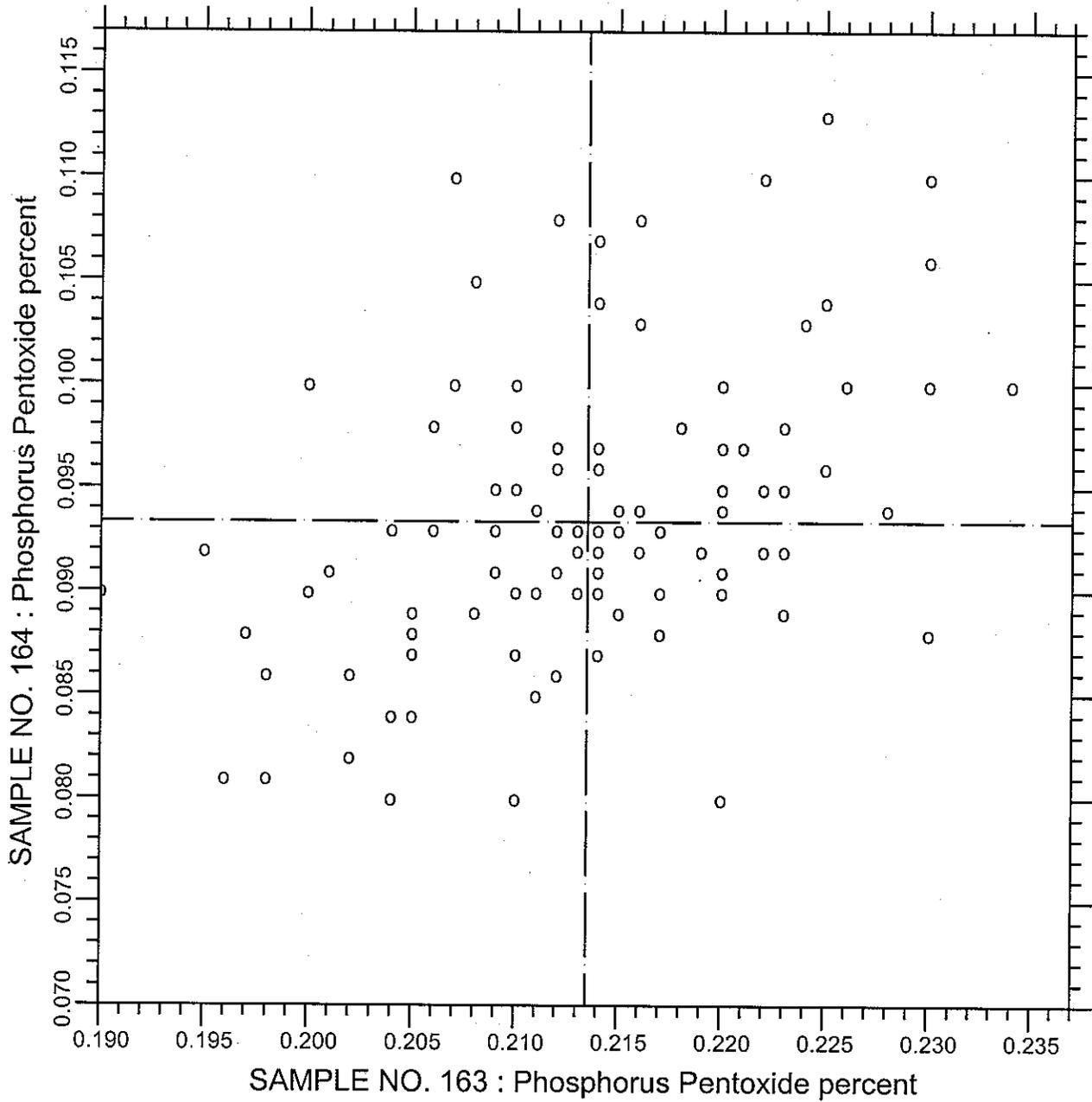
TEST NO.103 Titanium Dioxide 157 POINTS

SAMPLE NO. 163 AVE 0.30497 S.D. 0.012 C.V. 3.83

SAMPLE NO. 164 AVE 0.33057 S.D. 0.013 C.V. 3.97

LABS ELIMINATED 20 26 86 504 22 54 130 2292 2412 2466

CCRL PROFICIENCY SAMPLE PROGRAM
Phosphorus Pentoxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.102 Phosphorus Pentoxide 136 POINTS

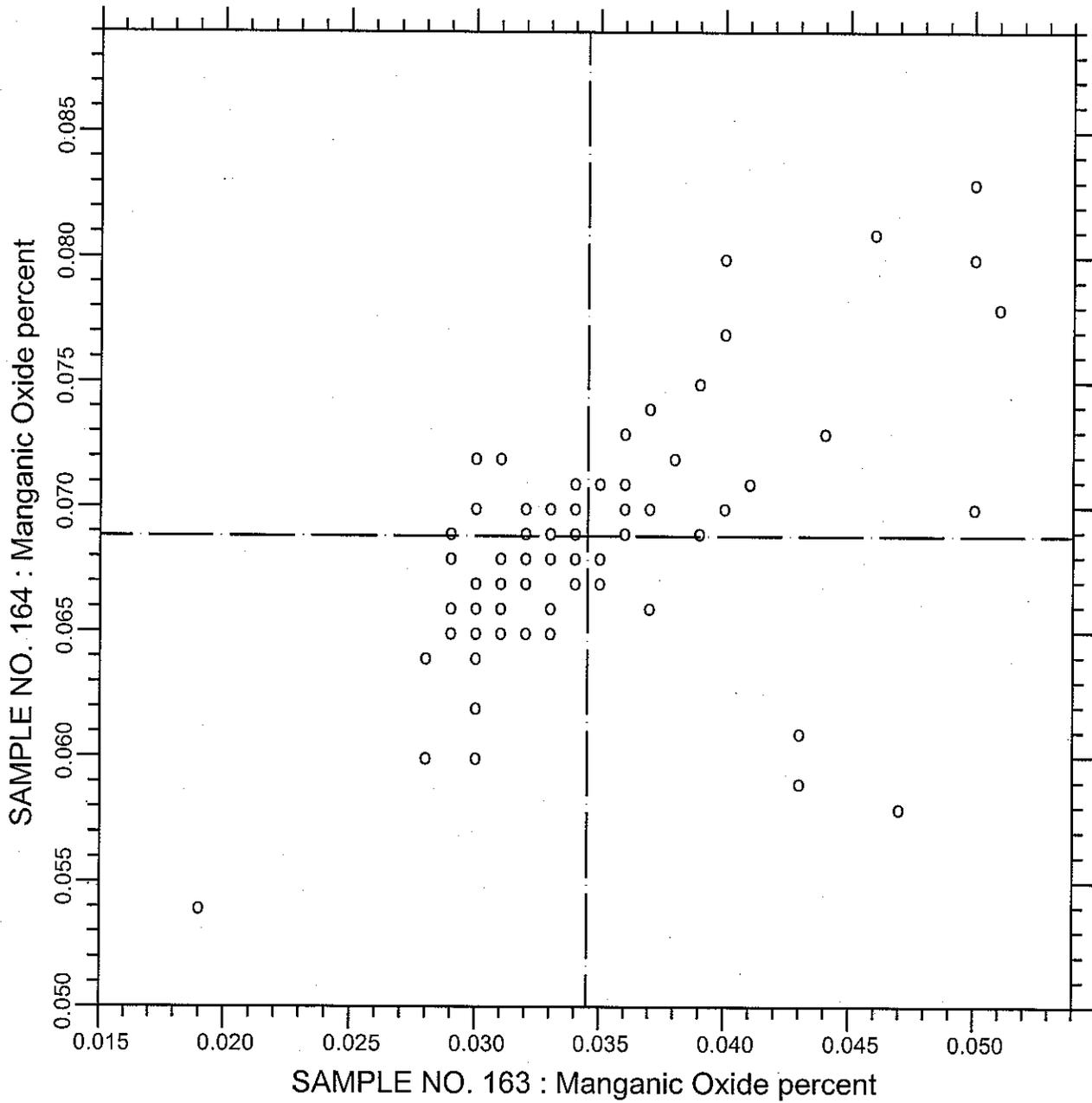
SAMPLE NO. 163 AVE 0.21351 S.D. 0.0086 C.V. 4.01

SAMPLE NO. 164 AVE 0.09335 S.D. 0.0066 C.V. 7.05

LABS ELIMINATED 54 86 207 413 493 504 1196 95 127 201 205 687 1799

2295 2466 9 56 166 181 497 2412 2462 3125

CCRL PROFICIENCY SAMPLE PROGRAM
Manganic Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.101

Manganic Oxide

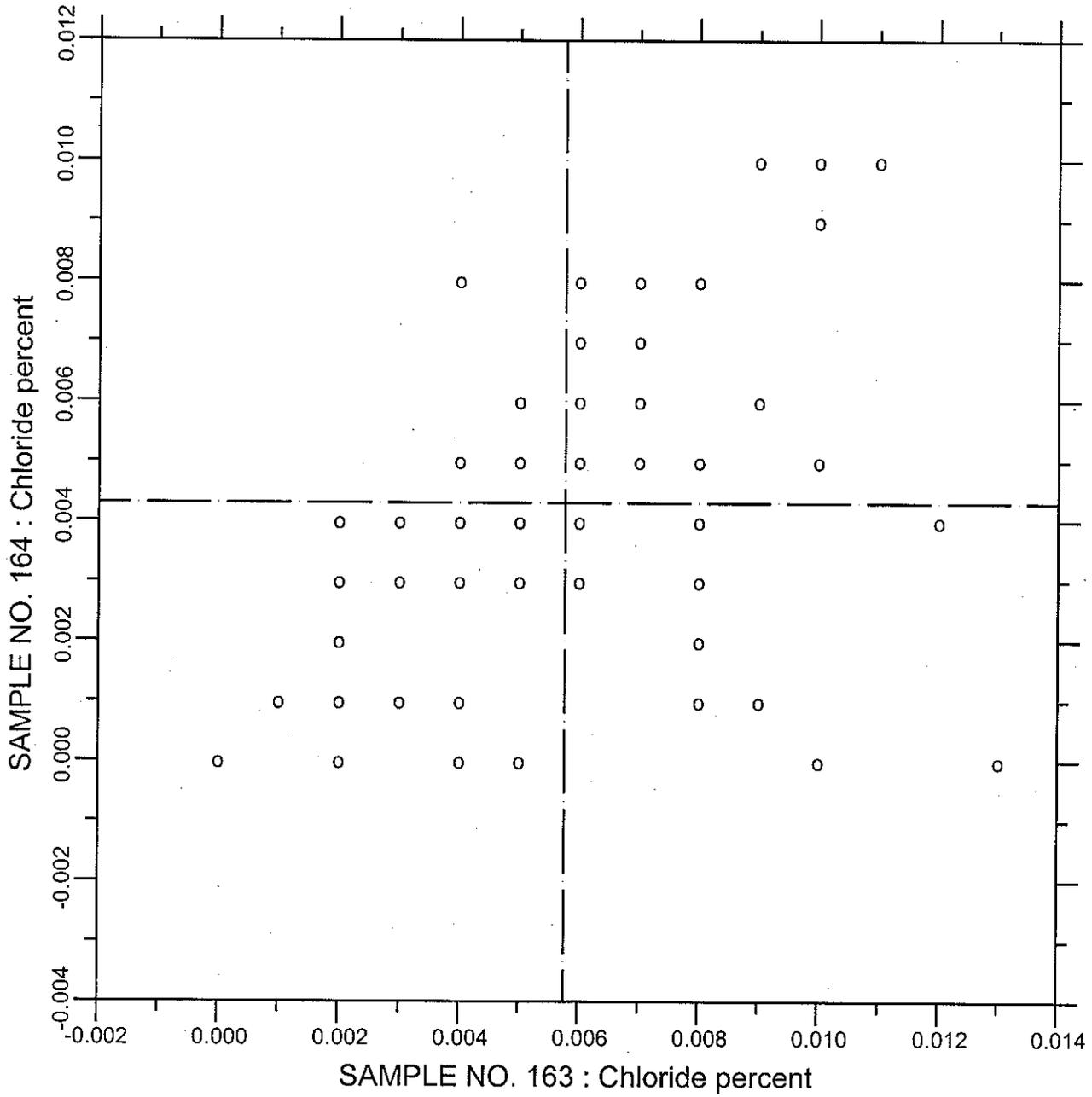
120 POINTS

SAMPLE NO. 163 AVE 0.03452 S.D. 0.0054 C.V. 15.81

SAMPLE NO. 164 AVE 0.06883 S.D. 0.0040 C.V. 5.88

LABS ELIMINATED 20 695 45 54 124 1466 2437 2462 3135

CCRL PROFICIENCY SAMPLE PROGRAM
Chloride
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.104

Chloride

84 POINTS

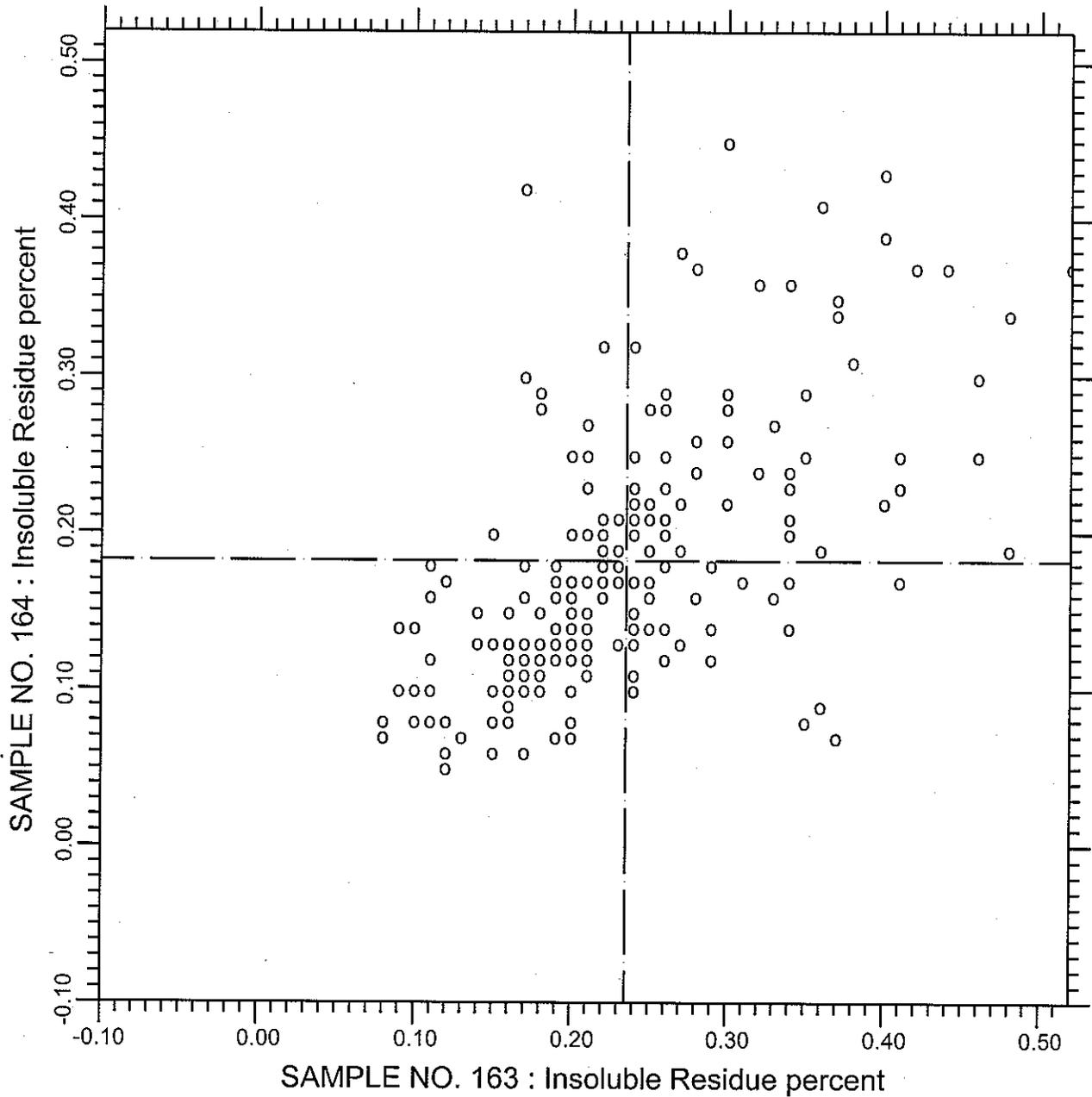
SAMPLE NO. 163 AVE 0.00576 S.D. 0.0029 C.V. 49.6

SAMPLE NO. 164 AVE 0.00430 S.D. 0.0029 C.V. 66.8

LABS ELIMINATED 246 870 2482 92 244 1644 2363 54 255 3057

LABS OFF DIAGRAM 1041

CCRL PROFICIENCY SAMPLE PROGRAM
 Insoluble Residue
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.80

Insoluble Residue

208 POINTS

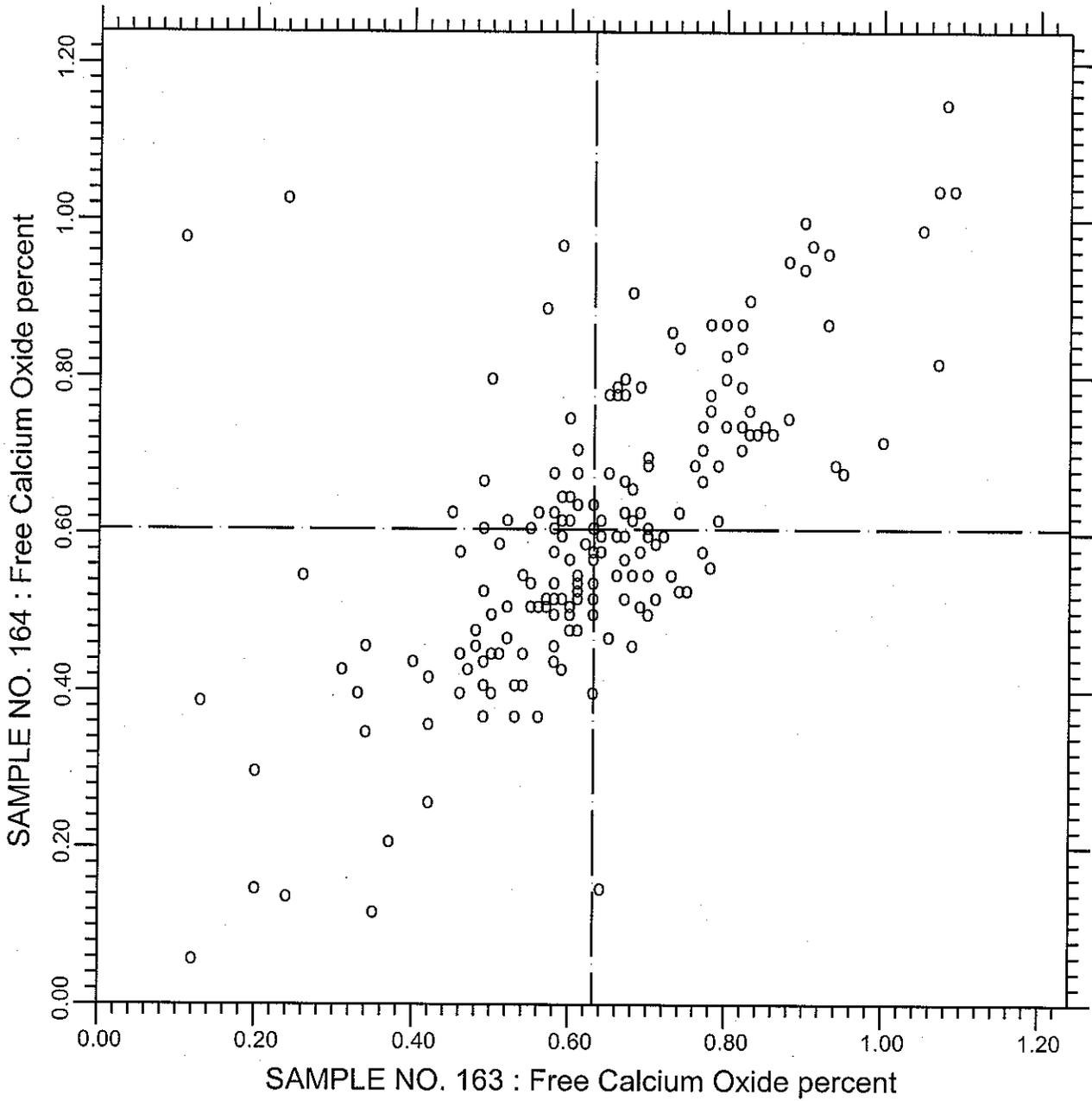
SAMPLE NO. 163 AVE 0.2354 S.D. 0.086 C.V. 36.7

SAMPLE NO. 164 AVE 0.1822 S.D. 0.082 C.V. 45.0

LABS ELIMINATED 270 501 697 1799 2491 3009 121 175 918 2437 2477

3057

CCRL PROFICIENCY SAMPLE PROGRAM
Free Calcium Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.41

Free Calcium Oxide

188 POINTS

SAMPLE NO. 163 AVE 0.631 S.D. 0.18 C.V. 27.8

SAMPLE NO. 164 AVE 0.606 S.D. 0.18 C.V. 30.6

LABS ELIMINATED 107 1799 2308 2463

CCRL PROFICIENCY SAMPLE PROGRAM
Carbon Dioxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164

No Diagram Printed for this Component

Samples No. 163 & No. 164 did not
Contain Limestone Additions.

Carbon Dioxide was not determined
for these samples.

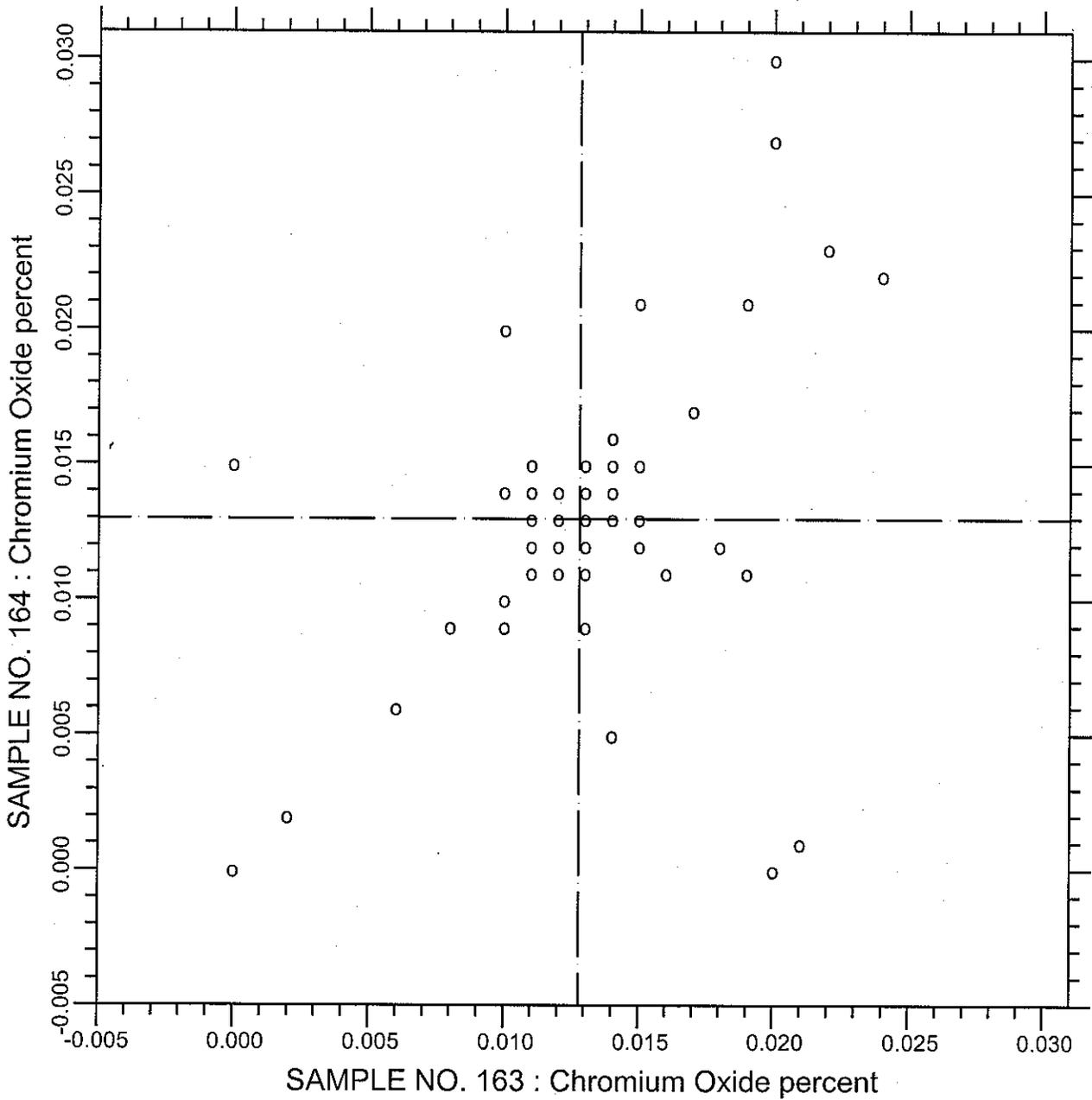
CCRL PROFICIENCY SAMPLE PROGRAM
Limestone Content
PORTLAND CEMENT SAMPLES NO. 161 & NO. 162

No Diagram Printed for this Component

Samples No. 163 & No. 164 did not
Contain Limestone Additions.

Limestone Content was not determined
for these samples.

CCRL PROFICIENCY SAMPLE PROGRAM
Chromium Oxide
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.105

Chromium Oxide

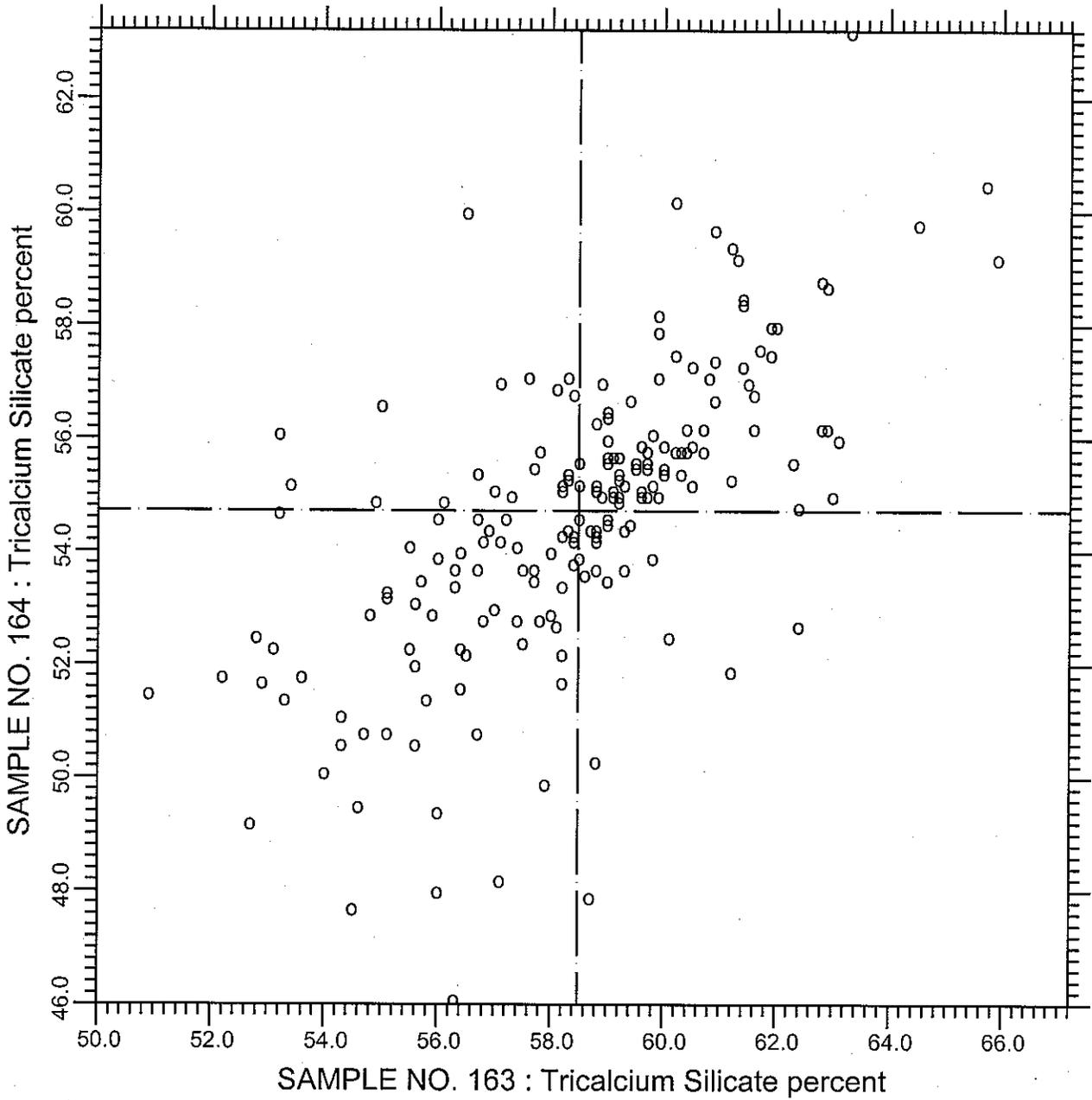
74 POINTS

SAMPLE NO. 163 AVE 0.01280 S.D. 0.0041 C.V. 32.1

SAMPLE NO. 164 AVE 0.01299 S.D. 0.0050 C.V. 38.4

LABS ELIMINATED 20 36 30 2934 3135

CCRL PROFICIENCY SAMPLE PROGRAM
Tricalcium Silicate
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.106

Tricalcium Silicate

191 POINTS

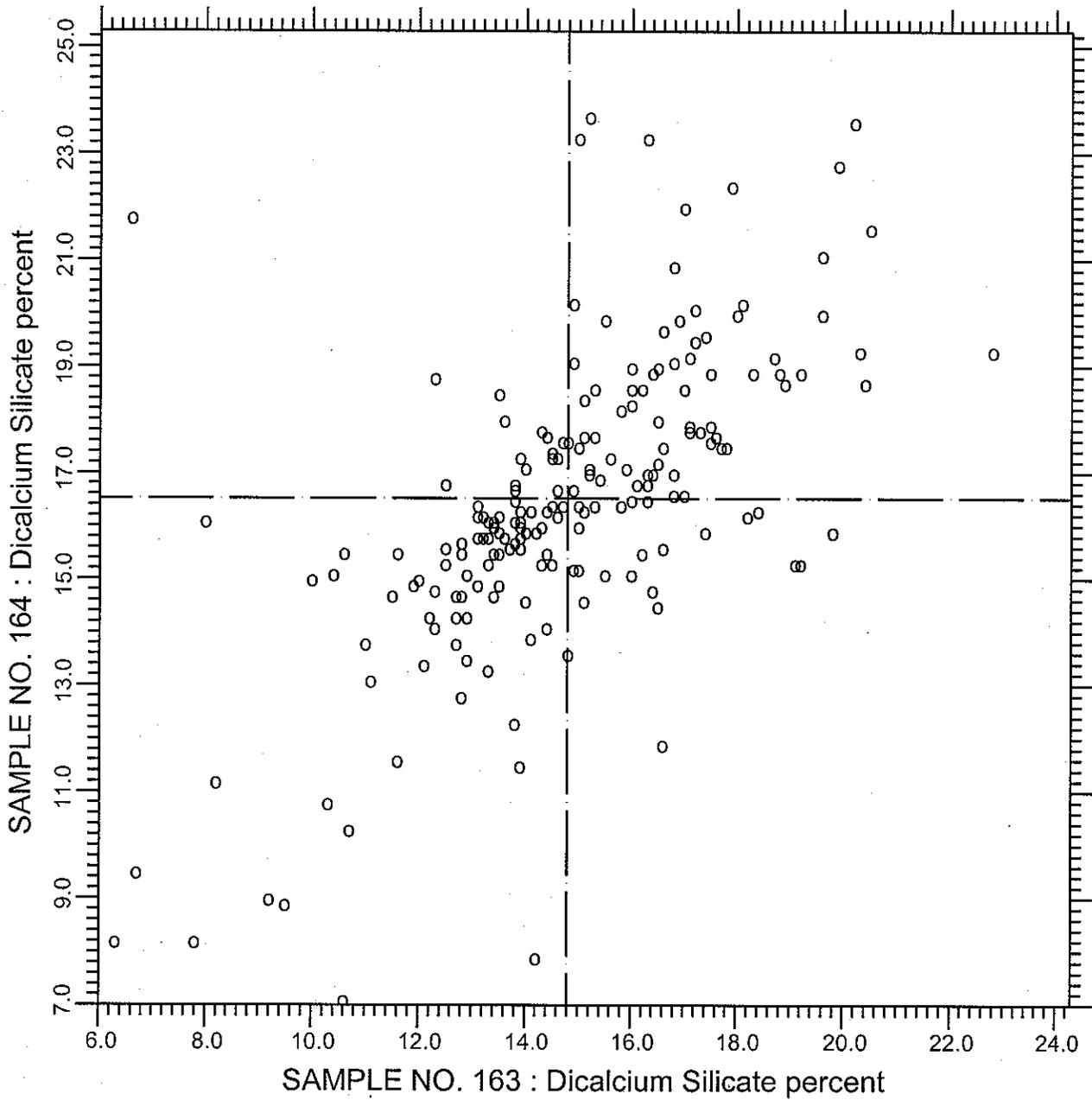
SAMPLE NO. 163 AVE 58.49 S.D. 2.7 C.V. 4.58

SAMPLE NO. 164 AVE 54.72 S.D. 2.6 C.V. 4.81

LABS ELIMINATED 30 158 1196 1379 1940 2305

LABS OFF DIAGRAM 36 201

CCRL PROFICIENCY SAMPLE PROGRAM
 Dicalcium Silicate
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.107

Dicalcium Silicate

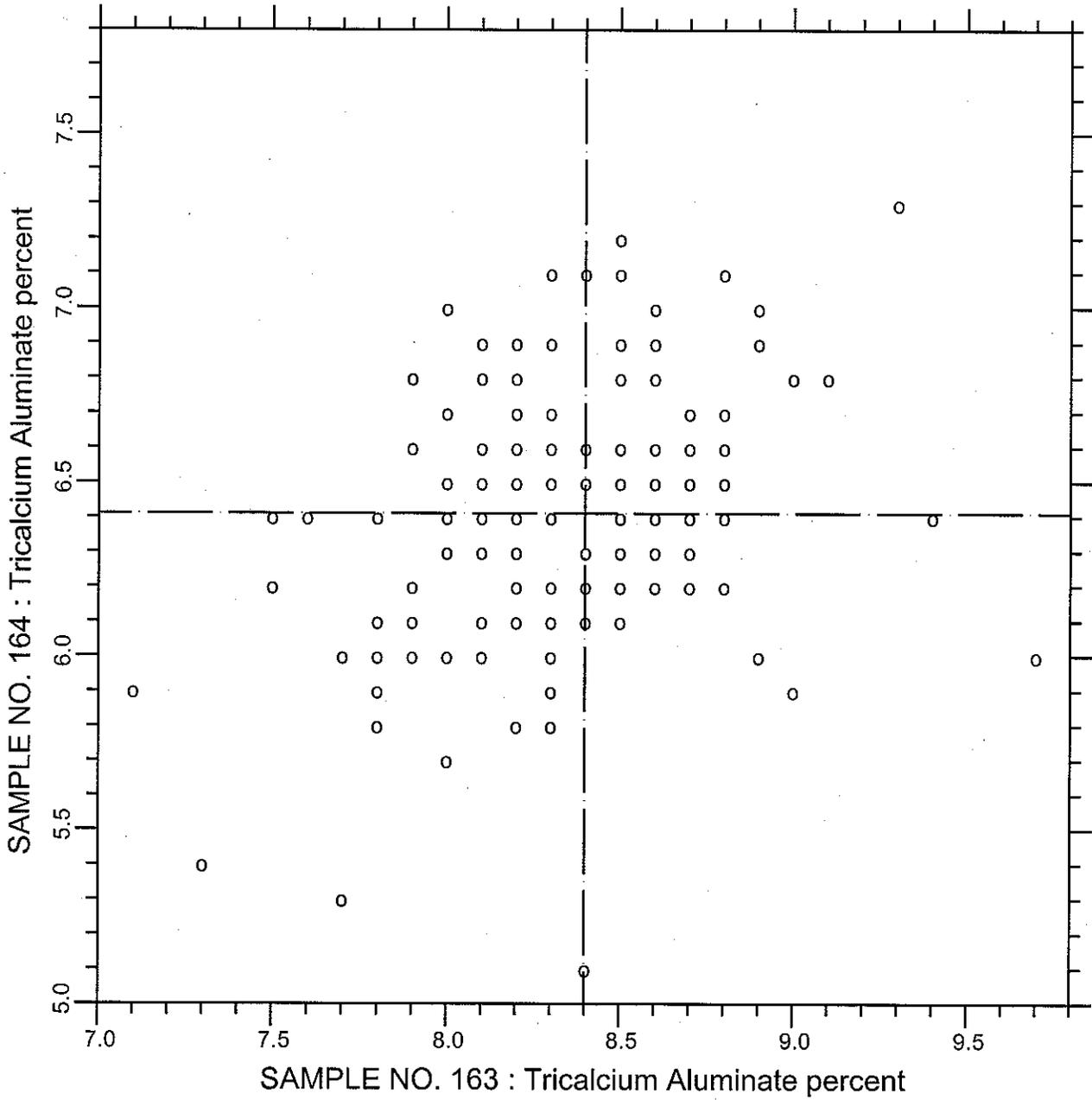
196 POINTS

SAMPLE NO. 163 AVE 14.79 S.D. 2.7 C.V. 18.2

SAMPLE NO. 164 AVE 16.52 S.D. 2.9 C.V. 17.5

LABS OFF DIAGRAM 1940

CCRL PROFICIENCY SAMPLE PROGRAM
 Tricalcium Aluminate
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.108 Tricalcium Aluminate 191 POINTS

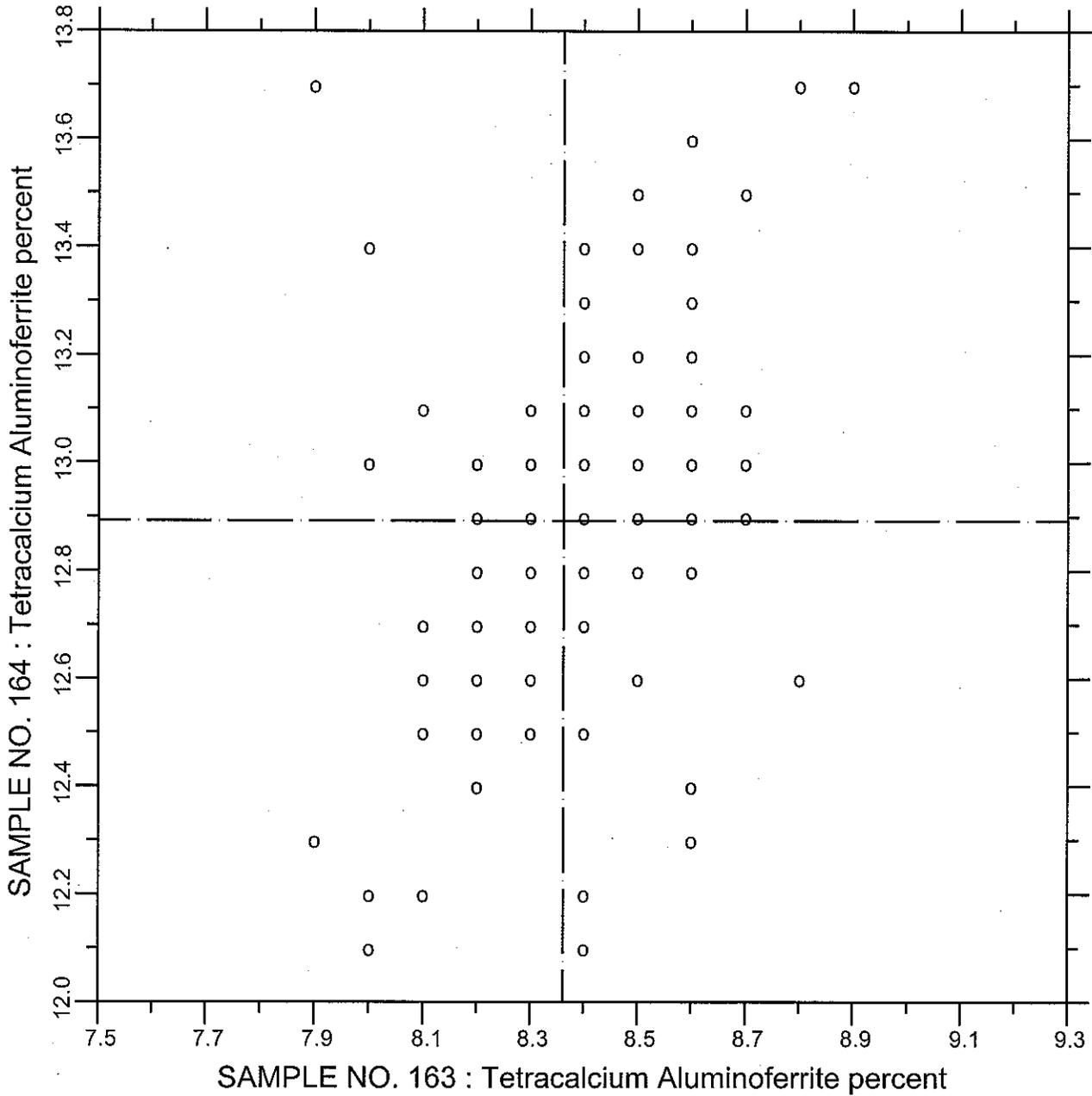
SAMPLE NO. 163 AVE 8.399 S.D. 0.42 C.V. 4.98

SAMPLE NO. 164 AVE 6.410 S.D. 0.36 C.V. 5.56

LABS ELIMINATED 47 143 175 1715 2466

LABS OFF DIAGRAM 154 201 305 2934

CCRL PROFICIENCY SAMPLE PROGRAM
Tetracalcium Aluminoferrite
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.109 Tetracalcium Aluminoferrite 188 POINTS

SAMPLE NO. 163 AVE 8.362 S.D. 0.17 C.V. 2.01

SAMPLE NO. 164 AVE 12.892 S.D. 0.28 C.V. 2.16

LABS ELIMINATED 8 458 1715 29 2466 3125

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Physical Results
 September 8, 2006

SUMMARY OF RESULTS

Test		#Labs	Sample No. 163			Sample No. 164		
			Average	S.D.	C.V.	Average	S.D.	C.V.
N.C. Water	prcnt	253	25.6	0.49	1.92	24.1	0.50	2.07
N.C. Water	prcnt	* 248	25.6	0.43	1.66	24.1	0.38	1.58
Vicat TS Initial	min	246	166	19.0	11.5	130	22.1	17.0
Vicat TS Initial	min	* 240	165	16.8	10.2	129	15.7	12.2
Vicat TS Final	min	238	273	37.1	13.6	236	33.3	14.1
Vicat TS Final	min	* 234	272	32.6	12.0	235	30.3	12.9
Gillmore TS Initial	min	170	199	30.3	15.2	165	34.7	21.1
Gillmore TS Initial	min	* 166	197	26.8	13.6	162	26.5	16.3
Gillmore TS Final	min	169	304	44.0	14.5	271	39.8	14.7
Gillmore TS Final	min	* 165	302	40.2	13.3	269	35.0	13.0
False Set	prcnt	208	85	7.0	8.30	73	11.0	15.12
False Set	prcnt	* 205	85	6.4	7.52	73	10.4	14.28
Autoclave Expan	prcnt	234	-0.007	0.026	-395.51	-0.02	0.047	-224.26
Autoclave Expan	prcnt	* 220	-0.007	0.013	-184.98	-0.02	0.023	-103.53

CONTINUED ON NEXT PAGE

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

N.C. Water	169 219 360 1525 2296
Vicat TS Initial	3 125 169 203 218 219
Vicat TS Final	3 126 218 823
Gillmore TS Initial	126 166 218 375
Gillmore TS Final	3 126 823 2982
False Set	611 696 1196
Autoclave Expansion	3 69 121 247 252 870 2351 2477 265 407 551 996 2296 3009

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Physical Results
 September 8, 2006

SUMMARY OF RESULTS

Test		#Labs	Sample No. 163			Sample No. 164		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Air Content	prcnt	226	10.0	1.3	13.2	8.5	1.9	22.8
Air Content	prcnt	* 223	10.0	1.1	11.1	8.4	1.3	15.6
AC Mix Water	prcnt	220	67.1	4.7	7.00	67.2	4.9	7.28
AC Mix Water	prcnt	* 211	67.6	2.1	3.18	67.6	2.2	3.29
AC Flow	prcnt	224	89	4.2	4.68	87	4.2	4.86
AC Flow	prcnt	* 220	89	3.4	3.87	87	3.5	4.02
Comp Str, 3 day	psi	260	3622	260.0	7.18	3593	259.2	7.21
Comp Str, 3 day	psi	* 257	3624	244.9	6.76	3598	252.6	7.02
Comp Str, 7 day	psi	259	4444	319.2	7.18	4670	327.8	7.02
Comp Str, 7 day	psi	* 255	4446	287.6	6.47	4671	307.6	6.58
Comp Str, 28 day	psi	225	5610	390.2	6.96	6473	459.8	7.10
Com Str, Flow	prcnt	222	118	9.7	8.19	119	9.6	8.11

CONTINUED ON NEXT PAGE

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

Air Content	196 265 309
Air Content Mix Water	246 413 1196 1644 51 360 1936 2351 2468
Air Content Flow	246 1196 127 1644
Comp Strength, 3 day	48 1079 2330
Comp Strength, 7 day	48 413 691 2330

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Physical Results
 September 8, 2006

SUMMARY OF RESULTS

Test	#Labs	Sample No. 163			Sample No. 164			
		Average	S.D.	C.V.	Average	S.D.	C.V.	
Fineness, AP	cm ² /g	252	3707	136.2	3.67	3732	148.0	3.96
Fineness, AP	cm ² /g *	247	3698	100.5	2.72	3720	99.7	2.68
Fineness, WT	cm ² /g	15	1904	504.5	26.5	1899	504.0	26.5
Fineness, WT	cm ² /g *	14	2033	76.8	3.78	2028	82.0	4.04
45µm Sieve	prcnt	233	94.01	1.3	1.39	91.73	1.3	1.41
45µm Sieve	prcnt *	212	94.14	0.69	0.738	91.70	0.88	0.960
C1038 Mortar Bar Expansion								
Mortar Expansion	prcnt	140	0.004	0.0084	193	0.006	0.0097	168
Mortar Expansion	prcnt *	137	0.004	0.0043	122.0	0.005	0.0038	83.0
Mortar Water	prcnt	140	240	23.8	9.91	239	23.6	9.87
Mortar Water	prcnt *	133	237	5.0	2.13	236	5.6	2.36
Mortar Flow	prcnt	136	110	3.3	2.96	110	3.6	3.23
Mortar Flow	prcnt *	132	110	2.6	2.34	110	2.7	2.48

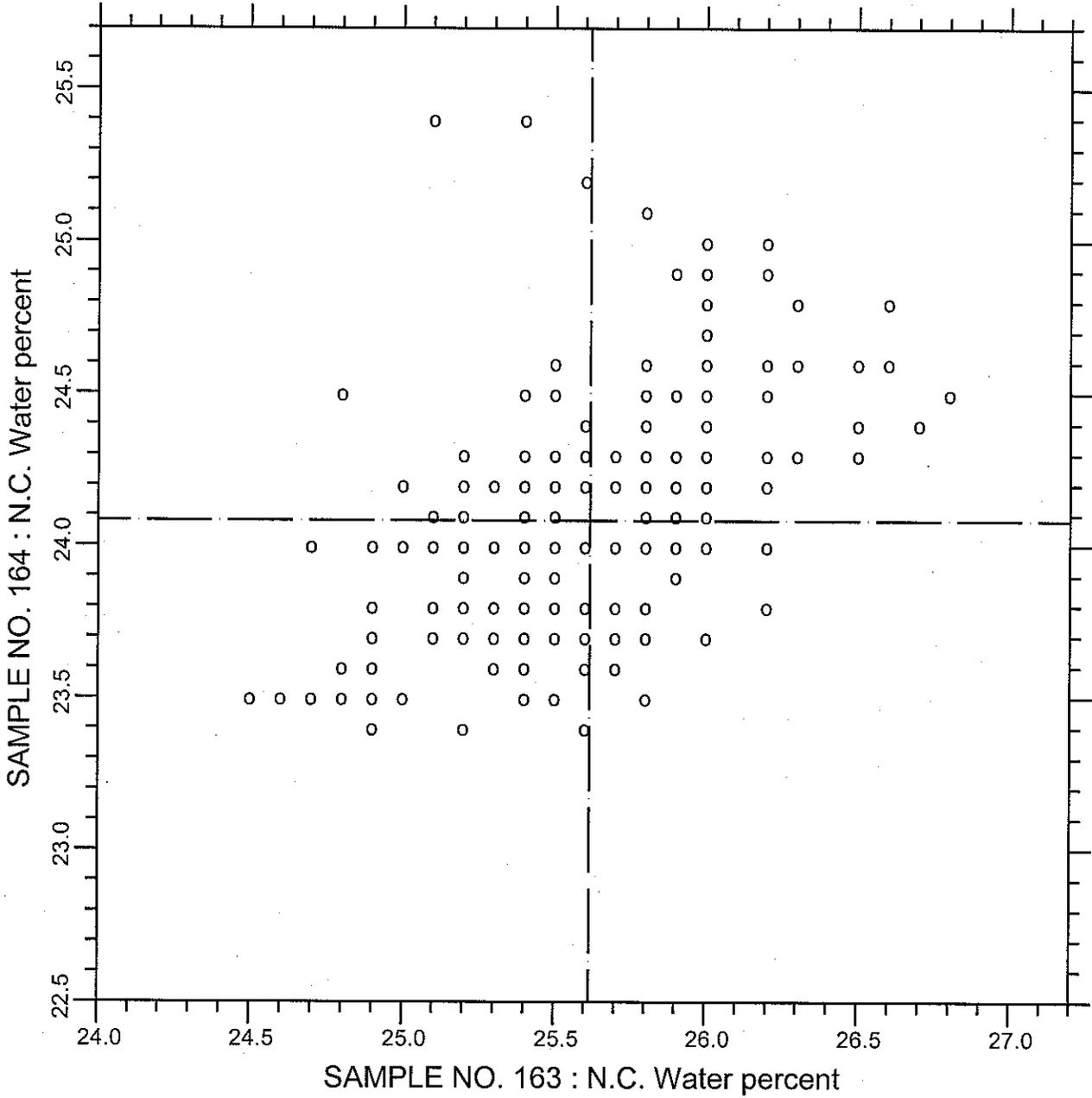
* ELIMINATED LABS: Data over three S.D. from the mean

Fineness, Air Permeability 31 33 51 196 3126
 Fineness, Wagner Turb 1435
 Fineness, 45µm Sieve 40 165 219 1644 1715 2477 19 52 80 90 125 169 354 416 565 2468 168
 493 768 1525 2484

C1038 Mortar Bar Expansion

C1038 Mortar Bar Exp 10 137 1799
 C1038 Mortar, Water 438 80 94 611 932 1936 2483
 C1038 Mortar, Flow 416 1936 243 3126

CCRL PROFICIENCY SAMPLE PROGRAM
 Normal Consistency - % Water
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.110

N.C. Water

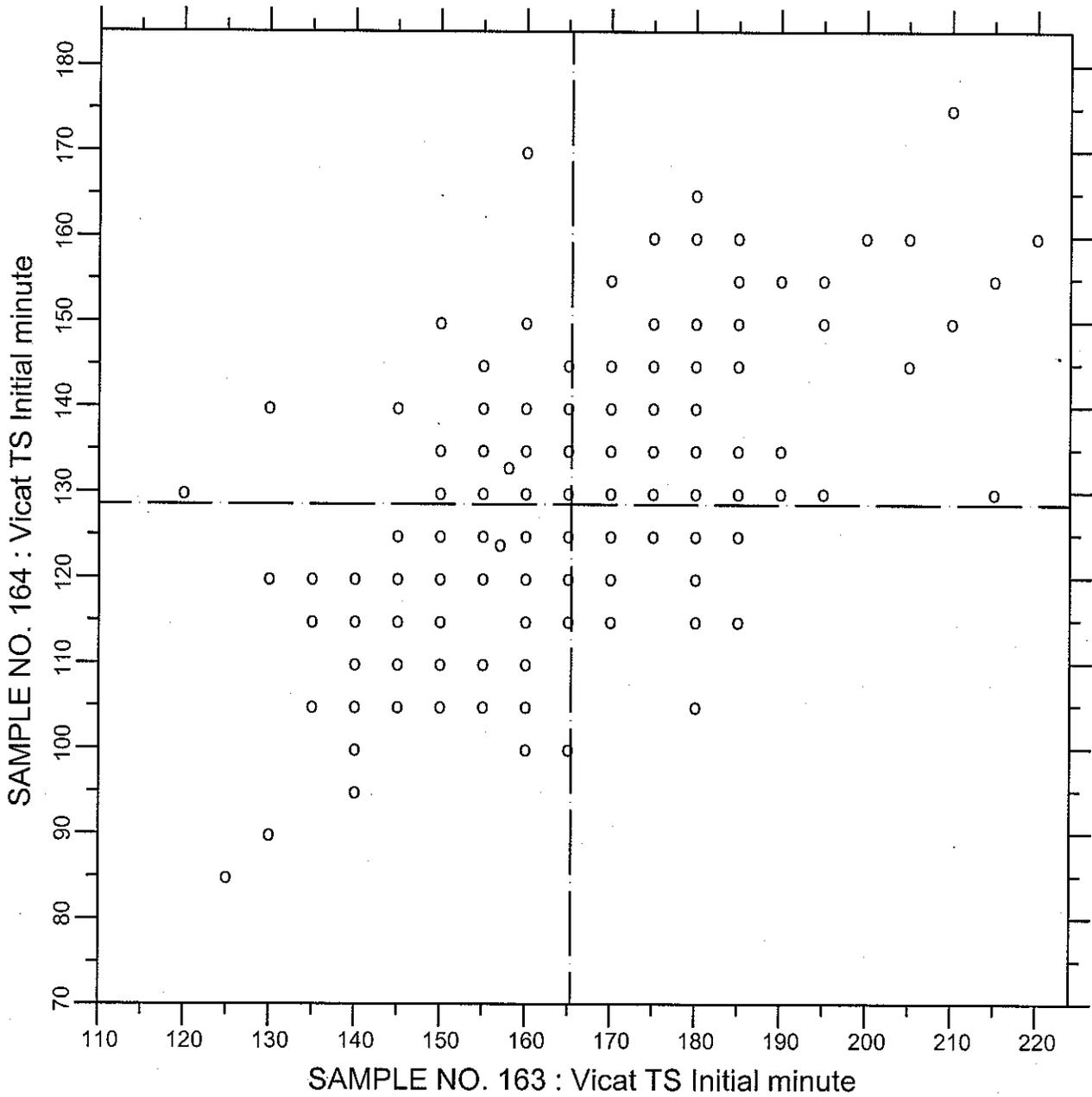
248 POINTS

SAMPLE NO. 163 AVE 25.617 S.D. 0.43 C.V. 1.66

SAMPLE NO. 164 AVE 24.083 S.D. 0.38 C.V. 1.58

LABS ELIMINATED 169 219 360 1525 2296

CCRL PROFICIENCY SAMPLE PROGRAM
 Vicat Time of Set - Initial
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.120

Vicat TS Initial

239 POINTS

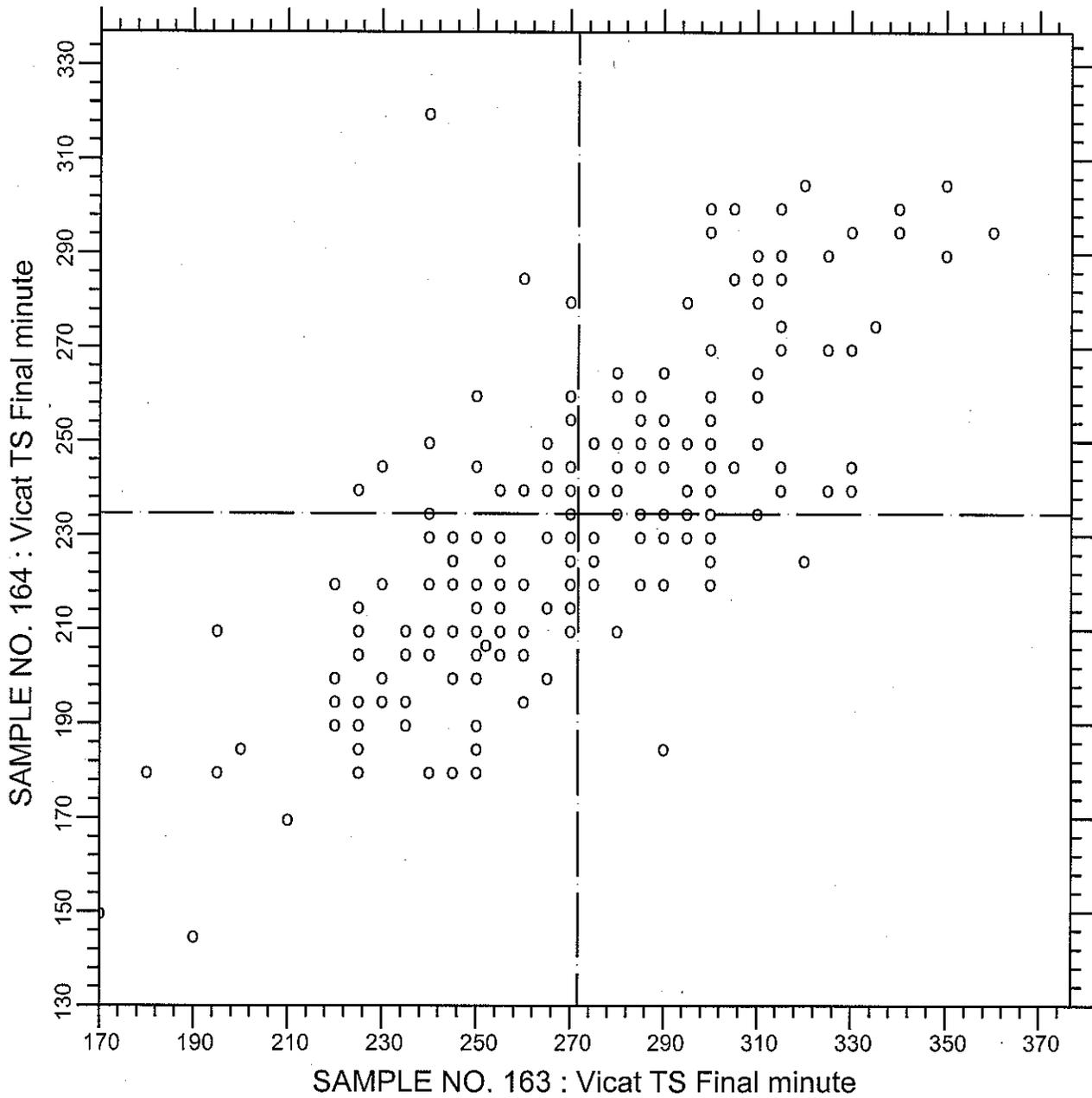
SAMPLE NO. 163 AVE 165.4 S.D. 16.8 C.V. 10.2

SAMPLE NO. 164 AVE 128.6 S.D. 15.7 C.V. 12.2

LABS ELIMINATED 3 125 169 203 218 219

LABS OFF DIAGRAM 34

CCRL PROFICIENCY SAMPLE PROGRAM
 Vicat Time of Set - Final
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.121

Vicat TS Final

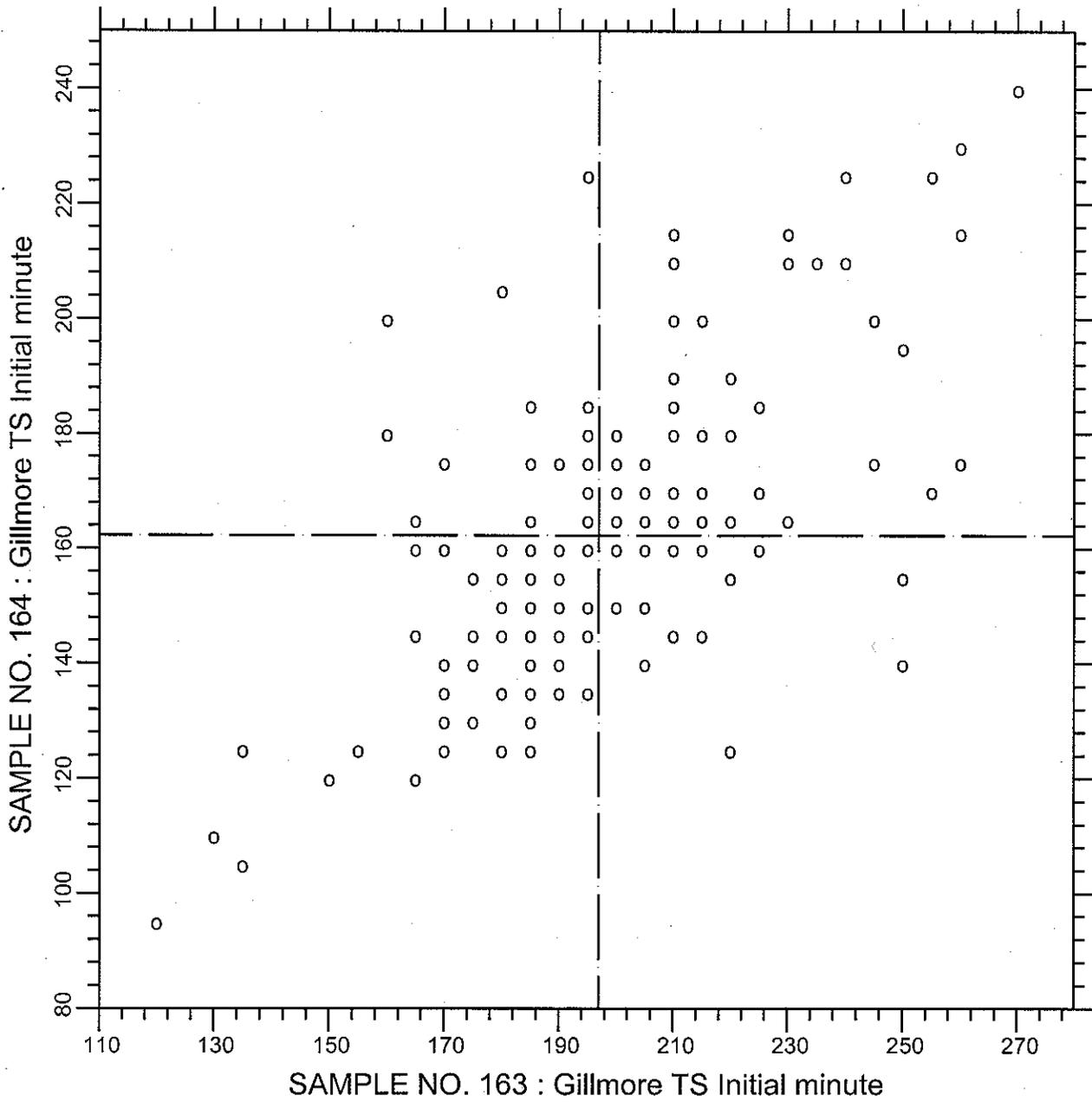
234 POINTS

SAMPLE NO. 163 AVE 271.6 S.D. 32.6 C.V. 12.0

SAMPLE NO. 164 AVE 234.6 S.D. 30.3 C.V. 12.9

LABS ELIMINATED 3 126 218 823

CCRL PROFICIENCY SAMPLE PROGRAM
 Gillmore Time of Set - Initial
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.130

Gillmore TS Initial

165 POINTS

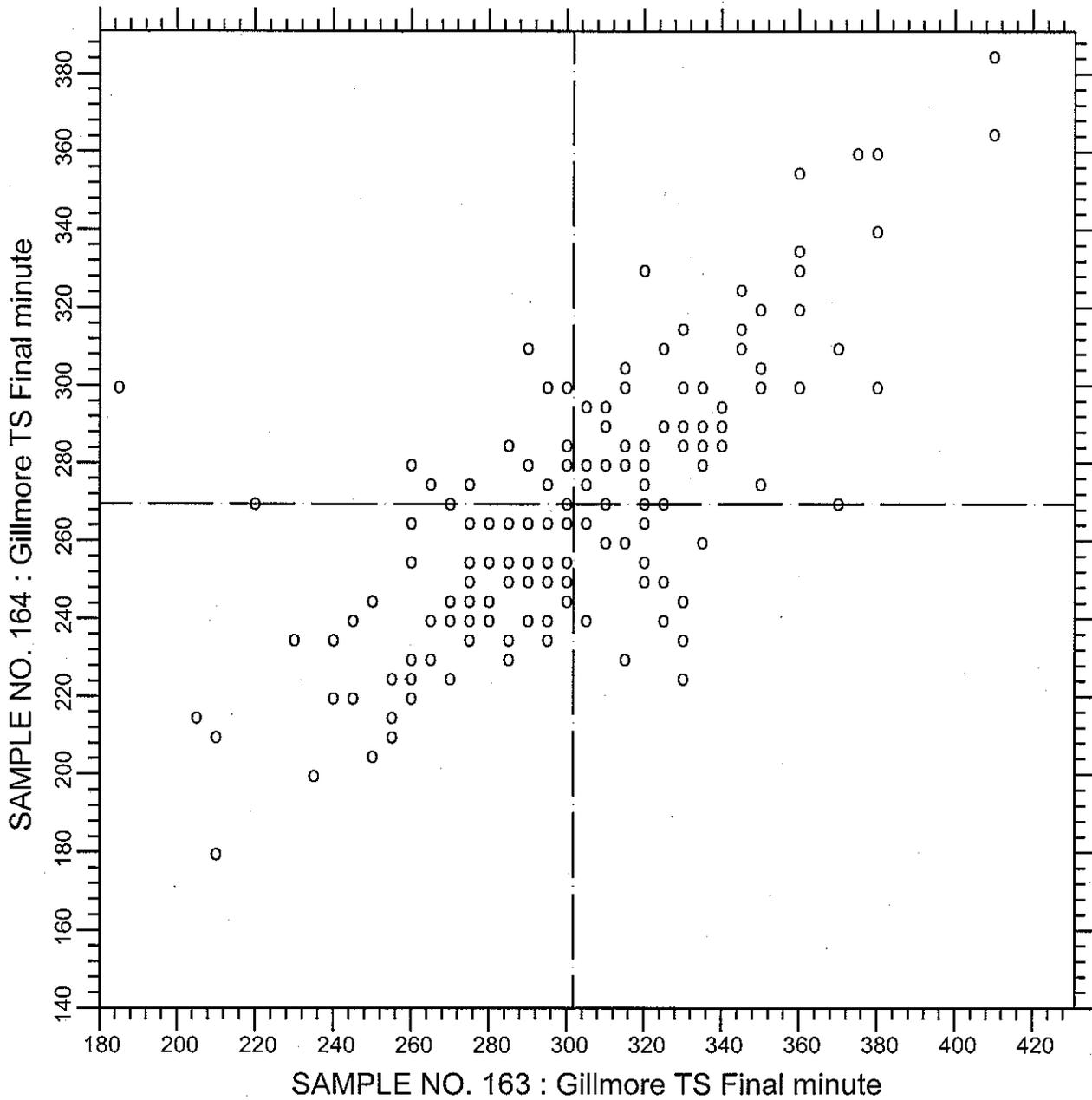
SAMPLE NO. 163 AVE 197.0 S.D. 26.8 C.V. 13.6

SAMPLE NO. 164 AVE 162.3 S.D. 26.5 C.V. 16.3

LABS ELIMINATED 126 166 218 375

LABS OFF DIAGRAM 148

CCRL PROFICIENCY SAMPLE PROGRAM
 Gillmore Time of Set - Final
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.140

Gillmore TS Final

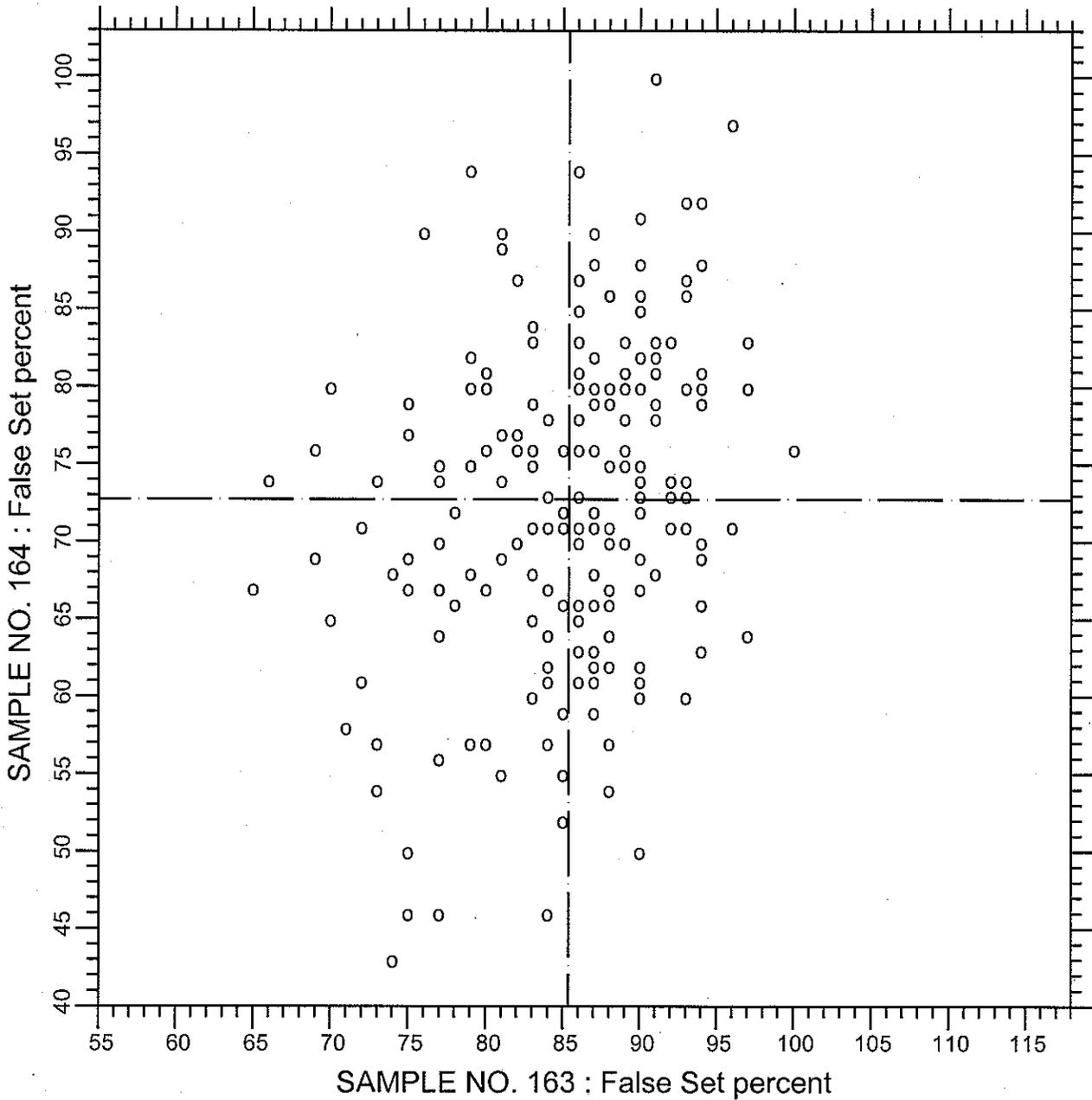
165 POINTS

SAMPLE NO. 163 AVE 301.7 S.D. 40.2 C.V. 13.3

SAMPLE NO. 164 AVE 269.4 S.D. 35.0 C.V. 13.0

LABS ELIMINATED 3 126 823 2982

CCRL PROFICIENCY SAMPLE PROGRAM
 False Set - Paste Method
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.150

False Set

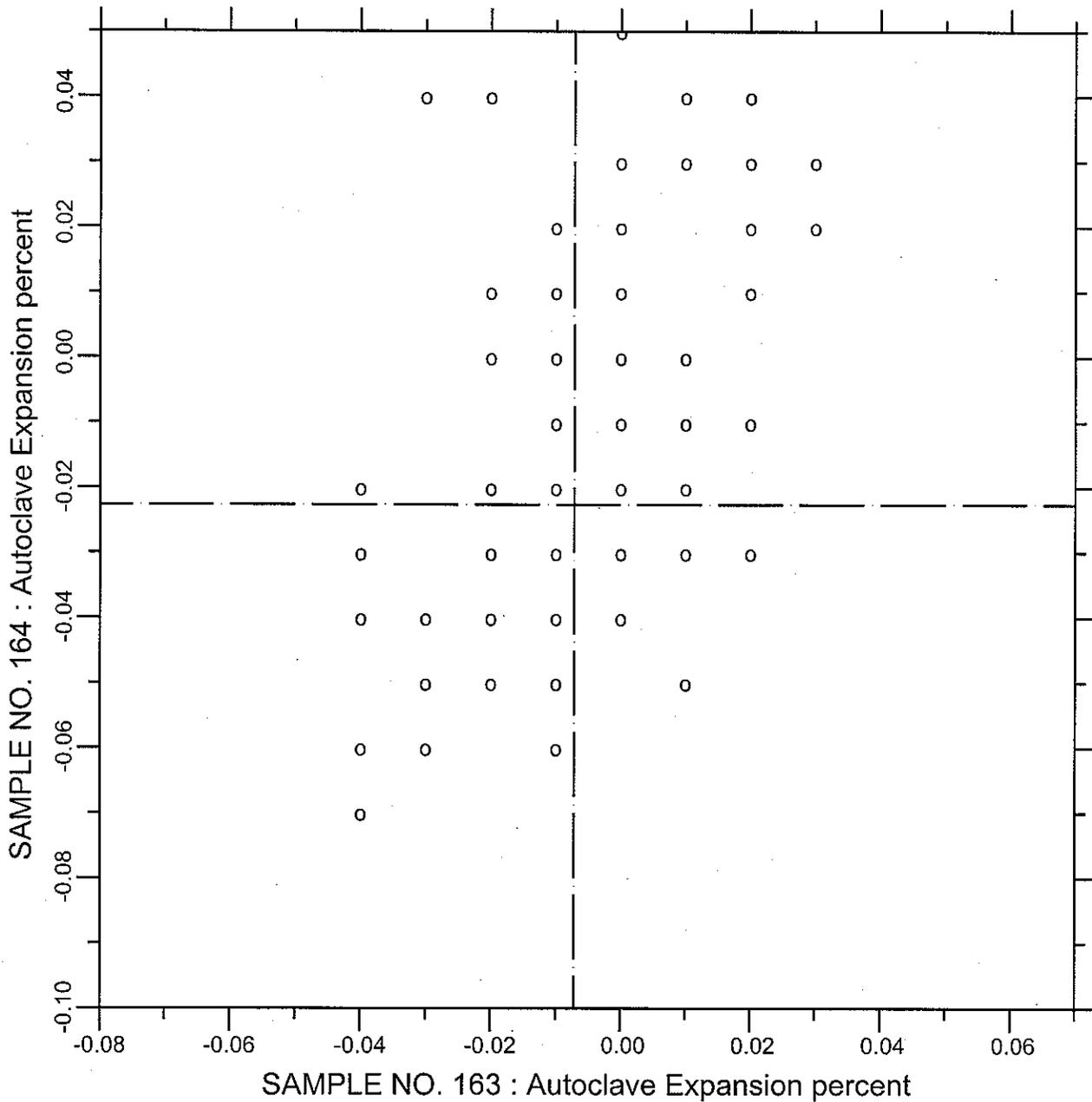
205 POINTS

SAMPLE NO. 163 AVE 85.38 S.D. 6.4 C.V. 7.52

SAMPLE NO. 164 AVE 72.74 S.D. 10.4 C.V. 14.28

LABS ELIMINATED 611 696 1196

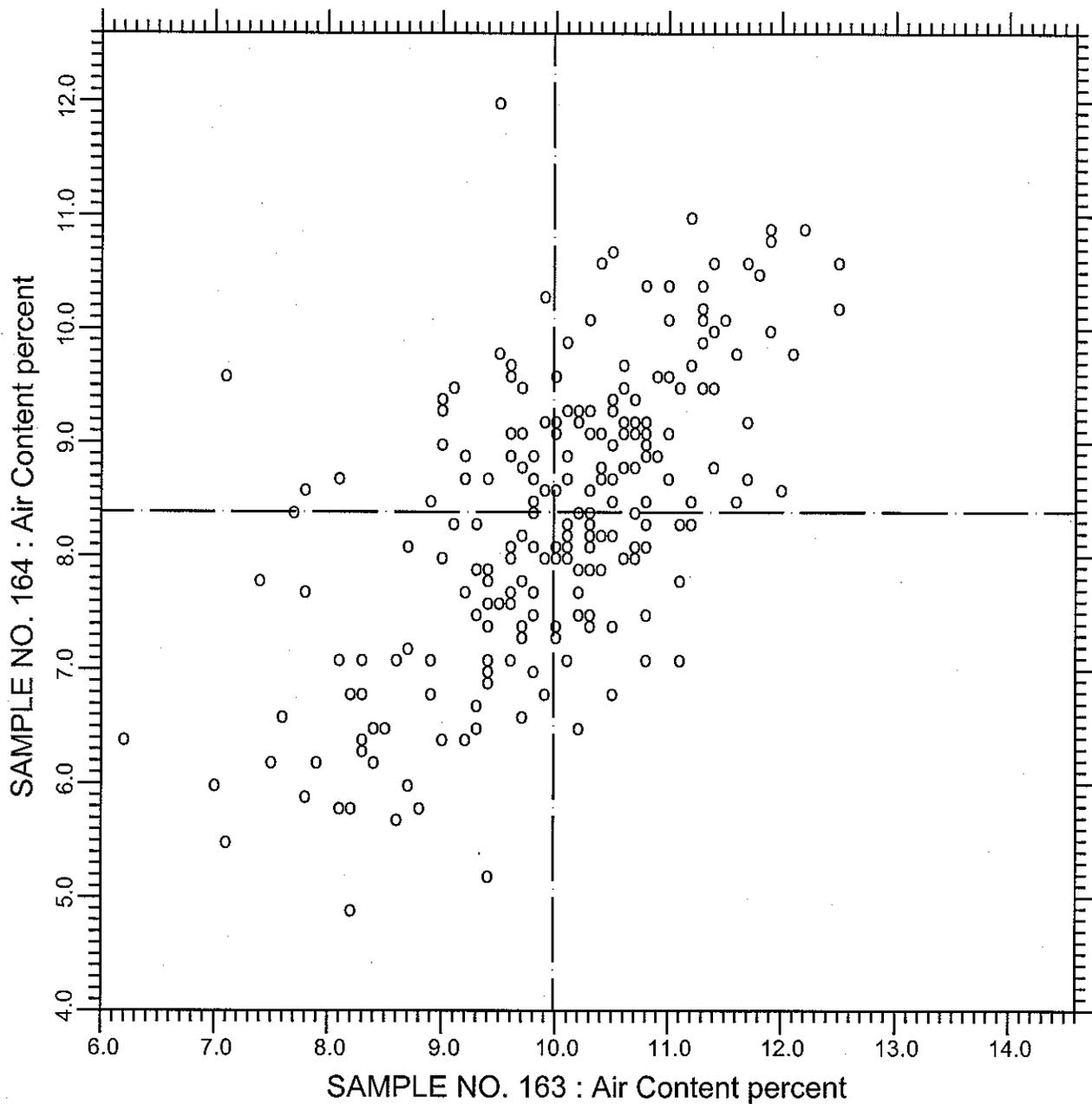
CCRL PROFICIENCY SAMPLE PROGRAM
Autoclave Expansion
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.160 Autoclave Expansion 220 POINTS

SAMPLE NO. 163 AVE -0.00718 S.D. 0.013 C.V. -184.984
 SAMPLE NO. 164 AVE -0.02264 S.D. 0.023 C.V. -103.526
 LABS ELIMINATED 3 69 121 247 252 870 2351 2477 265 407 551 996 2296

CCRL PROFICIENCY SAMPLE PROGRAM
Air Content
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.170

Air Content

222 POINTS

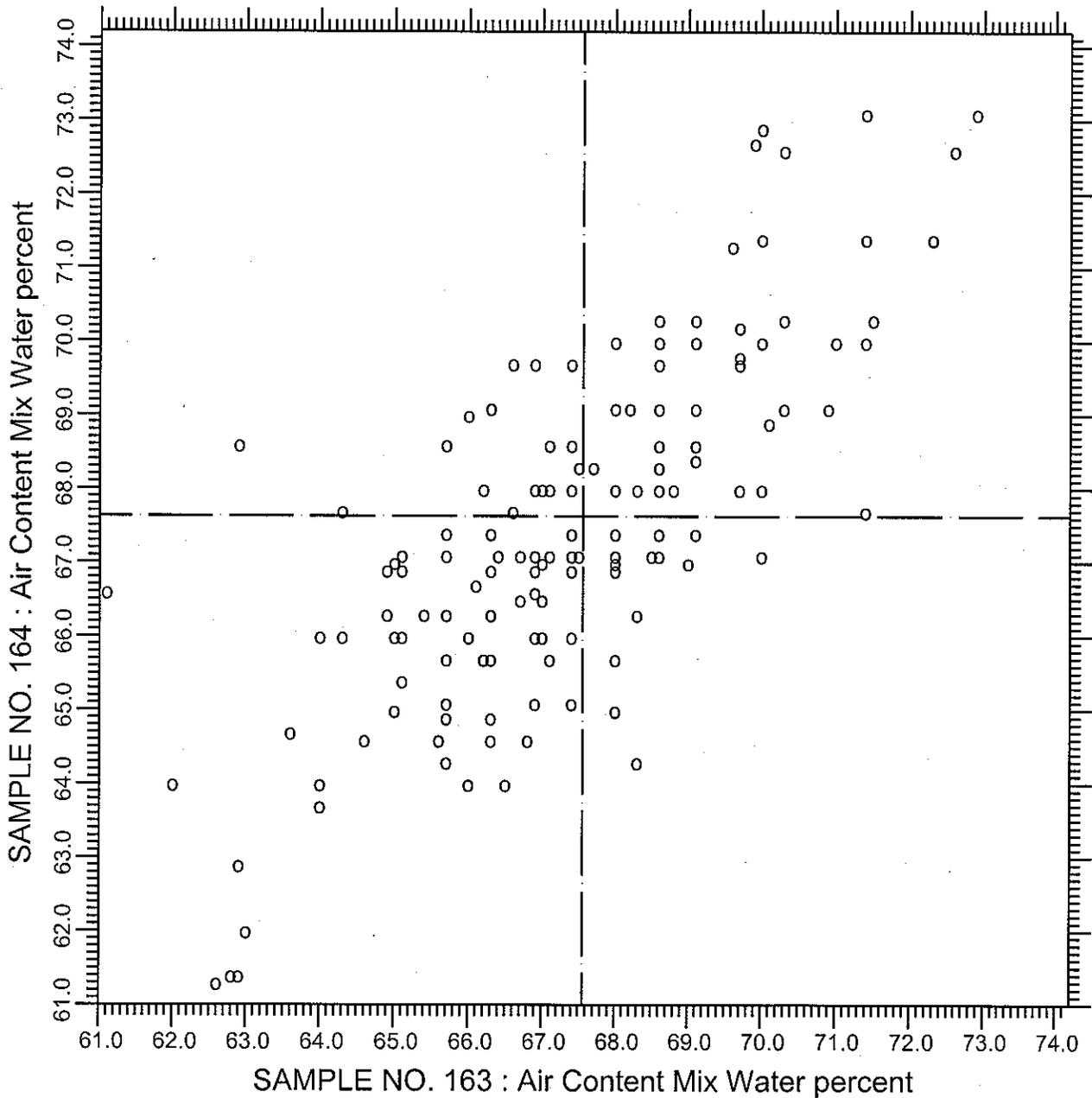
SAMPLE NO. 163 AVE 9.980 S.D. 1.1 C.V. 11.1

SAMPLE NO. 164 AVE 8.387 S.D. 1.3 C.V. 15.6

LABS ELIMINATED 196 265 309

LABS OFF DIAGRAM 3125

CCRL PROFICIENCY SAMPLE PROGRAM
Air Content - % Water
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.180

Air Content Mix Water

208 POINTS

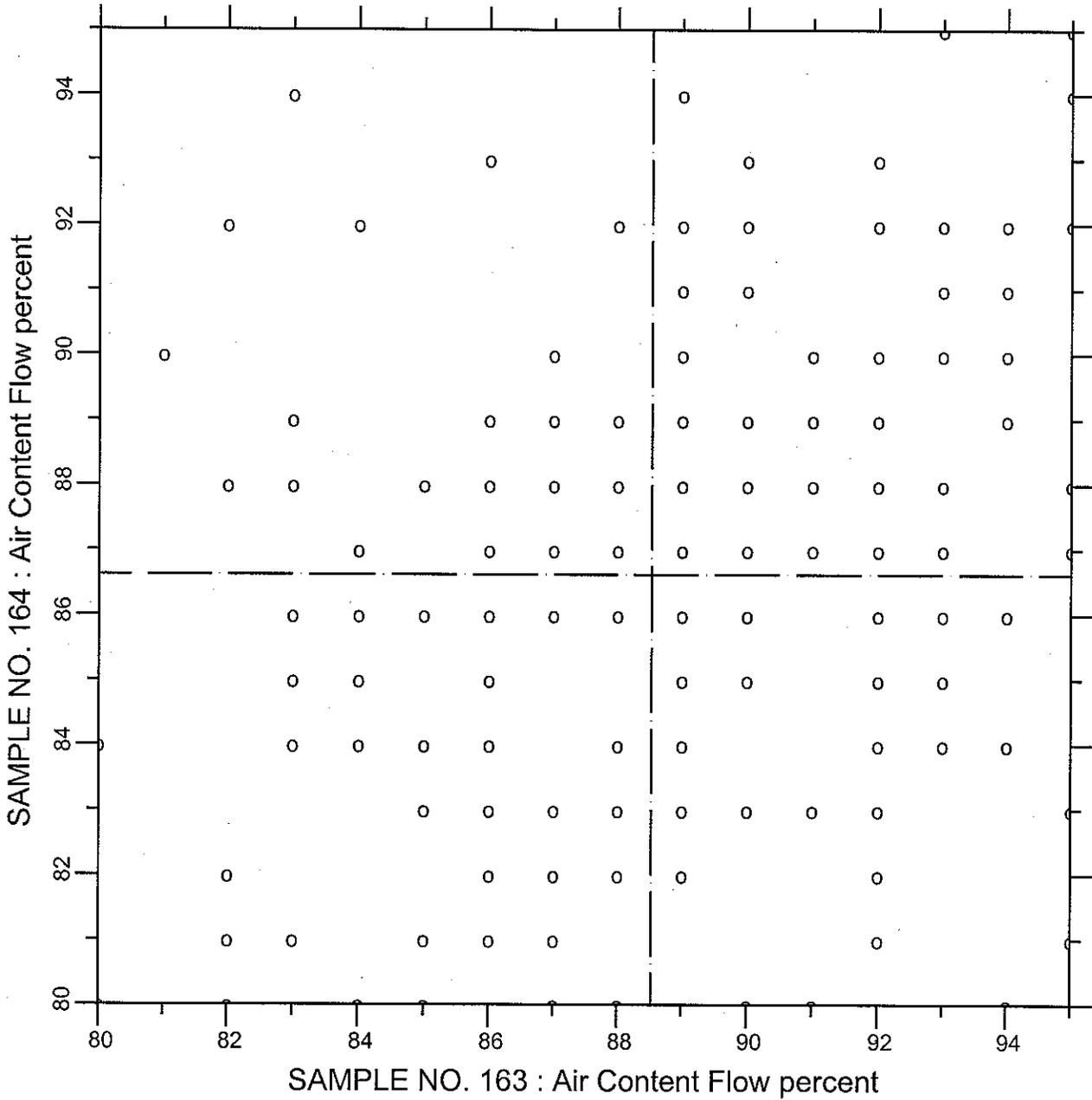
SAMPLE NO. 163 AVE 67.56 S.D. 2.1 C.V. 3.18

SAMPLE NO. 164 AVE 67.63 S.D. 2.2 C.V. 3.29

LABS ELIMINATED 246 413 1196 1644 51 360 1936 2351 2468

LABS OFF DIAGRAM 94 1042 1251

CCRL PROFICIENCY SAMPLE PROGRAM
Air Content - Flow
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.190

Air Content Flow

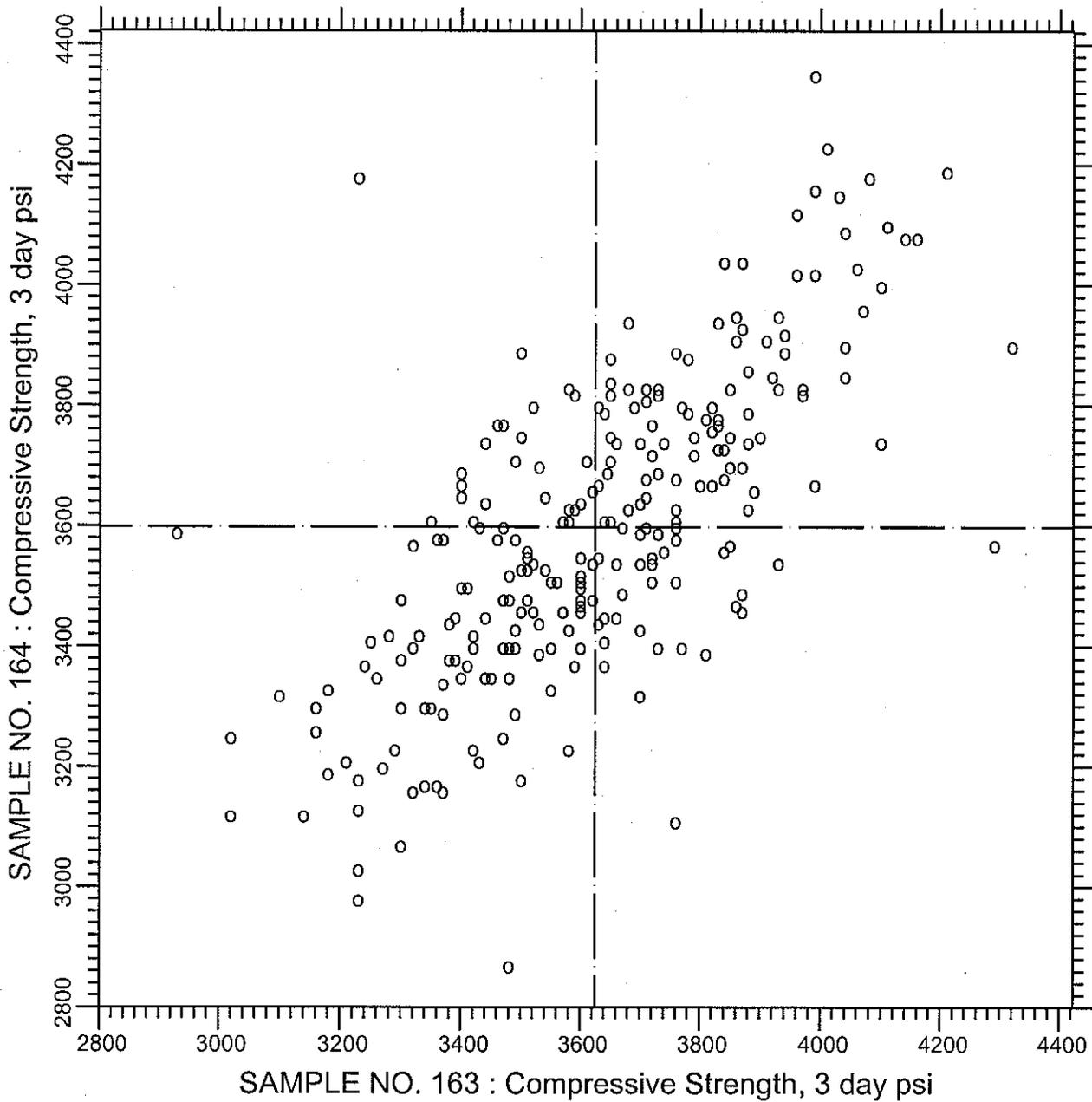
220 POINTS

SAMPLE NO. 163 AVE 88.53 S.D. 3.4 C.V. 3.87

SAMPLE NO. 164 AVE 86.62 S.D. 3.5 C.V. 4.02

LABS ELIMINATED 246 1196 127 1644

CCRL PROFICIENCY SAMPLE PROGRAM
Compressive Strength - 3 day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



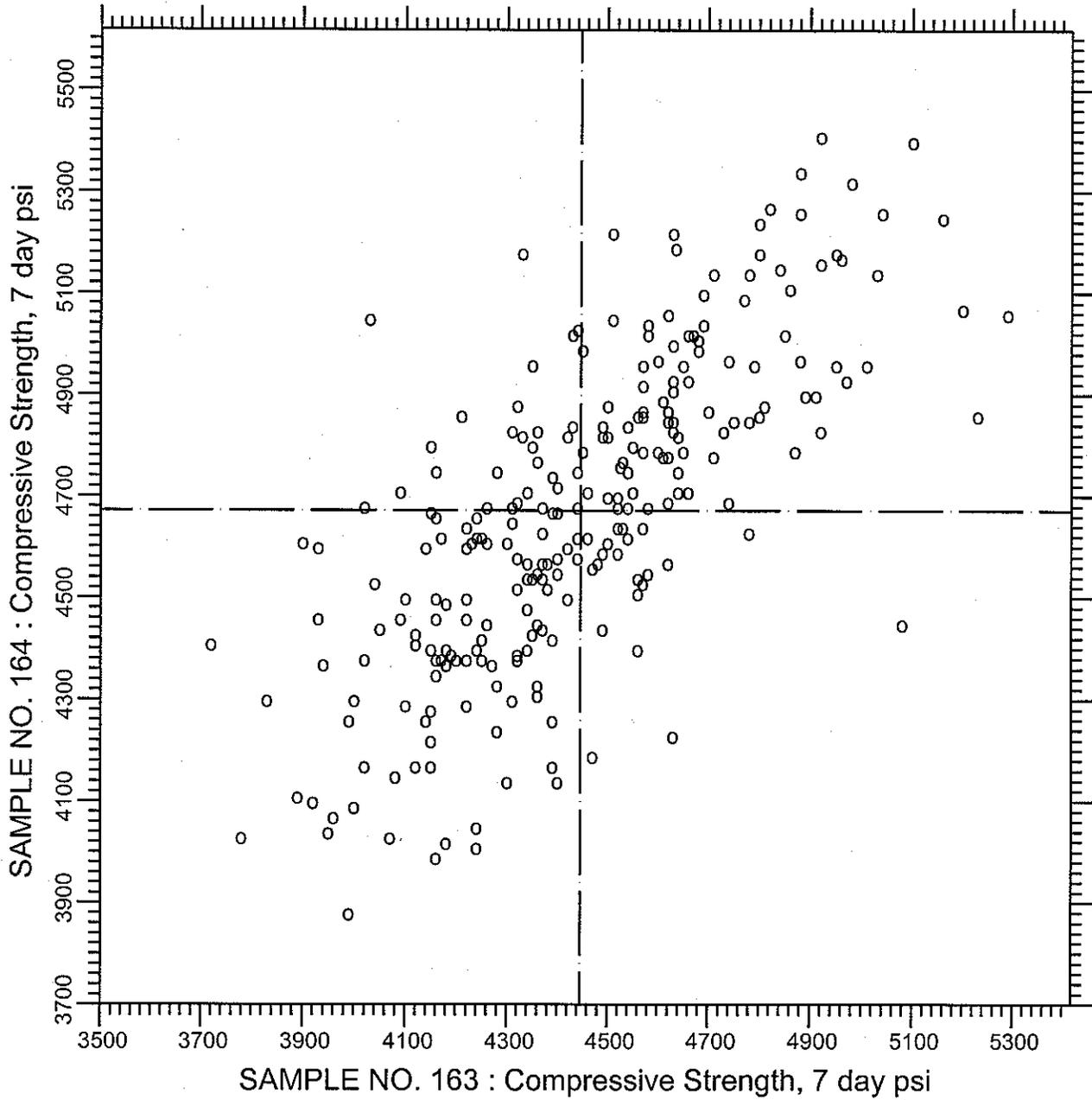
TEST NO.200 Compressive Strength, 3 day 257 POINTS

SAMPLE NO. 163 AVE 3624.5 S.D. 244.9 C.V. 6.76

SAMPLE NO. 164 AVE 3598.4 S.D. 252.6 C.V. 7.02

LABS ELIMINATED 48 1079 2330

CCRL PROFICIENCY SAMPLE PROGRAM
Compressive Strength - 7 day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



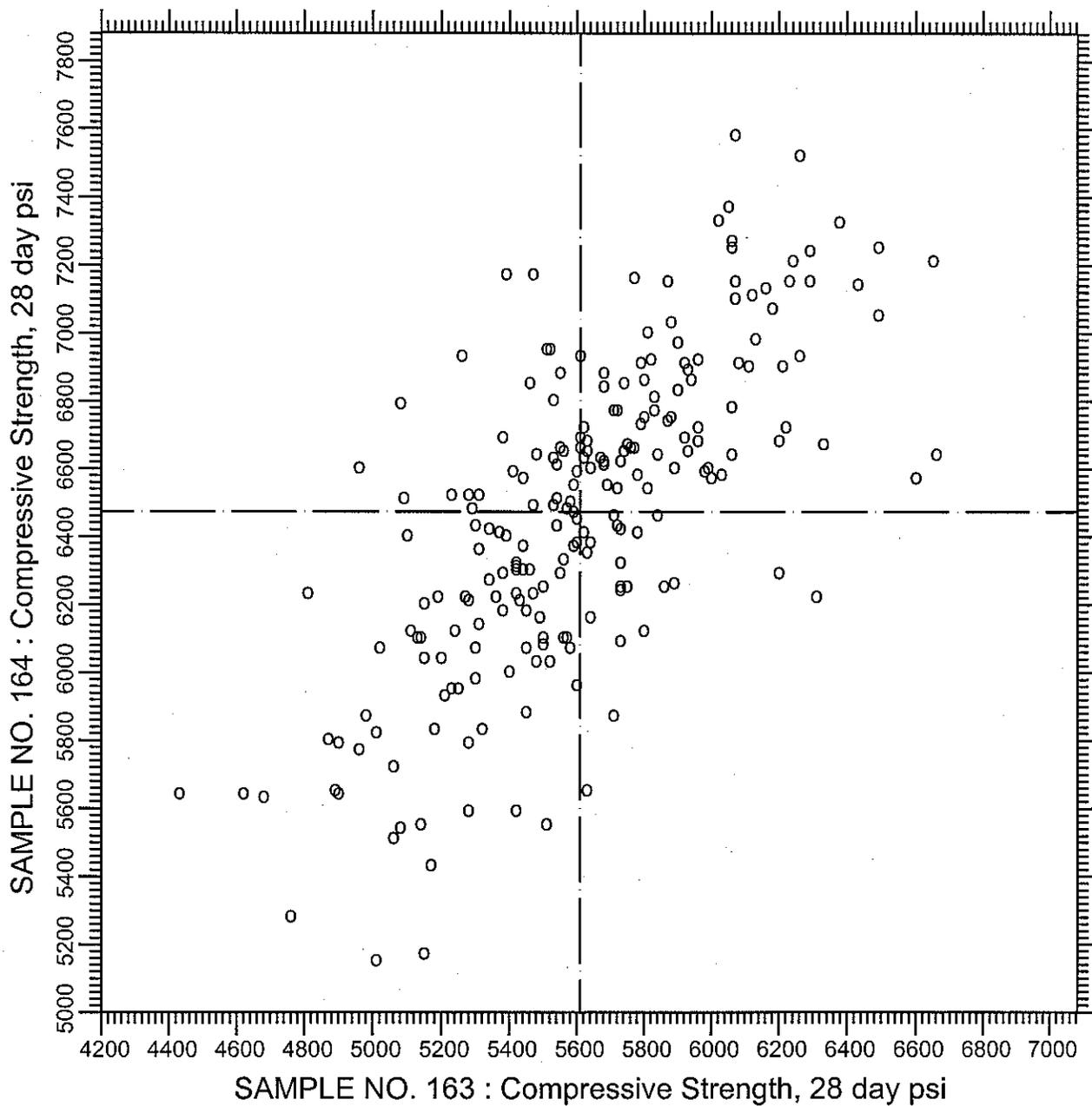
TEST NO.210 Compressive Strength, 7 day 255 POINTS

SAMPLE NO. 163 AVE 4446.4 S.D. 287.6 C.V. 6.47

SAMPLE NO. 164 AVE 4671.4 S.D. 307.6 C.V. 6.58

LABS ELIMINATED 48 413 691 2330

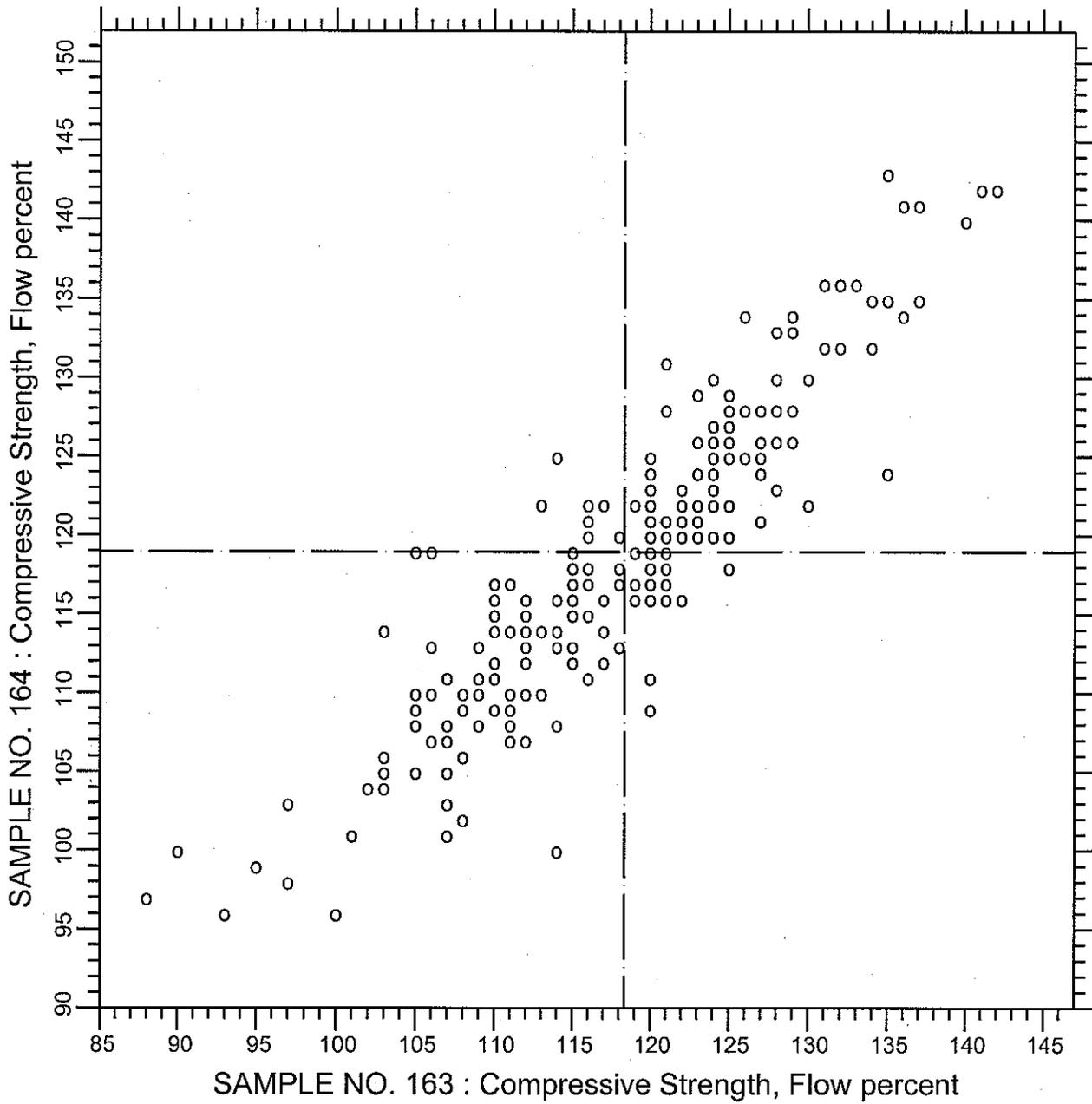
CCRL PROFICIENCY SAMPLE PROGRAM
Compressive Strength - 28 day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.211 Compressive Strength, 28 day 225 POINTS

SAMPLE NO. 163	AVE	5610.4	S.D.	390.2	C.V.	6.96
SAMPLE NO. 164	AVE	6473.4	S.D.	459.8	C.V.	7.10

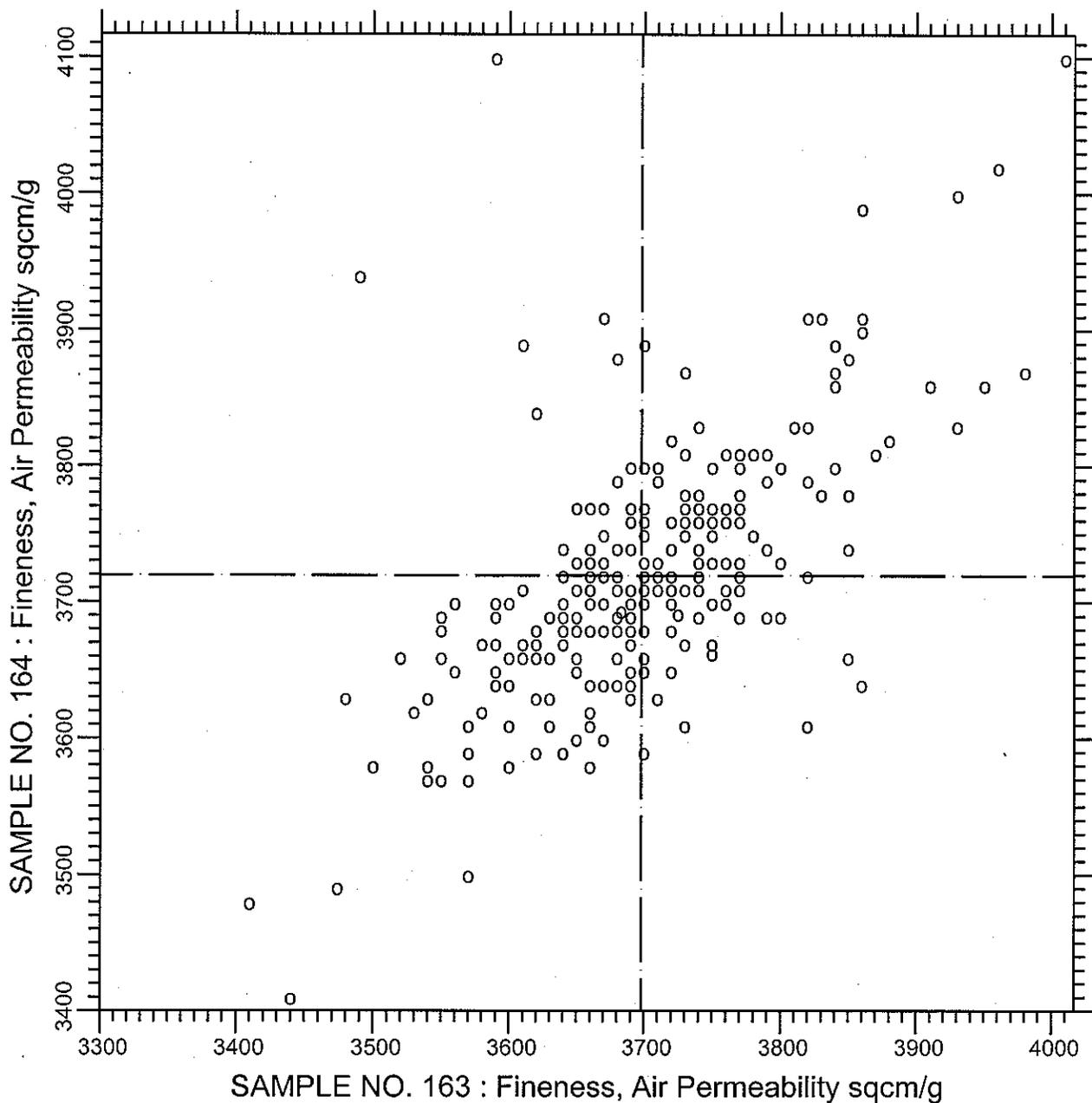
CCRL PROFICIENCY SAMPLE PROGRAM
Compressive Strength - Flow
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.230 Compressive Strength, Flow 222 POINTS

SAMPLE NO. 163	AVE	118.36	S.D.	9.7	C.V.	8.19
SAMPLE NO. 164	AVE	118.95	S.D.	9.6	C.V.	8.11

CCRL PROFICIENCY SAMPLE PROGRAM
Fineness - Air Permeability
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.270 Fineness, Air Permeability 245 POINTS

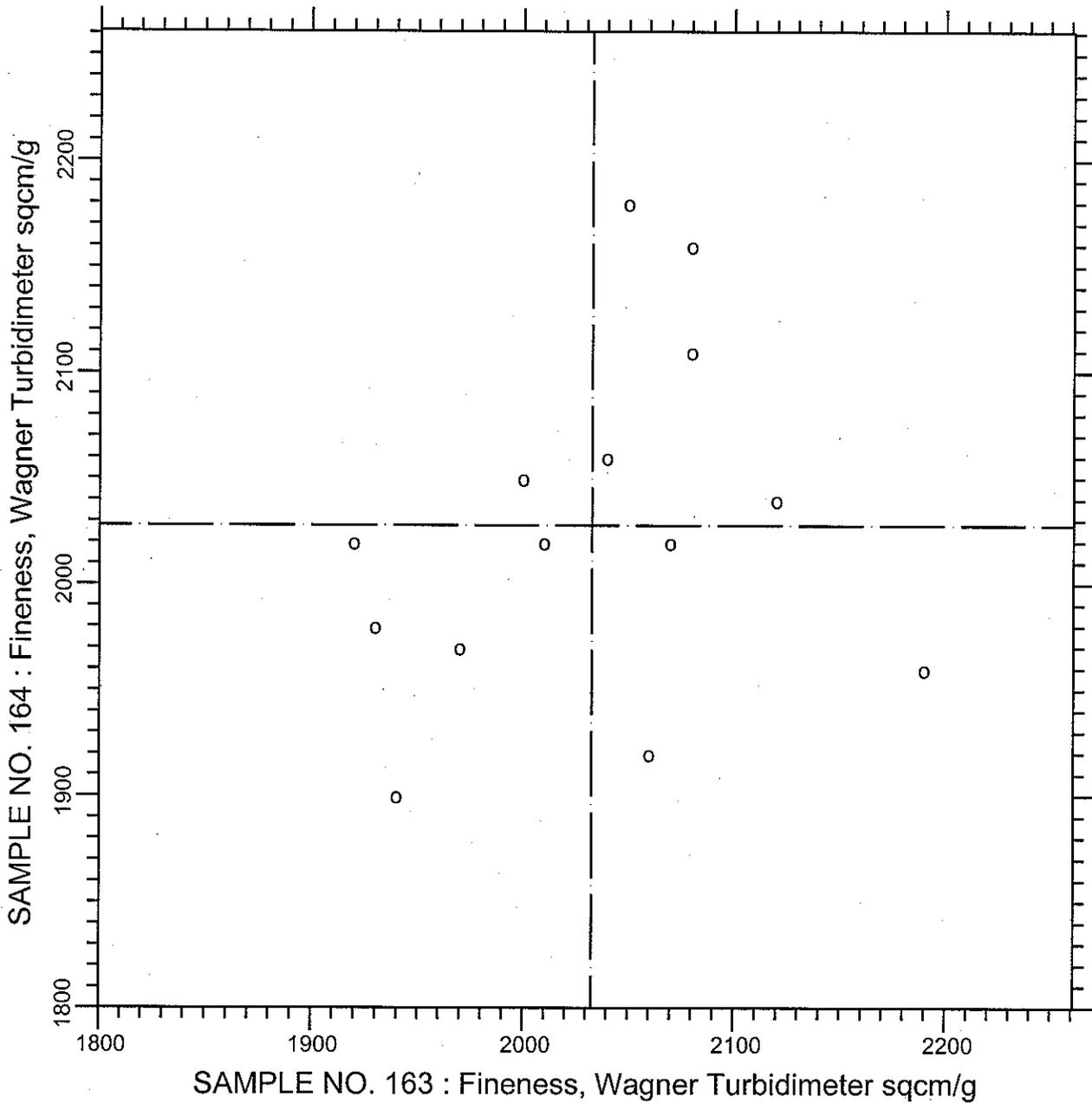
SAMPLE NO. 163 AVE 3698.1 S.D. 100.5 C.V. 2.72

SAMPLE NO. 164 AVE 3719.5 S.D. 99.7 C.V. 2.68

LABS ELIMINATED 31 33 51 196 3126

LABS OFF DIAGRAM 18 2938

CCRL PROFICIENCY SAMPLE PROGRAM
 Fineness - Wagner Turbidimeter
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



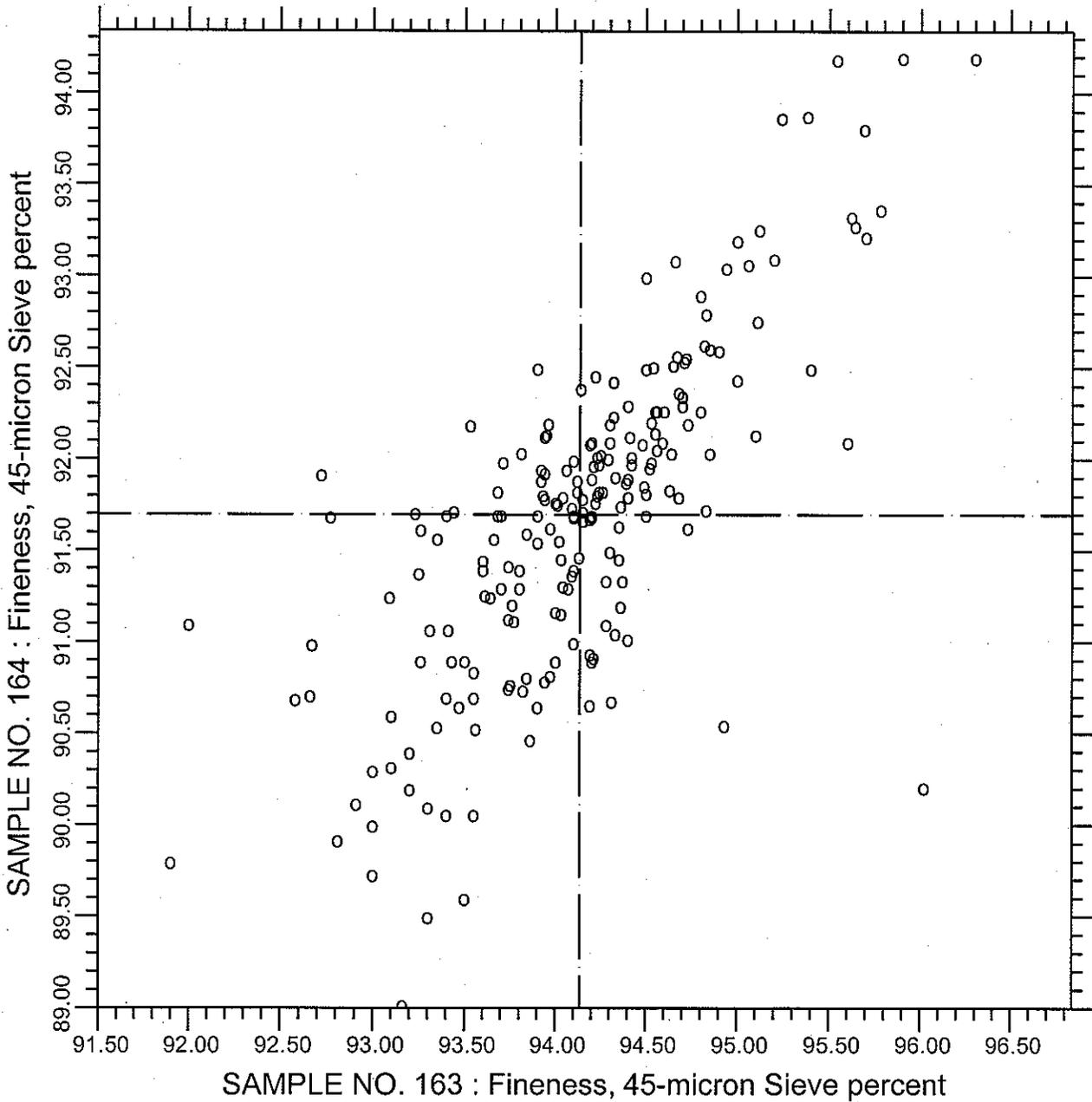
TEST NO.280 Fineness, Wagner Turbidimeter 14 POINTS

SAMPLE NO. 163 AVE 2032.8 S.D. 76.8 C.V. 3.78

SAMPLE NO. 164 AVE 2027.8 S.D. 82.0 C.V. 4.04

LABS ELIMINATED 1435

CCRL PROFICIENCY SAMPLE PROGRAM
45-micron Sieve - % Passing
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.281 Fineness, 45-micron Sieve 212 POINTS

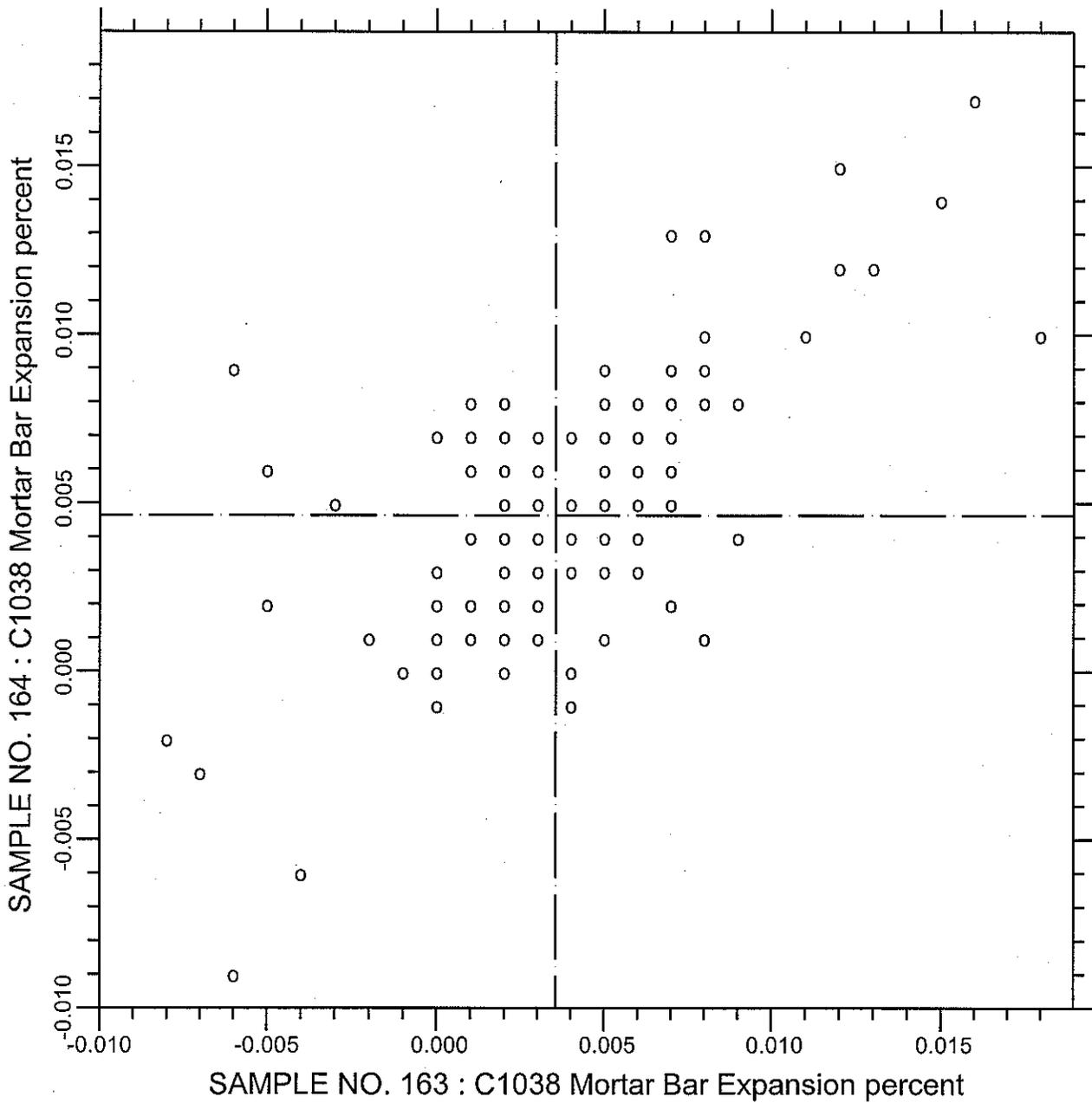
SAMPLE NO. 163 AVE 94.137 S.D. 0.69 C.V. 0.738

SAMPLE NO. 164 AVE 91.698 S.D. 0.88 C.V. 0.960

LABS ELIMINATED 40 165 219 1644 1715 2477 19 52 80 90 125 169 354

416 565 2468 168 493 768 1525 2484

CCRL PROFICIENCY SAMPLE PROGRAM
 C1038 Mortar Bar Expansion
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.400 C1038 Mortar Bar Expansion 136 POINTS

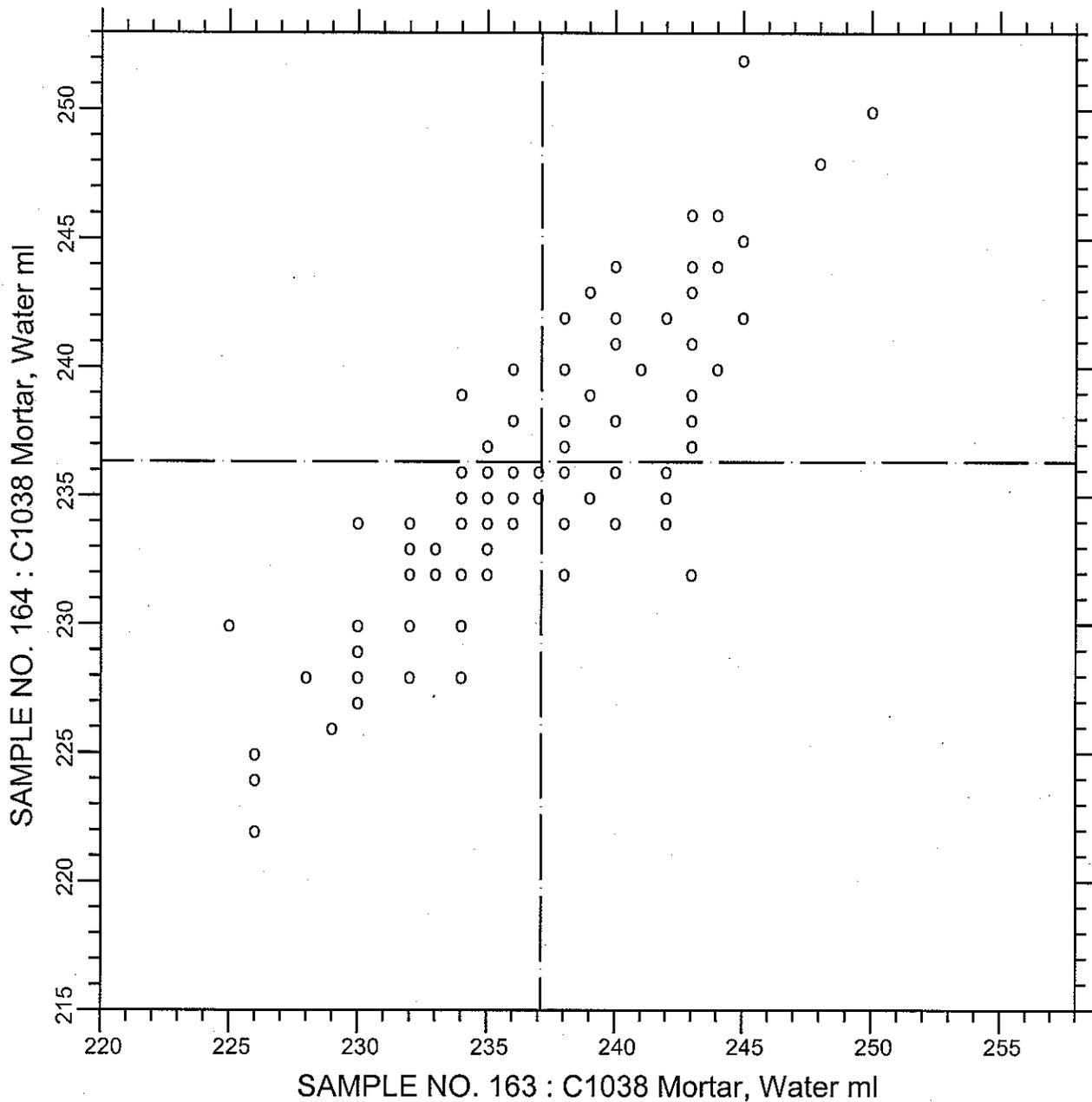
SAMPLE NO. 163 AVE 0.00354 S.D. 0.0043 C.V. 122.0

SAMPLE NO. 164 AVE 0.00464 S.D. 0.0038 C.V. 83.0

LABS ELIMINATED 10 137 1799

LABS OFF DIAGRAM 255

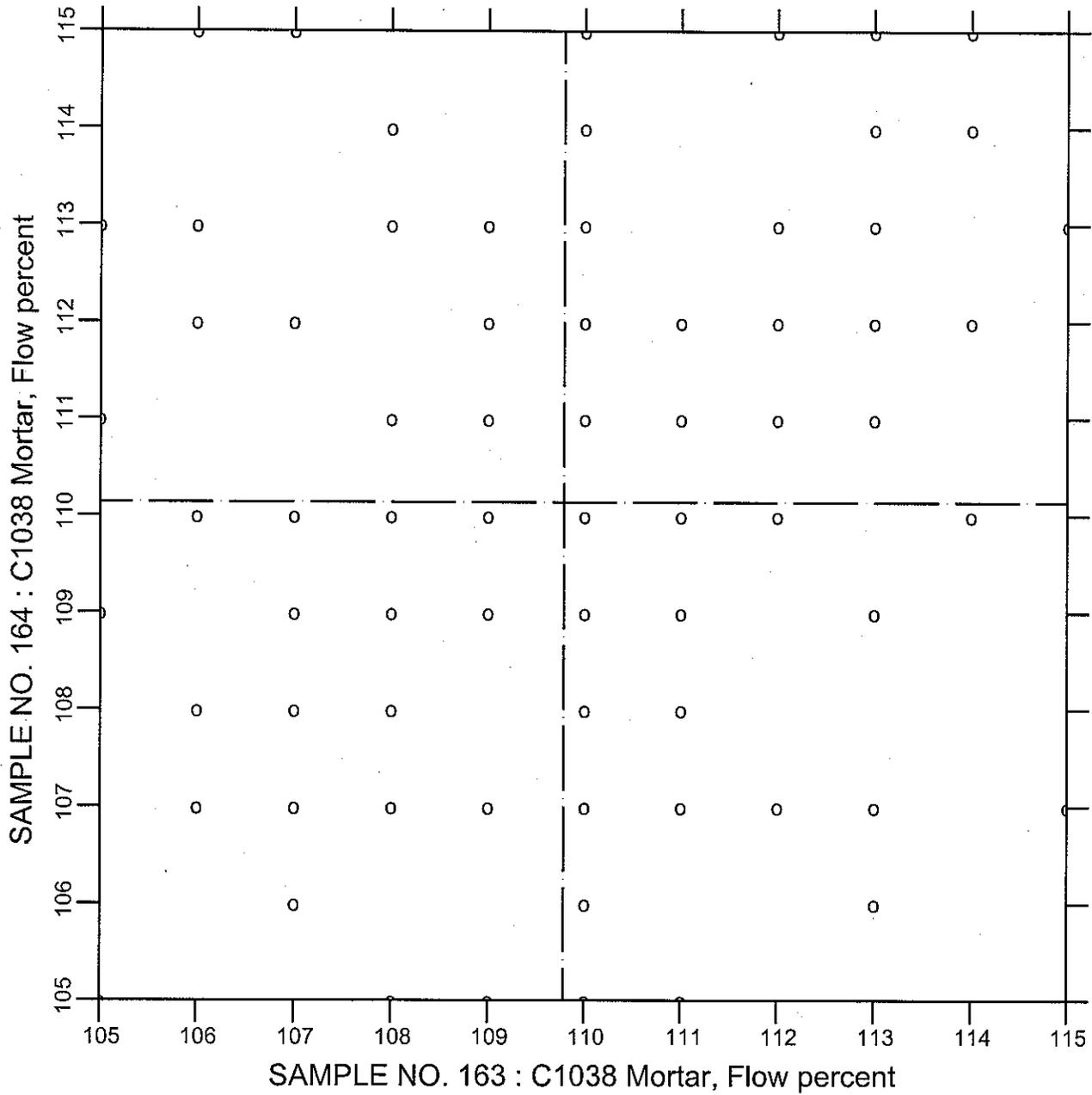
CCRL PROFICIENCY SAMPLE PROGRAM
 C1038 Mortar - Water
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.401 C1038 Mortar, Water 133 POINTS

SAMPLE NO. 163 AVE 237.12 S.D. 5.0 C.V. 2.13
 SAMPLE NO. 164 AVE 236.33 S.D. 5.6 C.V. 2.36
 LABS ELIMINATED 438 80 94 611 932 1936 2483

CCRL PROFICIENCY SAMPLE PROGRAM
 C1038 Mortar - Flow
 PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.402

C1038 Mortar, Flow

131 POINTS

SAMPLE NO. 163 AVE 109.79 S.D. 2.5 C.V. 2.29

SAMPLE NO. 164 AVE 110.14 S.D. 2.7 C.V. 2.45

LABS ELIMINATED 416 1936 243 3126 918

CCRL PROFICIENCY SAMPLE PROGRAM
 Portland Cement Proficiency Samples No. 163 and No. 164
 Final Report - Heat of Hydration Results
 April 8, 2007

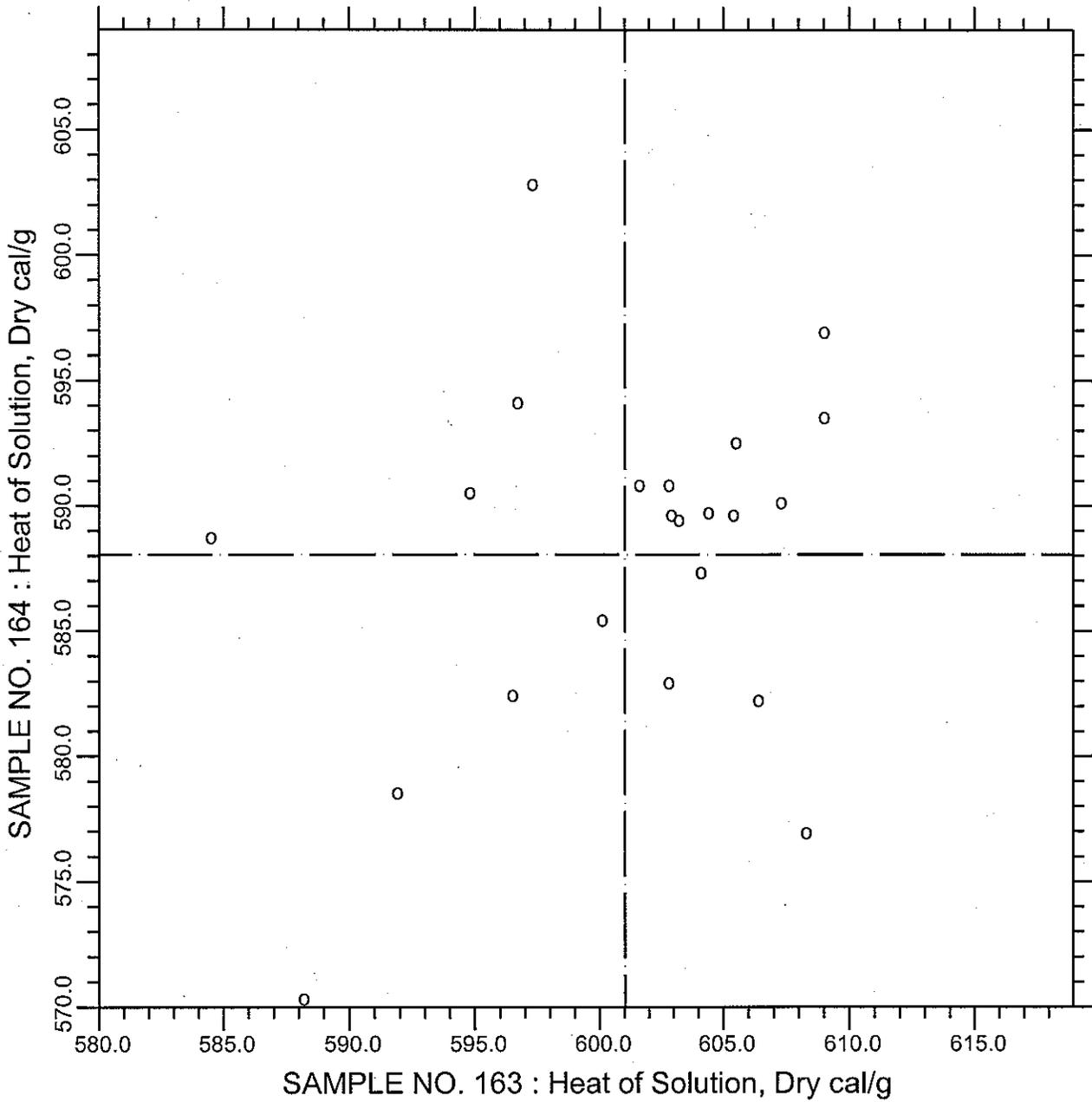
SUMMARY OF RESULTS

Test		#Labs	Sample No. 163			Sample No. 164		
			Average	S.D.	C.V.	Average	S.D.	C.V.
Heat Solution, Dry	cal/g	25	596.6	20.0	3.36	586.6	26.2	4.47
Heat Solution, Dry	cal/g *	22	601.0	6.7	1.11	588.0	7.1	1.20
Heat Sol, 7 day	cal/g	25	524.3	18.6	3.55	512.0	22.6	4.42
Heat Sol, 7 day	cal/g *	22	524.5	6.3	1.20	511.8	7.6	1.49
Heat Sol, 28 day	cal/g	16	513.5	3.8	0.731	499.8	7.2	1.432
Heat Hyd, 7 day	cal/g	29	79.5	9.8	12.3	81.3	19.2	23.6
Heat Hyd, 7 day	cal/g *	26	78.4	5.3	6.79	77.1	8.6	11.10
Heat Hyd, 28 day	cal/g	19	87.4	6.0	6.92	87.7	8.6	9.76

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

Heat of Solution, Dry 2292 2412 2464
 Heat of Solution, 7 day 2292 2412 2464
 Heat of Hydration, 7 day 2412 2464 2483

CCRL PROFICIENCY SAMPLE PROGRAM
Heat of Solution - Dry Cement
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.291

Heat of Solution, Dry

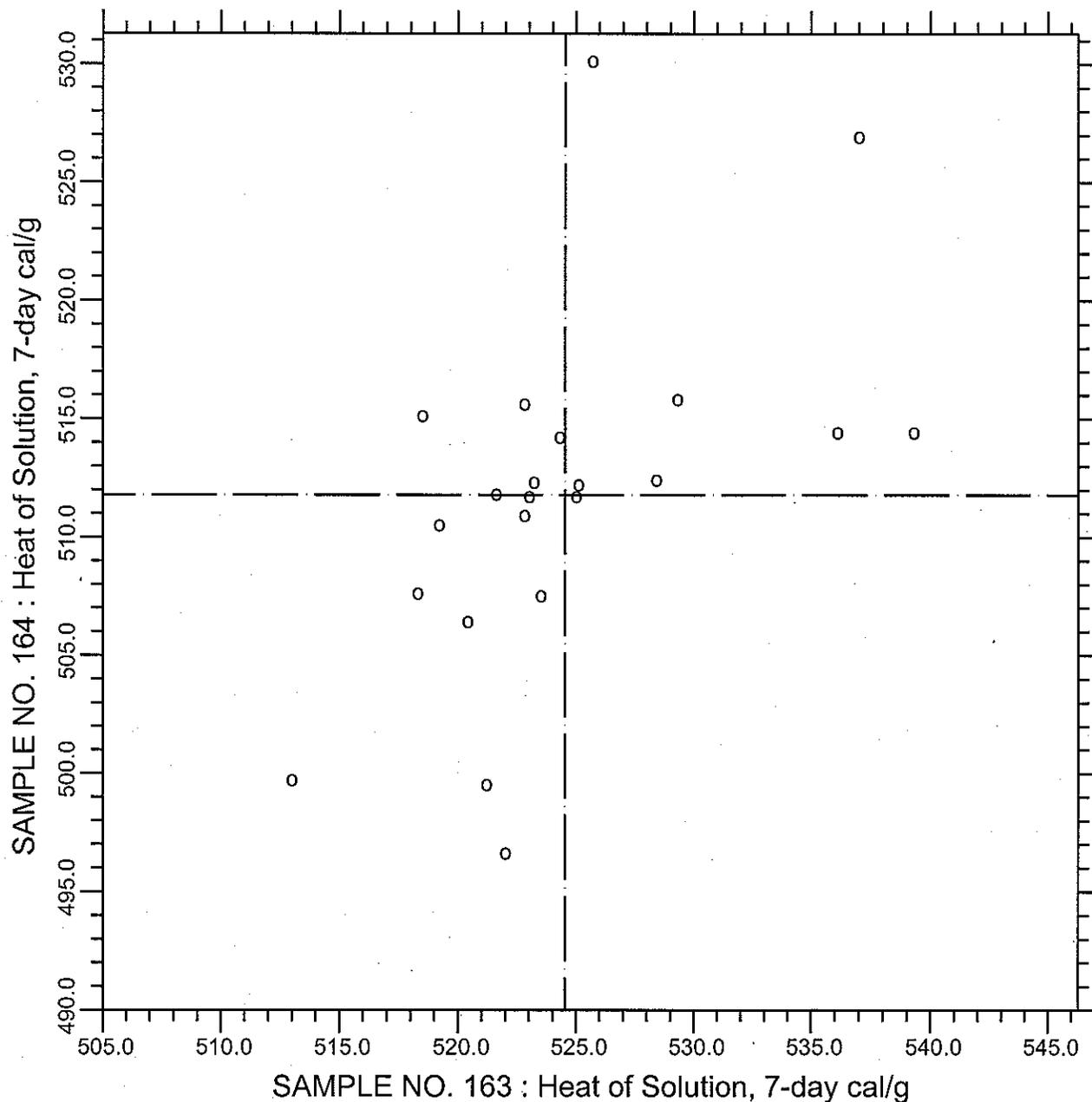
22 POINTS

SAMPLE NO. 163 AVE 601.0 S.D. 6.7 C.V. 1.11

SAMPLE NO. 164 AVE 588.0 S.D. 7.1 C.V. 1.20

LABS ELIMINATED 2292 2412 2464

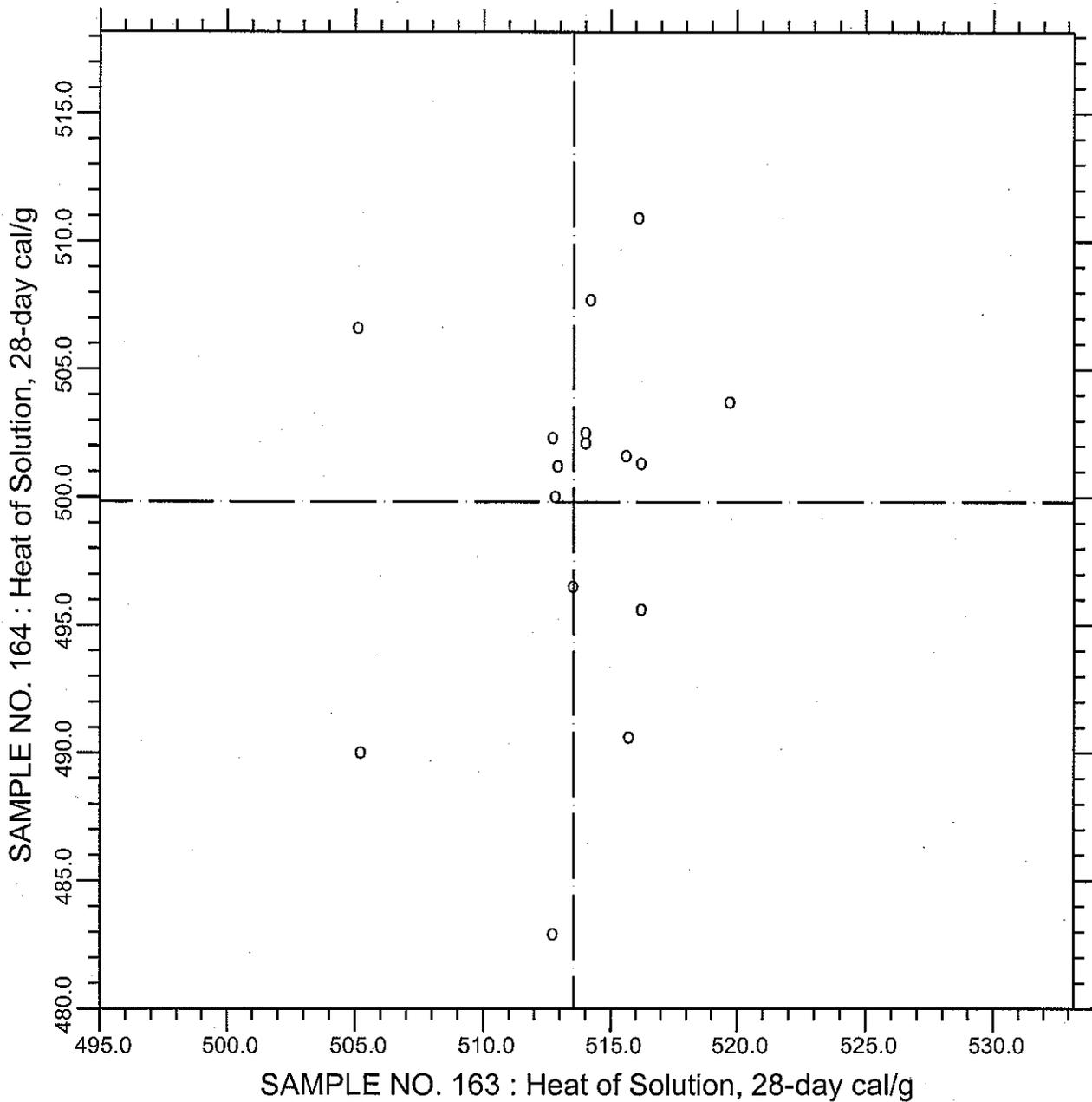
CCRL PROFICIENCY SAMPLE PROGRAM
Heat of Solution - 7-day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.292 Heat of Solution, 7-day 22 POINTS

SAMPLE NO. 163 AVE 524.5 S.D. 6.3 C.V. 1.20
 SAMPLE NO. 164 AVE 511.8 S.D. 7.6 C.V. 1.49
 LABS ELIMINATED 2292 2412 2464

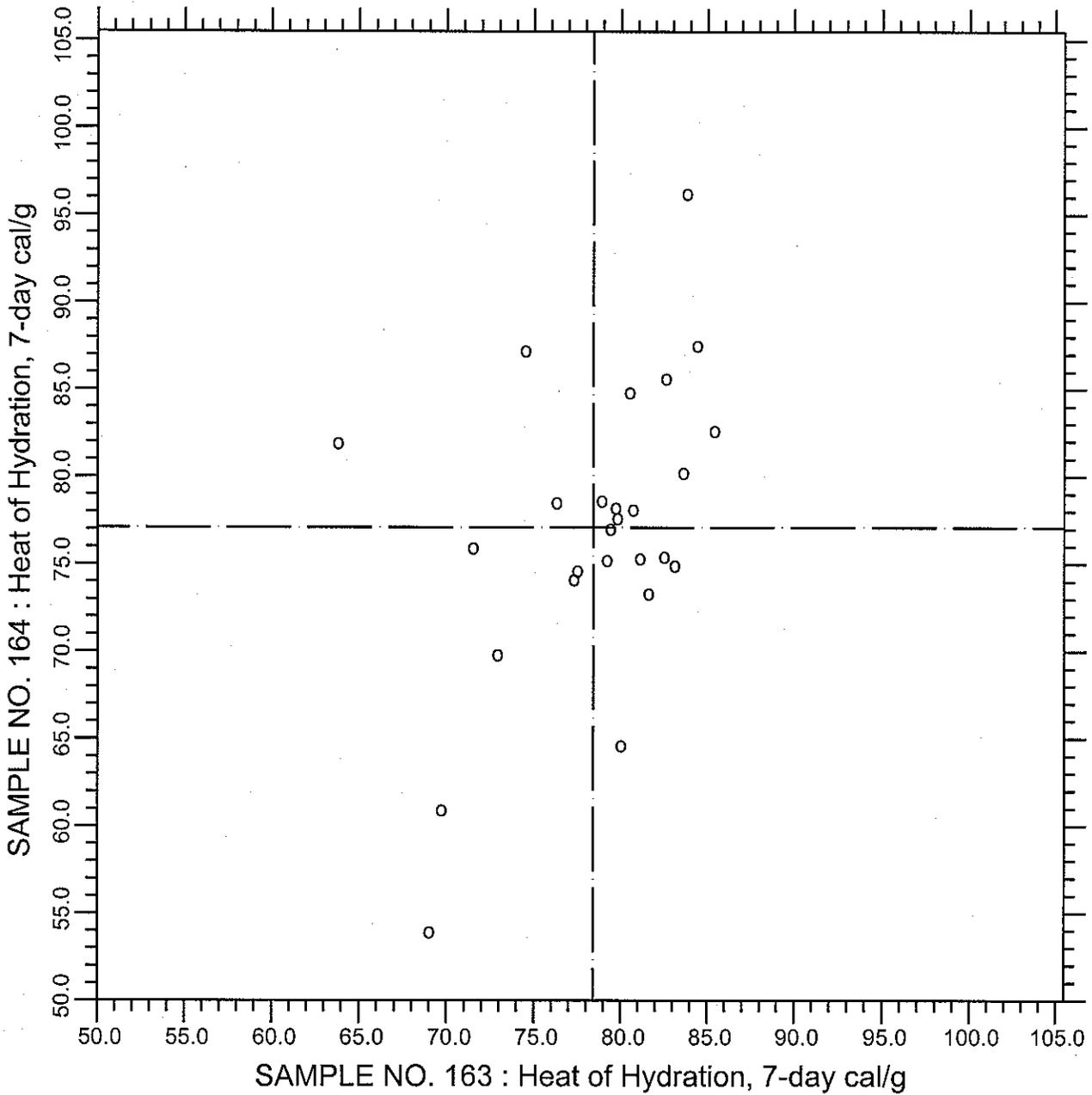
CCRL PROFICIENCY SAMPLE PROGRAM
Heat of Solution - 28-day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.301 Heat of Solution, 28-day 16 POINTS

SAMPLE NO. 163	AVE	513.54	S.D.	3.8	C.V.	0.731
SAMPLE NO. 164	AVE	499.82	S.D.	7.2	C.V.	1.432

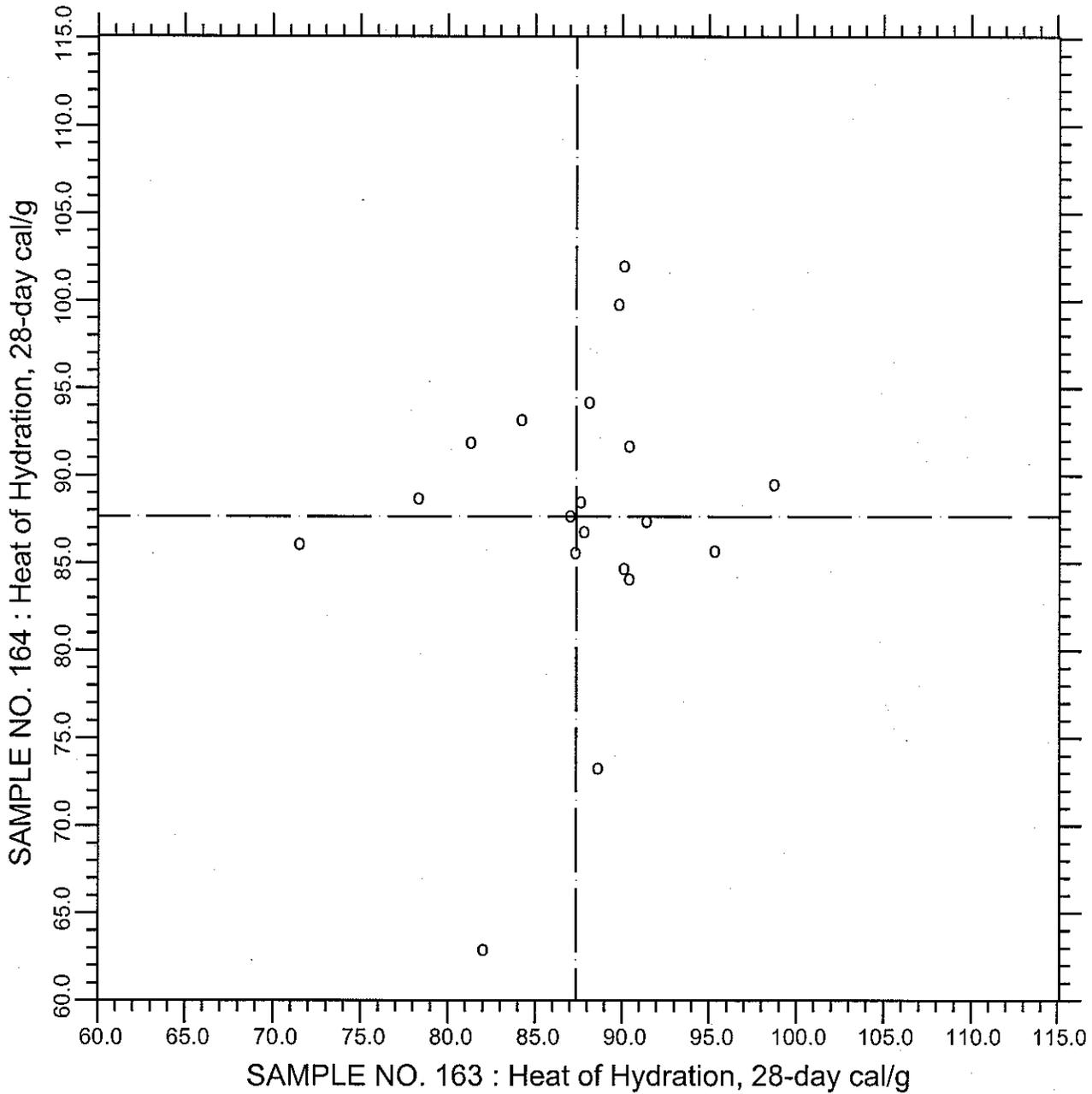
CCRL PROFICIENCY SAMPLE PROGRAM
Heat of Hydration - 7-day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.290 Heat of Hydration, 7-day 26 POINTS

SAMPLE NO. 163 AVE 78.4 S.D. 5.3 C.V. 6.79
 SAMPLE NO. 164 AVE 77.1 S.D. 8.6 C.V. 11.10
 LABS ELIMINATED 2412 2464 2483

CCRL PROFICIENCY SAMPLE PROGRAM
Heat of Hydration - 28-day
PORTLAND CEMENT SAMPLES NO. 163 & NO. 164



TEST NO.300 Heat of Hydration, 28-day 19 POINTS

SAMPLE NO. 163 AVE 87.4 S.D. 6.0 C.V. 6.92
 SAMPLE NO. 164 AVE 87.7 S.D. 8.6 C.V. 9.76