NATIONAL BUREAU OF STANDARDS REPORT

9826

Progress Report

January 1 Through March 31, 1968

DEVELOPMENT OF METHODS OF TEST

FOR QUALITY CONTROL OF PORCELAIN ENAMELS

Sponsored By
Porcelain Enamel Institute Research Associateship
National Bureau of Standards
Washington, D. C.

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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DEVELOPMENT OF METHODS OF TEST

FOR QUALITY CONTROL OF PORCELAIN ENAMELS

by
M. D. Burdick and M. A. Rushmer

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SUMMARY

Several modifications in the previously developed cleanability procedure have been suggested. The revised procedure was applied to a series of organic and inorganic finishes to illustrate a tentative grading system. Reproducible results were obtained for five of the seven surfaces tested.

The enamels in the 1966 Exposure Test of Nature-Tone enamels on steel were inspected after six months' exposure at Gaithersburg and one-year's exposure at both Kure Beach and South Florida. The results are presented and discussed.

INTRODUCTION

In the design and manufacture of equipment for home appliances, many types of finishes are in competition. The selection of a particular finish may be influenced by the environment in which it must operate, by considerations of public health in connection with the storage and serving of food and certainly by the economics of the alternate selections. The appearance, and the degree and ease of maintenance required to preserve and restore an acceptable appearance during service life, are also important considerations in consumer acceptance which should be weighed during the design process. The development of a testing procedure has been undertaken to permit an objective evaluation of the ease of cleaning of surface finishes considered for use in appliance design.

A procedure has been evolved and described in previous reports in this series, which permitted the evaluation of the ease of cleaning of porcelain enamel and other inert inorganic finishes. Modifications of this procedure are under study to extend its valid application to a wide variety of organic finishes which may be considered in performance testing for appliance systems.

RESULTS AND DISCUSSION

During the previous quarter some promise of reproducibility was obtained with a wet-cleaning procedure that involved adding one drop of distilled water to a soiled specimen before cleaning it mechanically with a tissue-covered head moving back and forth over

the rotating specimen. The previous work used water dispensed from a rubber squeeze-bulb dropping bottle. The drop-size obtained was not well controlled. Improved control of the amount of water used in cleaning was studied during the present period in order to select a cleaning treatment which would yield a good distinction between easy-to-clean and more difficult-to-clean types of finishes, and would also permit reproducible determinations at different times.

1. Preliminary tests with porcelain enamels.

Cleaning experiments were made with two porcelain enamels, Numbers 5 and 3F, which previous work with an oily soiling agent had shown to differ widely in the ease of cleaning.

The two porcelain enamels were used in an experiment with different amounts of water for cleaning and the results are given in Table 1. Analyses of variance indicated that the groups of determinations using the 18 gage hypodermic needle were reproducible from day-to-day while those with the 16 gage needle were not. The results given in Table 1 show the marked influence of the amount of water used in cleaning upon the amount of soil retained after the cleaning treatment.

Confidence limits of the form

$$\bar{x} \pm \frac{t\ s}{\sqrt{n}}$$

where: $\bar{x}$ = The mean of determined values

t = Student's t-distribution

n = Number of determinations

s = The estimate of standard deviation from n specimens

establish a band about the mean at any desired level of confidence.

The values of t decrease as the number of specimens increases. The size of the confidence limits, in general, decrease as n increases and the value of s becomes a more reliable estimate of the true standard deviation. Typical values for the confidence bands calculated for finish number 6 from Table 4 are shown below:

Number of Determinations	95 Percent Confidence Limits	95 Percent Confidence Band $\bar{x} \pm \frac{t\ s}{\sqrt{n}}$
	$\mu g/cm^2$	$\mu g/cm^2$
6	1.3	2.8 to 5.4
12	0.6	3.2 to 4.5
18	0.5	3.2 to 4.3

Table 2 gives the 95 percent confidence bands based on the first six determinations from Table 1. Determinations made at a later time are tabulated; those that fall outside the indicated confidence bands are underlined. It is readily apparent that all subsequent determinations in which the cleaning water was dispensed from an 18 gage needle fall within the predicted confidence bands. When the cleaning water was taken from a 16 gage needle, however, four out of six subsequent determinations fell outside the predicted band. These results suggest that the use of the 16 gage needle resulted in more variable drop-sizes and they also confirm the analyses of variance which indicated more nearly reproducible results from day-to-day when the cleaning water was dispensed from an 18 gage needle.

The results of another series of tests in which these two enamels were cleaned for two 22-second cycles and using a still broader variation in cleaning water, are given in Table 3 and are

shown also in Figure 1. The use of a series of hypodermic needles of different gages, ground at 90 degrees to their axes, provided a fair means of controlling water drop sizes. When small amounts of water were used, a good distinction was found between these porcelain enamel surfaces. The steep slope of the curves indicates, however, that a careful control of the amount of water used was required.

On the basis of these and previous tests, a drop-size of 0.016 g. (one drop from an 18 gage needle held at 45 degrees) and a cleaning time of 22 seconds for each of two cycles was selected for further work.

Some of the details of the method used in the tests that follow are given below:

Standard Soil

The soiling agent had the following composition:

Polyethylene glycol	98.0 Percent
Water soluble dye	1.0
Uranine	1.0

Washing of Specimens

The specimens were scrubbed with a soft sponge and a warm solution of a laboratory detergent.

Rinsing

The specimens were rinsed immediately with flowing tap water, with distilled water, and then with absolute alcohol.

Drying

The specimens were dried in a near vertical position for at least an hour at room temperature.

Soiling

One drop of soil was dispensed from a hypodermic syringe without a needle. The drop size for this soil was 0.044 grams. The soil was mechanically distributed over an area of seven square inches at the center of the specimen with a teflon-faced brass head.

Cleaning

One drop of distilled water was dispensed to the soiled specimen from a hypodermic syringe fitted with an 18 gage needle. A brass head, 2 1/4 inches in diameter covered with four thicknesses of laboratory tissue was mechanically rubbed over the specimen to absorb and remove the soiling agent during a 22-second period. The operation was repeated.

Extraction of Soiling Agent

An extraction cell with O-ring seal was clamped against the soiled specimen surface. A known amount of distilled water was dispensed into the extraction cell. After moderate agitation for three minutes in contact with the specimen surface, the water was poured out and its fluorescence measured.

Calculation of Soil Retained

The soil retained was calculated:

$$\text{Soil Retained, } \mu g/cm^2 = \frac{\text{Weight of Water Solvent, g, X Calibration Factor, } \mu g/g}{\text{Extraction Area, } cm^2}$$

2. Tests made on various surfaces

Table 4 gives results obtained on seven surfaces which are in common use in architectural or appliance systems. Individual results on six specimens of each finish are given for determinations

at three different times. This allows an estimate of the self-consistency of groups of six specimens and also gives an indication of the reproducibility of this testing procedure from day-to-day at the 95 percent confidence level.

Table 5 identified the types of finishes and gives the range and coefficients of variation over the 18 individual determinations on each finish. The relationship between soil retained and the range, shown in Figure 2, indicates that the soil retained on the easier-to-clean finishes was determined with the least variability and that those finishes which retained larger amounts of soil, after this cleaning procedure, had larger scatter of results. The coefficient of variation is the standard deviation expressed as a percentage of the mean value. This latter measure of scatter allows a more valid comparison of specimen groups whose means differ widely.

3. A tentative grading system

The value of soil retained may be used as an index of cleanability for these surfaces. A system for grading surfaces with respect to their cleanability might take the following form:

Cleanability Index	Grade
0.0 to 2.5	A
2.5 to 5.0	B
5.0 to 7.5	C
7.5 to 10.0	D
over 10.0	E

The grades which would be assigned to the surfaces evaluated under this system are given in Table 6. The values in the last three columns summarize the number of repeat determinations required

to establish that there was only a 5 percent probability that the specified bounds for a particular grade would be exceeded if the cleanability index were redetermined. For surface number 16 the first six values had sufficient precision to indicate that there was only a 5 percent probably that a repeat determination would not be within the band of 1.5 to 2.1 $\mu g/cm^2$.

As the variability increased for those surfaces that were more difficult to clean, more repeat determinations were required to narrow the confidence bands sufficiently to insure that the grading would not be changed if the cleanability index was redetermined. The number of determinations required was influenced not only by their imprecision but also by the nearness of the mean value to a grade bound.

4. Conclusion

The results of this wet cleaning procedure are not considered satisfactory. The calculations of the confidence limits were made to show the amount of replication required, at the present state-of-the-art to obtain reliable grading of these surfaces.

PLANS FOR THE NEXT REPORT PERIOD

Further modifications in the soiling and cleaning procedures will be sought. First, it is felt, that the cleaning operations needs to be "slowed down", possibly through the use of a less absorbant cleaning tissue system. Secondly, better control of the amount of water used for cleaning seems imperative. It is estimated that the variation in drop-size obtained in repeated measurements from an 18 gage needle may be responsible for nearly

50 percent of the variability found when cleaning surfaces with large amounts of soil retained. A precise burette has been ordered which is claimed to deliver small controlled amounts of solvent with good repeatability. If the variability found with the difficult to clean surfaces could be reduced by 50 percent, the method would appear to be satisfactorily controlled.

II. 1966 EXPOSURE TEST OF NATURE-TONE ENAMELS ON STEEL

INTRODUCTION

In the early sixties, the porcelain enamel industry developed a series of matte enamels with muted, earthy colors. This series of enamels was called Nature-Tones.

An exposure test consisting solely of Nature-Tone enamels on steel was initiated in 1966 to determine if these enamels followed the same patterns in respect to weathering as the older glossy enamels.

There were six specimens of each of twenty-five different enamels exposed at Kure Beach, North Carolina - 80 feet from the ocean; South Florida Test Service, Miami, Florida; and Gaithersburg, Maryland. Three specimens of each enamel are also kept inside in dark, dry storage.

The enamels exposed at Gaithersburg have just had their first or six-months inspection while those exposed at Kure Beach and South Florida and the storage enamels have just had their second or one-year inspection.

INSPECTION PROCEDURE

A. Cleaning of Specimens

The procedure used to clean the specimens in this test has

been to 1) scour 30 strokes with a sponge that has been moistened with a one percent, by weight, solution of trisodium phosphate and sprinkled with calcium carbonate, 2) rinse with tap water, 3) rinse with distilled water and 4) rinse with alcohol.

B. Visual Inspection

After the above cleaning process, the specimens were examined visually for discontinuities as evidenced by either irridescent or rust colored spots.

C. Gloss and Color

Th 45° specular gloss of the specimens was measured at four orientations near the center of the specimen. The gloss is reported as the percentage gloss retained after exposure. The change in color was measured with a color difference meter. One of the three storage specimens of each enamel was used as the color standard to obtain the maximum efficiency possible with this type of instrument. The color change is reported as color retention which is 100 minus the color change in NBS units.

RESULTS AND DISCUSSION

A. Color

The color retention values for the enamels exposed for six-months at Gaithersburg and one-year at Kure Beach, South Florida and Storage are presented in Table 7.

Observation of the data in this table would indicate that all the enamels except enamels 102 and 118 have changed less than one NBS unit and these enamels have changed just a little more than one NBS unit. This small amount of change is barely

noticeable to the trained observer under the best lighting conditions and would never be noticed in an architectural installation. In fact the color change of these enamels is so small that it is barely larger than the error that could be expected in measuring the color difference. The change in color of the enamels exposed 0-6 months and six-months to one-year is given in Table 8. These data further indicate that the rate of color change for most of the enamels in this test has decreased during the second six-months' exposure period. If this trend continues, then the nature-tone enamels may be characterized as having excellent color retention.

B. Gloss

The percentage gloss retained for these enamels is presented in Table 9. Although these values may be of interest to some, it is not felt that gloss is as sensitive an indicator of an enamel's weatherability as color. This is particularly true for these low gloss enamels where small changes in gloss retained result in large percentage differences.

C. Continuity of Coating

In an effort to determine whether or not the high-voltage continuity of coating test probe could cull enamels with poor continuity, one half of the enamels to be exposed were selected at random from those submitted while the other half was selected from those enamels which did not show any discontinuities when subjected to the high-voltage test probe. The number of exposed enamels that rusted at each exposure site is given in Table 10.

These data indicate that the enamels that passed the continuity of coating probe were two to three times less apt to rust than those selected at random. Although this is a big improvement, the premature rusting of enamels 102, 111, 112, and 113 is a cause for concern. Either the overvoltage used in testing these enamels was not high enough or the openings in the mesh of the probe are enough to permit it to miss some discontinuities in the enamels.

PLANS FOR NEXT REPORT PERIOD

The specimens have been returned to the exposure racks at all sites. The next inspection of the enamels exposed at Gaithersburg will be after 1-year's exposure, while the next inspection of the enamels exposed at Kure Beach, South Florida and storage will be after three years' exposure. After the enamels exposed at Gaithersburg have completed their one-year inspection, a complete report of the six months' and one-year inspection will be prepared.

Table 1. Soil Retained on Two Porcelain Enamels After Wet Cleaning

Soil 14, One Drop Water from Hypodermic Needles of Different Gages. Two 22-second Cycles.

Enamel	5		3F	
Needle Gage	18	16	18	16
Drop Size, g.	0.016	0.02	0.016	0.02
	$\mu g/cm^2$	$\mu g/cm^2$	$\mu g/cm^2$	$\mu g/cm^2$
	2.31	1.86	6.75	5.52
	2.10	1.53	6.42	5.19
	1.61	1.86	6.75	5.68
	2.06	1.61	6.99	4.86
	1.82	1.69	9.94	5.93
	2.39	1.78	4.86	4.45
$\bar{x}$ =	2.05	1.72	6.95	5.27
	1.78	1.74	9.45	3.96
	1.82	1.69	6.75	3.72
	2.02	2.06	7.65	5.35
	1.69	1.74	6.17	4.45
	1.90	1.45	6.34	3.72
	1.86	1.61	6.17	3.63
$\bar{x}$ =	1.84	1.72	7.09	4.14
	1.98	1.86	6.04	5.03
	1.98	2.15	7.48	5.11
	2.15	2.27	7.89	6.17
	2.23	2.02	5.85	5.27
	1.94	1.86	6.50	6.58
	2.35	1.90	4.45	5.11
$\bar{x}$ =	2.10	2.01	6.37	5.54
$\bar{\bar{x}}_{18}$	2.00	1.82	6.80	4.98

Table 2. Results of Repeated Determinations of the Soil Retained on Two Porcelain Enamels.

Enamel	5		3F	
Needle Gage	18	16	18	16
Mean value 1/ $\mu g/cm^2$	2.05	1.72	6.95	5.27
Confidence Band 1/	2.4	1.9	8.5	5.8
	1.7	1.6	5.4	4.7
Repeat Values				
From Table 1	1.8	1.7	7.1	4.1
"	2.1	2.0	6.4	5.5
From Table 3	2.1	2.2	6.0	6.0
From Table 4	2.1	--	7.0	--
"	2.2	--	7.2	--
"	2.4	--	5.8	--

1/ Calculated from the first group of six specimens in Table 1

Table 3. Comparison of Two Enamels Using Different Amounts of Water for Cleaning.

	Cleaning Water added, grams					
	0.013	0.016	0.02	0.04	0.06	0.08
Enamel 5						
Soil Retained Average of six, $\mu g/cm^2$	2.94	2.06	2.24	1.46	1.04	0.52
Coefficient of Variation, percent	12	10	10	17	17	18
Enamel 3F						
Soil Retained Average of six, $\mu g/cm^2$	9.86	6.95	5.97	2.72	1.30	0.88
Coefficient of Variation percent	7	21	7	13	22	14

Hypodermic Needle No.	Number of Drops	Water Dispensed grams
20	1	0.013
18	1	.016
16	1	.02
16	2	.04
16	3	.06
16	4	.08

Table 4. Soil Retained by Various Finishes After Wet Cleaning.

Soil 14; One drop water from No. 18 Needle; Two 22-Second Cycles.

Finish No.	16	18	5	15	6	3F	17
	all values given in $\mu g/cm^2$						
	1.94	2.19	2.10	2.72	5.38	7.32	9.90
	1.80	1.90	1.82	2.76	3.09	6.01	8.96
	1.94	1.90	2.19	3.13	2.23	7.73	6.75
	2.10	1.69	1.98	1.98	4.07	8.06	8.30
	1.41	1.69	2.31	3.13	4.64	6.42	8.88
	1.61	1.74	1.98	1.98	5.30	6.17	12.15
	(1.80)	(1.85)	(2.06)	(2.62)	(4.12)	(6.95)	(9.16)
	1.78	2.06	2.10	2.60	3.91	7.89	11.50
	1.74	1.82	2.35	4.64	2.64	9.70	8.30
	1.74	1.98	2.31	2.51	3.33	5.93	10.60
	1.61	1.74	2.19	3.37	3.12	9.61	8.56
	1.37	1.78	2.06	2.27	4.56	4.37	11.34
	1.53	1.82	2.39	3.91	4.28	6.01	10.28
	(1.63)	(1.87)	(2.23)	(3.22)	(3.64)	(7.25)	(10.10)
	1.78	1.33	2.80	2.84	3.25	7.40	11.91
	1.08	1.33	2.10	3.33	2.23	4.13	11.09
	1.82	1.41	2.68	2.19	2.19	5.68	10.43
	1.49	1.53	2.15	2.55	3.37	5.11	11.09
	0.92	1.16	2.35	2.73	4.64	7.24	15.51
	2.02	1.57	2.19	2.73	5.14	5.19	12.15
	(1.52)	(1.39)	(2.38)	(2.73)	(3.47)	(5.79)	(12.03
Mean	1.65	1.70	2.22	2.86	3.74	6.66	10.43

Table 5. Cleanability Results Obtained on Several Surfaces.

Specimen Designation	Type of Finish	45 Degree Gloss	Soil Retained After Wet Cleaning [1]	Reproducibility Of Test Procedure [2]	Range of Determined Values	Coefficient of Variation
			$\mu g/cm^2$		$\mu g/cm^2$	percent
16	Porcelain Enamel on Aluminum	75	1.6	Satisfactory	1.2	19
18	Baked Alkyd Enamel	52	1.7	Poor	1.0	16
5	Porcelain Enamel on Steel	61	2.2	Satisfactory	1.0	11
15	Thermal Setting Acrylic	9	2.9	Satisfactory	1.9	23
6	Brushed Chromium Plated Steel	-- [3]	3.7	Satisfactory	3.2	28
3F	Porcelain Enamel on Steel	13	6.7	Satisfactory	5.6	24
17	Anodic Coating on Aluminum	14	10.4	Poor	8.8	19

[1] The cleaning process involved mechanical rubbing with a tissue-covered head, operated in two cycles, each of 22 seconds duration. Each tissue was dampened with 0.016 grams of distilled water before use.

[2] "Satisfactory" indicates that the triplicate determinations of the soil retained on the same specimens did not differ significantly at the 95 percent confidence level. "Poor" indicates that the triplicate determinations of the soil retained on the same specimens showed a significant difference at the 95 percent confidence level.

[3] 45 degree gloss was not applicable to these chromium plated specimens. The indicated value was 100^{+}. (Off scale at the high end).

Table 6. A Tentative Grading of the Cleanability of Several Surface Finishes Using Soil Retained as an Index of Cleanability

Specimen Designation	Type of Finish	Cleanability Index	Grade	Number of Determinations 1/ Required to Establish a Suitably Narrow 95 Percent Confidence Band		
				Number	Confidence Band $\mu g/cm^2$	$\mu g/cm^2$
16	Porcelain Enamel on Aluminum	1.8	A	6	1.5	2.1
18	Baked Alkyd Enamel	1.8	A	6	1.6	2.0
5	Porcelain Enamel on Steel	2.1	A	6	1.8	2.3
15	Thermal Setting Acrylic	2.8	B	18	2.5_2	3.2
6	Brushed Chromium Plated Steel	3.9	B	12	3.2	4.5
3F	Porcelain Enamel on Steel (Matte)	6.7	C	18	5.9	7.4
17	Anodic Coating	10.4	(E)	--2/	---	---

1/ Based on results given in Table 4 and the cleaning procedure used.

2/ The variability of the results was such that 18 determinations was not sufficient to establish the grade at the 95 percent confidence level.

Table 7. Summary of Color Retention Data for Enamels in the 1966 Exposure Test of Nature-Tone Enamels on Steel.

Enamel	Color Retention			
	Kure Beach 1-Yr.	South Florida 1-Yr.	Gaithersburg 6-Mos.	Storage 1-Yr.
101	99.18	99.30	99.20	99.72
102	98.96	99.03	98.76	99.84
103	99.54	99.35	99.60	99.88
104	99.52	99.53	99.58	99.80
105	99.50	99.59	99.58	99.76
106	99.25	99.37	99.36	99.53
107	99.51	99.52	99.70	99.51
108	99.52	99.54	99.50	99.73
109	99.47	99.53	99.63	99.73
110	99.72	99.66	99.82	99.80
111	99.20	99.67	99.56	99.50
112	99.57	99.55	99.47	99.83
113	99.44	99.46	99.61	99.63
114	99.47	99.54	99.54	99.56
115	99.48	99.42	99.57	99.27
116	99.79	99.61	99.45	99.53
117	99.23	99.45	99.44	99.31
118	99.51	98.77	99.65	99.82
119	99.55	99.81	99.75	99.79
120	99.57	99.64	99.40	99.52
1	99.50	99.70	99.63	99.73
3	99.28	99.34	99.31	99.61
4	99.25	99.48	99.57	99.15
6	99.77	99.75	99.84	99.70
7	99.65	99.33	99.56	99.85
	99.42	99.48	99.52	99.62

Table 8. Comparison of Color Change Occurring in the Enamels in the 1966 Exposure Test of Nature-Tone Enamels on Steel

Enamel	Change in Color Retention						
	Kure Beach		South Florida		Gaithersburg	Storage	
	0- ½ Yr.	½ -1 Yr.	0-½ Yr.	½ -1 Yr.	0- ½ Yr.	0-½½ Yr.	½-1 Yr.
101	0.86	0.04	0.49	0.21	0.70	0.18	0.10
102	1.23	-0.19	1.06	-0.09	1.24	0.32	-0.16
103	0.34	0.12	0.51	0.14	0.40	0.12	0.00
104	0.34	0.14	0.20	0.27	0.42	0.23	-0.03
105	0.34	0.16	0.26	0.15	0.42	0.28	-0.02
106	0.58	0.17	0.33	0.30	0.64	0.32	0.15
107	0.45	0.04	0.62	-0.14	0.30	0.48	0.01
108	0.55	-0.07	0.30	0.16	0.50	0.47	-0.15
109	0.21	0.32	0.53	-0.06	0.37	0.26	0.01
110	0.25	0.03	0.40	-0.06	0.18	0.20	0.00
111	0.65	0.15	0.25	0.12	0.44	0.34	0.16
112	0.28	0.13	0.36	0.09	0.53	0.38	-0.21
113	0.37	0.19	0.57	-0.03	0.39	0.39	-0.02
114	0.22	0.31	0.41	0.05	0.46	0.39	0.05
115	0.44	0.08	0.38	0.10	0.43	0.52	0.21
116	0.46	-0.25	0.26	0.13	0.55	0.80	-0.33
117	0.73	0.04	0.35	0.20	0.56	0.08	0.61
118	0.50	-0.01	0.87	0.36	0.35	0.12	0.06
119	0.41	0.04	0.27	-0.08	0.25	0.71	-0.50
120	0.28	0.13	0.37	-0.01	0.60	0.35	0.13
1	0.47	0.03	0.21	0.07	0.37	0.35	0.06
3	0.59	0.13	0.55	0.11	0.69	0.36	0.03
4	0.61	0.14	0.46	0.06	0.43	0.19	0.66
6	0.24	-0.01	0.20	0.05	0.16	0.19	0.11
7	0.46	-0.11	0.51	0.16	0.44	0.14	0.01

Table 9. Summary of the Gloss Data for the Enamels Exposed in the 1966 Exposure Test of Nature-Tone Enamels on Steel.

Enamel	Percentage Gloss Retained			
	Kure Beach 1-Yr.	South Florida 1-Yr.	Gaithersburg 6-mos.	Storage 1-Yr.
101	84.58	90.35	87.46	102.43
102	76.59	85.85	82.15	102.31
103	88.91	90.60	91.49	99.22
104	83.48	99.33	98.48	100.19
105	87.18	89.21	90.70	101.95
106	83.33	90.58	90.11	99.78
107	84.98	90.16	90.11	98.65
108	97.78	99.62	99.05	99.95
109	100.45	97.77	103.62	100.12
110	101.88	93.34	102.11	100.13
111	94.97	99.69	92.29	101.91
112	102.71	102.62	101.68	100.46
113	104.86	105.72	102.45	103.37
114	89.12	92.09	91.37	98.54
115	89.86	93.58	94.96	97.71
116	90.95	94.04	92.49	95.97
117	84.44	87.08	87.42	99.04
118	92.82	93.69	95.04	94.17
119	86.60	93.06	92.45	100.88
120	88.76	96.06	92.46	97.81
1	82.42	88.02	91.33	99.41
3	85.00	88.34	90.48	100.52
4	85.88	89.24	87.47	99.04
6	142.55	144.70	133.73	138.85
7	125.02	129.96	109.95	125.26
	93.36	96.71	95.63	101.88

Table 10. Summary of Enamels in the 1966 Exposure Test of Nature-Tone Enamels on Steel That Rusted After One Year's Exposure

Enamel	No. Rusted at Kure Beach		No. Rusted at South Florida	
	Selected by High-Voltage Probe	Randomly Selected	Selected by High-Voltage Probe	Randomly Selected
101	0	1	0	1
102	1	1	0	1
103	3	3	0	0
104	0	1	0	2
105	1	2	1	1
106	0	0	0	1
107	1	2	0	0
108	0	0	0	0
109	0	0	0	0
110	0	0	0	0
111	1	1	0	0
112	0	0	1	1
113	0	0	2	0
114	0	0	0	0
115	0	0	0	0
116	0	0	0	1
117	0	0	0	1
118	0	0	0	0
119	0	0	0	1
120	0	0	0	0
1	1	0	0	0
3	0	0	0	0
4	0	0	0	0
6	0	2	0	1
7	0	1	0	0
	8	14	4	11

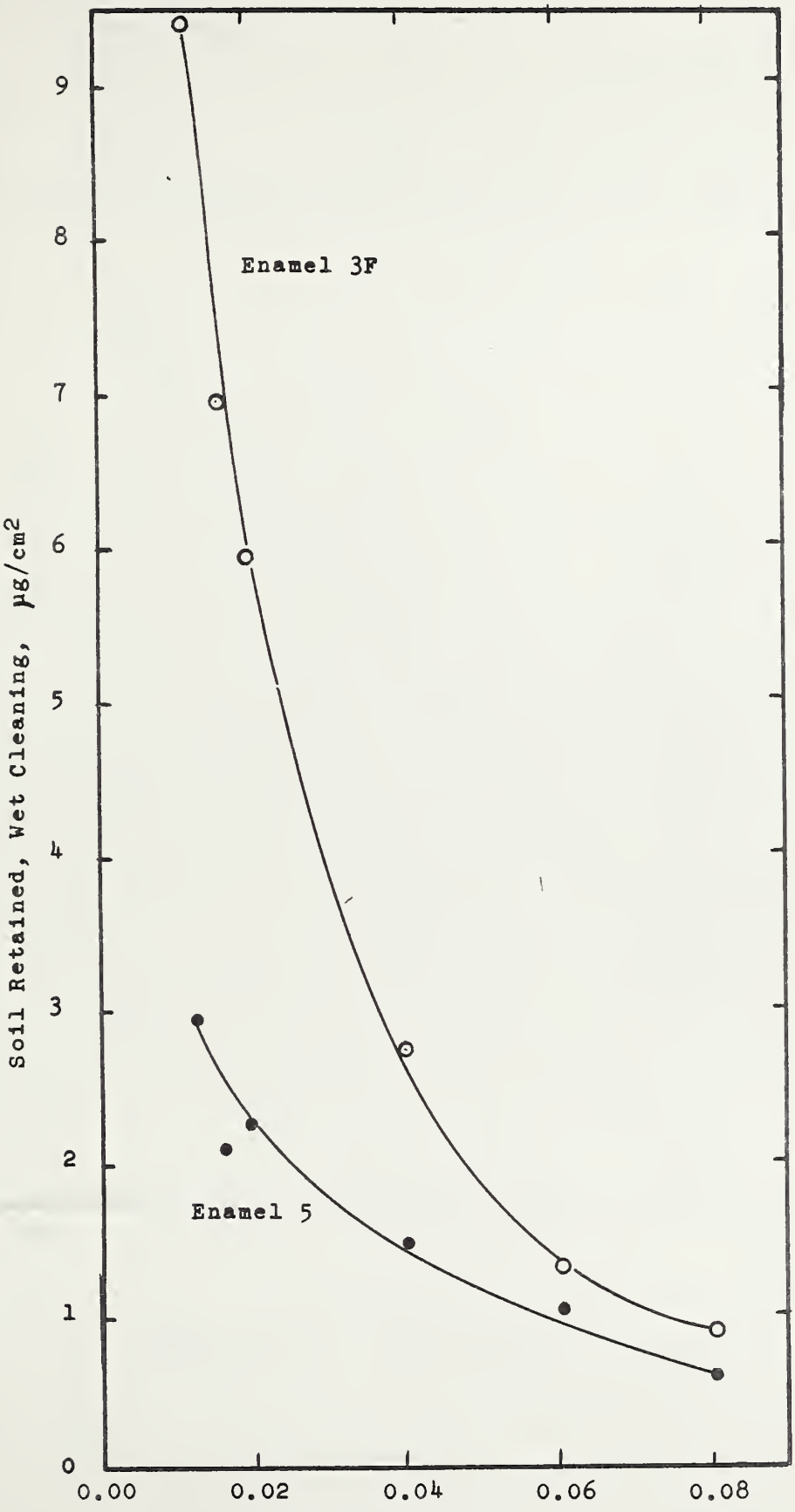

Figure 1. The Relation Between Soil Retained and Cleaning Water Used.

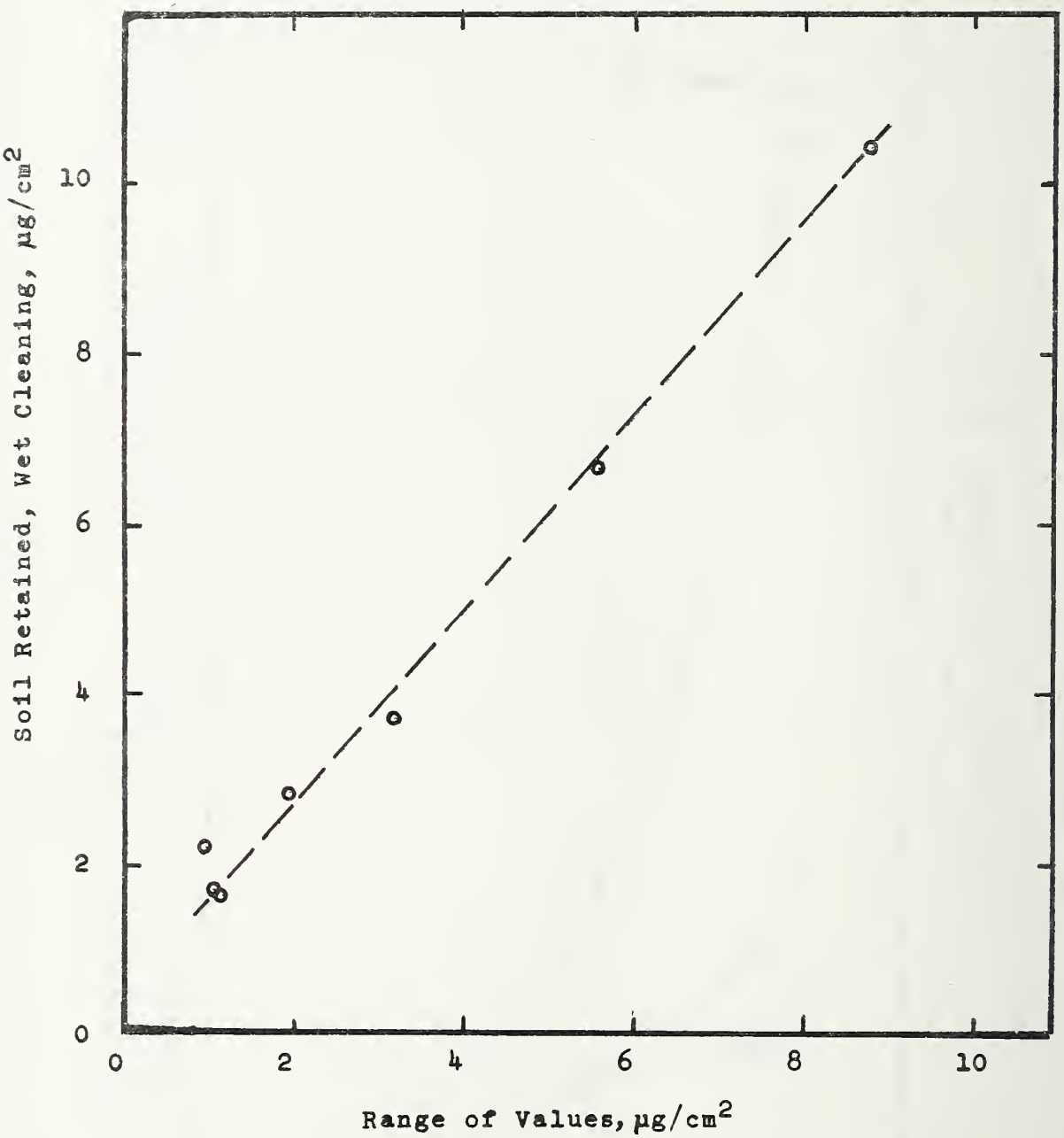

Figure 2. Relation between Retained Soil and the Scatter of Results.


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