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A Comparison of the Coating Properties of Domestic Clays to English Clays

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A COMPARSION OF THE COATING PROPERTIES OF DOMESTIC CLAYS TO ENGLISH CLAYS

A

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by

Suzanne K. Love

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OBJECTIVE

The objective of this thesis was to compare the coating properties of the English and domestic clays. Specifically, it was intended to note which set of clays excelled, if either, in the various properties tested. Furthermore, it would be observed from the results in which properties the primary clays (English) and the secondary clays (domestic) were in close agreement. The experimental work was designed to eliminate as many variables as possible with the exception of the type of clay used.

LITERATURE SURVEY

A literature survey was conducted to determine what work, if any, had been done to compare the coating properties of English and domestic clays. No publications on this subject matter were found.

EXPERIMENTAL DESIGN

To carry out the objective of this work, the following experimental design was planned. A simple coating formulation was devised containing clay, water, an adhesive, and a dispersing agent. The amount of each substance was kept constant with only the type of clay varying in the coating dispersions. Three domestic and three English clays were used for evaluation.

A standard method of preparing the coating dispersions was used and they were applied to a standard raw stock sheet with a definite drawdown procedure. Each of the six coating dispersions were prepared to six different percent solids to obtain a range of coating weights. In addition, supercalendering was done under controlled conditions, with sheets from each clay being given two, four and eight passes.

The clays were tested for particle size and viscosity. The sheets were tested for brightness and opacity before and after calendering and gloss and ink receptivity after calendering.

EXPERIMENTAL METHODS

Preparing the Coating Dispersions

The materials used in the coating formulation were: oxidized corn starch (Stayco M) as the adhesive, tetra sodium pyrophosphate (TSPP) as the dispersing agent, predispersed H.T. and Satin Spray clays(Edgar Clays) and Hydrafine clay (Huber Co.) as the domestic clays, Supreme, Star and Comet clays (Moore and Munger) as the English clays.

The preparation of the coating dispersions was primarily divided into two parts. The first was preparing a 25% dispersion of starch and second the addition of the starch to 51.5% dispersion of clay and dispersing agent. Sixteen percent adhesive on the weight of the oven dry clay was used.

The starch dispersion was prepared by mixing 48 grams of starch in 144 grams of distilled water and heating to 90° C. It was cooked for ten minutes at this temperature before adding, without cooling, to the clay mixture.

300 grams of clay were dispersed in 284 grams of distilled water containing 0.75 gram of TSPP. This mixture was blended in a Waring blender at low speed for ten minutes before adding the starch. After the addition it was blended five minutes more. The final percent solids of the coating dispersions were 45%.

100 gram samples of the coating mixture were poured into six beakers and diluted with distilled water as follows:

g. of water added	0	12.5	28.4	50	80	125
% Solids obtained	45	40	35	30	25	20

Application of Coating, Drying and Calendering

To produce drawdowns two doctor rods of No. 15 (medium) were chosen to apply the coating. Ten or more base sheets cut to approximately 20" x 16" were tacked to a sheet of celloex. They gave a ready supply of raw stock to speed the coating process and to produce a smooth backing surface with a cushioning effect.

Coating was applied to one end of the sheet. A dry, clean doctor rod was drawn through the coating and down the length of the sheet without applying pressure to the rod. The time required for a drawdown was not more than five seconds. The rods were thoroughly cleaned in hot water and dried after each use.

The coated sheets were air dried at room temperature (70 - 80°F.). The sheets were trimmed to 10" x 15" size and allowed to condition in a constant humdity room for not less than 48 hours. The basis weight of conditioned base sheets and coated sheets were determined and changed to a 25 x 38 - 500 ream size.

Supercalendering was done on a Wheeler Roll Co. laboratory installation with a nip pressure of 1680 pounds per linear inch. The calender was warmed one hour before use. Sheets from each percent solids from each clay were given two, four and eight passes through the rolls. Sheets coated with the different types of clay were distributed randomly within the three groups to prevent bias calendering action.

Evaluation Procedures

The particle size distributions of the coating clays were determined using Tappi's suggested method T 649 sm-54. Viscosities of the 45% clay dispersions were measured at 43° C. with the number three spindle of a Brookfield viscometer at 6, 12, 30 and 60 r.p.m.

Physical tests performed on the coated sheets, which were run according to TAPPI standards when possible, included brightness (T 452 m-58), gloss (T 480 m-51), opacity (T 425 m-35), and ink receptivity using K & N ink which was applied for 60 seconds. Ink receptivity was performed only on the coated sheets which passed through four nips in the calender stack.

Brightness and ink receptivity were measured on a G. E. Brightness instrument. The opacity was measured on a Bausch & Lomb opacimeter and the gloss was determined using the Photovolt gloss meter.

PRESENTATION OF RESULTS

From the data collected in the particle size distribution of the clays, the percentage of clay and the particle sizes in suspension were determined. This information was plotted on a graph with particle size versus percentage by weight finer than. The results in Table I were read from this graph.

TABLE I
Particle Size Distribution of Coating Clays

	Coarser than 10 Microns,%	5-10 Microns,%	Finer than 2 Microns,%
Hydrafine	8.2	0.2	89.0
Satin Spray	4.5	0.7	88.0
Pred. HT	3.5	3.0	81.0
Supreme	3.3	1.0	87.0
Comet	1.8	3.2	82.0
Star	4.7	1.7	77.3

The data secured in the viscosity determinations is observed in Figure 1, which is drawn with R.P.M. versus the scale reading of the Brookfield Viscometer.

The figures of brightness, opacity and gloss versus type of clay were all obtained in the same manner. The readings from each of these tests were plotted against the coat weight of the sheets. This was done because it is impossible to achieve identical coat weights for each type of clay at the same percent solids. From these graphs, the brightness, opacity and the gloss readings for each clay were read at the same coat weight so the results became comparable. The information procured from these graphs at three different coat weights can be observed in Figures 2 through 10.

The K & N ink data was plotted in percent ink absorbtion versus type of clay. The percentage of ink absorbed was calculated by using the following formula $\frac{BP - BI}{BP} \times 100 = IA$. BP equals the brightness of the calendered coated sheets and BI equals the brightness of the calendered coated sheets after the ink application. Figure 11 contains this data.

INTERPRETATION OF RESULTS

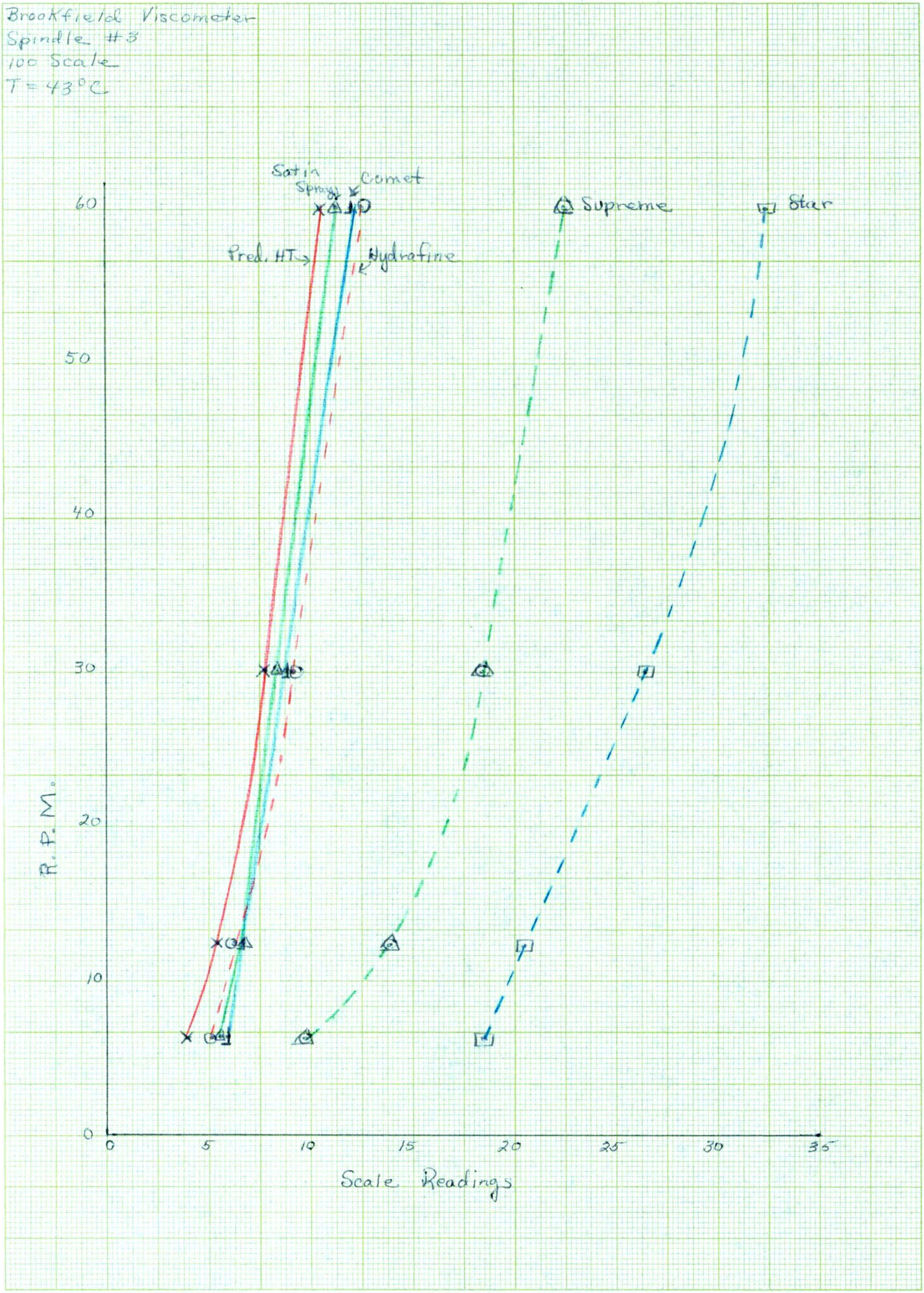
Particle Size Distribution

Table I indicates that the domestic clays, Hydrafine and Satin Spray, contain the greatest percent of particles finer than two microns followed by the English clays, Supreme and Comet, and than Pred. HT and Star.

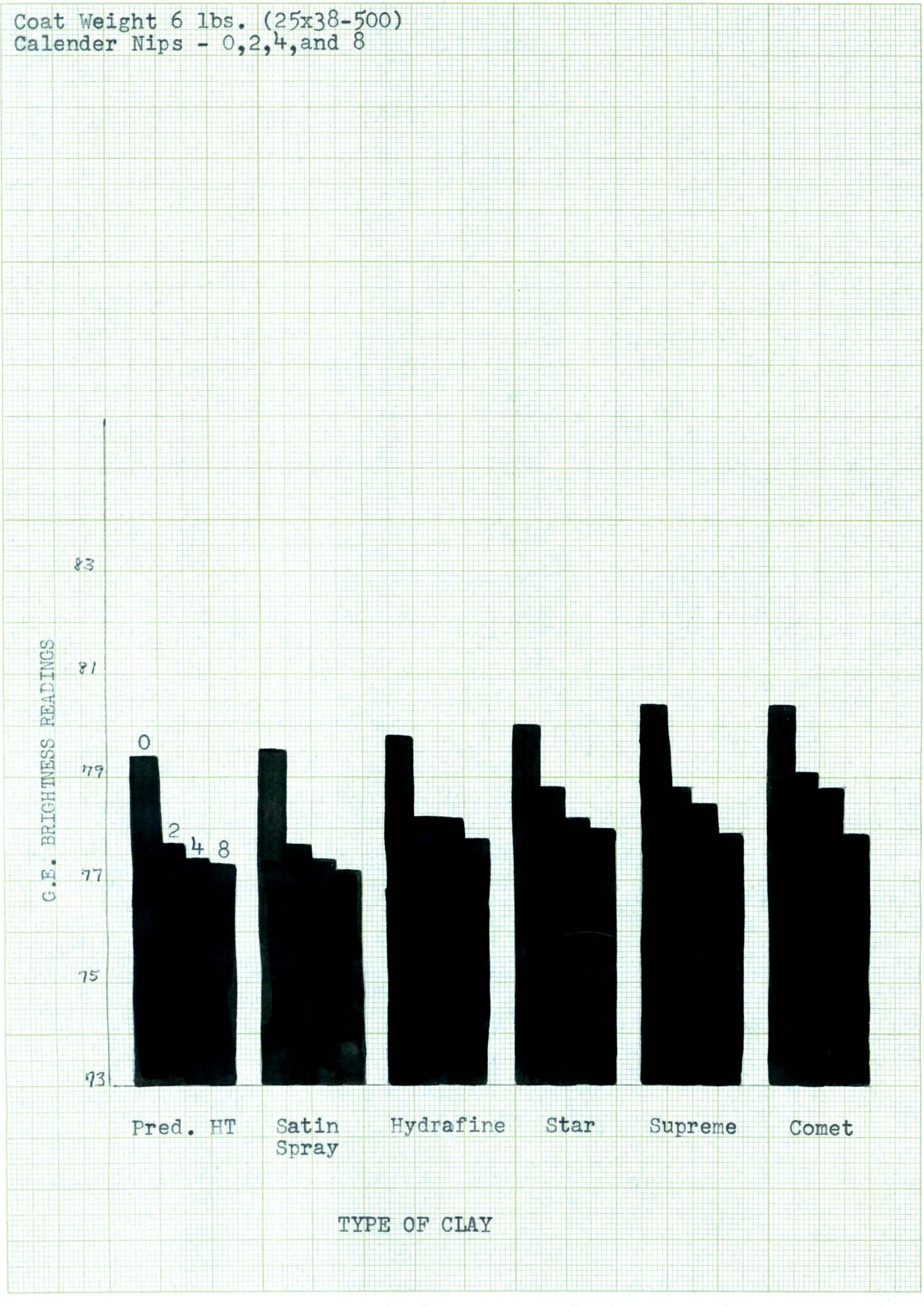
Viscosity

The two English clays, Star and Supreme, were found to have the highest viscosities respectively. The other English clay, Comet, has rheological properties comparable

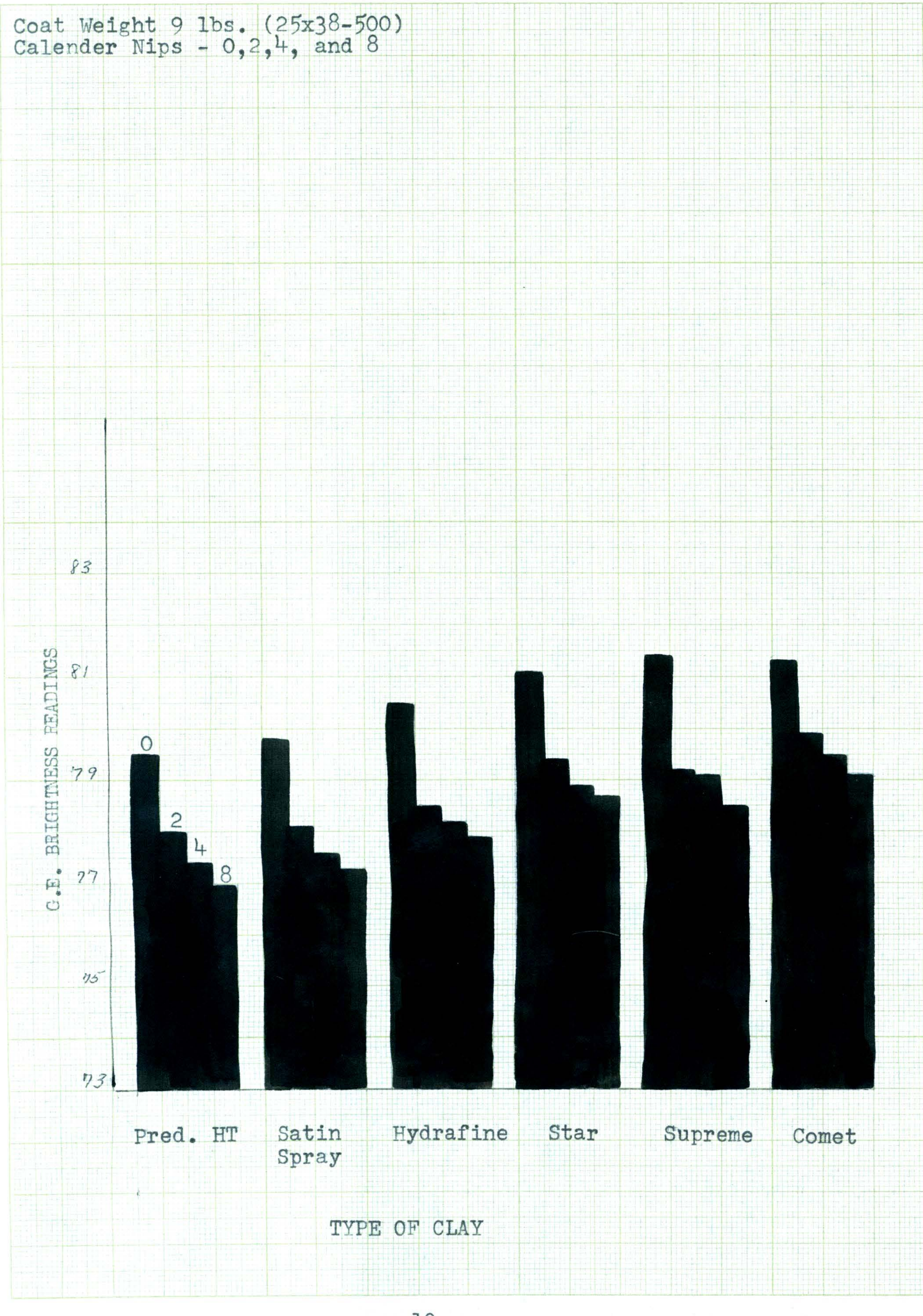
VISCOSITY MEASUREMENTS



BRIGHTNESS


Coat Weight 6 lbs. (25x38-500)
Calender Nips - 0,2,4,and 8
G.E. BRIGHTNESS READINGS
83
81
79
77
75
73
0
2
4
8
Pred. HT
Satin Spray
Hydrafine
Star
Supreme
Comet
TYPE OF CLAY

BRIGHTNESS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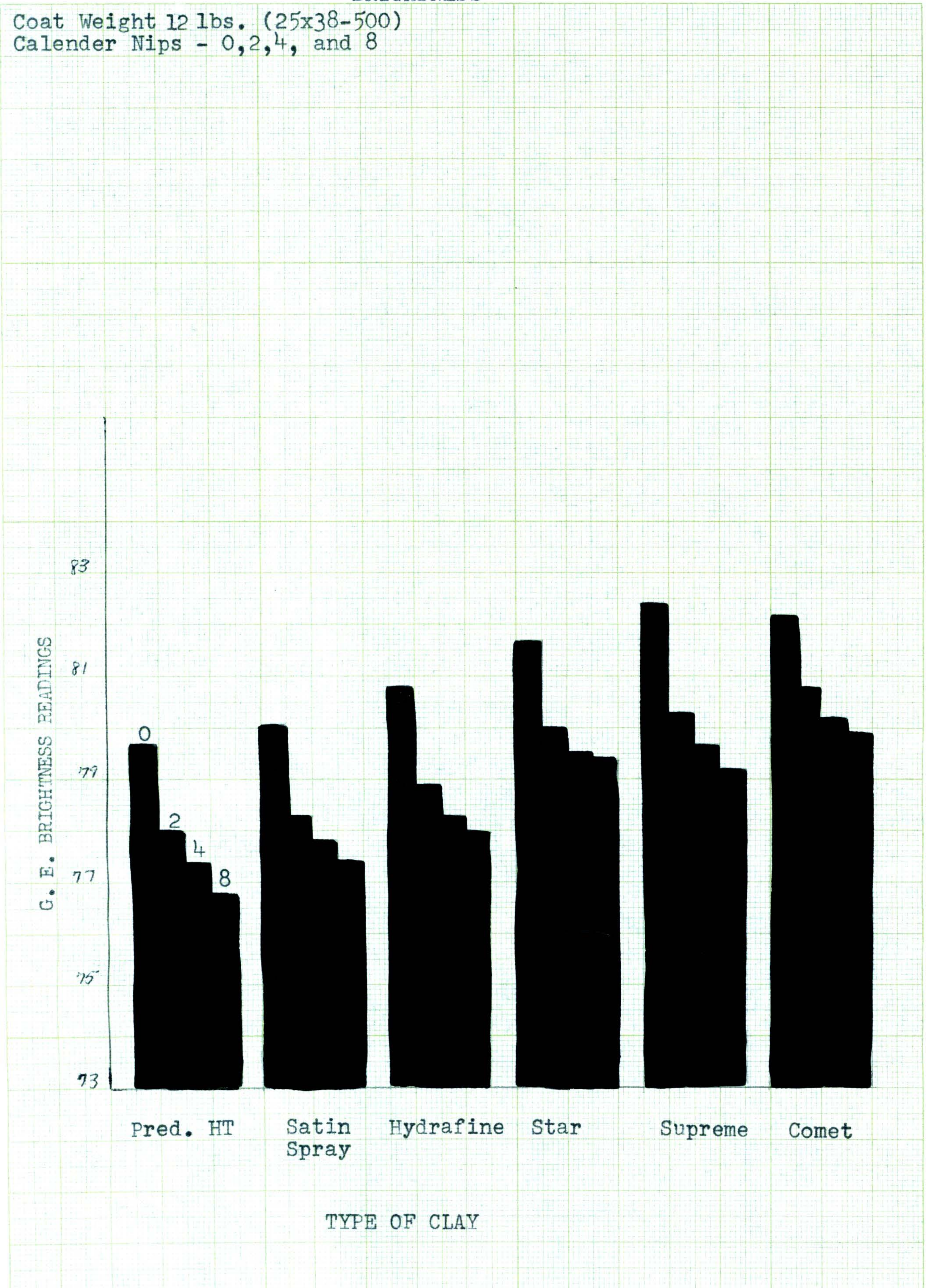
Calender Nips - 0,2,4, and 8
G.E. BRIGHTNESS READINGS
83
81
79
77
75
73
0
2
4
8
Pred. HT
Satin Spray
Hydrafine
Star
Supreme
Comet
TYPE OF CLAY

BRIGHTNESS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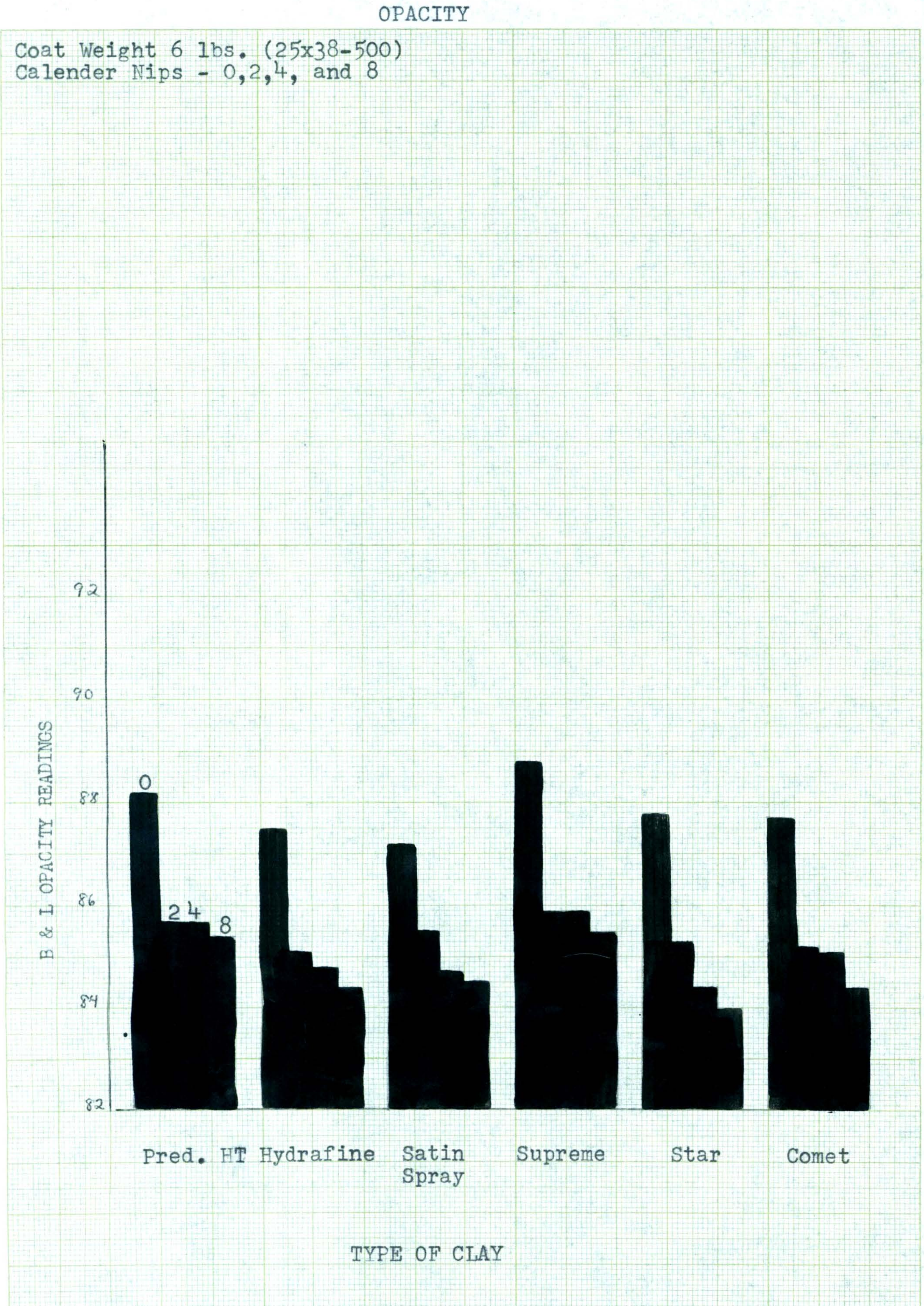
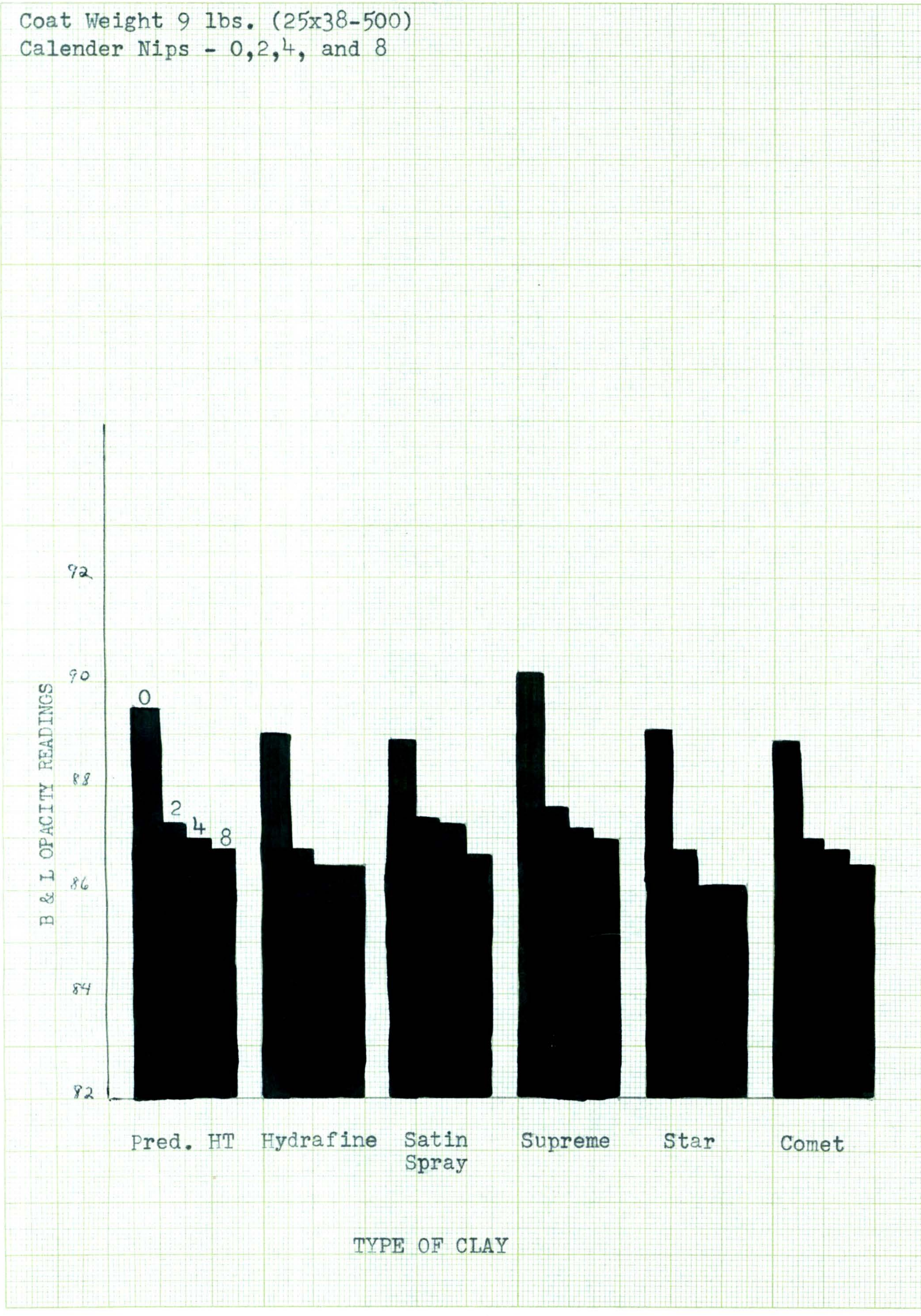
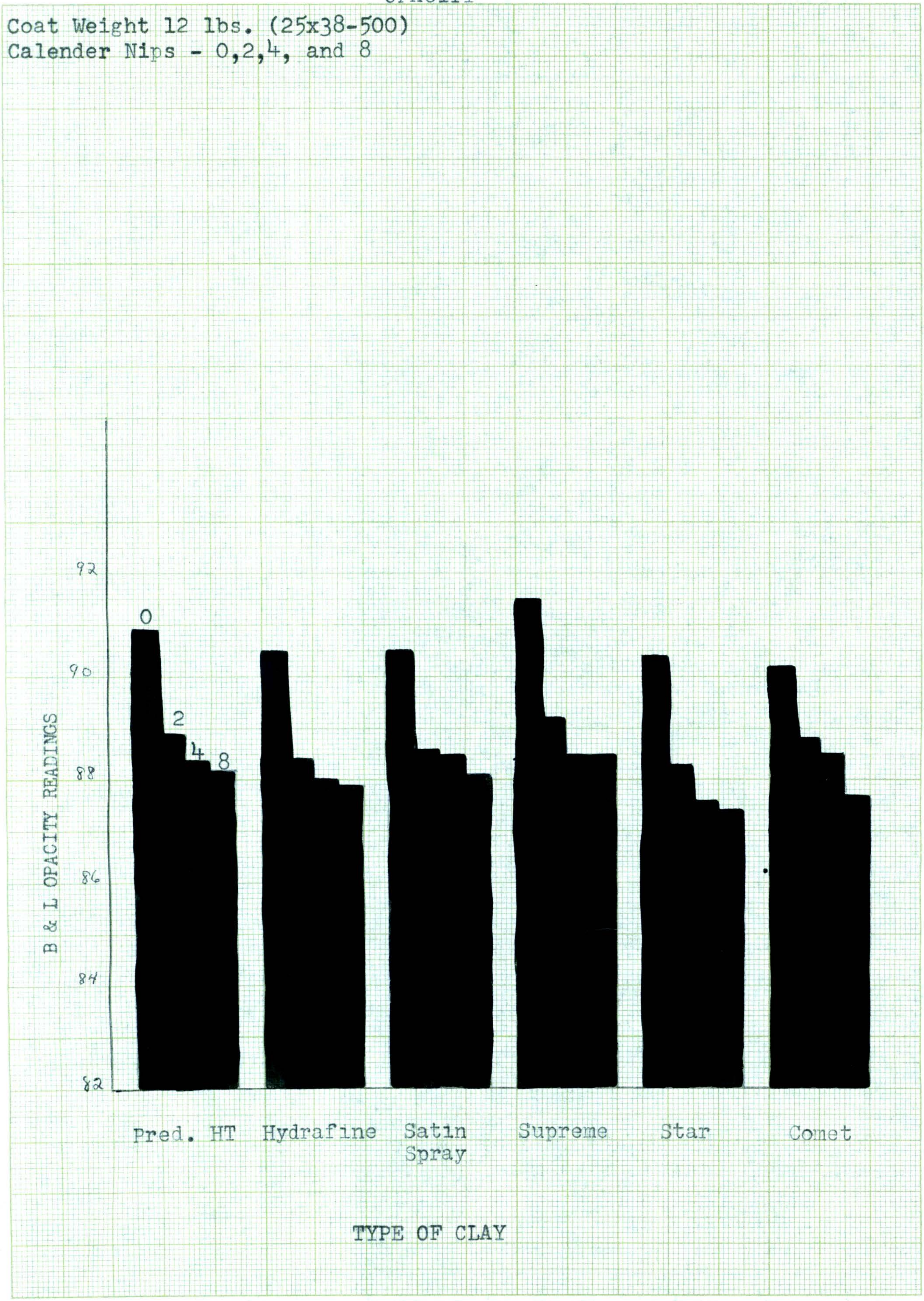
G. E. BRIGHTNESS READINGS
83
81
79
77
75
73
0
2
4
8
Pred. HT
Satin Spray
Hydrafine
Star
Supreme
Comet
TYPE OF CLAY


OPACITY
Coat Weight 6 lbs. (25x38-500)
Calender Nips - 0,2,4, and 8
B & L OPACITY READINGS
92
90
88
86
84
82
0
2 4
8
Pred. HT
Hydrafine
Satin Spray
Supreme
Star
Comet
TYPE OF CLAY

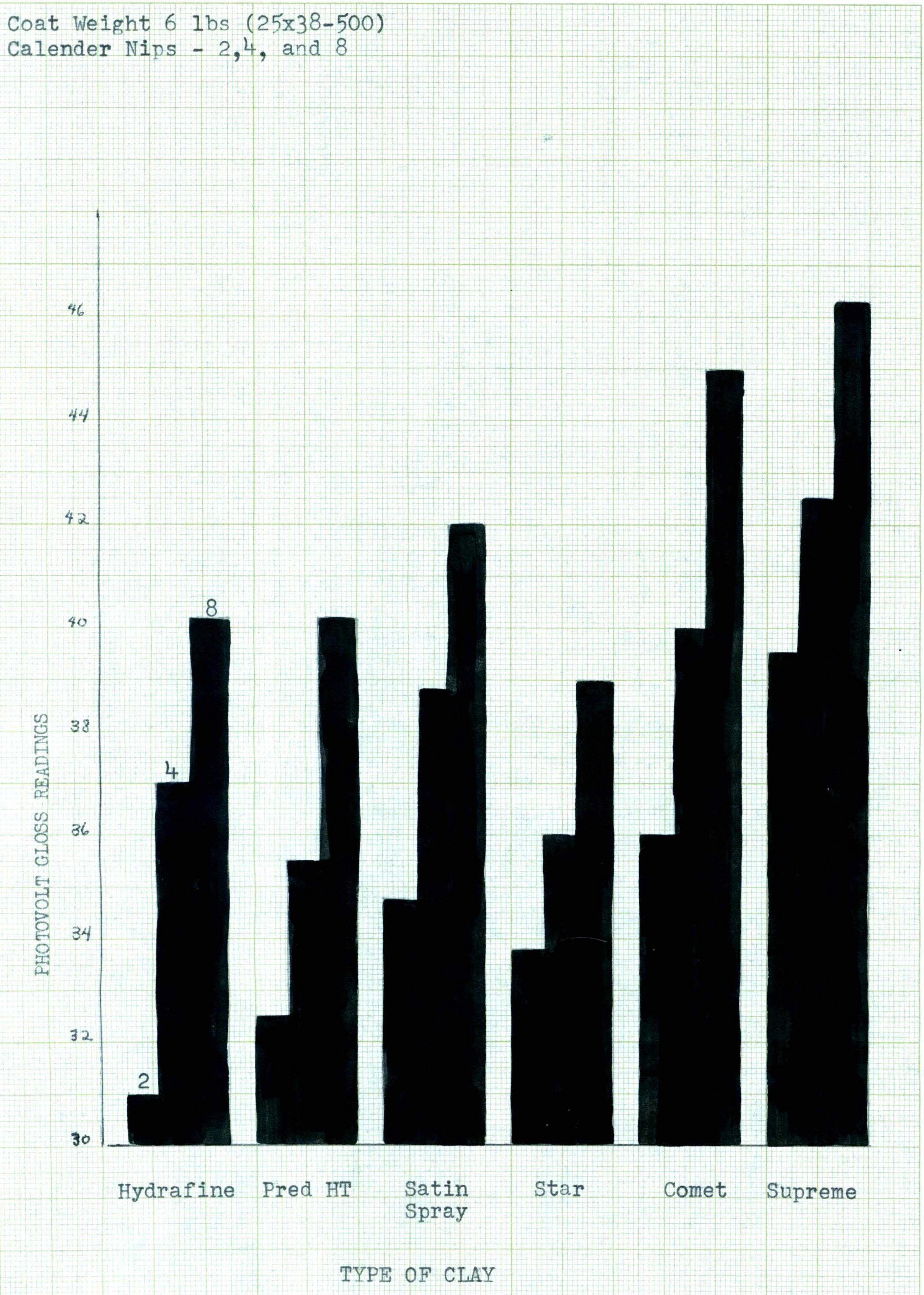
OPACITY


Coat Weight 9 lbs. (25x38-500)
Calender Nips - 0,2,4, and 8
B & L OPACITY READINGS
92
90
88
86
84
82
0
2
4
8
Pred. HT
Hydrafine
Satin Spray
Supreme
Star
Comet
TYPE OF CLAY

OPACITY


Coat Weight 12 lbs. (25x38-500)
Calender Nips - 0,2,4, and 8
B & L OPACITY READINGS
92
90
88
86
84
82
0
2
4
8
Pred. HT
Hydrafine
Satin Spray
Supreme
Star
Comet
TYPE OF CLAY

GLOSS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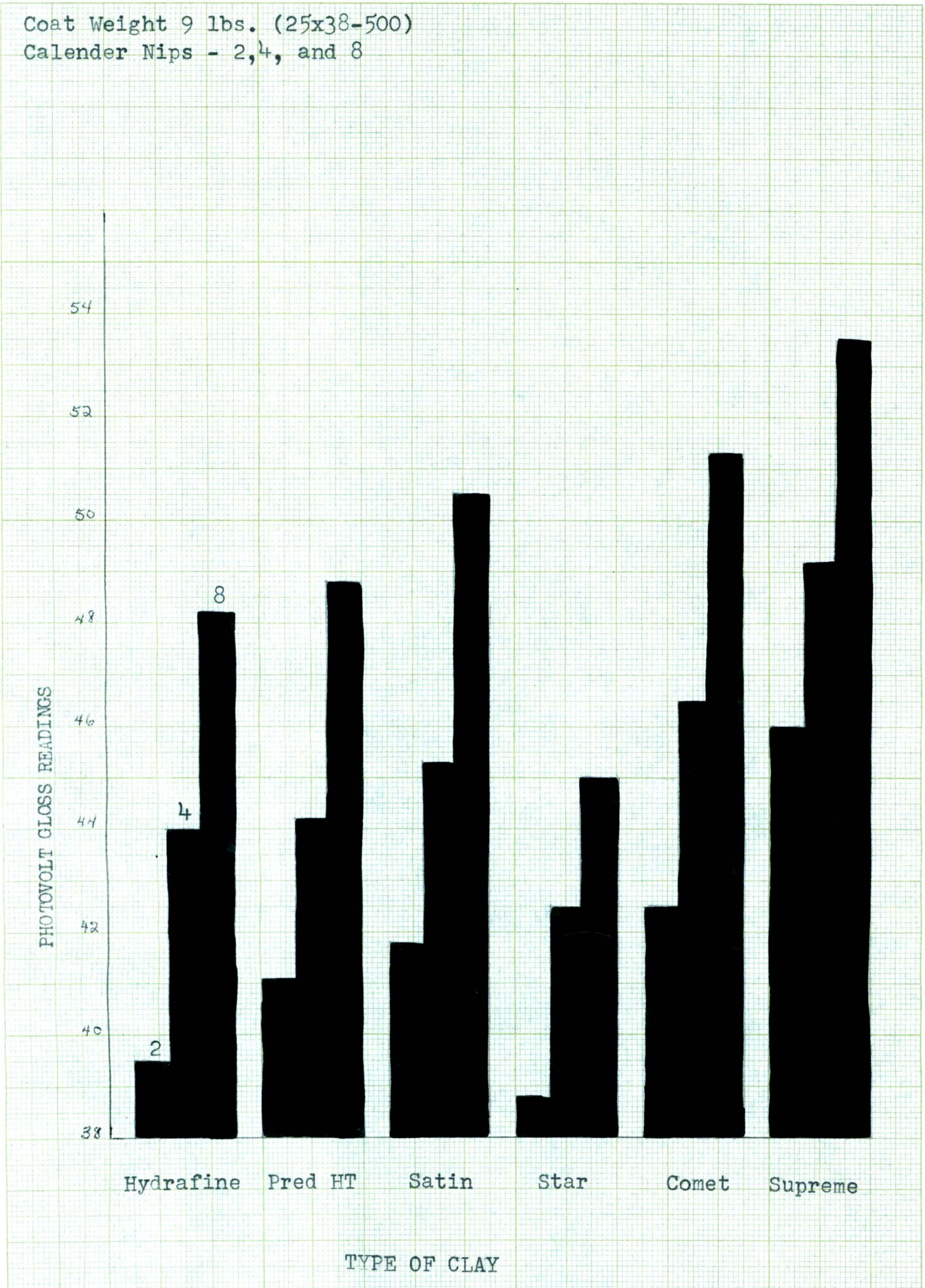
Calender Nips - 2,4, and 8
PHOTOVOLT GLOSS READINGS
46
44
42
40
38
36
34
32
30
2
4
8
Hydrafine
Pred HT
Satin Spray
Star
Comet
Supreme
TYPE OF CLAY

GLOSS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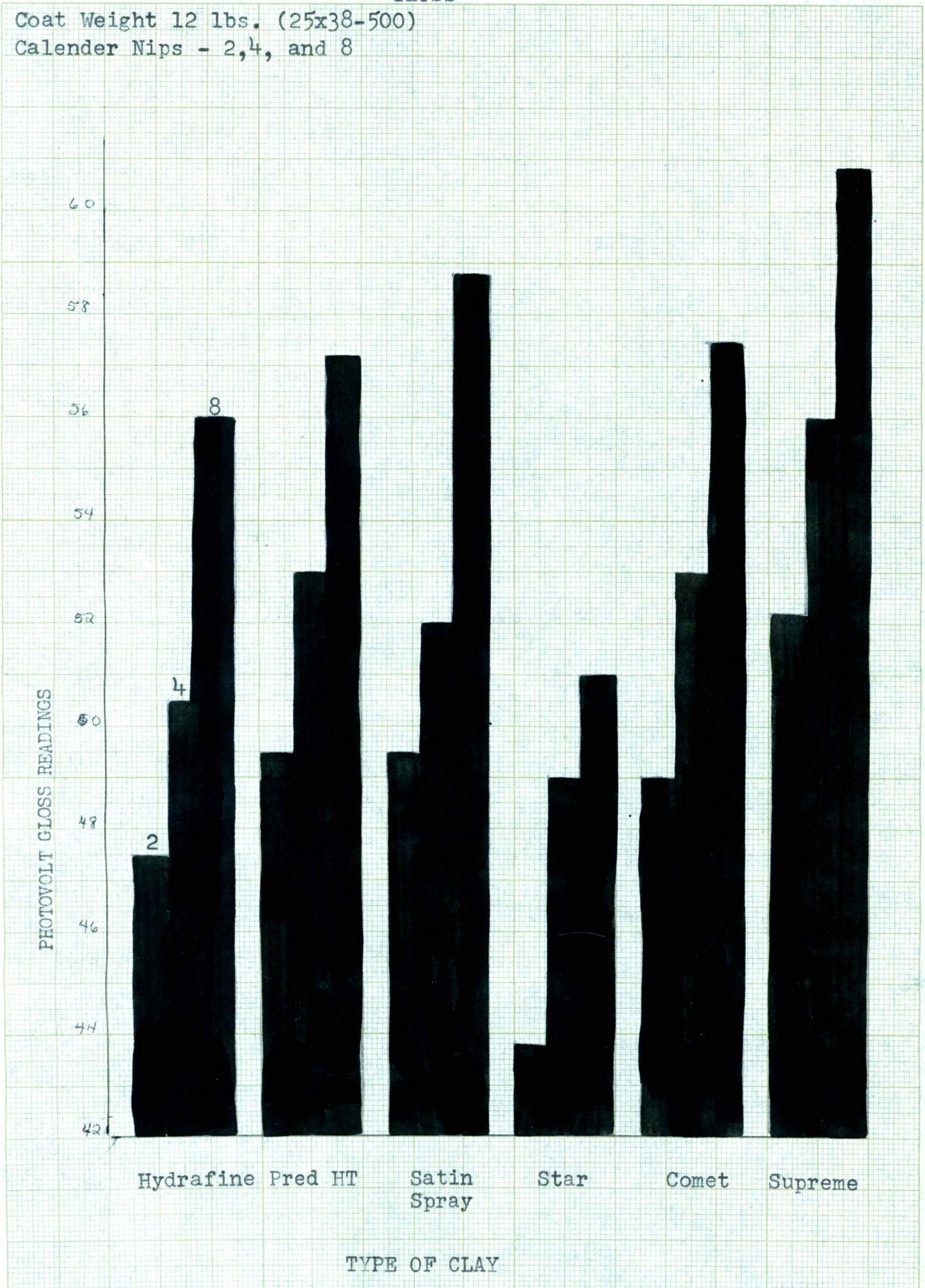
Calender Nips - 2,4, and 8
PHOTOVOLT GLOSS READINGS
54
52
50
48
46
44
42
40
38
2
4
8
Hydrafine
Pred HT
Satin
Star
Comet
Supreme
TYPE OF CLAY

GLOSS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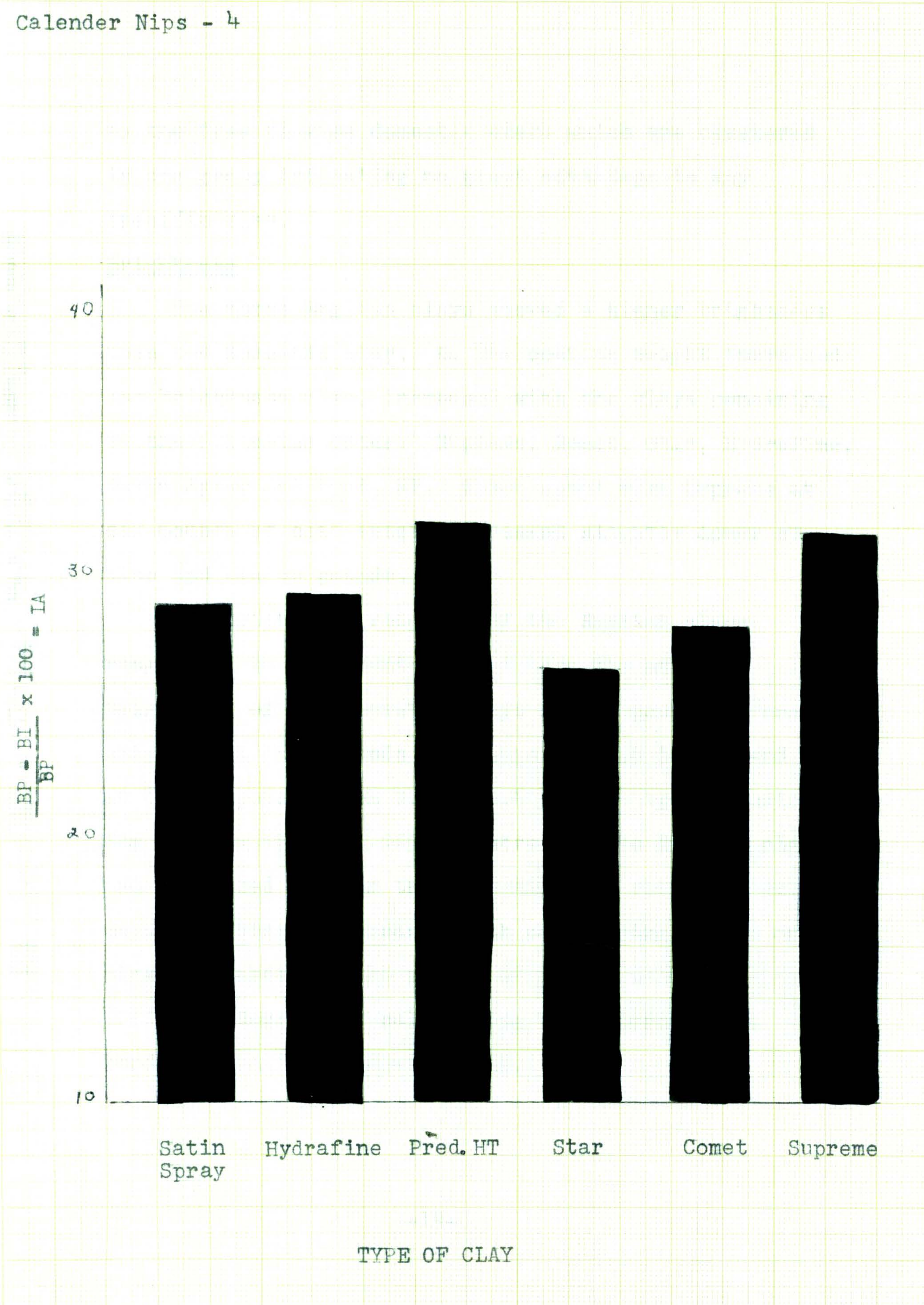
Calender Nips - 2,4, and 8
PHOTOVOLT GLOSS READINGS
60
58
56
54
52
50
48
46
44
42
2
4
8
Hydrafine
Pred HT
Satin Spray
Star
Comet
Supreme
TYPE OF CLAY

K & N INK ABSORBENCY



to the free flowing domestic clays which are clustered in one group indicating no great advantage to any specific clay.

Brightness

The three English clays showed a higher brightness than the domestic clay. As the coating weight increased the brightness,also, increased with the clays remaining in the following order: Supreme, Comet, Star, Hydrafine, Satin Spray and Pred. HT. Comet equal with Supreme at six pounds of coat weight decreased slightly lower at nine and twelve pounds.

The brightness readings of the English clays ranged 0.2 to 0.6 pounts higher than the maximum brightness of the domestic clays at six pounds of coat weight. At nine pounds the range was 0.6 to 0.9 and at twelve pounds from 0.9 to 1.6 points higher, indicating that as the coat weight increased the English clay had increased greater than the domestic clay. In all cases brightness decreased with calendering but no one clay decreased a least number of points with the different degrees of calendering but alternated at random depending on coat weight.

Opacity

The opacity of the sheet was found to increase with increasing coat weight. In Table II the clays are listed in decreasing order of opacity at each coat weight. Supreme gave the highest opacity followed by Pred. HT. The two English clays, Star and Comet, gave a higher opacity at six pounds but a lower opacity at twelve pounds than the domestic clays Satin Spray and Hydrafine. At nine pounds Comet shifted to last

TABLE II
The Clays in Order of Decreasing Opacity

Coat Weight (pounds)	6	9	12
	Supreme	Supreme	Supreme
	Pred. HT	Pred. HT	Pred. HT
	Star	Star	Hydrafine and
	Comet	Hydrafine	Satin Spray
	Hydrafine	Comet and	Star
	Satin Spray	Satin Spray	Comet

position equal to Satin Spray. Opacity decreased with calendering but no definite trend was noticeable between the clays.

Gloss

There was a substantial increase in the degree of gloss with an increase in coat weight. Table III lists the clays in decreasing degree of gloss in accordance with the coat weight.

TABLE III
The Clays in Order of Decreasing Gloss

Coat Weight (pounds)	6	9	12
	Supreme	Supreme	Supreme
	Comet	Comet	Satin Spray
	Satin Spray	Satin Spray	Comet
	Hydrafine	Pred. HT	Pred. HT
	and Pred. HT	Hydrafine	Hydrafine
	Star	Star	Star

Supreme gave the highest finish for each coat weight. The domestic clay, Satin Spray, decreased in gloss more with decreasing coat weight then the English clay, Comet. Therefore, while it took second place at twelve pounds, it took third place at nine and six pounds of coat weight. Pred. HT and Hydrafine took the next two places with the English clay, Star, giving the lowest degree of finish. Calendering increased gloss in every case but the amount of increase was random among the clays.

Ink Receptivity

Pred. HT gave the greatest percent of ink absorbency. The English clay, Supreme, came second followed closely by Hydrafine, Satin Spray and Comet respectively. Star had the lowest value among the six clays.