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REPORT NO. P-1593

DATE 12 February 1940

SUBJECT

Some Paint Compositions Applicable to Camouflage of Fleet Aircraft.

BY

NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

NRL Report No. P-1593
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NAVY DEPARTMENT

Report

on

Some Paint Compositions Applicable to

Camouflage of Fleet Aircraft.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

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Distribution: BuAer. (20)

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INTRODUCTION

(a) Authorization

1. This study was authorized by Bureau of Aeronautics Project No. 168-40.

(b) Statement of Problem

2. Although several reports have been written by the Division of Physical Optics of this Laboratory on the subject of camouflage, little has been mentioned concerning the quality of the paints to be employed. It is the object of this report to designate the composition of paints suitable for the camouflage of aircraft. The colors herein illustrated were established in previous reports as possessing desirable characteristics from the optical viewpoint, and this report designates suitable compositions for the colors and shades selected.

(c) Known Facts Bearing on the Problem

3. From past experience it has been demonstrated that reflection is one of the chief causes of aircraft betrayal. To eliminate this possibility all surfaces of the plane, however small, should be perfectly mat or as nearly so as may be practicable. A perfectly mat surface reflects light equally in all directions, regardless of the direction of the incident beam and this eliminates the glare possibility. Of considerable importance is the color of the mat surface which, in this case, should be such that the light reflected from it should be of the same intensity as that emanating from the background.

4. It is a well known fact that flat paints are not so durable as those of high gloss. As a matter of fact, a measure of the decrease in gloss has been proposed as a measure of the extent of deterioration of paint films. Therefore, in producing a flat or mat paint, there is a limit as to how far one can go and still retain the durability that is necessary. With the problem at hand, it appears likely that the question of durability is not paramount since the color of the aircraft might possibly be changed frequently, thus eliminating the requirement for a coating of exceptional durability. Since these changes may be required within brief time limits, the paint should have a maximum drying time of no more than ten minutes.

(d) Original Work Done at this Laboratory

5. As already pointed out, this Laboratory has written several reports on the camouflage of Naval aircraft. The more important of these are as follows:

(a) "Handbook of Instructions for Naval Airplane Camouflage," dated 15 March 1935. This report gives numerous definitions and covers the subject comprehensively up to this date. A complete bibliography up to 1935 is included. Certain recommendations are made for the use of water paints.

(b) "Airplane Camouflage - Reduction of Visibility by Artificial Illumination." Naval Research Laboratory Report No. H-1230, dated 20 January 1936.

(c) "Airplane Camouflage. Results of Tests of October 1, 1936." Naval Research Laboratory Report No. H-1324, dated 26 October 1936. These reports deal with the theory of camouflage and the practical results obtained from actual tests and observations. The quality of the paint used is not discussed in any great detail.

6. In addition, this Laboratory has written the following reports dealing with the subject of camouflage for the Fleet in general:

(a) "Handbook on Ship Camouflage," dated February 1937. This report includes a complete bibliography on the subject up to the beginning of 1937.

(b) "Camouflage of Submarines to Avoid Detection by Aircraft." Naval Research Laboratory Report No. H-1350, dated 20 March 1937.

(c) "Naval Camouflage Tests at Sea of May and June 1938." Naval Research Laboratory Report No. H-1496, dated 9 December 1938.

Although these reports deal exclusively with submarines and surface craft, the theory of camouflage and its value or advantage is discussed at great length.

METHODS

(a) Apparatus

7. The type paints described herein should be ground in most instances, preferably in a pebble mill, as each contains a good amount of volatile solvent which cannot be handled adequately on an open mill. Furthermore, the pebble mill tends to make for a duller finish, which is one of the prime requirements. However, these formulae may be handled successfully on a roller mill. This was done in the case of the materials discussed in this report, this method being much faster than the pebble mill operation.

8. For measuring the gloss of these films, an arrangement illustrated diagrammatically in Figure 1 was used.

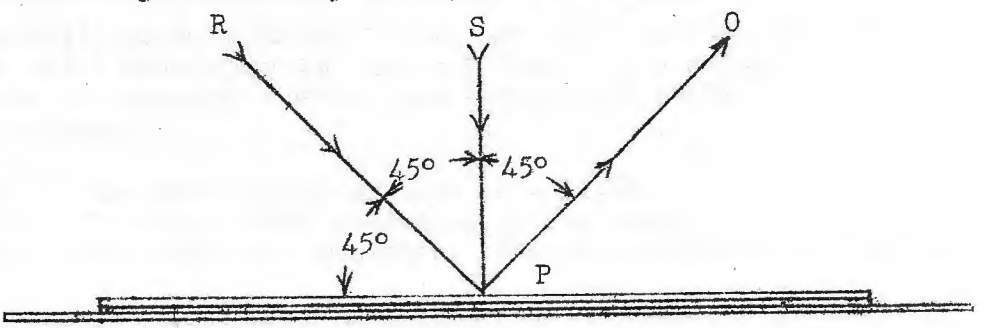


Figure 1

The light source was arranged so that it could be revolved between the positions R and S at 45° and 90° to the horizontal. The intensity of the reflected light from the panel at P was measured when observed at O by a General Electric light meter. Let B_r represent the brightness of the paint when illuminated from R and observed at O. Let B_s represent the brightness of the paint when illuminated from S and observed at O. Then the ratio of B_r/B_s will give a value representing the relative gloss of any series of observed objects. In the case of a perfect mirror, all of the incident light from R would be reflected in the direction of O and the relationship B_r/B_s would be infinity, B_s being equal to zero. In the instance of a perfectly mat surface, the light reflected from P would be equal in all directions, and B_r/B_s would be equal to one, in which case all the reflection is diffuse and there is no specular gloss.

9. Hunter[3] and Judd[2] distinguish between six different types of gloss. The type most obvious and most commonly met in paint films is designated by them as specular gloss and is defined as follows:

> "The ratio of apparent reflectance of the sample when illuminated uni-directionally and viewed in the direction of specular reflectance to the apparent reflectance of the ideal, completely reflecting perfect mirror."

Hunter and Judd[3] from the basis of their experiments recommend the use of a specular gloss measurement at 60° incidence and reflectance. Such an instrument, known as a 60° Glossmeter[1], is illustrated diagrammatically in Figure 2. It possesses the advantage of being compact and portable and is designed for use in the field as well as in the laboratory.

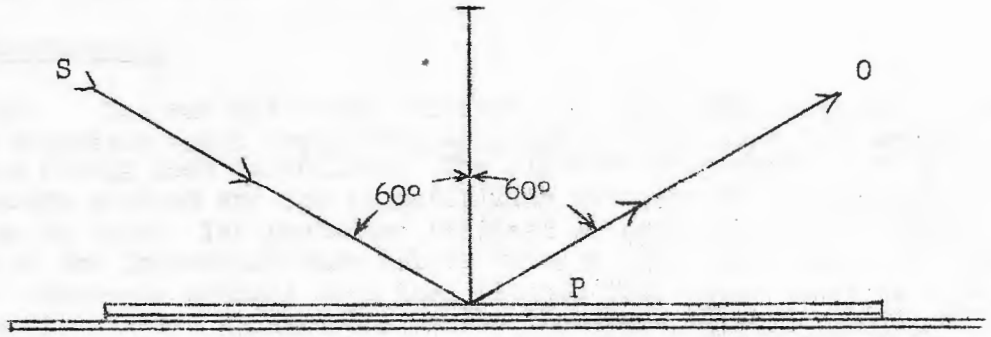


Figure 2

These conditions were found to give the best correlation with various paint manufacturers' gloss ratings for a group of panels submitted to represent current practice in the gloss designation of paint finishes.

10. The 60° Glossmeter uses as a light source a Mazda 965 eight-cell flashlight lamp operating on dry cells, and a General Electric light meter as a receptor. The scale on the meter is graduated

in units from 0 to 140. It is calibrated against a piece of polished black glass having a specular reflectance of 95 per mil as calculated from its index of refraction by Fresnel's Law. That is to say, the amount of light reflected from the surface of the glass is 95/1000 of that reflected from a perfect mirror, the incident beam being 60°. Before using the instrument, it is calibrated by placing it on the polished black glass and adjusting a rheostat until the indicator rests on the figure 95 of the scale. It is similarly used with the objects to be studied and the readings recorded in the same manner. A panel producing a reading of 8 would reflect specularly 8/1000 of the incident light, the diffuse light remaining unrecorded.

(b) Materials

11. Since the requisites of the product are such that the drying time be short, the following resins and other materials were among those considered.

Bakelite XK-13981
Bakelite XK-3962
Super Beckacite #3000
Beckosol Emulsion #1501
Beckosol Emulsion P-168
* Muralo #20 Chrome Oxide Green
* Muralo Carbon Black

* These two Muralo colors were dispersed in emulsions competitive with the Beckosol emulsions.

In addition to the above resinous materials, several inert pigments consisting of diatomaceous earths and metallic soaps were investigated for their flatting properties for use in these studies.

(c) Experimental

12. The raw materials selected for this study comprised resins which possessed rapid drying characteristics and which were known to possess fairly good durability. The pigments were selected to produce the colors desired and for compatibility with the resins with which they were to be used. The procedure followed in each case was to grind a paste of the individual base colors using a very high pigment to binder ratio. Numerous batches were then blended from these bases to give a series of shades. As directed in the "Handbook of Instructions for Naval Airplane Camouflage," these colors were matched against the Munsell color standards and that color possessing the shade most closely resembling the standard of the theoretically correct reflectivity was selected as the shade to be used for each particular color. Next a series of blends was made up in which the gloss varied using the shade previously selected. Measurements of gloss were made with each of the two instruments already described to accurately determine their relative gloss and properties of each. For a panel having maximum acceptable specular reflection, the ratio B_r/B_s had a numerical value

[redacted]

of 5 and produced a reading of 7 on the 60° Glossmeter. Thus a panel showing a value under 5 for the ratio B_r/B_s or a reading of less than 7 on the 60° Glossmeter is acceptable in so far as gloss and specular reflection are concerned.

13. It appeared impractical to produce an aluminum paint meeting these requirements of gloss because a workable pigment to binder ratio was exceeded before such a low gloss was produced. As a result, the maximum value of the ratio B_r/B_s was set at 10 and a maximum reading on the 60° Glossmeter was 12. An aluminum paint meeting these requirements and still possessing a practical pigment to binder ratio can be produced. However, its gloss is probably too great for best results. Another disadvantage is the fact that such a film is too rough for use on high speed planes. Any attempt at sanding to smooth the surface results in a substantial increase in gloss.

14. The colors most suitable and desirable for camouflage were designated as aluminum, black, dark gray, dark green, or dark blue. Detailed studies were made of each which are described in detail in the appendix. The formulae and color chips which were chosen as being most acceptable are described in the following sections.

DATA OBTAINED

(a) Formulae

15. Aluminum. The Laboratory formula for the aluminum vehicle is as follows:

10 ounces (by weight) Bakelite 3962
10 ounces (liquid) Xylol
5 ounces (liquid) Toluol

for which the 100 gallon formula is:

331 pounds Bakelite 3962
41.5 gallons (298 pounds) Xylol
21.0 gallons (149 pounds) Toluol

100 gallons

Body H (Gardner-Holdt)
Weight per gallon - 7.77 pounds
Solids - 21.30 per cent

This varnish is aluminized as follows:

8 ounces (liquid) Varnish
2-1/2 ounces (weight) Aluminum Powder #601
2 ounces T-25-d Thinner

[redacted]

For which the 100 gallon formula is:

72.5	gallons Varnish
18.0	gallons T-25-d Thinner
181.5	pounds Aluminum Powder #601
100	gallons

Weight per gallon - 8.76 pounds
Solids - 34-1/2%
Pigment/Binder Ratio - 151
60° Glossmeter Reading - 10-12

Color Chip

16. Dull Black. A convenient laboratory formula for the black follows:

22-7/8	ounces (weight) Bakelite 3962
1-1/8	ounces Carbon Black
5-5/8	ounces Dicalite White Filler
11-1/4	ounces (liquid) Xylol
5-1/8	ounces (liquid) Toluol

For which the 100 gallon formula is:

448	pounds Bakelite 3962
22-1/2	pounds Carbon Black
113-1/2	pounds Dicalite White Filler
28	gallons (203 pounds) Xylol
14	gallons (102 pounds) Toluol
100	gallons

Weight per gallon - 8.86 pounds
Solids 40.5%
Pigment/Binder Ratio - 61.0

For application by spray reduce 5 parts paint with 3 parts T-25-d Thinner.

[redacted]

Viscosity - 25 seconds
(Gardner Mobilometer - Solid Disc)
Solids at Gun - 26 per cent
Drying Time (Tack free) - 5-7 minutes
60° Glossmeter Reading - Maximum 6

Color Chip

17. Dull Dark Gray. The laboratory formula is as follows:

24 ounces (weight) Bakelite 3962
8 ounces Titanox A.M.O.
8 ounces Dicalite White Filler
1/2 ounce Carbon Black
16 ounces (liquid) Xylol
9 ounces (liquid) Toluol

For which the 100 gallon formula is:

376 pounds Bakelite 3962
125 pounds Titanox A.M.O.
125 pounds Dicalite White Filler
7-3/4 pounds Carbon Black
31 gallons (225 pounds) Xylol
17-1/2 gallons (127-1/2 pounds) Toluol

Weight per gallon - 9.85 pounds
Solids - 45.0%
Pigment/Binder Ratio - 137

For application by spray reduce 6 parts of paint with 4-5 parts of T-25-d thinner.

Viscosity - 21 seconds (Gardner Mobilometer - Solid Disc)
Solids at Gun - 28%
Drying Time (Tack free) - 5-7 minutes
60° Glossmeter Reading - Maximum 6

Color Chip

[redacted]

18. Dull Dark Green. The laboratory formula is as follows:

30	ounces (weight) Bakelite 3962
8	ounces Dark Chrome Green
8	ounces Dicalite White Filler
0.6	ounces Carbon Black
16	ounces (weight) Xylol
6	ounces (weight) Toluol

For which the 100 gallon formula is:

420	pounds Bakelite 3962
112	pounds Dark Chrome Green
112	pounds Dicalite White Filler
8-1/2	pounds Carbon Black
31	gallons (224 pounds) Xylol
11-1/2	gallons (84 pounds) Toluol

Weight per gallon - 9.60 pounds
Solids - 46.0%
Pigment/Binder Ratio - 110

For application by spray reduce 6 parts of paint with 4-5 parts T-25-d thinner.

Viscosity - 25 seconds
(Gardner Mobilometer - Solid Disc)
Solids at Gun - 27.5%
Drying Time (Tack free) - 5-7 minutes
60° Glossmeter Reading - Maximum 6

Color Chip

19. Dull Blue. The laboratory formula is as follows:

18	ounces (weight) Bakelite 3962
6	ounces Dicalite White Filler
6	ounces 4035 Iron Blue (Reichhold)
1-1/2	ounces Titanox A.M.O.
7	ounces (liquid) Xylol
3-1/2	ounces Toluol

For which the 100 gallon formula is:

455	pounds Bakelite 3962
155	pounds Dicalite White Filler

(Continued)

[redacted]

100 gallon formula (Continued)

155	pounds 4035 Iron Blue (Reichhold)
38	pounds Titanox A.M.O.
23	gallons Xylol
11-1/2	gallons Toluol

Weight per gallon - 10.35 lb.
Solids - 54.9%
Pigment/Binder Ratio - 150

For application by spray reduce 4 parts paint with 3 parts T-25-d thinner.

Viscosity - 22 seconds
(Gardner Mobilometer - Solid Disc)
Solids at Gun - 36%
Drying Time (Tack free) 5-7 minutes
60° Glossmeter Reading - Maximum 6

Color Chip

20. The resin and other constituents of the foregoing formulae were selected after extensive studies including several materials of varying properties. Bakelite XK-13981 when substituted for Bakelite XK-3962 produced films which dried rapidly and otherwise possess many desirable properties. The film produced from its use was rough and gritty in appearance. Several alkyd emulsions were investigated and their properties noted. By their use it was possible to prepare films practically mat. The drying period was too long, but more important was the fact that they do not adhere to lacquer films so well and considerable checking was evident. In addition, several finished products were studied for their properties as camouflaging materials. In most cases some objectionable feature such as too long drying period or too much gloss automatically eliminated them.

(b) Discussion

21. The formulae as presented were selected as the most applicable to the problem of aircraft camouflage from numerous combinations tried. The resin employed, while not possessing all the characteristics that would make it ideal, does approach it more closely than others investigated. It dries fast and hard and since its wetting capacity is relatively poor, it tends to produce a duller sheen than vehicles possessing superior dispersing qualities. However,

[redacted]

this deficiency is not sufficient to make settling a problem. Samples stored for considerable time under varying conditions of temperature appear to be quite stable. All these paints may be thinned with toluol or T-25-d thinner, either of which is already available in quantity at most overhaul bases.

22. It does not appear practical to produce a paint containing aluminum pigment alone of sufficient matness to be of value as a camouflage material. Experiments indicate that it is impossible to raise the pigment to binder ratio to such a value that sufficient matness is obtained. Before this point is reached, the pigment to binder ratio is so far out of balance that a cheesy film results which is entirely too rough for use on aircraft and possesses little or no value as a protective coating. From Plate 2, it may be seen that a pigmentation of from 2 to 2-1/2 pounds per gallon is the practical limit, as beyond this point no marked decrease in gloss is noted and the film produced is rough and non-uniform.

23. Plate 1 illustrates an interesting point. The aluminum powder used for the pigmentation represented here is highly polished. As the pigment to binder ratio is increased, a decrease in gloss is noted up to a point of approximately 1-1/2 pounds per gallon. As this point is passed, another maximum in gloss is noted at a pigmentation of approximately 2 pounds per gallon. Further addition of pigment then reduces the gloss in the usual manner that is to be expected. From this behavior it may be concluded that the initial gloss of the film is due to the characteristics of the binder and addition of pigment reduces this gloss as ordinarily is expected. However, at a pigmentation of approximately 2 pounds per gallon the binder ceases to be the predominating factor in gloss intensity and the reflectivity becomes largely due to the aluminum pigment itself. It may be supposed that here the number of aluminum particles present are of such an order that it still possesses good leafing qualities. As the number of particles increases further, they become so crowded that good leafing cannot occur and the effective light reflecting power is decreased again as a result. This particular phenomena is not noticed in instances where a dull pigment is used, as is evident from Plates 2 to 6.

24. Any attempt to produce a mat aluminum paint by incorporating an inert flatting agent such as a metallic soap or diatomaceous earth were quite unsuccessful. As a matter of fact, the addition of varying amounts of this type material had no visible effect on the gloss. This is explained by the fact that the properties of the aluminum particles are such that in a wet film they float to the surface and leaf over the inert particles forming an effective film just as though this pigment were not present.

CONCLUSIONS AND RECOMMENDATIONS

(a) Facts Established

25. Formulae have been presented for dull finishes suitable for aircraft camouflage in colors of gray, green, black and aluminum. These

colors selected were chosen as directed by "Handbook of Instructions for Naval Airplane Camouflage" and the proper shade of each was determined by reference to the Munsell book of color standards. The formulae were developed to meet these shade and color designations.

26. The use of an aluminum finish in camouflage work is definitely limited by the fact that extremely dull surfaces cannot be prepared from it. For treating surfaces where it normally would be used a gray paint of approximately the same tone should be applied.

27. Two methods of estimating the gloss of a painted surface have been described and their application discussed. While the laboratory instrument probably yields somewhat greater accuracy, the 60° Glossmeter is more practical and is immediately available to prospective users. Limits of gloss have been established for each paint in terms of this instrument.

(b) Recommendations

28. It is recommended that these materials be subjected to a service test as compared to the extremely flat lacquers which are available.

29. A more detailed study of direct and diffuse reflectance would permit the writing of more exact specifications for the evaluation of the reflecting properties of various camouflage materials.

APPENDIX

1. In order to determine the proper shade for each color, it was necessary to make up numerous batches of varying shades from which the correct one was selected. As previously pointed out, the shade of each color to be used was selected as directed in "Handbook of Instructions for Naval Airplane Camouflage." These instructions indicate the per cent reflectivity which each color should possess. The various shades of these colors are compared to the Munsell color standards whereby the shade of proper reflectivity can be easily selected. Once the proper shade is determined, the sheen or gloss is varied by making another series of batches and from them the proper pigment to binder ratio limits are determined for each color.

2. Aluminum. For the aluminum paint two grades of aluminum powder were investigated - Federal Specification 52-A-1d, Type A, and Aluminum Company of America's powder #601. Since the final formulae have already been given, it will suffice here to say that Bakelite No. 3962 was reduced with suitable thinners to a viscosity of C (Gardner-Holdt) and then aluminized as designated in Table 1. Further reduction with Bureau of Aeronautics Specification thinner T-25-d was necessary in the case of the more highly pigmented samples for a spraying viscosity. Table 1 also includes the values of the ratio B_r/B_s as a measure of specular reflection which is described in detail in paragraph 8 of this report. The values for gloss as obtained by the 60° Glossmeter are also included. In each case, the paint was sprayed over an aluminum panel previously coated with one coat of zinc chromate primer (P-27-b1) and a coat of pigmented lacquer (L-12a).

Table 1

Relation of Gloss to Pigment-Binder Ratio.

Panel No.	Pounds 52-A-1d Aluminum per Gallon Vehicle	Relative Gloss	
		B_r/B_s	60° Glossmeter Value
1	1/2	14	50
2	1	9.5	
3	1-1/2	9.8	38
4	2	9.3	50
5	2-1/2	8.3	50
6	3	8.1	47
7	3-1/2	6.1	38
8	4	4.7	33

3. All the panels prepared with 52-A-1d appeared too glossy. As an alternative a similar series was prepared under the same conditions using Aluminum Company of America's dull powder #601. The compositions, color chips and results of gloss measurements are given in Table 2. These results are represented graphically in Plate 2.

Table 2

Color Chips for Aluminum.

	Relative Gloss		Pigment
	B_r/B_s	60° Glossmeter	Lb./Gallon
12	6.1	21	1
13	2.8	15	1-1/2
14	2.2	11	2
15	1.65	9	2-1/2
16	1.48	7-8	3
17	1.43	6-7	3-1/2

[redacted]

4. The paints represented by panels numbers 8 (Table 1) and 17 above apparently passed a practical limit for pigment to binder ratio. This was evidenced by the rough surface of the film and by the fact that the film itself was somewhat cheesy rather than tough and hard as is characteristic of this type finish. Since panel No. 8 was judged too glossy for camouflage purposes, 52-A-1d was eliminated for use as a pigment. The results obtained with Aluminum Company of America's powder #601 displayed greater possibilities from the optical standpoint. The paint on panel No. 15 was pigmented about as highly (2-1/2 pounds per gallon) as appears practical, and since its specular reflectance was about as low as that of one pigmented considerably higher, it was selected as the standard for the dull aluminum finish. Color chips showing the effect of varying the pigment to binder ratio were included in Plate 2 along with the value of specular reflectance as measured by the two instruments.

5. Preliminary experiments indicated that for the black paint a pigment to binder ratio greater than 1/2 diminishes the gloss at a very slow rate. Consequently, a paste was prepared having two parts binder to one part carbon black. From this paste, a series of six blends was made decreasing the pigment to binder ratio between each step. Table 3 shows the relative gloss of each blend and color chips in addition to the pigment to binder ratio. These data are shown graphically in Plate 3.

Table 3

Color Chips for Black.

	Relative Gloss		Pigment to Binder Ratio
	B_r/B_s	60° Glossmeter	
1	4.6	4	0.500
2	15.6	8	0.358
3	34.6	12	0.278
4	191	15	0.228
5	561	30	0.193
6	623	33	0.176

6. As a result of the measurements indicated in Table 3, a formula similar to that represented by sample No. 2 was judged to be adequate. However, it was discovered that a high carbon black content had a tendency to cause considerable bodying in the packaged material. In the final formula submitted in the main body of this report, the amount of carbon black was greatly reduced and the pigment to binder ratio maintained by the addition of inert diatomaceous earth. Subsequent tests indicated this material to be equally low in specular reflectance and sufficiently stable in the package.

7. Table 4 and Plate 4 show the relationship of gloss to pigment to binder ratio for the dull gray formula. Panel No. 1 appears to possess the desired characteristics for this color and the submitted formula was derived from this blend.

8. Dull Dark Green. The dull green formula designed for use on the top of aircraft was developed in the same manner as the foregoing. The relationship of gloss to pigment to binder ratio is shown in Table 5 and Plate 5.

9. As a possible substitute for green, a blue formula is shown in Table 6 and Plate 6.

Table 4

Color Chips for Gray.

	Relative Gloss		Pigment to Binder Ratio
	B_r/B_s	60° Glossmeter	
 1	1.22	2	1.26
 2	3.55	4	0.05
 3	5.6	7	0.892
 4	9.0	11	0.758
 5	23.3	17	0.632

[redacted]

Table 5

Color Chips for Green.

	Relative Gloss		Pigment to
	B_r/B_s	60° Glossmeter	Binder Ratio
 1	7.4	4	1.260
 2	21	7	1.085
 3	49	10	0.950
 4	70	20	0.758
 5	240	30	0.632

Table 6

Color Chips for Dull Blue.

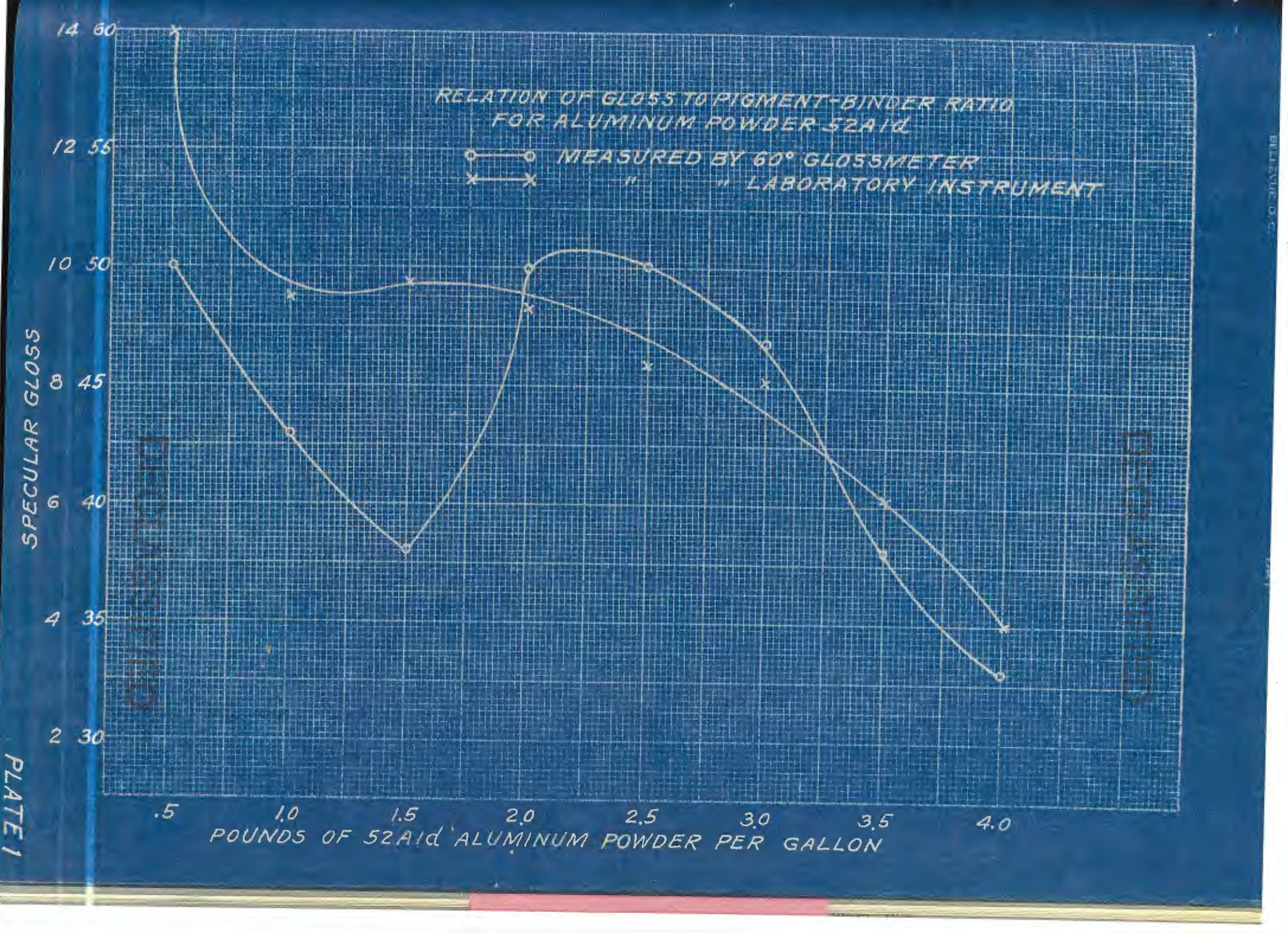
	Relative Gloss 60° Glossmeter	Pigment to Binder Ratio
 1	4	1.19
 2	6	0.87
 3	9	0.68
 4	14	0.57

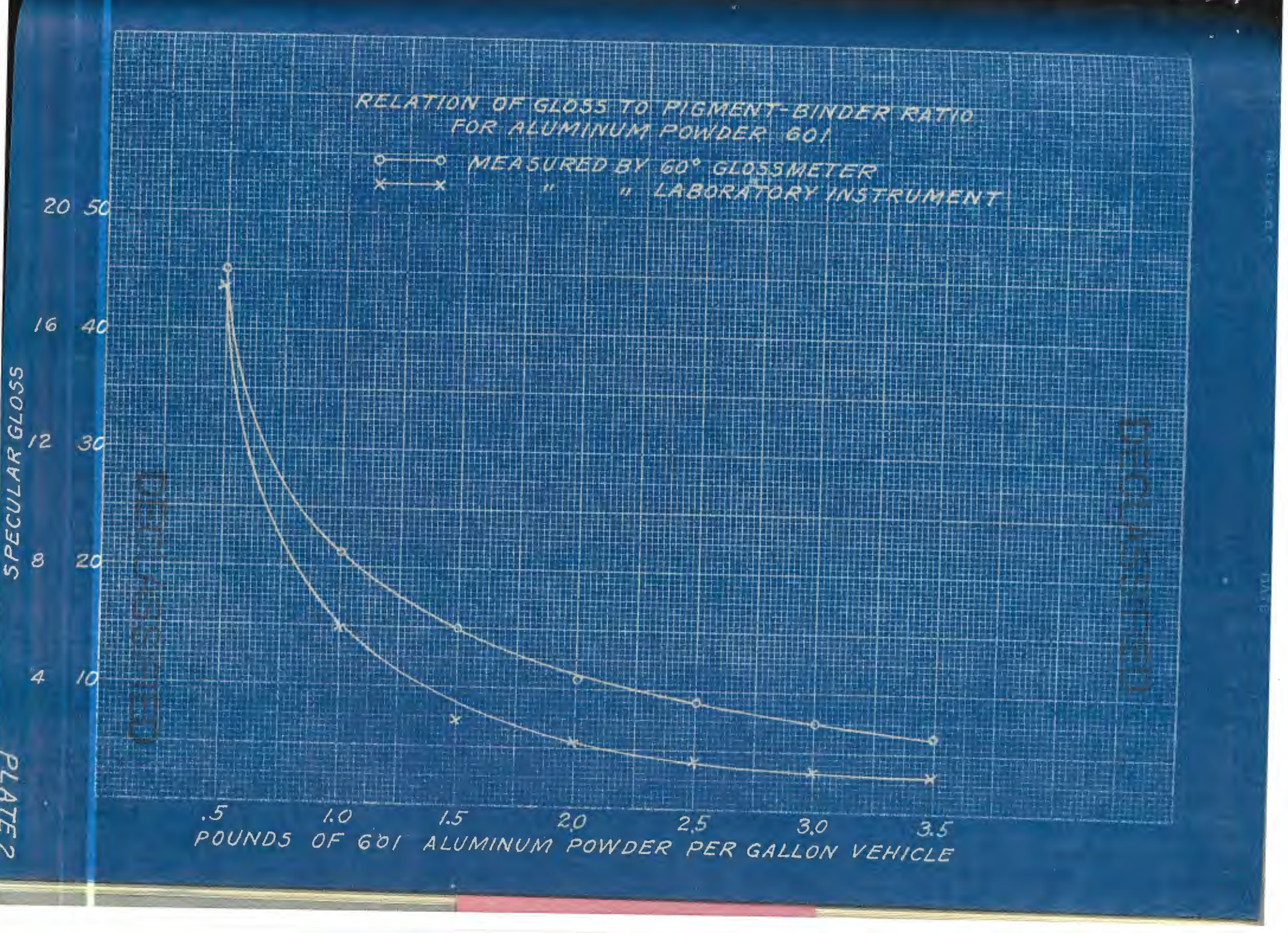
REFERENCES

(1) Circular No. 583, Scientific Section, National Paint, Varnish and Lacquer Association, Incorporated.

(2) Hunter and Judd, Dean - "Development of a Method of Classifying Paints According to Gloss," A.S.T.M. Bulletin No. 97, 11-8 (March 1939).

(3) Hunter - "Methods of Determining Gloss," Bureau of Standards Journal of Research, 18, 19 (1937).


RELATION OF GLOSS TO PIGMENT-BINDER RATIO
FOR ALUMINUM POWDER 52 Aid
MEASURED BY 60° GLOSSMETER
" " LABORATORY INSTRUMENT
SPECULAR GLOSS
14 60
12 55
10 50
8 45
6 40
4 35
2 30
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
POUNDS OF 52 Aid ALUMINUM POWDER PER GALLON
PLATE 1


RELATION OF GLOSS TO PIGMENT-BINDER RATIO
FOR ALUMINUM POWDER 601
MEASURED BY 60° GLOSSMETER
" " LABORATORY INSTRUMENT
SPECULAR GLOSS
20 50
16 40
12 30
8 20
4 10
.5 1.0 1.5 2.0 2.5 3.0 3.5
POUNDS OF 601 ALUMINUM POWDER PER GALLON VEHICLE
PLATE 2

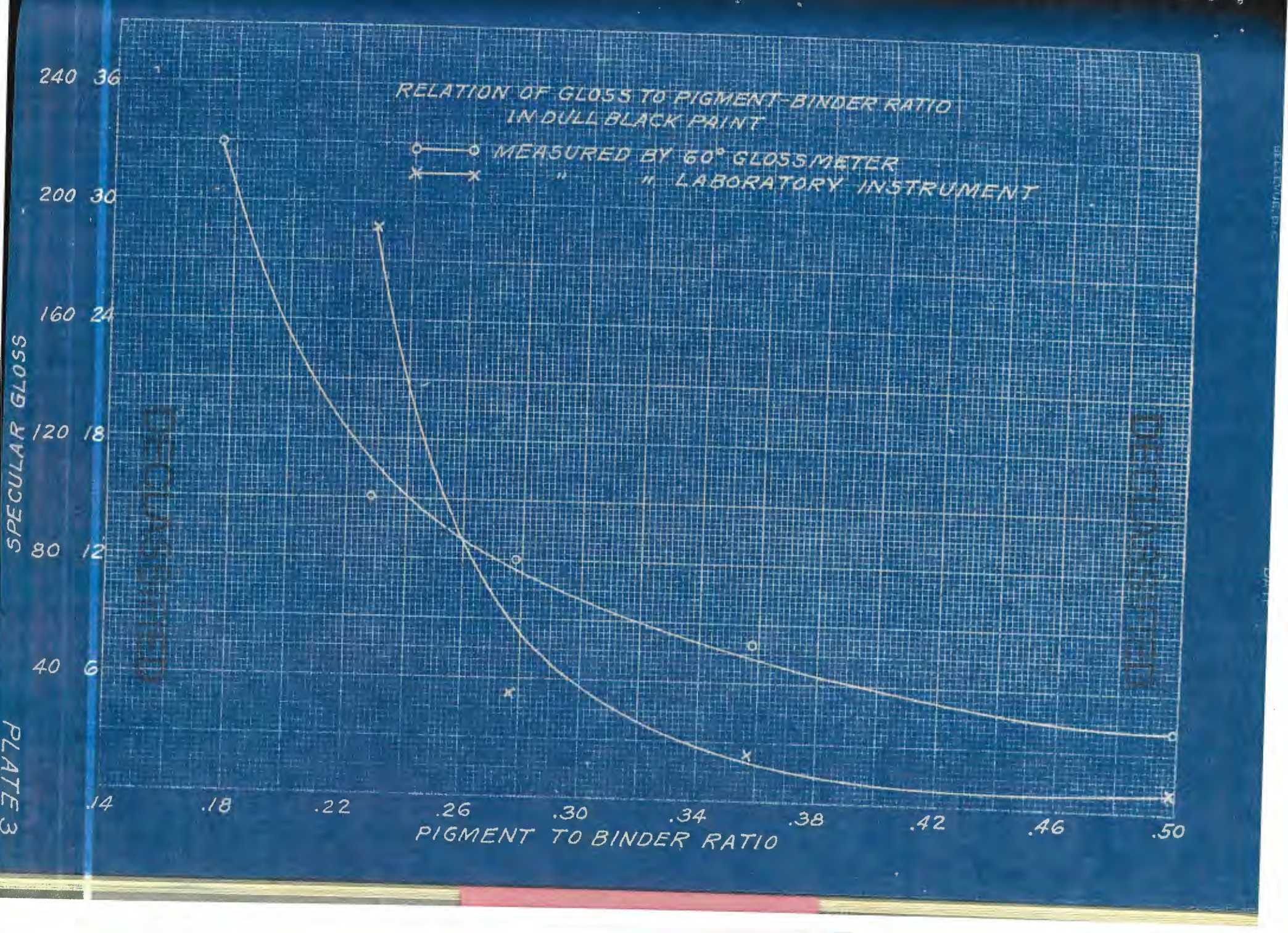
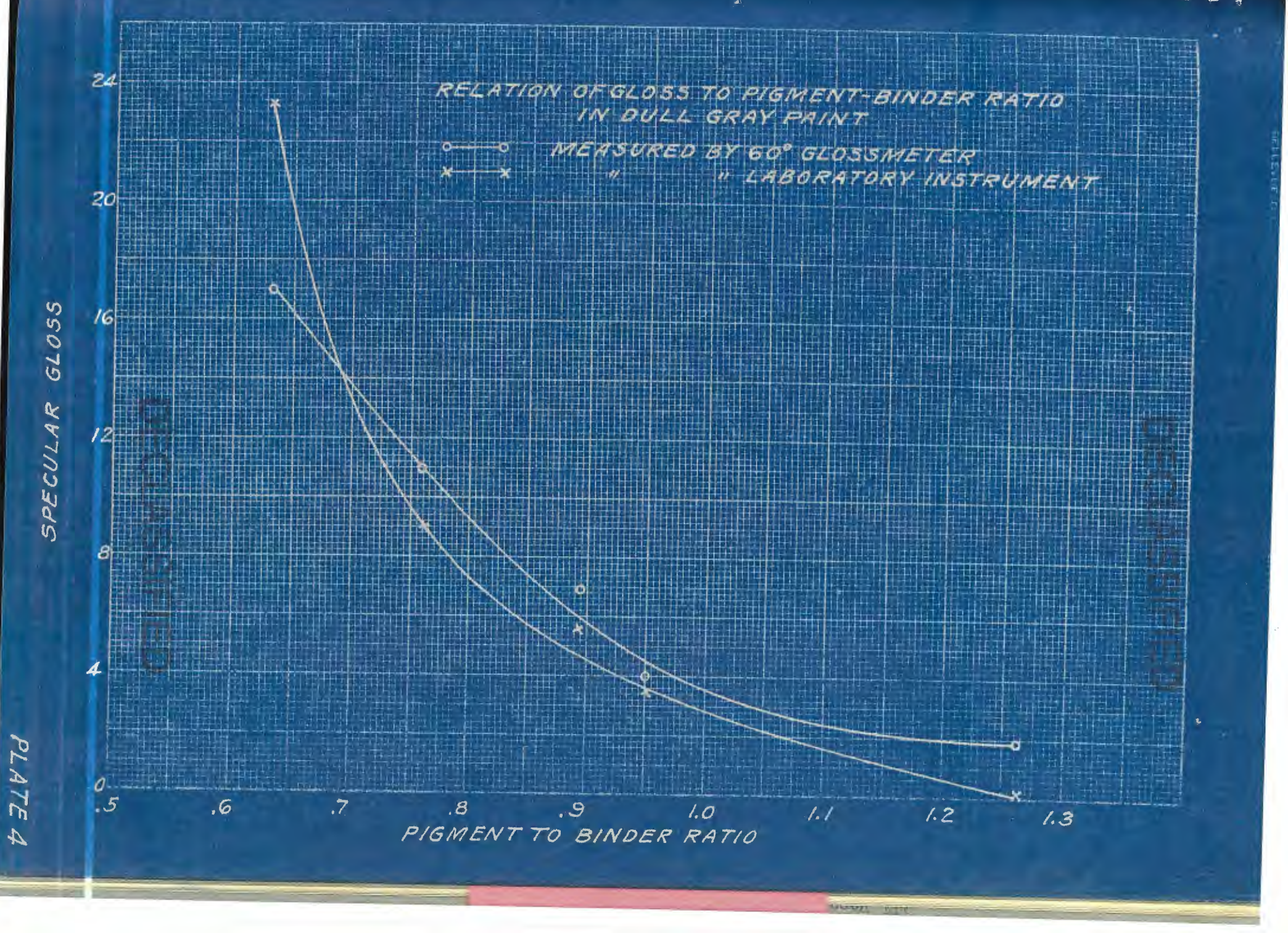
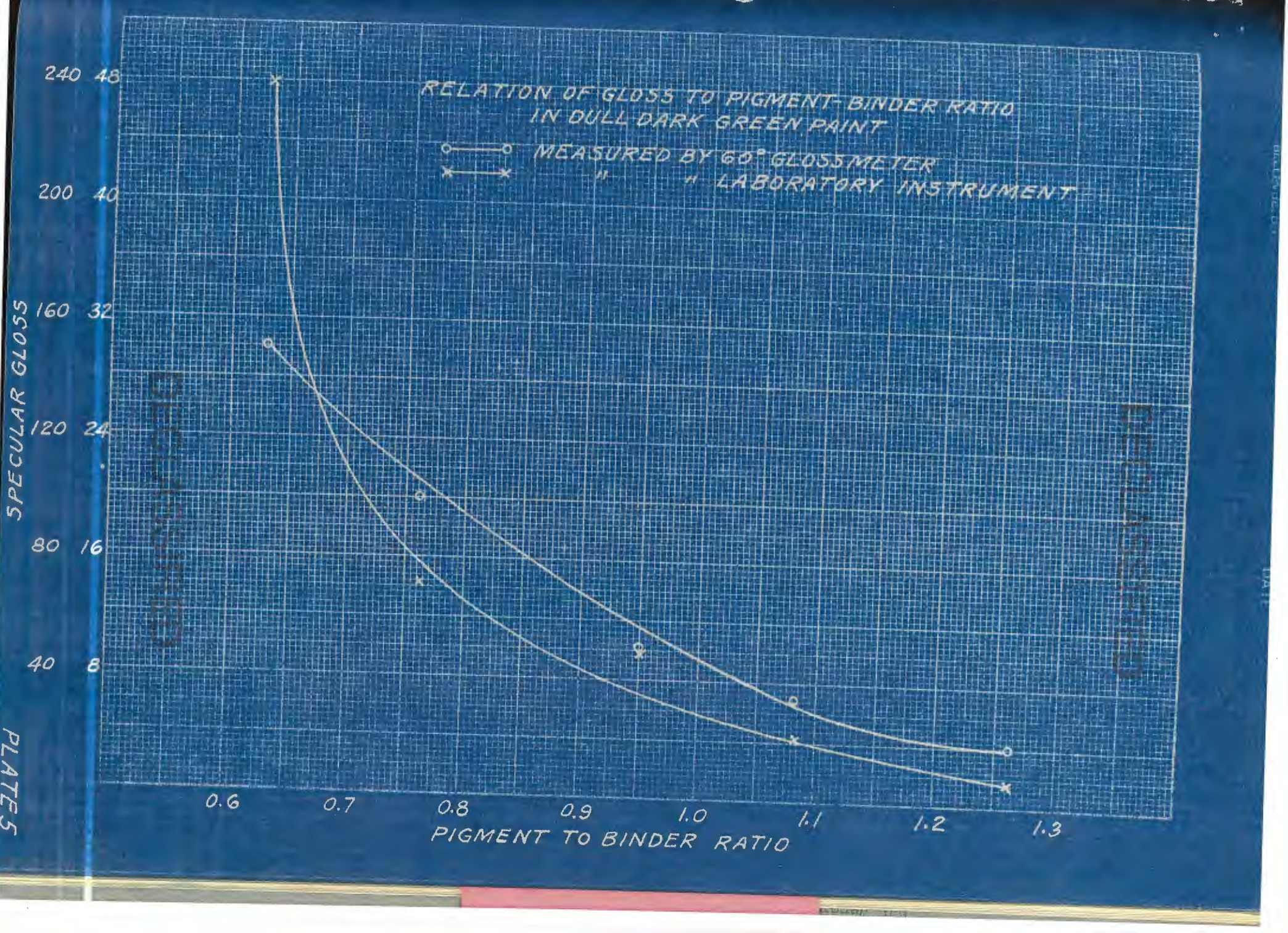

RELATION OF GLOSS TO PIGMENT-BINDER RATIO
IN DULL BLACK PAINT
MEASURED BY 60° GLOSSMETER
" " LABORATORY INSTRUMENT
SPECULAR GLOSS
240 36
200 30
160 24
120 18
80 12
40 6
.14 .18 .22 .26 .30 .34 .38 .42 .46 .50
PIGMENT TO BINDER RATIO

PLATE 3


RELATION OF GLOSS TO PIGMENT-BINDER RATIO
IN DULL GRAY PAINT
MEASURED BY 60° GLOSSMETER
" " LABORATORY INSTRUMENT
SPECULAR GLOSS
24
20
16
12
8
4
0
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
PIGMENT TO BINDER RATIO
PLATE 4


RELATION OF GLOSS TO PIGMENT-BINDER RATIO
IN DULL DARK GREEN PAINT
MEASURED BY 60° GLOSSMETER
" " LABORATORY INSTRUMENT
SPECULAR GLOSS
PLATES
240
200
160
120
80
40
48
40
32
24
16
8
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
PIGMENT TO BINDER RATIO