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A Study of Organic Coatings for

the Camouflage of Fleet Aircraft

NAVAL RESEARCH LABORATORY

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NAVY DEPARTMENT

Report on

A Study of Organic Coatings for the Camouflage of Fleet Aircraft

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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TABLE OF CONTENTS

APPENDICES

INTRODUCTION

(a) Authorization

1. This study was authorized by Bureau of Aeronautics Project Order 47-41.

(b) Statement of Problem

2. The project order authorizing this investigation directed that a study be made to develop camouflage coatings, formulae and specifications for two types of material, namely (1) semi-durable type, and (2) temporary or fugitive type.

3. Since the above project order was issued, the Bureau of Aeronautics has directed that Naval aircraft be finished with a non-specular coating of a durable type. Thus Type No. 1 above has been eliminated and the purpose of the studies described herein has been to determine the most suitable and durable organic protective coating to meet the requirements for the successful camouflage of Naval aircraft. The finish subsequently recommended toward the conclusion of this report is of a durable, rather than of a semi-durable type.

4. Experience has proved that a more or less light colored material is most suitable for day-time camouflage. However, such a material has the decided disadvantage of being highly susceptible to searchlight detection during the course of night operations. To overcome this, the temporary or single mission camouflage coating has been proposed. This product should be either black or midnight blue, probably black, as this color can be most easily duplicated under widely varying conditions. The coating should be perfectly mat, easily applied, and quick to dry, and it should be of such a nature that it can be readily removed from an airplane surface with, but preferably without, the use of special solvents. Most important of all perhaps, this temporary finish and the solvents used to remove it should in no way affect the permanent coating.

5. For the purpose of determining the type of finish and its composition most adaptable to the conditions so far outlined, this study was inaugurated to make a comprehensive survey of the various type products that are currently available for the finishing of Naval aircraft. In addition, formulae should be developed to render these finishes non-specular, as well as to make them workable with a system of single mission marking, as already discussed.

(c) Known Facts Bearing on the Problem

6. In the past, Naval aircraft have been finished with enamel, lacquer and more recently silosyn, a composition based on polymers of methacrylate ester. During this time, lacquer has been used most widely, and only recently has silosyn been introduced as an alternative. Specifications for each of these materials have required that they possess a very high gloss, whereas this characteristic is necessarily eliminated in any camouflage

material. Since all three of these materials have been used and their application, durability and general properties are well understood, methods were considered whereby these products would be rendered mat, after which the material possessing the best all-around properties could be selected.

7. A glyceral phthalate enamel similar to Bureau of Aeronautics Specification E-5 is known to possess exceptional durability and reports from its use on aircraft indicate it to be among the better coatings tested for corrosion prevention. It is easy to raise the solids content of an enamel of this type to such a point that ample coverage can be obtained with one coat. A single property makes the enamel objectionable; namely, its mediocre resistance to prolonged exposure to water. However, even in this respect it compares favorably with a nitro-cellulose film. Another property of secondary importance which is objectionable in the case of enamel is the difficulty encountered in its removal. The normally used strippers do not touch a finish of this type, and it is necessary to use chlorinated hydrocarbons which are toxic in nature. However, this finish is designed to be permanent and its frequent removal is not required. Since enamel is not easily attacked by the usual solvents, the removal of single mission coats would be rendered much more simple, as several of the ordinary removers could be used for taking off the single mission paint without attacking the enamel.

8. Nitro-cellulose lacquer conforming to Bureau of Aeronautics Specification L-12 has been most widely used for the protection of Naval aircraft. A coating meeting this specification is sufficiently high in alkyd-type resin to give it some of the advantages attributable to an enamel and yet it retains the properties characteristic of lacquer. It possesses the decided advantage of drying rapidly, and while its durability, abrasion resistance, hiding power, adhesion and water resistance are not as good as that of the enamel, it dries fast to a harder film. While this film is harder than the enamel, it still possesses excellent flexibility and is sufficiently durable to meet all demands upon it. At overhauling periods, it is easily and completely removed with the usual removers, thus simplifying a touch-up or refinishing job. Since the solid content of lacquer is much lower than that of enamel, it is necessary to apply two coats for complete coverage.

9. Silosyn is the trade name of a newer finish based on polymers of the acrylates and methacrylates. During the last two years, its use on Naval aircraft has received favorable comment. Among the properties which make it so desirable are its extreme lightness, excellent resistance to water, good adhesion, elasticity and rapid drying qualities. In the latter respect it is similar to lacquer. However, silosyn does possess the undesirable property of prolonged solvent retention, and surfaces coated with it should not be submerged in water until they have dried under normal conditions for approximately six days.

10. Unquestionably the most remarkable property of this finish is its resistance to water. Cases have been noted when it actually appears to harden while submerged in water. Quite the opposite is true in the case of lacquer and enamel. These materials appear to soften and become cheesy under

prolonged exposure to water, and this renders the film on a hull bottom much more susceptible to abrasion and general destruction during take-off and landing operations.

11. Until very recently, this product has been offered pigmented only with aluminum. It has been rather clearly demonstrated that it is impossible to prepare an aluminum finish sufficiently mat to be adaptable to camouflage needs, but if additional research should indicate that a durable finish can be prepared from a similar resin combination but pigmented with the usual Navy non-specular colors, it should prove of great interest as a permanent finish.

(d) Original Work Done at this Laboratory

12. This Laboratory has written a number of reports on the subject of camouflage. The more important of these having to do with aircraft camouflage 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 #H-1230, dated 20 January 1936.

(c) "Airplane Camouflage - Results of Tests of October 1, 1936." Naval Research Laboratory Report #H-1325, 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.

(d) "Some Paint Compositions Applicable to Camouflage of Fleet Aircraft." Naval Research Laboratory Report #P-1593, dated 12 February 1940. This report discusses at some length the various methods for measuring gloss and makes a recommendation for a specific method. Numerous formulae are included covering a range of colors which are given considerable study to determine their adaptability to camouflage work. The quality of the paints so designated is of the semi-durable type which more recently has been displaced in favor of the durable type of mat finish. The relationship of the gloss of the paint to its pigment-binder ratio is discussed in detail. The impracticability of producing a dull aluminum paint is demonstrated and evidence is offered in favor of a light gray material in its stead.

13. In addition to the foregoing reports on camouflage specifically for aircraft, 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 #H-1350 dated 20 March 1937.

(c) "Naval Camouflage Tests at Sea," of May and June 1938. Naval Research Laboratory Report #H-1496, dated 9 December 1938.

METHODS

(a) Selection of Materials - Metal Finishes.

14. Since lacquer of a high resin content corresponding to Bureau of Aeronautics Specification L-12 has been acceptable as a top finish for Naval aircraft, this material was employed as a standard of reference for comparing the properties of the various type products under investigation.

15. The specific materials coming under the scope of this investigation are listed as follows:

(a) Lacquer, High Resin Phthalate, Gloss. Bureau of Aeronautics Specification L-12b.

(b) Chlorinated Rubber Base Enamel (i.e., Roxoprene, Carrier Plane Gray).

(c) Lacquer. High Resin Phthalate. Non-specular. Bureau of Aeronautics Specification M-485.

(d) Silosyn - pigmented.

(e) Enamel, Glyceral Phthalate, Non-specular.

(f) Methacrylate Base Finish - Naval Research Laboratory formulation.

16. Dope - Fabric Finish - In addition to the materials listed above, a specification for a flat pigmented cellulose nitrate dope has been prepared and appears herewith as Appendix C. The requirements of this specification for gloss and color are identical with those of the metal finishes described in detail in the foregoing sections. The specification for the finishing of fabric surfaces is substantially the same as required for doping fabric with clear dope, Bureau of Aeronautics Specification D-15d, and pigmented glossy dope, D-16d. The only difference in the two systems is the substitution of the specification material of Appendix C for the final coat of Bureau of Aeronautics Specification D-16d. The durability, flexibility, and general utility of the fabric so treated compare most favorably with the complete system for a glossy finish.

17. The gloss lacquer used in the tests described herein was obtained from two suppliers of the specification product L-12d and approved by the

Naval Aircraft Factory. The colors employed were aircraft gray and insignia blue.

18. The chlorinated rubber base enamel was selected from the line of products of one of the leading manufacturers of this type material. The enamel was formulated especially to meet the gloss and color requirements of Bureau of Aeronautics Specification M-485. Special attention was given to grinding the pigment to a smooth consistency, thus producing a film of minimum skin resistance, while still maintaining the characteristics of a mat surface necessary for successful camouflage.

19. In the tests of the high resin phthalate, non-specular lacquer corresponding to Bureau of Aeronautics Specification M-485, samples of light gray were obtained from a bidder approved by the Bureau. In addition, samples of light gray and of blue-gray formulated in this Laboratory to meet this specification were included.

20. Samples of silosyn were furnished by the manufacturer of this proprietary product.

21. For checking the performance of the glyceral phthalate enamel, samples were obtained from an approved manufacturer complying with the requirements of the tentative specification for this product as described in Appendix A. The color and gloss were formulated to meet the requirements of M-485.

EXPERIMENTAL

22. In all of the following experiments, the films are applied to panels of 24ST aluminum alloy which have been anodized and coated with zinc chromate primer P-27b.

23. Abrasion Resistance - For determining the abrasion resistance of the various materials under test, an abrasion meter(1) of the type illustrated in Plate IV was used. Films of the finishes to be studied are prepared on panels, size 4 x 4". The films are sprayed out and allowed to dry for a standard time interval of one week before the tests are run. After drying, the panel containing the film is placed in a closed metal box at the bottom of the apparatus at an angle of 45°. The heat-treated steel grit abrasive of uniform size (90 - 170 mesh) is placed in an inverted container held in position directly above the closed box. Before the experiment is begun, the weight of the abrasive and container is carefully recorded. The outlet from the container is then connected to a Y-shaped tube leading into the box in a vertical position. Through the other arm of the Y tube, a gentle blast of air under constant pressure is maintained. The abrasive is then released in the form of a fine stream, and coming in contact with the stream of air, a blast of the abrasive is directed against the stationary panel. The accurate control of the air pressure and the rate of flow of the abrasive is of paramount importance for consistent results. The point of contact is closely watched through the glass opening and at the first

(1) Abrasion Test - Martin, "Lacquer and Synthetic Enamel Finishes," page 263. (D. Van Nostrand Co.)

sign of a break through the film the flow of the abrasive is stopped. The abrasive and container are weighed a second time and the difference from the original weight is a relative measure of the abrasion resistance of the film. A minimum of four measurements is made on each test panel. The thickness of the film is measured by means of a micrometer, and the final value of abrasive resistance is recorded in grams per mil.

24. Wet Abrasion - The abrasion resistance of these materials after the film has been soaked in water for 24 hours is measured in a similar manner. The panels containing the films are placed in a container of distilled water where they are allowed to remain for 24 hours. Upon removal, the adhering water is removed with blotting paper and they are further dried by means of a blast of compressed air. The abrasion resistance is then determined immediately before the film has had an opportunity to give up any appreciable amount of the absorbed water.

25. Weathering - To determine the outdoor durability of the materials under investigation, panels are prepared for outdoor exposure at an angle of 45° facing south, which is generally accepted as the most reliable measure of their durable qualities. A minimum exposure time of two months is required to tentatively establish the quality of any product.

26. Roughness - For comparing the roughness or smoothness of the material under test with the standard L-12 lacquer, the two materials are sprayed (full wet coat) side by side on a test panel. After thorough drying, the area of junction of the two films is studied through a low power microscope for dissimilarity in film structure.

27. Water Resistance - The water resistance of these test films is determined by submerging coated panels in distilled water for periods up to one week. Comparison is then made of their hardness, adhesion, blistering tendencies, and adherence to primer.

28. Gloss and Polishing Characteristics - Gloss measurements are made by means of a 60° gloss meter as described in detail in Naval Research Laboratory Report No. P-1593, dated 12 February 1940. A maximum gloss of 5 per mil is considered acceptable for camouflage finishes. For determining the polishing characteristics of the film, the gloss is measured before polishing, and is measured a second time after the surface has been given forty strokes with a soft rag on which has been placed the usual amount of a suitable rubbing compound, such as Duco #7.

29. Flexibility - Flexibility tests are conducted as authorized and required in Bureau of Aeronautics Specification ST-15 for the inspection of organic materials.

30. Salt Spray Test - Panels covered with the materials in question are placed in a salt spray box in which an intermittent mist of brine solution (20 per cent) is maintained. The spray mist is maintained for a period of three minutes and then shut off for an equal period. The length of time that the film holds up under these conditions is a measure of its protective value against salt water corrosion.

31. Adhesion - Quantitative methods for the measurement of adhesion are entirely lacking. A qualitative test for establishing the relative adhesive qualities of a protective coating consists simply of scraping the coating from the metal surface by means of a knife, finger nail, or some other hard object. The relative ease with which several coatings may be removed is the most reliable measure of their adhesion. When testing films of the kind studied herein, care should be exercised to note adherence of the top coating to the primer, as well as adherence of the entire system to the metal beneath. The ratings given the various coatings studied are referred to L-12 lacquer, which is arbitrarily given a rating of 5. Lower numbers indicate relatively improved adhesion.

32. Color - As a result of numerous tests made under the auspices of the Bureau of Aeronautics, a particular shade of light gray and a much deeper shade of blue gray were selected as the most adaptable colors for the successful camouflage of Fleet aircraft. The exact shades of these colors are illustrated in Appendix F. In addition, standard shades of Insignia Blue, Insignia White, Insignia Red, and Black are shown. All of these colors are non-specular and are standard for both color and gloss. The appended specifications for non-specular lacquer, enamel, and pigmented dope meet these requirements for color and gloss. The specifications, Appendices D and E, single mission coatings, meet the requirements of the black chip for color and gloss.

33. Sensitivity of standard colors to infra-red - The standard colors as designated in Appendix F were studied to determine their appearance when viewed through an infra-red filter and when photographed on an infra-red sensitive plate. The pigments used to compound the colors of Appendix F which are designated in the Appendices A - E were chosen in so far as possible to produce colors equally sensitive to infra-red and panchromatic light. This is true in all cases except that of Insignia Red, which characteristically appears black when photographed with panchromatic light, while it possesses about the same reflectivity in infra-red as numerous white pigments. Of particular interest in this connection is the case of the blue-gray color of Appendix F. This color is produced with an iron-blue pigment which contains no red. As a result it appears the same whether it is viewed with or without a red filter, since all of these pigments with the single exception of the red appear the same whether they are observed in infra-red or visible light. This should be of considerable value in avoiding detection by photographic means while the planes are based on deck or on the ground.

DATA OBTAINED

34. Abrasion resistance - The abrasion resistance of the material studied was measured and the results correlated in Table 1. Items 2 and 3 are samples of N-485 gray lacquer as supplied by two separate manufacturers. Item #7 is a sample of white non-specular lacquer corresponding to U. S. Army Air Corps Specification 14105. The films were soaked in water for 24 hours, dried with blotting paper and compressed air, and the abrasion resistance measured immediately. Results of these measurements appear in Table 2.

TABLE 1

Abrasion Resistance of Dry Camouflage Coatings

No.	Coating Designation	Type of Coating	Average Wt. of Abrasive	Film Thickness in Mils	Specific Abrasion (Wt. Abrasive/Thickness)
1	Aluminized Silosyn	Methacrylate Resin	46.8 gm	2.34	55.8
2	(a) M-485G	Gray Flat Lacquer	66.0	3.98	16.6
3	(b) M-485G	Gray Flat Lacquer	96.6	3.61	26.8
4	M-485BG	Blue Gray Flat Lacquer	154.0	2.24	68.8
5	L-12G	Gray Gloss Lacquer	263.8	2.96	89.1
6	L-12B1	Blue Gloss Lacquer	295.0	3.10	95.5
7	USAC 14105	Air Corps Flat Lacquer	151.2	3.22	47.0
8	Roxaprene	Chlorinated Rubber	119.9	4.72	25.4
9	71-013	Gray Alkyd Enamel	178.5	2.90	61.6
10	71-030	Alkyd Enamel	184.7	2.34	79.0
11	Pigmented Silosyn	Methacrylate Resin	174.7	4.10	42.6
12	A10-Black	Methacrylate Resin	33.2	0.74	44.9

TABLE 2

Abrasion Resistance of Wet Camouflage Coatings

No.	Coating Designation	Type of Coating	Average Wt. of Abrasive	Film Thickness in Mils	Specific Abrasion (Wt. Abrasive/Thickness)
1	Aluminized Silosyn	Methacrylate Resin	38.2	0.84	45.5
2	(a) M-485G	Gray Flat Lacquer	73.0	3.98	18.3
3	(b) M-485G	Gray Flat Lacquer	92.6	3.61	25.6
4	M-485BG	Blue Gray Flat Lacquer	219.0	2.34	95.8
5	L-12G	Gray Gloss Lacquer	331.0	2.96	112.0
6	L-12Bl	Blue Gloss Lacquer	452.0	3.10	146.0
7	USAC 14105	Air Corps Flat Lacquer	194.0	3.22	60.2
8	Roxaprene	Chlorinated Rubber	133.0	4.72	28.2
9	71-013	Gray Alkyd Enamel	238.0	2.90	82.0
10	71-030	Alkyd Enamel	315.0	2.34	134.0
11	Pigmented Silosyn	Methacrylate Resin	Inconsistent results - Poor adhesion in between coats.		
12	A-10 Black	Methacrylate Resin	32.5	0.74	44.0

35. Roughness - The roughness of the film of each product under investigation relative to L-12 gray lacquer is illustrated in the photographs of Plates I to III, inclusive. The samples as illustrated are as follows:

	Left	Right
Plate I, Fig. 1	L-12 Gray Lacquer	(a) M-485
Fig. 2	" " "	Roxaprene (chlorinated rubber)
Plate II, Fig. 1	(b) M-485	L-12 Gray Lacquer
Fig. 2	L-12 Gray Lacquer	USAC 14105 Flat White Lacquer
Plate III, Fig. 1	L-12 Gray Lacquer	Gray Alkyd Enamel
Fig. 2	" " "	A-10 Green (Methacrylate)

It will be noted in all cases that the L-12 gray gloss lacquer invariably possesses the smoothest surface such as is characteristic of glossy coating materials. In these photographs, two samples, (a) (b), of L-485 lacquer from two manufacturers were studied. The contrast in the color of Figure 2, Plate II, is due to the fact that the L-12 lacquer was gray, whereas the U. S. Army Air Corps 14105 flat lacquer was white. Figure 2, Plate III, shows a sample of gray L-12 lacquer when compared to a sample of deep green methacrylate resin enamel.

36. Weathering - The appearance of the test panels after eight weeks on the roof is recorded in Table 3. Notations and designations are the same as in Tables 1 and 2.

TABLE 3

Quality of Test Panels After Roof Exposure

No.	Coating Designation	Color Change	Blistering	Checking	Chalking	Corrosion	General All Round Quality
1	Aluminized Silosyn	Lost Gloss	Slight	None	None	None	Fair
2	(a) M-485G	None	None	"	"	"	Excellent
3	(b) M-485G	"	"	"	"	"	"
4	M-485BG	"	"	"	"	"	"
5	L-12G	Darkened Slightly	"	"	"	"	"
6	L-12Bl	None	"	"	"	"	"
7	USAC 14105	Bleached Slightly	"	"	Poor	"	Good
8	Roxaprene	Faded Slightly	"	"	None	"	Excellent
9	71-013	None	"	"	"	"	"
10	71-030	"	"	"	"	"	"
11	Pigmented Silosyn	"	"	"	"	"	"
12	A-10 Blue	"	"	"	"	"	"
13	A-10 Black	"	"	"	"	"	"
14	A-10 Green	"	"	"	"	"	"
15	A-10 Green-1	"	"	"	"	"	"

37. Water Resistance - The water resistance of the subject material is shown in Table 4. Observations were made daily and the notations indicated represent the condition of the panels at the end of 18 days.

TABLE 4

Condition of Camouflage Coatings After Exposure to Water

No.	Coating Designation	Hardness	Adhesion	Blistering	Corrosion	General Appearance
1	Aluminized Silosyn	Fair	Fair	Very poor	Two spots	Numerous small blisters
2	(a) M-485G	Good	Good	Good	None	Some fading
3	(b) M-485G	Excellent	Excellent	Excellent	"	Some fading
4	M-485BG	Good	Excellent	Good	"	Good
5	L-12G	Fair	Fair	Very poor	"	Fading & small blisters
6	L-12BL	Good	Good	Very poor	"	Faded badly & blistered
7	USAC 14105	Excellent	Excellent	Excellent	"	Excellent
8	Roxaprene	Excellent	Excellent	Excellent	"	Excellent
9	71-013	Excellent	Excellent	Excellent	"	Excellent
10	71-030	Excellent	Excellent	Excellent	"	Excellent
11	Pigmented Silosyn	Good	Fair	Excellent	One spot	Good
12	A-10 Black	Fair	Fair	Excellent	None	Excellent

38. Table 5 lists several of the characteristics of the proposed films.

Table 5

Characteristics of Camouflage Coatings

No.	Coating Designation	Gloss		Flexibility	Salt Spray	Adhesion	
		Initial	After Polishing			Before Exposure	After Exposure
1	Aluminized Silosyn	75	85	Passed	OK	7	7
2	(a) M-485G	4	20	Failed	OK	6	7
3	(b) M-485G	5	20	Failed	Chalked	4	
4	(c) M-485G	4	15	Passed	OK	5	5
5	M-485BG	2	11	Passed	OK	4	5
6	L-12G	60	94	Passed	OK	5	6
7	L-12B1	90	100	Passed	Dulled	5	5
8	USAC 14105	9	29	Failed	OK	4	5
9	Roxaprene	5	15	Failed	One large blister	6	6
10	71-013	2	8	Passed	OK	5	5
11	71-030	9	24	Failed	OK	4	6
12	Pigmented Silosyn	20	50	Failed	OK	5	5
13	A-10 Black	1	2	Passed	Blistered	8	7
14	A-10 Blue	2	-	-	OK	7	7
15	A-10 Green	3	10	-	OK	7	7
16	A-10 Green-1	6	10	-		7	7

CONCLUSIONS AND RECOMMENDATIONS

(a) Facts Established.

39. From an examination of the data on the abrasion resistance of the different materials investigated, an unusual fact disclosed itself, namely, the abrasion resistance of lacquer is greater after the film has soaked in water for a period of 24 hours. This probably does not mean that the film itself is a great deal tougher than when dry. However, it is evident that the nitrocellulose film has been rendered much more flexible. It is not so easily affected by abrasive particles with which it might come in contact during take-off and landing operations. From Tables 1 and 2, it is further evident that there is little change in the abrasion resistance of methacrylate and chlorinated rubber resins after soaking in water. The improvement in the resistance of alkyd resins is a little more marked but does not improve to the same extent as the lacquer. This improvement in abrasion resistance after contact with water appears to be the function of two properties of the coatings. Of these several materials, the nitrocellulose composition is known to form a harder film and is more susceptible to water adsorption. The alkyd resin is apparently harder than chlorinated

rubber and methacrylate, and absorbs water somewhere in between these resins and lacquer. The amount of water absorbed tends to increase the flexibility of the film and at the same time increases its resistance to abrasive action. In this respect the lacquer is definitely superior to the other materials studied.

40. It should be pointed out, however, that these measurements in no way should be construed as representing a measure of adherence of these films but merely indicate their relative value toward combatting abrasive forces.

41. General Durability - An examination of Table 3 further enhances the value of M-485 lacquer as a camouflage protective coating for aircraft. Although the exposure time of eight weeks does not conclusively indicate the ultimate value of each material, several products do appear to be inferior. These tests are being continued and final report will be made in letter form. Attention is directed to the condition of the U. S. Army Air Corps white lacquer Specification 14105, which had shown considerable chalking at the end of two months. This is probably due to exceedingly heavy pigmentation and to the use of a chalking type of titanium dioxide. The general quality of the film is still good.

42. From Plates I to III, inclusive, it is evident that no material so far examined will meet the gloss requirements of Specification M-485 and still possess the smooth, slick surface characteristic of L-12 gloss lacquer. From the materials examined, M-485 lacquer possesses the smoothest finish and is more suitable for finishing aircraft to produce a surface exhibiting minimum skin resistance.

43. Water Resistance - The susceptibility of lacquer, and particularly the methacrylate base finishes, such as silosyn, to water is further shown by the results indicated in Table 4. Items 1, 12 and 13, which are methacrylate compositions, and Items 2, 6 and 7, which are nitrocellulose lacquers, show some indication that prolonged exposure to water gives rise to an undesirable condition such as loss of hardness, adhesion and slight blistering.

44. General Characteristics - Several of the characteristics of the various coatings as correlated in Table 5 deserve some comment. The most undesirable property noted here is the inability of a number of these materials to pass the flexibility test as specified in Navy Aeronautical Specification ST-15. This lack of flexibility in most cases is due no doubt to the high pigmentation characteristic of non-specular coatings. By the proper choice of vehicle and inert pigment it is fairly simple to formulate a lacquer meeting all the requirements of M-485, including that of flexibility tests. This is borne out by the results recorded for Items 4 and 5 in Table 5.

45. As a general summary, it may be concluded that all of the products examined are satisfactorily resistant to salt spray. In only one or two instances a small amount of blistering occurred, but then only after

considerable exposure.

46. The comparison of the gloss of the various products before and after polishing indicates M-485 to be as resistant to "glossing up" as any product examined with the exception of the methacrylates, Items 13-16, Table 5. This one desirable property of methacrylate finishes is of small relative importance when compared to the more durable qualities attributable to M-485 lacquer.

47. The adhesion of M-485 lacquer before and after exposure compares favorably with all competitive material investigated.

(b) Recommendations

48. In the light of the evidence offered as a result of the experiments described in this study, there appears to be no real justification to recommend a complete change from lacquer (M-485) to another type of product for the finishing of Fleet aircraft in non-specular colors. It is recommended, however, that the durability of the alkyd enamel with which a small number of Naval planes are to be finished be closely observed and compared with ships subjected to similar service conditions finished in lacquer. Particular attention should be directed to planes which are frequently given a temporary coating of black single mission camouflage paint. Checking is a little more easily produced in lacquer films than in enamels and frequent application and removal of temporary top coats will likely shorten the life of lacquer a little more rapidly than it will the enamel.

SUMMARY

49. A comprehensive study has been made of numerous products designed for the successful camouflage of Fleet aircraft. From the materials examined, recommendation has been made to continue the use of the non-specular lacquer with allowance for the inclusion of an alkyd type enamel as a limited alternative.

50. Specifications covering the following products have been prepared which appear as Appendices A to E of this report:

(a) Enamel, Glyceral Phthalate, Non-Specular
(b) Lacquer, High Resin Phthalate, Non-Specular
(c) Dope, Nitrocellulose, Pigmented, Non-Specular
(d) Paint Camouflage, Single Mission Black, Water Soluble
(e) Lacquer Camouflage, Single Mission Black, Removable

51. Color chips representing standard shades of color and gloss have been made and are included in Appendix F.

APPENDIX A

TENTATIVE

NAVY AERONAUTICAL SPECIFICATION
ENAMEL, GLYCERYL PHTHALATE, MAT

A. APPLICABLE SPECIFICATIONS

A-1. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

A-1a. Navy Department Specifications:

General Specifications for Inspection of Material
52-O-16 Oil, Tung (Chinawood) Raw
52-S-4d Burnt Sienna

A-1b. Navy Aeronautical Specifications:

ST-15 Specifications for Inspection of Organic Protective Coatings for Aircraft
RM-11 Linseed Oil
RM-93 Dipentine
RM-103 Mineral Spirits
RM-111 Toluene
RM-130-5 Antimony Oxide
RM-130-6 Titanium Oxide; Chalk Resisting Type
RM-131-1 Carbon Black
RM-132-1 Iron Blue
RM-133-2 Toluidine Red
RM-133-3 Cadmium Red
RM-120 Driers, Naphthenate, Conc. Liquid

A-1c. Federal Specifications:

TT-B-601 Bone Black
TT-L-71 Lampblack

B. GRADE, TYPE AND COLORS

B-1. This specification covers one grade and type only in the following colors, and such other colors as may be found necessary: Insignia Red, Insignia White, Insignia Blue, Blue Gray, Light Gray, and Black.

B-2. All colors shall have identical properties except as specified otherwise under section E.

[redacted]

C. MATERIAL AND WORKMANSHIP

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the applicable raw material specifications.

C-2. The glyceral phthalate resin composition shall be made of first quality and uniform raw materials whose chemical union shall be accurately controlled by means of adequate manufacturing equipment and testing methods.

C-3. The component raw materials shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-4. The pigments shall be finely ground and free from floating or caking in the container.

C-5. The products shall be free from toxic ingredients and rosin or rosin derivatives.

C-6. All products conforming to this specification shall be designed for use with zinc chromate primer, Specification P-27, in accordance with the standard formula.

D. GENERAL REQUIREMENTS

D-1. There are no general requirements for this specification.

E. DETAIL REQUIREMENTS

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product -

Non-Volatile.	Min. 60
Volatile.	Max. 40

E-1b. Non-Volatile -

Vehicle.	Min. 28
Pigment.	Max. 72

E-1c. Volatile -

Hydrocarbon solvents . .	100

E-1d. Vehicle -

Resin.	100

[redacted]

E-2. Ingredients - Shall conform to the above and also to the following:

E-2a. Resin - Shall be a glyceral phthalate type, showing not less than 31% phthalic anhydride quantitative, free from rosin and rosin derivatives.

E-2b. Driers - Shall conform to Specification RM-120 and added as required to obtain the specified drying and baking properties with a high degree of package stability.

E-2c. Volatile - Shall be entirely of hydrocarbon solvents having the following distillation characteristics:

Initial Point. . . . Min. 120°C. (248°F.)
50% Fraction . . . . Min. 160°C. (320°F.)
End Point. . . . . Max. 207°C. (404°F.)

E-2d. Extender - As needed to match color and gloss but in no case shall extender exceed 25% of total pigment.

E-2e. Pigments - The colors shall be pigmented as follows; the pigments shall meet the appropriate specifications of Section A-1b.

Insignia Red	- Cadmium or Toluidine Red
Insignia White	- Titanium Oxide and Antimony Oxide tinted with Iron Blue
Insignia Blue	- Iron Blue 88% and 12% of a mixture of Titanium and Antimony Oxide
Blue Gray	- Iron Blue, a mixture of Titanium Oxide and Antimony Oxide, Carbon Black, and Burnt Sienna
Light Gray	- Titanium Oxide, Carbon Black, Burnt Sienna
Black	- Carbon Black

NOTE: Where mixtures of Titanium Oxide and Antimony Oxide are specified, the total amount of Antimony Oxide shall not exceed 50% of the mixture.

E-3. Appearance - Shall be uniform, homogeneous and free from bubbles. There shall be no trace of grit, rough particles or separation of pigments.

E-4. Odor - Shall be normal for the volatiles permitted by the specification. The film shall retain no residual odor 48 hours after application.

E-5. Viscosity - The viscosity of the package material shall be reported.

E-6. Weight per Gallon - At 25°C. (77°F.) shall be not less than 9.50 pounds.

E-7. Moisture Content - Shall not exceed 0.1 per cent by weight.

E-8. Flash Point - Shall be not less than 27°C. (80°F.).

E-9. Dilution Stability - The product shall remain stable after a reduction of 1 part of mineral spirits, Specification RM-103, to 2 parts of package material.

E-10. Skinning - Shall be absent in a partly filled closed container after 48 hours.

E-11. Application Properties.

E-11a. Working Properties - When applied by spraying, it shall be a freely working product with acceptable leveling properties.

E-11b. Self-Lifting Properties - Recoating by spray after 2, 6, and 18 hours shall produce no film irregularity.

E-11c. Smoothness - A full wet spray coat, after drying, shall appear as smooth and free from rough particles as a standard control product when examined under a minimum magnification of 15 diameters.

E-12. Drying Properties -

E-12a. Drying Time - A medium spray coat shall air-dry to touch in not more than 10 minutes and dry firm and hard in not more than 6 hours, when applied over a standard primer.

E-12b. Surface Appearance - The film upon drying shall be free from streaks, blisters, silking or other irregularities of surface.

E-13. Color and Gloss.

E-13a. Color - When applied to a glass panel and allowed to dry, it shall match the standard color cards.

E-13b. Specular Gloss - Shall be as low or lower than the standard.

Note: The specular gloss of the standard shall not exceed 5 per mil when measured under the following conditions. The specular gloss at

[redacted]

60 degrees is defined as the fraction of incident light energy reflected in the direction of specular (that is, "mirror") reflection when the surface is illuminated by a parallel beam of light at an angle of 60 degrees from the normal to the surface. The incident light shall be of daylight quality (I.C.I. Illuminant C), and the photometer shall have visual spectral response (I.C.I. 1931 Standard Observer); or any source-photometer combination of equivalent spectral characteristics may be used. Both the incident and reflected light beams shall be substantially parallel, the total angular spread not exceeding 5 degrees in the plane of measurement. The area of surface studied shall be at least 25 millimeters in diameter. Values of specular gloss shall be reported in parts per thousand (abbreviated "per mil"). Specular gloss is conveniently measured by comparing the brightness of the illuminated surface with that of a standard surface similarly illuminated and viewed. Polished black glass of known reflection factor (obtained from known index of refraction by use of Fresnel's equation) may be used as such a secondary standard surface, having specular gloss of approximately 95 per mil at 60 degrees. Measurements made according to A.S.T.M. D523-39T will be acceptable under this specification.

E-14. Baking Properties - A flow-out film, air dried 16 hours and baked at 80 to 85°C. (176 to 185°F.) for 2 hours, shall be hard, tough, smooth and free from all defects such as checking, wrinkling and dulling. The baked film shall show no appreciable discoloration.

E-15. Cold Cracking - The film on the baked panel above shall withstand a bend test of 180° around a 3/16-inch rod at 0°C. (32°F.).

E-16. Coating Anchorage - A spray coat over baked primer shall show satisfactory anchorage of the top coat after drying hard.

E-17. Water Resistance (Cold) - A flow-out film, air dried 24 hours, shall withstand immersion in water at room temperature for 48 hours. It shall show no checking, blistering, appreciable whitening and only a very slight dulling when observed 5 minutes after removal. The film on the immersed side shall be equal in hardness, toughness, gloss and anchorage to the film on the emersed side, 3 hours after removal.

[redacted]

E-18. Gasoline Resistance - A flow-out film, air dried 24 hours, shall withstand immersion in lead free gasoline at room temperature for 24 hours; 1 hour after removal the film shall be equal in hardness, toughness, gloss and anchorage to the film of a similarly prepared panel which has not been subjected to gasoline.

E-19. Weather Resistance - The weather resistance shall be equal to and the discoloration shall be no greater than that of a standard control product when tested on a comparative basis in sub-tropical climate for a period of one year.

F. METHODS OF SAMPLING, INSPECTION AND TEST

F-1. Sampling by the government inspector and manufacturer shall be in accordance with Specification ST-15.

F-2. Analysis and Test.

F-2a. Shall be conducted and reported by the manufacturer as prescribed by Specification ST-15. Manufacturers are advised to follow these instructions carefully.

F-2b. All tests for the requirements of paragraphs E-1 to E-10, inclusive, shall be made on package material. All tests for the requirements of paragraphs E-11 to E-19, inclusive, shall be made with material reduced to application viscosity.

F-2c. Alclad panels shall be used for test unless otherwise specified.

F-2d. All required tests which are not specifically described in this section shall be conducted in accordance with applicable methods specified in Specification ST-15.

F-3. Reports of Tests

F-3a. The paint manufacturer shall furnish test reports in duplicate, certified by a responsible officer of the company, by affidavit, showing quantitative results for all tests and analysis required by this specification and signed by the director of the laboratory in which the tests were conducted.

These reports shall also certify the source and source identification code numbers of each ingredient used. When inspection is conducted at the contractor's plant, these reports shall be furnished to the inspector.

F-3b. The paint manufacturer shall report quantitatively, in the units and forms specified, the results of his tests for non-volatile content, viscosity, weight per gallon and moisture content.

F-3c. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the

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requirements for color and gloss, cold cracking, and water and gasoline resistance.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT

G-1. Packaging and Packing - The product shall be packed in suitable commercial packages containing the quantity specified by the purchase order or contract.

G-2. Marking - The following information shall appear on all containers:

Name of Paint Manufacturer
Enamel: Glyceral Phthalate, Non-Specular
Specification:
Manufacturer's Formula #
Manufacturer's Batch #
Date of Manufacture
Net Quantity Contained
Government Order # (or Contract #, if Order # is not assigned)
Thinning Directions: The paint manufacturer's recommendations shall be given with the code number of the thinner to be used.

Application Directions: This material is for spray application only.

H. REQUIREMENTS APPLICABLE TO INDIVIDUAL DEPARTMENTS

H-1. The following departmental specifications of the issue in effect on date of invitation for bids shall form a part of this specification, applicable to purchases by the agency indicated.

H-1a. Navy - Navy Department General Specifications for Inspection of Material. Copies may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.

I. NOTES

I-1. This product is intended for use as a flat camouflage finish for aircraft.

I-2. Ordering Data - Requisitions, contracts, and orders shall state the size of the containers in which the enamel is to be furnished. The material shall be purchased by volume; the unit being a U. S. Gallon at 25°C. (77°F.). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

I-3. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of manufacturers is called to this requirement

and they are urged to forward samples of the product which they propose to offer to the Navy in future, in order that check tests may be made. These tests shall be conducted at the expense of the manufacturers. It is further to be understood that the manufacturer shall pay all transportation charges to and from the Navy testing laboratories. In the case of failure of the sample submitted to prove satisfactory, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product, or its ingredients which are considered sufficient to warrant additional tests.

I-3a. Any intentional falsification of records or affidavits will automatically remove the paint manufacturer from the approved list for a period of not less than two years.

I-4. Specifications - When requesting specifications refer to both title and number.

I-4a. Copies of this specification may be obtained upon application to the Bureau of Aeronautics, Navy Department, Washington, D. C.

APPENDIX B

TENTATIVE

NAVY AERONAUTICAL SPECIFICATIONS, LACQUER
HIGH RESIN PHTHALATE, NON-SPECULAR

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids form part of this specification, and bidders and contractors should provide themselves with the necessary copies.

A-1a. Navy Department Specifications:

General Specifications for Inspection of Materials.
52-S-4d Burnt Sienna

A-1b. Navy Aeronautical Specifications:

ST-15	Specification for Inspection of Organic Protective Coatings for Aircraft.
RM-1	Cellulose Nitrate.
RM-4	Ethyl Cellulose
RM-21	Glycol Sebacate
RM-44	Butyl Alcohol, Normal
RM-50	Ethyl Acetate
RM-52	Butyl Acetate
RM-111	Toluene (Toluol)
RM-120	Drier Naphthenate
RM-130-5	Antimony Oxide
RM-130-6	Titanium Oxide; Chalk Resisting Type
RM-131-1	Carbon Black
RM-132-1	Iron Blue
RM-133-2	Toluidine Red
RM-133-3	Cadmium Red
T-25-d	Thinner, Nitrocellulose Dopes and Lacquers
T-29	Thinner, Nitrocellulose Dopes and Lacquers, Blush Retarding
P-27-b2	Primer, Zinc Chromate

A-1c. Federal Specification:

TT-B-601	Bone-Black; Dry, Paste-In-Japan, Paste-In-Oil

B. GRADE, TYPE, AND COLORS.

This specification covers one grade and type of a nitro-cellulose, high resin glyceryl phthalate type non-specular lacquer in the following colors: Insignia Red, Insignia White, Insignia Blue, Black, Light Gray, and Blue Gray.

C. MATERIAL AND WORKMANSHIP.

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with approved and applicable raw material specifications.

C-2. The glyceryl phthalate resin composition shall be made of first quality and uniform raw materials whose chemical union shall be accurately controlled by means of adequate manufacturing equipment and testing methods.

C-3. The component raw materials shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-4. The pigments shall be finely ground and free from floating or caking in the container.

C-5. All products conforming to this specification shall be designed for use with Zinc Chromate Primer, Specification P-27, in accordance with the standard formula.

D. GENERAL REQUIREMENTS

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product:

Non-volatile, minimum	45
Volatile, maximum	55

E-1b. Non-volatile - The ratio of nitrocellulose to the remainder of the binder shall not exceed 20% of the total. The pigment to binder ratio will be such as needed to meet requirements of color and gloss.

E-1c. Volatile -

Esters and alcohols	Min. 50
Hydrocarbons	Max. 50

E-2. Ingredients - All ingredients in the manufacture of these products shall comply with the requirements of Section C, also the following:

E-2a. Cellulose Nitrate - Specification RM-1, Types I and II.

E-2b. Ethyl Cellulose - Specification RM-4, Type I.

E-2c. Resin and Modifying Agents - Shall be of a glyceryl phthalate type which may be modified as required to obtain the specified properties of the product. The type of modifying agents shall be indicated.

E-2d. Extender - As needed to match color and gloss, but in no case shall extender exceed 25% of total pigment.

E-2e. Pigments - Shall be as follows and in accordance with all applicable specifications:

Color	Specifications
Insignia Red	Cadmium or Toluidine Red
Insignia White	Titanium Oxide Chalk Resisting Type 4 parts (Type I) and Antimony Oxide 1 part, tinted with Iron Blue.
Insignia Blue	Iron Blue 88% and 12% equal parts Titanium Oxide and Antimony Oxide.
Black	Carbon Black
Light Gray	Titanium Oxide, Burnt Sienna, and Carbon Black
Blue Gray	Iron Blue, Titanium Oxide Chalk Resisting Type, Antimony Oxide, Carbon Black and Burnt Sienna

NOTE 1: Not over 4% of dibutyl phthalate based on pigment by weight may be used as a dispersing agent with Insignia Blue.

NOTE 2: When mixtures of Titanium Oxide and Antimony Oxide are specified, the total amount of Antimony Oxide shall not exceed 50% of the mixture.

E-3. Vehicle Properties -

E-3a. Color - The vehicle for all pigmented colors shall be no darker than 3 L on the Hellige scale.

E-3b. Non-Yellowing - After baking for two hours at 121°C. (250°F.), two dip coats on a glass tube shall be no darker than 6 L on the Hellige scale.

E-3c. Water Resistance - A flow-out film of unreduced vehicle over a spray coat of Specification P-27 primer, air-dried 24 hours, shall with-

[redacted]

stand cold water for 24 hours and boiling water for 10 minutes. It shall show no haze, milky appearance, or other defect when examined 3 hours after removal. Any dulling shall be readily removed by a cloth and water. Boiling water tests shall be conducted on a flow coat on a glass panel after 24 hours air drying.

E-4. Physical Properties -

E-4a. Appearance - Shall be uniform, homogeneous, and free from bubbles. There shall be no trace of grit, rough particles, or separation of pigments.

E-4b. Odor - Shall be normal for the volatiles permitted by the specification. The film shall retain no residual odor 48 hours after application.

E-4c. Coarse Particles - Shall not exceed 0.1 per cent by weight retained on a No. 325 screen.

E-4d. Viscosity - The package viscosity of the lacquer shall be so adjusted that when reduced two volumes of lacquer and one volume of thinner, Specification T-25-d, a viscosity between 1.0 and 1.75 poises at 25 degrees C. (77 degrees F.) is obtained.

E-4e. Weight per Gallon - At 25°C. (77°F.) shall be not less than 7.50 pounds.

E-5. Application Properties (Applied over P-27 primer of standard formula) -

E-5a. Working Properties - When applied by spray, it shall be a freely working product. When applied by brush, it shall show flowing and leveling properties equal to the standard formula product.

E-5b. Self-Lifting Properties - The second coat of lacquer over P-27 primer shall show no lifting after drying intervals of 4, 8, 24, 48, 72, 96 and 168 hours.

E-5c. Smoothness - A full wet spray coat after drying shall appear as smooth and free from rough particles as a standard control product when examined under a minimum magnification of 15 diameters.

E-6. Drying Properties (Applied over a P-27 primer of standard formula).

E-6a. Drying Time - The film shall dry in not more than 40 minutes.

E-6b. Surface Appearance - The film upon drying shall be free from streaks, blisters, silking, or other irregularities of surface.

E-6c. Print Proof - A sprayed film shall show no permanent print from cheesecloth under a pressure of one pound per square inch for one hour

when applied three hours after application of the lacquer, and observed four hours after removal of pressure.

E-7. Film Properties.

E-7a. Color - When applied to a glass panel and allowed to dry it shall match the standard color cards.

E-7b. Specular Gloss - Shall be as low or lower than the standard.

NOTE 1: The specular gloss of the standard shall not exceed 5 per mil when measured under the following conditions. The specular gloss at 60 degrees is defined as the fraction of incident light energy reflected in the direction of specular (that is, "mirror") reflection when the surface is illuminated by a parallel beam of light at an angle of 60 degrees from the normal to the surface. The incident light shall be of daylight quality (I.C.I. Illuminant C), and the photometer shall have visual spectral response (I.C.I. 1931 Standard Observer); or any source-photometer combination of equivalent spectral characteristics may be used. Both the incident and reflected light beams shall be substantially parallel, the total angular spread not exceeding 5 degrees in the plane of measurement. The area of surface studied shall be at least 25 millimeters in diameter. Values of specular gloss shall be reported in parts per thousand (abbreviated "per mil"). Specular gloss is conveniently measured by comparing the brightness of the illuminated surface with that of a standard surface similarly illuminated and viewed. Polished black glass of known reflection factor (obtained from known index of refraction by use of Fresnel's equation) may be used as such a secondary standard surface, having specular gloss of approximately 95 per mil at 60 degrees. Measurements made according to A.S.T.M. D523-39T will be acceptable under this specification.

E-7c. Primer Absorption - The lacquer shall show no tendency to sink into the primer, to change its gloss, or to develop embrittlement through a combination with the primer when compared to a similar metal panel without primer.

E-7d. Flexibility - The baked panel shall withstand the specified cold cracking bend test over a 1/8-inch rod.

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E-7e. Metal Anchorage - The primer shall show satisfactory anchorage and adhesion to the metal when examined as specified.

E-7f. Coating Anchorage - The lacquer shall show satisfactory anchorage and adhesion to the primer when examined as specified.

E-7g. Discoloration - The baked film shall show no appreciable color change when compared to an unbaked film.

E-8. Resistance Properties.

E-8a. Water Resistance - A flow-out film on a glass panel, air dried 24 hours, shall withstand immersion in water at room temperature for 24 hours. It shall show no checking, blistering, appreciable whitening, and only a very slight dulling when observed 5 minutes after removal. The film on the immersed side shall be equal in hardness, toughness, gloss, and anchorage to the film on the emersed side, 3 hours after removal.

E-8b. Gasoline Resistance - A flow-out film, air dried 24 hours, shall withstand immersion in lead free gasoline at room temperature for 4 hours; 24 hours after removal the film shall be equal in hardness, toughness, gloss, and anchorage to the film of a similarly prepared standard formula product.

E-8c. Weather Resistance - The weather resistance shall be equal to and the discoloration shall be no greater than that of the standard formula product when tested on a comparative basis. There shall be no premature checking or cracking failure after a period of at least six months.

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Specification ST-15.

F-2. Analyses and Tests.

F-2a. Shall be conducted on a comparative basis to a properly manufactured standard formula product and reported by the manufacturer as prescribed by Specification ST-15, the applicable raw material specifications, and Form No. FM-1. Manufacturers are advised to follow these instructions.

F-2b. Tests and analyses to determine conformance with the paragraphs in Section E headed "Composition," "Ingredients," "Vehicle Properties," and "Physical Properties" shall be made on packaged material. Tests for conformance to the remainder of the Detail Requirements shall be made after thinning with Specification T-25 Thinner to a viscosity of approximately one poise absolute at 25°C. (77°F.).

F-2c. Aluminum alloy panels shall be used for coating application tests, except as otherwise specified. Application of the lacquer shall be over Zinc Chromate Primer, Specification P-27 of standard formula.

[redacted]

F-2d. Prepare color and gloss test panel as specified by Specification ST-15. Prepare necessary panels for testing the remaining requirements of paragraph in Section E headed "Film Properties" using aluminum coated, aluminum alloy sheet (alclad). Apply one full coat of Zinc Chromate Primer, Specification P-27 of standard formula to obtain practically full hiding, dry one hour, apply two coats of the lacquer under test and dry each one hour. Examine a freshly prepared panel for compliance with the Primer Absorption requirement, then place in an oven and bake at 93°C. (200°F.) for 48 hours. After completion of baking, examine for the remaining requirements of "Film Properties" paragraphs of Section E.

F-2e. Self-Lifting Properties - Particular attention shall be given to colors containing titanium oxide.

F-2f. Tests to determine compliance with the Appearance requirement in the "Physical Properties" paragraph of Section E shall be conducted by dipping a glass panel into the lacquer.

F-3. Reports and Exhibits.

F-3a. The manufacturer shall report quantitatively, where applicable, and in the units or form specified, the results of all tests for the requirements of paragraphs in Section E headed "Product" (under Composition), "Vehicle Properties," and "Physical Properties."

F-3b. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the requirements in Section E headed "Application Properties," "Drying Properties," "Film Properties," "Water Resistance," and "Gasoline Resistance" with similar exhibits of the standard control product for direct comparison purposes.

F-4. Manufacturer's Formula - The manufacturer shall submit in appropriate manner a complete extraction of his batch production data in form, arrangement, and yield to be strictly comparable to the standard formula, including name, code, and source of each ingredient and the ingredient specification on which procurement of each ingredient is to be made and inspected. This data shall be approved by the Naval Aircraft Factory or the Bureau of Aeronautics. An exact copy of the approved formula shall be available for the Government Inspector at time of plant inspection. Approval of the formula does not constitute approval of the manufactured product. The formula may be disapproved if it is considered unsuited to the performance requirements, or if it contains an objectionable ingredient. Manufacturers are encouraged to submit alternative formulas which will show definite improvement in performance as compared to the standard.

F-5. Standard Formula of Clear Vehicle - On the basis of a 100 gallon yield is as follows:

150 lbs.	Paraplex RG-2 (60%), Specification RM-21
45 lbs.	Amberlac B-94 (80%)
35 lbs.	Aroclor 5460 (100%)
35 lbs.	3-4 Sec. Ethyl Cellulose (100%), Specification RM-4
70 lbs.	1/4 Sec. R.S. Nitrocellulose (70%), Specification RM-1

[redacted]

5 gallons	No. 1 Ethyl Alcohol
5 gallons	Ethyl Acetate, Specification RM-50
15 gallons	Butyl Alcohol, Specification RM-44
25 gallons	Butyl Acetate, Specification RM-52
17 gallons	Toluene, Specification RM-111
0 to 1/4 gallon maximum	Drier, Specification RM-120

F-6. Inspection and Test of Standard Formula - Product Material which has been previously approved and is offered as being in strict compliance with the standard formula is required to be tested and reported only in respect to the physical properties listed below, provided the Government Inspector is satisfied by process inspection that the specified ingredients of proper quality have been used throughout and that they have been properly combined in the required proportions.

1. Solids Content.
2. Viscosity in Poises Absolute at 25°C.
3. Weight per Gallon.
4. Drying Time and Print Resistance.
5. Color and Gloss.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging, Packing, and Marking - Shall be in accordance with Specification ST-15.

G-2. Marking - Individual cans or containers shall be labeled to carry the following information:

(Manufacturer's Name)
LACQUER, NON-SPECULAR (Color)
Navy Aeronautical Specification
Manufacturer's Formula No. _____
Manufacturer's Batch No. _____
Net Quantity _____
Contract No. _____
Date of Manufacture _____
Thinning Directions - For spraying or brushing reduce as required with Specification T-25 thinner. For improved brushing flow, thin with Specification T-29 thinner.

H. NOTES.

H-1. Use - This product is intended for use as an exterior protective coating for metal, to be applied over Zinc Chromate primer, Specification P-27. It may also be used for insignia and marking purposes on fabric.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C. (77°F.). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. Approval Procedure -

H-3a. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. Approval samples, together with ingredient samples, related test reports, and exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Philadelphia, Pennsylvania. It is to be understood that the manufacturers shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturers for additional tests only after it has been clearly shown that changes have been made in the product, or its ingredients which are considered sufficient to warrant conducting additional tests.

H-3b. Alternative Approval - In those cases where the manufacturer's reports and exhibits indicate clearly and unmistakably that all of the reported results are bonafide, the Supply Officer, Naval Aircraft Factory, may, at his discretion, approve the product in advance of completion of weather exposure or other government tests for consideration in connection with routine Naval Aircraft Factory proposals. Where it appears to be in the Government's interest because of the extended nature of the tests, such product may also be recommended to the Bureau of Supplies and Accounts as an approved product in advance of the completion of Government tests. Manufacturers are warned that full compliance with all specifications must be properly reported and that abbreviated reports or questionable data are not acceptable.

H-4. Specifications - May be obtained upon application to the Manager, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pennsylvania. When requesting specifications refer to both title and number.

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APPENDIX C

TENTATIVE
NAVY AERONAUTICAL SPECIFICATION
DOPE, NITROCELLULOSE, PIGMENTED, NON-SPECULAR

A. APPLICABLE SPECIFICATIONS

A-1. The following specifications of the issue in effect on date of invitation for bids, shall form a part of this specification and bidders and contractors should provide themselves with the necessary copies:

Navy Department Specifications:

General Specifications for Inspection of Materials	
49C13	Cloth, Airplane, Cotton, Mercerized
52-S-4d	Burnt Sienna

Navy Aeronautical Specifications:

ST-15	Inspection of Organic Protective Coatings for Aircraft
RM-1	Cellulose Nitrate
RM-21	Glycol Sebacate
RM-44	Butyl Alcohol
RM-50	Ethyl Acetate
RM-52	Butyl Acetate
RM-106	Aromatic Petroleum Naphtha
RM-130-5	Antimony Oxide
RM-133-2	Toluidine Red
RM-133-3	Cadmium Red
RM-132-1	Iron Blue
RM-131-1	Carbon Black
T-25	Thinner, Nitrocellulose Dopes and Lacquers
RM-130-6	Titanium Oxide, Chalk Resisting Type

B. GRADE, TYPE AND COLORS

B-1. This specification covers one grade and type of pigmented nitrocellulose dopes in the following colors: Insignia Red, Insignia White, Insignia Blue, Black, Light Gray, and Blue Gray.

C. MATERIAL AND WORKMANSHIP

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the applicable raw material specifications.

C-2. The component ingredients shall be intimately assembled and processed as required to produce products which are stable and not subject to abnormal change with age in sealed containers.

[redacted]

C-3. The pigments shall be finely ground and free from floating or caking in the container.

C-4. The products shall be homogeneous and free from coarse particles when examined under a flexible spatula.

C-5. The workmanship shall be products which are equal in all respects to standard control products conforming to all detail requirements.

D. GENERAL REQUIREMENTS

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Solids -

Color	RM-1 Type II (Dry) Maximum	RM-21 (Dry) Maximum	Pigment (Dry) Minimum	Total Solids of Product Minimum
Insignia Red	56	27	17	16
Insignia White	38	25	37	18
Insignia Blue	45	32	23	17
Black	66	29	5	15
Light Gray	40	26	34	16
Blue Gray	42	24	34	16

E-1b. Thinner -

Ethyl Acetate (RM-50) . . . . . Min. 25.5
Butyl Acetate (RM-52) . . . . . Min. 25.5
Butyl Alcohol (RM-44) . . . . . Min. 12.7
Aromatic Petroleum Naphtha (RM-106 Type I). . . . . Max. 36.3

NOTE: Product will also include the following, introduced only as indicated and only as required:

Ethyl Alcohol (From RM-1) . . . . . Max. 4.7
Toluene (From RM-21) . . . . . Max. 3.7

E-2. Ingredients - Shall conform to all applicable specifications and to the following:

E-2a. Cellulose Nitrate - Shall conform to Navy Aeronautical Specification RM-1, Type II, except that pigments may be dispersed in a lower viscosity nitrocellulose and Type III may be added to bring the average within the range of Type II.

E-2b. Plasticizer - Shall be 100% glycol sebacate.

E-2c. Extender - As needed to match color and gloss but in no case shall extender exceed 25% (by weight) of total pigment.

E-2d. Pigments - The colors shall be pigmented as follows:

Color	Specification
Insignia Red	RM-133-3 Cadmium Red.
Insignia White	RM-130-6 Titanium Oxide Chalk Resisting Type 80%, and RM-130-5 Antimony Oxide 20%, Tinted with RM-132-1 Iron Blue.
Insignia Blue	RM-132-1 Iron Blue 88% and RM-130-4 Titanium Oxide 12%.
Light Gray	RM-130-4 Titanium Dioxide, Burnt Sienna, Carbon Black.
Black	RM-131-1 Carbon Black.
Blue Gray	RM-130-4 Titanium Oxide, RM-132-1 Iron Blue, RM-131-1 Carbon Black, Burnt Sienna.

E-3. Color - Shall match the Navy Aircraft Color Standards.

E-4. Hiding - Shall show the maximum value attainable from complete grinding of pigment.

E-5. Specular Gloss - Shall be as low or lower than that of the Navy Aircraft Color Standard.

NOTE 1: The specular gloss of the standard shall not exceed 5 per mil or 0.5% of the incident light when measured under the following conditions. The specular gloss at 60 degrees is defined as the fraction of incident light energy reflected in the direction of specular (that is, "mirror") reflection when the surface is illuminated by a parallel beam of light at an angle of 60 degrees from the normal to the surface. The incident light shall be of daylight

quality (I.C.I. Illuminant C), and the photometer shall have visual spectral response (I.C.I. 1931 Standard Observer); or any source-photometer combination of equivalent spectral characteristics may be used. Both the incident and reflected light beams shall be substantially parallel, the total angular spread not exceeding 5 degrees in the plane of measurement. The area of surface studied shall be at least 25 millimeters in diameter. Values of specular gloss shall be reported in parts per thousand (abbreviated "per mil"). Specular gloss is conveniently measured by comparing the brightness of the illuminated surface with that of a standard surface similarly illuminated and viewed. Polished black glass of known reflection factor (obtained from known index of refraction by use of Fresnel's equation) may be used as such a secondary standard surface, having specular gloss of approximately 95 per mil at 60 degrees. Measurements made according to A.S.T.M. D523-39T will be acceptable under this specification.

E-6. Acidity - Of vehicle shall not exceed 36 per cent as acetic acid.

E-7. Function Properties - When compared to a standard product formulated in accordance with this specification the dope shall show equivalent application properties, blush resistance, drying time, tautness, smoothness of surface and weather resistance.

F. METHODS OF SAMPLING, INSPECTION AND TEST

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Navy Aeronautical Specification ST-15.

F-2. Analyses and tests shall be conducted and reported by the manufacturer as prescribed by the applicable raw material specifications, Navy Aeronautical Specification ST-15 and Form FM-1.

F-2a. Each batch of the product shall be reported analytically and quantitatively with suitable accuracy for each of the following properties:

1 Solids Content
2 Pigment Content
3 Viscosity in poises absolute at 25°C
4 Weight per gallon at 25°C
5 Acidity of Vehicle as Acetic Acid
6 Volatile Distillation of Vehicle
7 Refractive Index of Vehicle at 25°C
8 Color Match, Hiding and Gloss (Submit Exhibit)

[redacted]

F-2b. Provided only that the selection of test batches is made by the Government Inspector, one out of each five batches or fraction thereof may be considered sufficient for complete tests. Each batch, however, shall be tested and reported for the following:

1 Solids Content
2 Viscosity in poises absolute at 25°C
3 Weight per Gallon at 25°C
4 Color Match, Hiding and Gloss (Submit Exhibit)

F-3. The manufacturer shall submit on a typewritten sheet or sheets supplementing Form FM-1 a complete extraction of data from his batch production card or cards, indicating which batch or batches each record applies to. These data shall be submitted in the units of weight or volume measure as used on the card and employed by the plant, and shall include a statement of the theoretical yield of the batch.

F-4. Government tests as required shall be conducted in accordance with the detail procedure of Navy Aeronautical Specification ST-15 as follows:

F-4a. Check conformance of product and ingredients with the manufacturer's FM-1 data and specification requirements.

F-4b. Determine equivalent functional properties as compared to a standard product formulated in accordance with this specification.

F-4c. Determine equivalent solids and volatile composition, ash content, film tensile strength and film elongation as compared to a standard product formulated in accordance with this specification.

G. PACKAGING, PACKING AND MARKING FOR SHIPMENT

G-1. Packaging, Packing and Marking - Shall be in accordance with Navy Aeronautical Specification ST-15.

G-2. Labeling - Individual cans or containers shall be labeled to carry the following information:

Manufacturer's Name
DOPE, NITROCELLULOSE, PIGMENTED (COLOR) NON-SPECULAR
Navy Aeronautical Specification_____
Batch Number _____
Net Quantity _____
Contract Number _____
Date of Manufacture _____

THINNING DIRECTIONS - Thinning is normally not required. When required use thinner, Navy Aeronautical Specification T-25. The reduction should be such that by the method of application employed a two coat application will deposit a film ranging in weight between 1.75 and 2.25 ounces per square yard.

H. NOTES

H-1. This product is intended for use as the top coat on airplane fabric surfaces which have previously been treated with D15d clear and D16d pigmented dopes.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C (77°F). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. These tests will be conducted at the expense of the manufacturer in accordance with a schedule which will be supplied upon application to the Manager, Naval Aircraft Factory, Navy Yard, Philadelphia, Pennsylvania. Approval samples together with related test reports and exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Navy Yard, Philadelphia, Pennsylvania. It is to be understood that the manufacturer shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product or its ingredients which are considered sufficient to warrant additional tests.

H-4. Specifications - When requesting specifications, refer to both title and number.

H-4a. Navy Aeronautical Specifications are aeronautical material and process specifications, issued under the cognizance of the Bureau of Aeronautics which have not been adopted either initially or in their current revised form as Navy Department Leaflet Specifications. These include approved specifications prepared by the Naval Aircraft Factory, and specifications prepared by this Bureau which were formerly designated "Tentative Navy Department Specifications." Copies of these specifications, process specifications and FM-1 forms may be obtained upon application to the Naval Aircraft Factory, Navy Yard, Philadelphia, Pennsylvania, or to the Bureau of Aeronautics, Navy Department, Washington, D. C.

H-4b. Copies of Navy Department leaflet specifications and any other specifications forming a part thereof, may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., except that Naval Activities should make application to the Commandant, Navy Yard, New York.

[redacted]

APPENDIX D

TENTATIVE
NAVY AERONAUTICAL SPECIFICATION
PAINT CAMOUFLAGE, SINGLE MISSION, BLACK

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids shall form a part of this specification and bidders and contractors should provide themselves with the necessary copies.

A-1a. Navy Department Specifications:

General Specifications for Inspection of Materials

A-1b. Navy Aeronautical Specifications:

ST-15	Inspection of Organic Protective Coatings for Aircraft.
D-15c	Dope, Nitrocellulose, Clear
D-16d	Dope, Nitrocellulose, Pigmented
E-5d	Enamel, Glyceryl Phthalate, Aircraft
M-485	Lacquer, Non-Specular
M-498	Dope, Non-Specular, Pigmented
P-27b	Primer, Zinc Chromate, Naval Aircraft
RM-44	Butanol

A-1c. Navy Department Specification:

51-G-1d Glycerin

A-1d. Federal Specification:

C-G-451 Glue, Animal, Granular, White, Grade J2.

B. GRADE, TYPE, AND COLORS.

B-1. This specification covers one grade and type of a pigmented, black, non-specular removable finish for the camouflage of aircraft during a single mission flight.

C. MATERIAL AND WORKMANSHIP.

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the approved and applicable raw material specifications.

C-2. The component ingredients shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

[redacted]

C-3. The pigment shall be finely ground and free from floating or caking in the container.

C-4. The product shall be homogeneous and free from coarse particles when examined under a flexible spatula.

C-5. The product conforming to this specification shall be designed for temporary use over Dope, Nitrocellulose, Clear and Pigmented, Specifications D-15 and D-16; Dope, Non-Specular, Pigmented, Specification M-498, Enamel Glyceryl Phthalate, Aircraft Specification E-5; Lacquer, Non-Specular, Specification M-485; and removal shall be effected without impairing or affecting these permanent finishes.

D. GENERAL REQUIREMENTS.

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS.

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product -

Non-volatile, minimum	19%
Volatile, maximum	81%

E-1b. Non-Volatile - The ratio of pigment (including extender) to binder shall not exceed 200%.

E-1c. Volatile - The volatile shall be 96% water.

E-2. Ingredients - All ingredients in the manufacture of this product shall comply with the requirements of Section C and also of the following:

E-2a. Binder and Modifying Agents - Animal glue, granular, white, Federal Specification C-G-451, Grade J2. This binder shall be modified as required to obtain the specified properties of the product. The type of modifying agents shall be indicated.

E-2b. Mold Preventative - The paint shall have incorporated therein a mold preventative agent.

E-2c. Pigment - The pigment shall consist of carbon black, Navy Aeronautical Specification RM-131-1b.

E-2d. Extender - Shall be added as required to meet requirements of color and gloss.

E-3. Physical Properties.

[redacted]

E-3a. Appearance - Shall be uniform, homogeneous and free from bubbles. There shall be no rough particles or separation of the pigments.

E-3b. Coarse Particles - Shall not exceed 0.1% by weight, retained on a number 325 screen.

E-3c. Weight per Gallon - At 25°C (77°F) shall not be less than 9.0 pounds.

E-3d. Water Soluble Material - The pigments shall be insoluble in water. The filtrate from a water mixture shall contain only such soluble adhesives as may be present.

E-4. Application Properties.

E-4a. Working Properties - When applied by spray, it shall be a freely working product. When applied by brush or sponge it shall show flowing and leveling properties equal to the standard product.

E-5a. Drying Properties - The film shall dry in not more than forty minutes when applied over lacquered or doped surfaces.

E-5b. Surface Appearance - The film, upon drying, shall be free from blisters, bubbles, silking and other irregularities of surface.

E-6. Film Properties.

E-6a. Color - Shall match the standard Navy non-specular Black.

E-6b. Gloss - The specular gloss shall not exceed 2 per mil when measured in accordance with the method described in Navy Aeronautical Specification M-485.

E-6c. Adhesion - The dried film shall not brush off when applied to a clean smooth surface of doped fabric, lacquered metal surface, or clean unpainted metal surface. A sprayed film that has dried for six hours at room temperature shall withstand for one hour a blast of cold water (18°C) emerging from a 3/8" nozzle under 35 pounds/sq. inch pressure and striking the panel at an angle of 45°. The panel shall be placed six inches below the nozzle and the streaming water shall be directed vertically down. At the end of this test the panel shall be uniformly covered with no washed out holes appearing in the film.

E-6d. Removal - Complete removal of the film shall be effected by rubbing the coated surface with a soft brush or sponge and warm water. Any residual stain adhering to non-specular lacquer M-485 white or light gray shall be removed by gentle scrubbing with a mild soap solution. Organic or strongly alkaline solvents are to be avoided.

E-6e. Surface Tension - The paint shall have incorporated therein a constituent capable of reducing the surface tension so that it will form a smooth continuous film when applied over surfaces not thoroughly cleansed from oil and grease.

[redacted]

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Specification ST-15.

F-2. Analyses and Tests.

F-2a. Shall be conducted on a comparative basis to a properly manufactured standard product and reported by the manufacturer as prescribed by Specification ST-15, the Applicable Raw Material Specifications, and Form No. FM-1. Manufacturers are advised to follow these instructions.

F-2b. Tests and Analyses to determine conformance with paragraphs in Section E shall be made on the packaged material.

F-2c. Metal panels which have been coated with light gray non-specular lacquer, Navy Aeronautical Specification M-485 over Zinc Chromate primer, P-27b, shall be used for these tests. Aluminum alloy panels are preferable.

F-3. Reports and Exhibits.

F-3a. The manufacturer shall report quantitatively where applicable and in the units or form specified, the results of all tests for the requirements of paragraphs in Section E.

F-3b. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the requirements in Section E headed "Application Properties," "Drying Properties," and "Film Properties."

F-4. Manufacturer's Formula - The manufacturer shall submit in appropriate manner a complete extraction of his batch production data in form, arrangement, and yield to be strictly comparable to the standard formula, including name, code, and source of each ingredient and the ingredient specification on which procurement of each ingredient is to be made and inspected. These data shall be approved by the Naval Aircraft Factory or the Bureau of Aeronautics. An exact copy of the approved formula shall be available for the Government Inspector at time of plant inspection. Approval of the formula does not constitute approval of the manufactured product. The formula may be disapproved if it is considered unsuited to the performance requirements, or if it contains an objectionable ingredient. Manufacturers are encouraged to submit alternative formulas which will show definite improvement in performance as compared to the standard.

F-5. Standard Formula on the basis of a 100-gallon yield is as follows:

51.5 lbs.	Glue, animal, granular, white, Federal Specification C-G 451, Grade J2.
34.3 lbs.	Carbon black, RM-131-1b.
68.6 lbs.	Diatomaceous silica (dicalite white filler, celite, 165-S, etc.)
85.5 gals.	Water.
2-1/8 gals.	Glycerin, Navy Specification 51G-1d.
1-1/4 lbs.	Camphor
2-1/8 gals.	Butanol, RM-44.

F-6. Inspection and Test of Standard Formula - Product Material which has been previously approved and is offered as being in strict compliance with the standard formula is required to be tested and reported only in respect to the physical properties listed below, provided the Government Inspector is satisfied by process inspection that the specified ingredients of proper quality have been used throughout and that they have been properly combined in the required proportions.

1. Solids Content
2. Weights per Gallon
3. Drying Time

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging, Packing, and Marking - Shall be in accordance with Specification ST-15.

G-2. Marking - Individual cans or containers shall be labeled to carry the following information:

(Manufacturer's Name)
SINGLE MISSION CAMOUFLAGE BLACK PAINT
Navy Aeronautical Specification _____
Manufacturer's Formula Number _____
Manufacturer's Batch Number _____
Net Quantity _____
Contract Number _____
Date of Manufacture _____
Thinning Directions - For brushing or spraying reduce with water as required.

H. NOTES.

H-1. This product is to be used as a single mission camouflage coating for aircraft. It is to be applied over the lacquer, with which Naval Aircraft are finished. The product shall be capable of being easily removed from the lacquer finish 18 to 36 hours after its application without producing any noticeable effect on the lacquer film.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C (77°F). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. Approval Procedure -

H-3a. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. Approval samples, together with ingredient samples, related test reports, and

exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Philadelphia, Pennsylvania. It is to be understood that the manufacturers shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturers for additional tests only after it has been clearly shown that changes have been made in the product or its ingredients which are considered sufficient to warrant conducting additional tests.

H-3b. Alternative Approval - In those cases where the manufacturer's reports and exhibits indicate clearly and unmistakably that all of the reported results are bonafide, the Supply Officer, Naval Aircraft Factory, may, at his discretion, approve the product in advance of completion of exposure or other government tests for consideration in connection with routine Naval Aircraft Factory proposals. Where it appears to be in the Government's interest because of the extended nature of the tests, such product may also be recommended to the Bureau of Supplies and Accounts as an approved product in advance of the completion of Government tests. Manufacturers are warned that full compliance with all specifications must be properly reported and that abbreviated reports or questionable data are not acceptable.

H-4. Specifications - May be obtained upon application to the Manager, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pennsylvania. When requesting specifications refer to both title and number.

APPENDIX E

TENTATIVE
NAVY AERONAUTICAL SPECIFICATION
LACQUER CAMOUFLAGE, SINGLE MISSION, BLACK (REMOVABLE)

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids shall form a part of this specification and bidders and contractors should provide themselves with the necessary copies.

A-1a. Navy Department Specifications:

General Specifications for Inspection of Materials

A-1b. Navy Aeronautical Specifications:

ST-15	Inspection of Organic Protective Coatings for Aircraft.
D-15c	Dope, Nitrocellulose, Clear
D-16d	Dope, Nitrocellulose, Pigmented
E-5d	Enamel, Glyceryl Phthalate, Aircraft
M-485	Lacquer, Non-Specular
M-498	Dope, Non-Specular, Pigmented
P-27b	Primer, Zinc Chromate, Naval Aircraft

B. GRADE, TYPE, AND COLORS.

B-1. This specification covers one grade and type of a pigmented, black, non-specular removable lacquer for the camouflage of aircraft during a single mission flight.

C. MATERIAL AND WORKMANSHIP.

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the approved and applicable raw material specifications.

C-2. The component ingredients shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-3. The pigment shall be finely ground and free from floating or caking in the container.

C-4. The product shall be homogeneous and free from coarse particles when examined under a flexible spatula.

C-5. The product conforming to this specification shall be designed for temporary use over Dope, Nitrocellulose, Clear and Pigmented, Specifica-

tions D-15 and D-16; Dope, Non-Specular, Pigmented, Specification M-498, Enamel Glyceryl Phthalate, Aircraft Specification E-5; Lacquer, Non-Specular, Specification M-485; and removal shall be effected without impairing or affecting these permanent finishes.

D. GENERAL REQUIREMENTS.

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS.

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product -

Non-volatile, minimum	40%
Volatile, maximum	80%

E-1b. Non-Volatile - The ratio of pigment (including extender) to binder shall not exceed 60%.

E-1c. Volatile - The volatile shall be as follows:

Ethyl alcohol, minimum	90%
Water, maximum	10%

E-2. Ingredients - All ingredients in the manufacture of this product shall comply with the requirements of Section C and also of the following:

E-2a. Binder and Modifying Agents - The binder shall consist of a resin soluble in ethyl alcohol, into which may be incorporated necessary plasticizers to give required properties.

E-2b. Pigment - The pigment shall consist of carbon black, Navy Aeronautical Specification RM-131-1b.

E-2c. Extender - Shall be added as required to meet requirements of color and gloss.

E-3. Physical Properties.

E-3a. Appearance - Shall be uniform, homogeneous and free from bubbles. There shall be no rough particles or separation of the pigments.

E-3b. Coarse Particles - Shall not exceed 0.1% by weight, retained on a number 325 screen.

E-3c. Weight per Gallon - At 25°C (77°F) shall not be less than 7.5 pounds.

E-3d. Water Soluble Material - The pigments shall be insoluble in water.

E-3e. Viscosity - The packaged material when reduced with equal parts of ethyl alcohol shall have a viscosity of not less than 0.5 poise absolute nor more than 1.75 poises absolute at 25°C.

E-4. Application Properties.

E-4a. Working Properties - When applied by spray, it shall be a freely working product. When applied by brush or sponge it shall show flowing and leveling properties equal to the standard product.

E-5a. Drying Properties - The film shall dry dust free in not more than ten minutes when applied over lacquered or doped surfaces.

E-5b. Surface Appearance - The film, upon drying, shall be free from blisters, bubbles, silking and other irregularities of surface.

E-6. Film Properties.

E-6a. Color - Shall match the standard Navy non-specular Black.

E-6b. Gloss - The specular gloss shall not exceed 2 per mil when measured in accordance with the method described in Navy Aeronautical Specification M-485.

E-6c. Baking Properties - A flow-out film, air dried 16 hours and baked at 80 to 85°C (175 to 185°F) for two hours, shall be hard, tough, smooth and free from all defects such as checking, wrinkling, and dulling.

E-6d. Cold Cracking - The film on the baked panel above shall withstand a bend test of 180° around a 3/16" rod at 0°C (32°F).

E-6e. Removal - Shall be accomplished by the use of a 50% mixture of ethyl alcohol and water.

E-6f. Hiding - When reduced 100% with ethyl alcohol complete coverage by one spray coat shall be obtained over D-16 orange dope or L-12 orange yellow lacquer.

E-6g. Metal Anchorage - The product shall show satisfactory adhesion to unprimed, anodized aluminum and after air-drying 24 hours shall withstand a bend of 180° over a 3/16" mandrel.

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Sampling by the manufacturer and by the Government Inspector shall in accordance with Specification ST-15.

F-2. Analyses and Tests.

[redacted]

F-2a. Shall be conducted on a comparative basis to a properly manufactured standard product and reported by the manufacturer as prescribed by Specification ST-15, the Applicable Raw Material Specifications, and Form No. FM-1. Manufacturers are advised to follow these instructions.

F-2b. Tests and Analyses to determine conformance with paragraphs in Section E shall be made on the packaged material.

F-2c. Metal panels which have been coated with light gray non-specular lacquer, Navy Aeronautical Specification M-485 over Zinc Chromate primer, P-27b, shall be used for these tests. Aluminum alloy panels are preferable.

F-3. Reports and Exhibits.

F-3a. The manufacturer shall report quantitatively where applicable and in the units or form specified, the results of all tests for the requirements of paragraphs in Section E.

F-3b. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the requirements in Section E headed "Application Properties," "Drying Properties," and "Film Properties."

F-4. Manufacturer's Formula - The manufacturer shall submit in appropriate manner a complete extraction of his batch production data in form, arrangement, and yield to be strictly comparable to a standard formula, including name, code, and source of each ingredient and the ingredient specification on which procurement of each ingredient is to be made and inspected. These data shall be approved by the Naval Aircraft Factory or the Bureau of Aeronautics. An exact copy of the approved formula shall be available for the Government Inspector at time of plant inspection. Approval of the formula does not constitute approval of the manufactured product. The formula may be disapproved if it is considered unsuited to the performance requirements, or if it contains an objectionable ingredient. Manufacturers are encouraged to submit alternative formulas which will show definite improvement in performance.

F-5. Inspection and Test Formula - Product Material which has been previously approved and is offered as being in strict compliance with the acceptable formula is required to be tested and reported only in respect to the physical properties listed below, provided the Government Inspector is satisfied by process inspection that the specified ingredients of proper quality have been used throughout and that they have been properly combined in the required proportions.

1. Solids Content
2. Weights per Gallon
3. Drying Time

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging, Packing, and Marking - Shall be in accordance with Specification ST-15.

G-2. Marking - Individual cans or containers shall be labeled to carry the following information:

(Manufacturer's Name)
LACQUER, CAMOUFLAGE, SINGLE MISSION BLACK (REMOVABLE)
Navy Aeronautical Specification _____
Manufacturer's Formula Number _____
Manufacturer's Batch Number _____
Net Quantity _____
Contract Number _____
Date of Manufacture _____
Thinning Directions - For brushing or spraying reduce with alcohol as required.

H. NOTES.

H-1. This product is to be used as a single mission camouflage coating for aircraft. It is to be applied over the lacquer with which Naval aircraft are finished. The product shall be capable of being easily removed from the lacquer finish 18 to 36 hours after its application without producing any noticeable effect on the lacquer film.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C (77°F). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. Approval Procedure.

H-3a. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. Approval samples, together with ingredient samples, related test reports, and exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Philadelphia, Pennsylvania. It is to be understood that the manufacturers shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturers for additional tests only after it has been clearly shown that changes have been made in the product, or its ingredients, which are considered sufficient to warrant conducting additional tests.

H-3b. Alternative Approval - In those cases where the manufacturer's reports and exhibits indicate clearly and unmistakably that all of the reported results are bonafide, the Supply Officer, Naval Aircraft Factory, may, at his discretion, approve the product in advance of completion of exposure or other government tests for consideration in connection with routine Naval Aircraft Factory proposals. Where it appears to be in the Government's interest because of the extended nature of the tests, such product may also
[illegible]d to the Bureau of Supplies and Accounts as an approved product

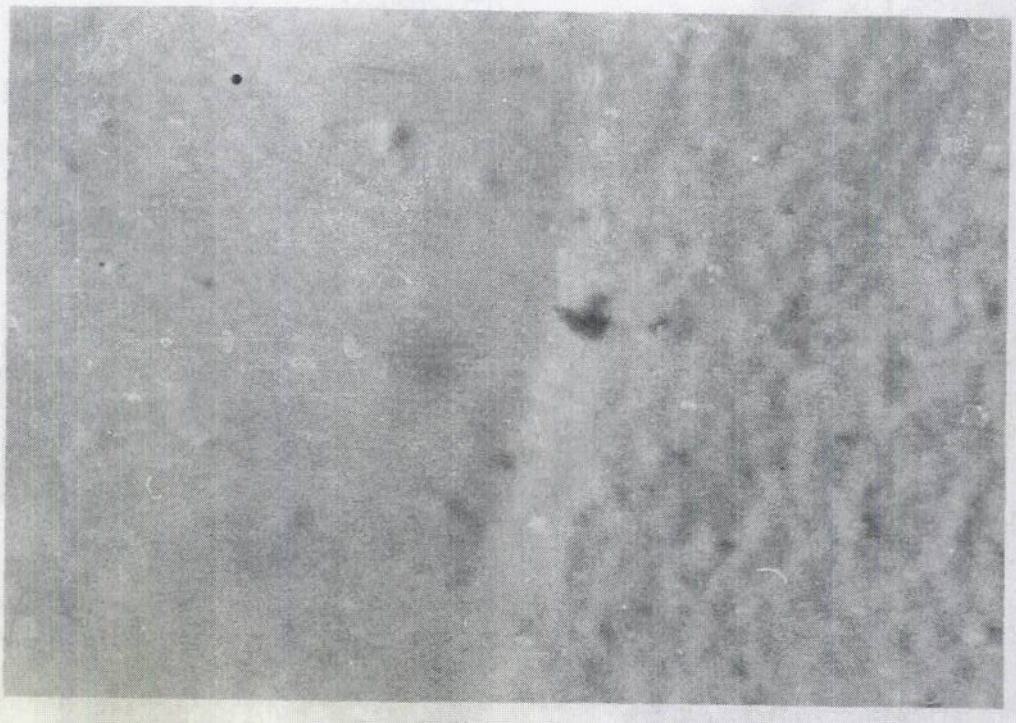

FIG. 1

FIG. 2

PLATE I

FIG. 1

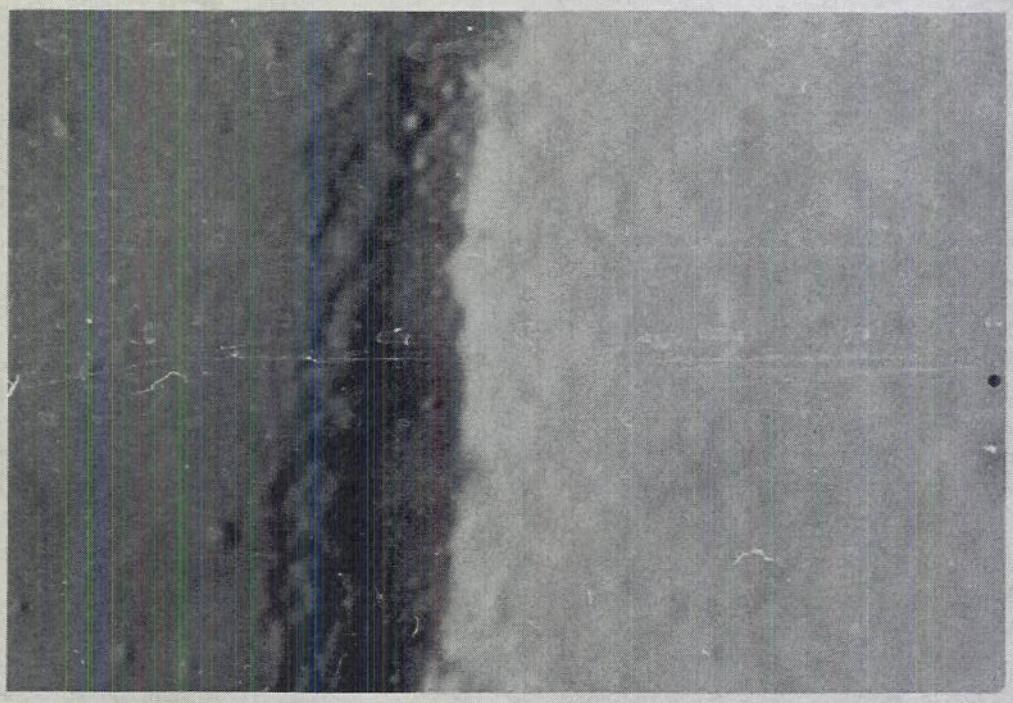

FIG. 2

PLATE 2

FIG. 1

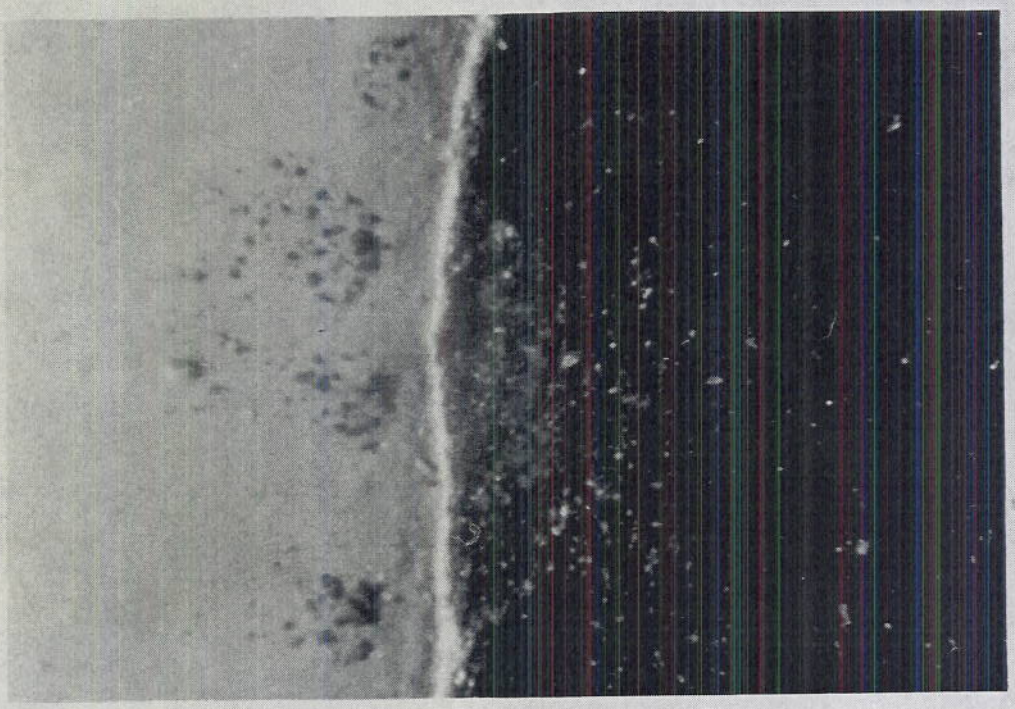

FIG. 2

PLATE 3

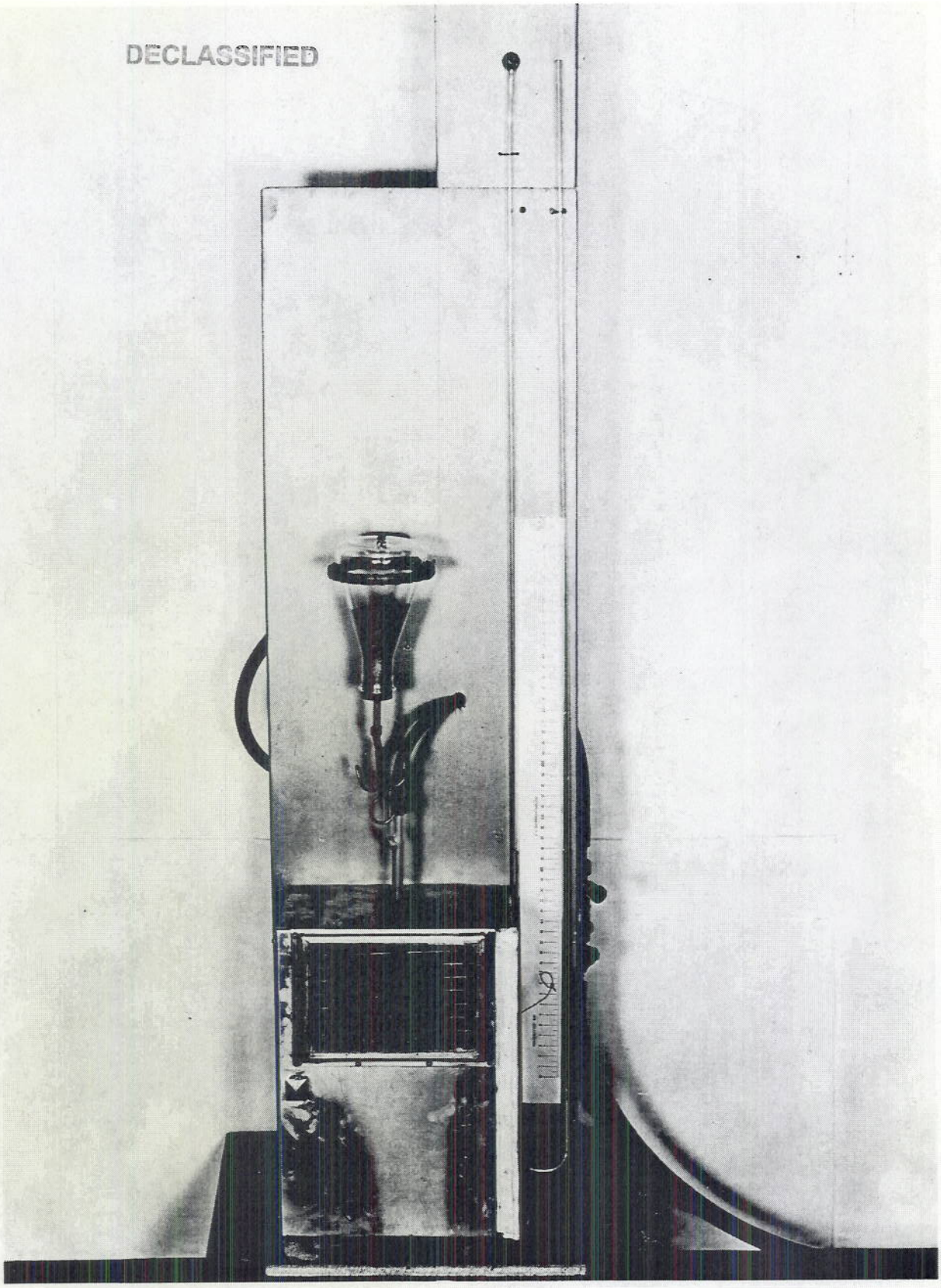

PLATE 4

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APPENDIX B

TENTATIVE

NAVY AERONAUTICAL SPECIFICATIONS, LACQUER
HIGH RESIN PHTHALATE, NON-SPECULAR

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids form part of this specification, and bidders and contractors should provide themselves with the necessary copies.

A-1a. Navy Department Specifications:

General Specifications for Inspection of Materials.
52-S-4d Burnt Sienna

A-1b. Navy Aeronautical Specifications:

ST-15	Specification for Inspection of Organic Protective Coatings for Aircraft.
RM-1	Cellulose Nitrate.
RM-4	Ethyl Cellulose
RM-21	Glycol Sebacate
RM-44	Butyl Alcohol, Normal
RM-50	Ethyl Acetate
RM-52	Butyl Acetate
RM-111	Toluene (Toluol)
RM-120	Drier Naphthenate
RM-130-5	Antimony Oxide
RM-130-6	Titanium Oxide; Chalk Resisting Type
RM-131-1	Carbon Black
RM-132-1	Iron Blue
RM-133-2	Toluidine Red
RM-133-3	Cadmium Red
T-25-d	Thinner, Nitrocellulose Dopes and Lacquers
T-29	Thinner, Nitrocellulose Dopes and Lacquers, Blush Retarding
P-27-b2	Primer, Zinc Chromate

A-1c. Federal Specification:

TT-B-601	Bone-Black; Dry, Paste-In-Japan, Paste-In-Oil

B. GRADE, TYPE, AND COLORS.

This specification covers one grade and type of a nitro-cellulose, high resin glyceryl phthalate type non-specular lacquer in the following colors: Insignia Red, Insignia White, Insignia Blue, Black, Light Gray, and Blue Gray.

C. MATERIAL AND WORKMANSHIP

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the applicable raw material specifications.

C-2. The glyceral phthalate resin composition shall be made of first quality and uniform raw materials whose chemical union shall be accurately controlled by means of adequate manufacturing equipment and testing methods.

C-3. The component raw materials shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-4. The pigments shall be finely ground and free from floating or caking in the container.

C-5. The products shall be free from toxic ingredients and rosin or rosin derivatives.

C-6. All products conforming to this specification shall be designed for use with zinc chromate primer, Specification P-27, in accordance with the standard formula.

D. GENERAL REQUIREMENTS

D-1. There are no general requirements for this specification.

E. DETAIL REQUIREMENTS

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product -

Non-Volatile.	Min. 60
Volatile.	Max. 40

E-1b. Non-Volatile -

Vehicle.	Min. 28
Pigment.	Max. 72

E-1c. Volatile -

Hydrocarbon solvents . .	100

E-1d. Vehicle -

Resin.	100

[redacted]

E-2. Ingredients - Shall conform to the above and also to the following:

E-2a. Resin - Shall be a glyceral phthalate type, showing not less than 31% phthalic anhydride quantitative, free from rosin and rosin derivatives.

E-2b. Driers - Shall conform to Specification RM-120 and added as required to obtain the specified drying and baking properties with a high degree of package stability.

E-2c. Volatile - Shall be entirely of hydrocarbon solvents having the following distillation characteristics:

Initial Point. . . . Min. 120°C. (248°F.)
50% Fraction . . . . Min. 160°C. (320°F.)
End Point. . . . . Max. 207°C. (404°F.)

E-2d. Extender - As needed to match color and gloss but in no case shall extender exceed 25% of total pigment.

E-2e. Pigments - The colors shall be pigmented as follows; the pigments shall meet the appropriate specifications of Section A-1b.

Insignia Red	- Cadmium or Toluidine Red
Insignia White	- Titanium Oxide and Antimony Oxide tinted with Iron Blue
Insignia Blue	- Iron Blue 88% and 12% of a mixture of Titanium and Antimony Oxide
Blue Gray	- Iron Blue, a mixture of Titanium Oxide and Antimony Oxide, Carbon Black, and Burnt Sienna
Light Gray	- Titanium Oxide, Carbon Black, Burnt Sienna
Black	- Carbon Black

NOTE: Where mixtures of Titanium Oxide and Antimony Oxide are specified, the total amount of Antimony Oxide shall not exceed 50% of the mixture.

E-3. Appearance - Shall be uniform, homogeneous and free from bubbles. There shall be no trace of grit, rough particles or separation of pigments.

[redacted]

E-4. Odor - Shall be normal for the volatiles permitted by the specification. The film shall retain no residual odor 48 hours after application.

E-5. Viscosity - The viscosity of the package material shall be reported.

E-6. Weight per Gallon - At 25°C. (77°F.) shall be not less than 9.50 pounds.

E-7. Moisture Content - Shall not exceed 0.1 per cent by weight.

E-8. Flash Point - Shall be not less than 27°C. (80°F.).

E-9. Dilution Stability - The product shall remain stable after a reduction of 1 part of mineral spirits, Specification RM-103, to 2 parts of package material.

E-10. Skinning - Shall be absent in a partly filled closed container after 48 hours.

E-11. Application Properties.

E-11a. Working Properties - When applied by spraying, it shall be a freely working product with acceptable leveling properties.

E-11b. Self-Lifting Properties - Recoating by spray after 2, 6, and 18 hours shall produce no film irregularity.

E-11c. Smoothness - A full wet spray coat, after drying, shall appear as smooth and free from rough particles as a standard control product when examined under a minimum magnification of 15 diameters.

E-12. Drying Properties -

E-12a. Drying Time - A medium spray coat shall air-dry to touch in not more than 10 minutes and dry firm and hard in not more than 6 hours, when applied over a standard primer.

E-12b. Surface Appearance - The film upon drying shall be free from streaks, blisters, silking or other irregularities of surface.

E-13. Color and Gloss.

E-13a. Color - When applied to a glass panel and allowed to dry, it shall match the standard color cards.

E-13b. Specular Gloss - Shall be as low or lower than the standard.

Note: The specular gloss of the standard shall not exceed 5 per mil when measured under the following conditions. The specular gloss at

[redacted]

60 degrees is defined as the fraction of incident light energy reflected in the direction of specular (that is, "mirror") reflection when the surface is illuminated by a parallel beam of light at an angle of 60 degrees from the normal to the surface. The incident light shall be of daylight quality (I.C.I. Illuminant C), and the photometer shall have visual spectral response (I.C.I. 1931 Standard Observer); or any source-photometer combination of equivalent spectral characteristics may be used. Both the incident and reflected light beams shall be substantially parallel, the total angular spread not exceeding 5 degrees in the plane of measurement. The area of surface studied shall be at least 25 millimeters in diameter. Values of specular gloss shall be reported in parts per thousand (abbreviated "per mil"). Specular gloss is conveniently measured by comparing the brightness of the illuminated surface with that of a standard surface similarly illuminated and viewed. Polished black glass of known reflection factor (obtained from known index of refraction by use of Fresnel's equation) may be used as such a secondary standard surface, having specular gloss of approximately 95 per mil at 60 degrees. Measurements made according to A.S.T.M. D523-39T will be acceptable under this specification.

E-14. Baking Properties - A flow-out film, air dried 16 hours and baked at 80 to 85°C. (176 to 185°F.) for 2 hours, shall be hard, tough, smooth and free from all defects such as checking, wrinkling and dulling. The baked film shall show no appreciable discoloration.

E-15. Cold Cracking - The film on the baked panel above shall withstand a bend test of 180° around a 3/16-inch rod at 0°C. (32°F.).

E-16. Coating Anchorage - A spray coat over baked primer shall show satisfactory anchorage of the top coat after drying hard.

E-17. Water Resistance (Cold) - A flow-out film, air dried 24 hours, shall withstand immersion in water at room temperature for 48 hours. It shall show no checking, blistering, appreciable whitening and only a very slight dulling when observed 5 minutes after removal. The film on the immersed side shall be equal in hardness, toughness, gloss and anchorage to the film on the emersed side, 3 hours after removal.

E-18. Gasoline Resistance - A flow-out film, air dried 24 hours, shall withstand immersion in lead free gasoline at room temperature for 24 hours; 1 hour after removal the film shall be equal in hardness, toughness, gloss and anchorage to the film of a similarly prepared panel which has not been subjected to gasoline.

E-19. Weather Resistance - The weather resistance shall be equal to and the discoloration shall be no greater than that of a standard control product when tested on a comparative basis in sub-tropical climate for a period of one year.

F. METHODS OF SAMPLING, INSPECTION AND TEST

F-1. Sampling by the government inspector and manufacturer shall be in accordance with Specification ST-15.

F-2. Analysis and Test.

F-2a. Shall be conducted and reported by the manufacturer as prescribed by Specification ST-15. Manufacturers are advised to follow these instructions carefully.

F-2b. All tests for the requirements of paragraphs E-1 to E-10, inclusive, shall be made on package material. All tests for the requirements of paragraphs E-11 to E-19, inclusive, shall be made with material reduced to application viscosity.

F-2c. Alclad panels shall be used for test unless otherwise specified.

F-2d. All required tests which are not specifically described in this section shall be conducted in accordance with applicable methods specified in Specification ST-15.

F-3. Reports of Tests

F-3a. The paint manufacturer shall furnish test reports in duplicate, certified by a responsible officer of the company, by affidavit, showing quantitative results for all tests and analysis required by this specification and signed by the director of the laboratory in which the tests were conducted.

These reports shall also certify the source and source identification code numbers of each ingredient used. When inspection is conducted at the contractor's plant, these reports shall be furnished to the inspector.

F-3b. The paint manufacturer shall report quantitatively, in the units and forms specified, the results of his tests for non-volatile content, viscosity, weight per gallon and moisture content.

F-3c. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the

requirements for color and gloss, cold cracking, and water and gasoline resistance.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT

G-1. Packaging and Packing - The product shall be packed in suitable commercial packages containing the quantity specified by the purchase order or contract.

G-2. Marking - The following information shall appear on all containers:

Name of Paint Manufacturer
Enamel: Glyceral Phthalate, Non-Specular
Specification:
Manufacturer's Formula #
Manufacturer's Batch #
Date of Manufacture
Net Quantity Contained
Government Order # (or Contract #, if Order # is not assigned)
Thinning Directions: The paint manufacturer's recommendations shall be given with the code number of the thinner to be used.

Application Directions: This material is for spray application only.

H. REQUIREMENTS APPLICABLE TO INDIVIDUAL DEPARTMENTS

H-1. The following departmental specifications of the issue in effect on date of invitation for bids shall form a part of this specification, applicable to purchases by the agency indicated.

H-1a. Navy - Navy Department General Specifications for Inspection of Material. Copies may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.

I. NOTES

I-1. This product is intended for use as a flat camouflage finish for aircraft.

I-2. Ordering Data - Requisitions, contracts, and orders shall state the size of the containers in which the enamel is to be furnished. The material shall be purchased by volume; the unit being a U. S. Gallon at 25°C. (77°F.). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

I-3. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of manufacturers is called to this requirement

and they are urged to forward samples of the product which they propose to offer to the Navy in future, in order that check tests may be made. These tests shall be conducted at the expense of the manufacturers. It is further to be understood that the manufacturer shall pay all transportation charges to and from the Navy testing laboratories. In the case of failure of the sample submitted to prove satisfactory, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product, or its ingredients which are considered sufficient to warrant additional tests.

I-3a. Any intentional falsification of records or affidavits will automatically remove the paint manufacturer from the approved list for a period of not less than two years.

I-4. Specifications - When requesting specifications refer to both title and number.

I-4a. Copies of this specification may be obtained upon application to the Bureau of Aeronautics, Navy Department, Washington, D. C.

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APPENDIX B

TENTATIVE

NAVY AERONAUTICAL SPECIFICATIONS, LACQUER
HIGH RESIN PHTHALATE, NON-SPECULAR

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids form part of this specification, and bidders and contractors should provide themselves with the necessary copies.

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52-S-4d Burnt Sienna

A-1b. Navy Aeronautical Specifications:

ST-15	Specification for Inspection of Organic Protective Coatings for Aircraft.
RM-1	Cellulose Nitrate.
RM-4	Ethyl Cellulose
RM-21	Glycol Sebacate
RM-44	Butyl Alcohol, Normal
RM-50	Ethyl Acetate
RM-52	Butyl Acetate
RM-111	Toluene (Toluol)
RM-120	Drier Naphthenate
RM-130-5	Antimony Oxide
RM-130-6	Titanium Oxide; Chalk Resisting Type
RM-131-1	Carbon Black
RM-132-1	Iron Blue
RM-133-2	Toluidine Red
RM-133-3	Cadmium Red
T-25-d	Thinner, Nitrocellulose Dopes and Lacquers
T-29	Thinner, Nitrocellulose Dopes and Lacquers, Blush Retarding
P-27-b2	Primer, Zinc Chromate

A-1c. Federal Specification:

TT-B-601	Bone-Black; Dry, Paste-In-Japan, Paste-In-Oil

B. GRADE, TYPE, AND COLORS.

This specification covers one grade and type of a nitro-cellulose, high resin glyceryl phthalate type non-specular lacquer in the following colors: Insignia Red, Insignia White, Insignia Blue, Black, Light Gray, and Blue Gray.

[redacted]

C. MATERIAL AND WORKMANSHIP.

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with approved and applicable raw material specifications.

C-2. The glyceryl phthalate resin composition shall be made of first quality and uniform raw materials whose chemical union shall be accurately controlled by means of adequate manufacturing equipment and testing methods.

C-3. The component raw materials shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-4. The pigments shall be finely ground and free from floating or caking in the container.

C-5. All products conforming to this specification shall be designed for use with Zinc Chromate Primer, Specification P-27, in accordance with the standard formula.

D. GENERAL REQUIREMENTS

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product:

Non-volatile, minimum	45
Volatile, maximum	55

E-1b. Non-volatile - The ratio of nitrocellulose to the remainder of the binder shall not exceed 20% of the total. The pigment to binder ratio will be such as needed to meet requirements of color and gloss.

E-1c. Volatile -

Esters and alcohols	Min. 50
Hydrocarbons	Max. 50

E-2. Ingredients - All ingredients in the manufacture of these products shall comply with the requirements of Section C, also the following:

E-2a. Cellulose Nitrate - Specification RM-1, Types I and II.

E-2b. Ethyl Cellulose - Specification RM-4, Type I.

E-2c. Resin and Modifying Agents - Shall be of a glyceryl phthalate type which may be modified as required to obtain the specified properties of the product. The type of modifying agents shall be indicated.

E-2d. Extender - As needed to match color and gloss, but in no case shall extender exceed 25% of total pigment.

E-2e. Pigments - Shall be as follows and in accordance with all applicable specifications:

Color	Specifications
Insignia Red	Cadmium or Toluidine Red
Insignia White	Titanium Oxide Chalk Resisting Type 4 parts (Type I) and Antimony Oxide 1 part, tinted with Iron Blue.
Insignia Blue	Iron Blue 88% and 12% equal parts Titanium Oxide and Antimony Oxide.
Black	Carbon Black
Light Gray	Titanium Oxide, Burnt Sienna, and Carbon Black
Blue Gray	Iron Blue, Titanium Oxide Chalk Resisting Type, Antimony Oxide, Carbon Black and Burnt Sienna

NOTE 1: Not over 4% of dibutyl phthalate based on pigment by weight may be used as a dispersing agent with Insignia Blue.

NOTE 2: When mixtures of Titanium Oxide and Antimony Oxide are specified, the total amount of Antimony Oxide shall not exceed 50% of the mixture.

E-3. Vehicle Properties -

E-3a. Color - The vehicle for all pigmented colors shall be no darker than 3 L on the Hellige scale.

E-3b. Non-Yellowing - After baking for two hours at 121°C. (250°F.), two dip coats on a glass tube shall be no darker than 6 L on the Hellige scale.

E-3c. Water Resistance - A flow-out film of unreduced vehicle over a spray coat of Specification P-27 primer, air-dried 24 hours, shall with-

stand cold water for 24 hours and boiling water for 10 minutes. It shall show no haze, milky appearance, or other defect when examined 3 hours after removal. Any dulling shall be readily removed by a cloth and water. Boiling water tests shall be conducted on a flow coat on a glass panel after 24 hours air drying.

E-4. Physical Properties -

E-4a. Appearance - Shall be uniform, homogeneous, and free from bubbles. There shall be no trace of grit, rough particles, or separation of pigments.

E-4b. Odor - Shall be normal for the volatiles permitted by the specification. The film shall retain no residual odor 48 hours after application.

E-4c. Coarse Particles - Shall not exceed 0.1 per cent by weight retained on a No. 325 screen.

E-4d. Viscosity - The package viscosity of the lacquer shall be so adjusted that when reduced two volumes of lacquer and one volume of thinner, Specification T-25-d, a viscosity between 1.0 and 1.75 poises at 25 degrees C. (77 degrees F.) is obtained.

E-4e. Weight per Gallon - At 25°C. (77°F.) shall be not less than 7.50 pounds.

E-5. Application Properties (Applied over P-27 primer of standard formula) -

E-5a. Working Properties - When applied by spray, it shall be a freely working product. When applied by brush, it shall show flowing and leveling properties equal to the standard formula product.

E-5b. Self-Lifting Properties - The second coat of lacquer over P-27 primer shall show no lifting after drying intervals of 4, 8, 24, 48, 72, 96 and 168 hours.

E-5c. Smoothness - A full wet spray coat after drying shall appear as smooth and free from rough particles as a standard control product when examined under a minimum magnification of 15 diameters.

E-6. Drying Properties (Applied over a P-27 primer of standard formula).

E-6a. Drying Time - The film shall dry in not more than 40 minutes.

E-6b. Surface Appearance - The film upon drying shall be free from streaks, blisters, silking, or other irregularities of surface.

E-6c. Print Proof - A sprayed film shall show no permanent print from cheesecloth under a pressure of one pound per square inch for one hour

when applied three hours after application of the lacquer, and observed four hours after removal of pressure.

E-7. Film Properties.

E-7a. Color - When applied to a glass panel and allowed to dry it shall match the standard color cards.

E-7b. Specular Gloss - Shall be as low or lower than the standard.

NOTE 1: The specular gloss of the standard shall not exceed 5 per mil when measured under the following conditions. The specular gloss at 60 degrees is defined as the fraction of incident light energy reflected in the direction of specular (that is, "mirror") reflection when the surface is illuminated by a parallel beam of light at an angle of 60 degrees from the normal to the surface. The incident light shall be of daylight quality (I.C.I. Illuminant C), and the photometer shall have visual spectral response (I.C.I. 1931 Standard Observer); or any source-photometer combination of equivalent spectral characteristics may be used. Both the incident and reflected light beams shall be substantially parallel, the total angular spread not exceeding 5 degrees in the plane of measurement. The area of surface studied shall be at least 25 millimeters in diameter. Values of specular gloss shall be reported in parts per thousand (abbreviated "per mil"). Specular gloss is conveniently measured by comparing the brightness of the illuminated surface with that of a standard surface similarly illuminated and viewed. Polished black glass of known reflection factor (obtained from known index of refraction by use of Fresnel's equation) may be used as such a secondary standard surface, having specular gloss of approximately 95 per mil at 60 degrees. Measurements made according to A.S.T.M. D523-39T will be acceptable under this specification.

E-7c. Primer Absorption - The lacquer shall show no tendency to sink into the primer, to change its gloss, or to develop embrittlement through a combination with the primer when compared to a similar metal panel without primer.

E-7d. Flexibility - The baked panel shall withstand the specified cold cracking bend test over a 1/8-inch rod.

E-7e. Metal Anchorage - The primer shall show satisfactory anchorage and adhesion to the metal when examined as specified.

E-7f. Coating Anchorage - The lacquer shall show satisfactory anchorage and adhesion to the primer when examined as specified.

E-7g. Discoloration - The baked film shall show no appreciable color change when compared to an unbaked film.

E-8. Resistance Properties.

E-8a. Water Resistance - A flow-out film on a glass panel, air dried 24 hours, shall withstand immersion in water at room temperature for 24 hours. It shall show no checking, blistering, appreciable whitening, and only a very slight dulling when observed 5 minutes after removal. The film on the immersed side shall be equal in hardness, toughness, gloss, and anchorage to the film on the emersed side, 3 hours after removal.

E-8b. Gasoline Resistance - A flow-out film, air dried 24 hours, shall withstand immersion in lead free gasoline at room temperature for 4 hours; 24 hours after removal the film shall be equal in hardness, toughness, gloss, and anchorage to the film of a similarly prepared standard formula product.

E-8c. Weather Resistance - The weather resistance shall be equal to and the discoloration shall be no greater than that of the standard formula product when tested on a comparative basis. There shall be no premature checking or cracking failure after a period of at least six months.

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Specification ST-15.

F-2. Analyses and Tests.

F-2a. Shall be conducted on a comparative basis to a properly manufactured standard formula product and reported by the manufacturer as prescribed by Specification ST-15, the applicable raw material specifications, and Form No. FM-1. Manufacturers are advised to follow these instructions.

F-2b. Tests and analyses to determine conformance with the paragraphs in Section E headed "Composition," "Ingredients," "Vehicle Properties," and "Physical Properties" shall be made on packaged material. Tests for conformance to the remainder of the Detail Requirements shall be made after thinning with Specification T-25 Thinner to a viscosity of approximately one poise absolute at 25°C. (77°F.).

F-2c. Aluminum alloy panels shall be used for coating application tests, except as otherwise specified. Application of the lacquer shall be over Zinc Chromate Primer, Specification P-27 of standard formula.

F-2d. Prepare color and gloss test panel as specified by Specification ST-15. Prepare necessary panels for testing the remaining requirements of paragraph in Section E headed "Film Properties" using aluminum coated, aluminum alloy sheet (alclad). Apply one full coat of Zinc Chromate Primer, Specification P-27 of standard formula to obtain practically full hiding, dry one hour, apply two coats of the lacquer under test and dry each one hour. Examine a freshly prepared panel for compliance with the Primer Absorption requirement, then place in an oven and bake at 93°C. (200°F.) for 48 hours. After completion of baking, examine for the remaining requirements of "Film Properties" paragraphs of Section E.

F-2e. Self-Lifting Properties - Particular attention shall be given to colors containing titanium oxide.

F-2f. Tests to determine compliance with the Appearance requirement in the "Physical Properties" paragraph of Section E shall be conducted by dipping a glass panel into the lacquer.

F-3. Reports and Exhibits.

F-3a. The manufacturer shall report quantitatively, where applicable, and in the units or form specified, the results of all tests for the requirements of paragraphs in Section E headed "Product" (under Composition), "Vehicle Properties," and "Physical Properties."

F-3b. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the requirements in Section E headed "Application Properties," "Drying Properties," "Film Properties," "Water Resistance," and "Gasoline Resistance" with similar exhibits of the standard control product for direct comparison purposes.

F-4. Manufacturer's Formula - The manufacturer shall submit in appropriate manner a complete extraction of his batch production data in form, arrangement, and yield to be strictly comparable to the standard formula, including name, code, and source of each ingredient and the ingredient specification on which procurement of each ingredient is to be made and inspected. This data shall be approved by the Naval Aircraft Factory or the Bureau of Aeronautics. An exact copy of the approved formula shall be available for the Government Inspector at time of plant inspection. Approval of the formula does not constitute approval of the manufactured product. The formula may be disapproved if it is considered unsuited to the performance requirements, or if it contains an objectionable ingredient. Manufacturers are encouraged to submit alternative formulas which will show definite improvement in performance as compared to the standard.

F-5. Standard Formula of Clear Vehicle - On the basis of a 100 gallon yield is as follows:

150 lbs.	Paraplex RG-2 (60%), Specification RM-21
45 lbs.	Amberlac B-94 (80%)
35 lbs.	Aroclor 5460 (100%)
35 lbs.	3-4 Sec. Ethyl Cellulose (100%), Specification RM-4
70 lbs.	1/4 Sec. R.S. Nitrocellulose (70%), Specification RM-1

5 gallons	No. 1 Ethyl Alcohol
5 gallons	Ethyl Acetate, Specification RM-50
15 gallons	Butyl Alcohol, Specification RM-44
25 gallons	Butyl Acetate, Specification RM-52
17 gallons	Toluene, Specification RM-111
0 to 1/4 gallon maximum	Drier, Specification RM-120

F-6. Inspection and Test of Standard Formula - Product Material which has been previously approved and is offered as being in strict compliance with the standard formula is required to be tested and reported only in respect to the physical properties listed below, provided the Government Inspector is satisfied by process inspection that the specified ingredients of proper quality have been used throughout and that they have been properly combined in the required proportions.

1. Solids Content.
2. Viscosity in Poises Absolute at 25°C.
3. Weight per Gallon.
4. Drying Time and Print Resistance.
5. Color and Gloss.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging, Packing, and Marking - Shall be in accordance with Specification ST-15.

G-2. Marking - Individual cans or containers shall be labeled to carry the following information:

(Manufacturer's Name)
LACQUER, NON-SPECULAR (Color)
Navy Aeronautical Specification
Manufacturer's Formula No. _____
Manufacturer's Batch No. _____
Net Quantity _____
Contract No. _____
Date of Manufacture _____
Thinning Directions - For spraying or brushing reduce as required with Specification T-25 thinner. For improved brushing flow, thin with Specification T-29 thinner.

H. NOTES.

H-1. Use - This product is intended for use as an exterior protective coating for metal, to be applied over Zinc Chromate primer, Specification P-27. It may also be used for insignia and marking purposes on fabric.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C. (77°F.). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. Approval Procedure -

H-3a. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. Approval samples, together with ingredient samples, related test reports, and exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Philadelphia, Pennsylvania. It is to be understood that the manufacturers shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturers for additional tests only after it has been clearly shown that changes have been made in the product, or its ingredients which are considered sufficient to warrant conducting additional tests.

H-3b. Alternative Approval - In those cases where the manufacturer's reports and exhibits indicate clearly and unmistakably that all of the reported results are bonafide, the Supply Officer, Naval Aircraft Factory, may, at his discretion, approve the product in advance of completion of weather exposure or other government tests for consideration in connection with routine Naval Aircraft Factory proposals. Where it appears to be in the Government's interest because of the extended nature of the tests, such product may also be recommended to the Bureau of Supplies and Accounts as an approved product in advance of the completion of Government tests. Manufacturers are warned that full compliance with all specifications must be properly reported and that abbreviated reports or questionable data are not acceptable.

H-4. Specifications - May be obtained upon application to the Manager, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pennsylvania. When requesting specifications refer to both title and number.

APPENDIX C

TENTATIVE
NAVY AERONAUTICAL SPECIFICATION
DOPE, NITROCELLULOSE, PIGMENTED, NON-SPECULAR

A. APPLICABLE SPECIFICATIONS

A-1. The following specifications of the issue in effect on date of invitation for bids, shall form a part of this specification and bidders and contractors should provide themselves with the necessary copies:

Navy Department Specifications:

General Specifications for Inspection of Materials	
49C13	Cloth, Airplane, Cotton, Mercerized
52-S-4d	Burnt Sienna

Navy Aeronautical Specifications:

ST-15	Inspection of Organic Protective Coatings for Aircraft
RM-1	Cellulose Nitrate
RM-21	Glycol Sebacate
RM-44	Butyl Alcohol
RM-50	Ethyl Acetate
RM-52	Butyl Acetate
RM-106	Aromatic Petroleum Naphtha
RM-130-5	Antimony Oxide
RM-133-2	Toluidine Red
RM-133-3	Cadmium Red
RM-132-1	Iron Blue
RM-131-1	Carbon Black
T-25	Thinner, Nitrocellulose Dopes and Lacquers
RM-130-6	Titanium Oxide, Chalk Resisting Type

B. GRADE, TYPE AND COLORS

B-1. This specification covers one grade and type of pigmented nitrocellulose dopes in the following colors: Insignia Red, Insignia White, Insignia Blue, Black, Light Gray, and Blue Gray.

C. MATERIAL AND WORKMANSHIP

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the applicable raw material specifications.

C-2. The component ingredients shall be intimately assembled and processed as required to produce products which are stable and not subject to abnormal change with age in sealed containers.

[redacted]

C-3. The pigments shall be finely ground and free from floating or caking in the container.

C-4. The products shall be homogeneous and free from coarse particles when examined under a flexible spatula.

C-5. The workmanship shall be products which are equal in all respects to standard control products conforming to all detail requirements.

D. GENERAL REQUIREMENTS

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Solids -

Color	RM-1 Type II (Dry) Maximum	RM-21 (Dry) Maximum	Pigment (Dry) Minimum	Total Solids of Product Minimum
Insignia Red	56	27	17	16
Insignia White	38	25	37	18
Insignia Blue	45	32	23	17
Black	66	29	5	15
Light Gray	40	26	34	16
Blue Gray	42	24	34	16

E-1b. Thinner -

Ethyl Acetate (RM-50) . . . . . Min. 25.5
Butyl Acetate (RM-52) . . . . . Min. 25.5
Butyl Alcohol (RM-44) . . . . . Min. 12.7
Aromatic Petroleum Naphtha (RM-106 Type I). . . . . Max. 36.3

NOTE: Product will also include the following, introduced only as indicated and only as required:

Ethyl Alcohol (From RM-1) . . . . . Max. 4.7
Toluene (From RM-21) . . . . . Max. 3.7

E-2. Ingredients - Shall conform to all applicable specifications and to the following:

E-2a. Cellulose Nitrate - Shall conform to Navy Aeronautical Specification RM-1, Type II, except that pigments may be dispersed in a lower viscosity nitrocellulose and Type III may be added to bring the average within the range of Type II.

E-2b. Plasticizer - Shall be 100% glycol sebacate.

E-2c. Extender - As needed to match color and gloss but in no case shall extender exceed 25% (by weight) of total pigment.

E-2d. Pigments - The colors shall be pigmented as follows:

Color	Specification
Insignia Red	RM-133-3 Cadmium Red.
Insignia White	RM-130-6 Titanium Oxide Chalk Resisting Type 80%, and RM-130-5 Antimony Oxide 20%, Tinted with RM-132-1 Iron Blue.
Insignia Blue	RM-132-1 Iron Blue 88% and RM-130-4 Titanium Oxide 12%.
Light Gray	RM-130-4 Titanium Dioxide, Burnt Sienna, Carbon Black.
Black	RM-131-1 Carbon Black.
Blue Gray	RM-130-4 Titanium Oxide, RM-132-1 Iron Blue, RM-131-1 Carbon Black, Burnt Sienna.

E-3. Color - Shall match the Navy Aircraft Color Standards.

E-4. Hiding - Shall show the maximum value attainable from complete grinding of pigment.

E-5. Specular Gloss - Shall be as low or lower than that of the Navy Aircraft Color Standard.

NOTE 1: The specular gloss of the standard shall not exceed 5 per mil or 0.5% of the incident light when measured under the following conditions. The specular gloss at 60 degrees is defined as the fraction of incident light energy reflected in the direction of specular (that is, "mirror") reflection when the surface is illuminated by a parallel beam of light at an angle of 60 degrees from the normal to the surface. The incident light shall be of daylight

quality (I.C.I. Illuminant C), and the photometer shall have visual spectral response (I.C.I. 1931 Standard Observer); or any source-photometer combination of equivalent spectral characteristics may be used. Both the incident and reflected light beams shall be substantially parallel, the total angular spread not exceeding 5 degrees in the plane of measurement. The area of surface studied shall be at least 25 millimeters in diameter. Values of specular gloss shall be reported in parts per thousand (abbreviated "per mil"). Specular gloss is conveniently measured by comparing the brightness of the illuminated surface with that of a standard surface similarly illuminated and viewed. Polished black glass of known reflection factor (obtained from known index of refraction by use of Fresnel's equation) may be used as such a secondary standard surface, having specular gloss of approximately 95 per mil at 60 degrees. Measurements made according to A.S.T.M. D523-39T will be acceptable under this specification.

E-6. Acidity - Of vehicle shall not exceed 36 per cent as acetic acid.

E-7. Function Properties - When compared to a standard product formulated in accordance with this specification the dope shall show equivalent application properties, blush resistance, drying time, tautness, smoothness of surface and weather resistance.

F. METHODS OF SAMPLING, INSPECTION AND TEST

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Navy Aeronautical Specification ST-15.

F-2. Analyses and tests shall be conducted and reported by the manufacturer as prescribed by the applicable raw material specifications, Navy Aeronautical Specification ST-15 and Form FM-1.

F-2a. Each batch of the product shall be reported analytically and quantitatively with suitable accuracy for each of the following properties:

1 Solids Content
2 Pigment Content
3 Viscosity in poises absolute at 25°C
4 Weight per gallon at 25°C
5 Acidity of Vehicle as Acetic Acid
6 Volatile Distillation of Vehicle
7 Refractive Index of Vehicle at 25°C
8 Color Match, Hiding and Gloss (Submit Exhibit)

F-2b. Provided only that the selection of test batches is made by the Government Inspector, one out of each five batches or fraction thereof may be considered sufficient for complete tests. Each batch, however, shall be tested and reported for the following:

1 Solids Content
2 Viscosity in poises absolute at 25°C
3 Weight per Gallon at 25°C
4 Color Match, Hiding and Gloss (Submit Exhibit)

F-3. The manufacturer shall submit on a typewritten sheet or sheets supplementing Form FM-1 a complete extraction of data from his batch production card or cards, indicating which batch or batches each record applies to. These data shall be submitted in the units of weight or volume measure as used on the card and employed by the plant, and shall include a statement of the theoretical yield of the batch.

F-4. Government tests as required shall be conducted in accordance with the detail procedure of Navy Aeronautical Specification ST-15 as follows:

F-4a. Check conformance of product and ingredients with the manufacturer's FM-1 data and specification requirements.

F-4b. Determine equivalent functional properties as compared to a standard product formulated in accordance with this specification.

F-4c. Determine equivalent solids and volatile composition, ash content, film tensile strength and film elongation as compared to a standard product formulated in accordance with this specification.

G. PACKAGING, PACKING AND MARKING FOR SHIPMENT

G-1. Packaging, Packing and Marking - Shall be in accordance with Navy Aeronautical Specification ST-15.

G-2. Labeling - Individual cans or containers shall be labeled to carry the following information:

Manufacturer's Name
DOPE, NITROCELLULOSE, PIGMENTED (COLOR) NON-SPECULAR
Navy Aeronautical Specification _____
Batch Number _____
Net Quantity _____
Contract Number _____
Date of Manufacture _____

THINNING DIRECTIONS - Thinning is normally not required. When required use thinner, Navy Aeronautical Specification T-25. The reduction should be such that by the method of application employed a two coat application will deposit a film ranging in weight between 1.75 and 2.25 ounces per square yard.

H. NOTES

H-1. This product is intended for use as the top coat on airplane fabric surfaces which have previously been treated with D15d clear and D16d pigmented dopes.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C (77°F). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. These tests will be conducted at the expense of the manufacturer in accordance with a schedule which will be supplied upon application to the Manager, Naval Aircraft Factory, Navy Yard, Philadelphia, Pennsylvania. Approval samples together with related test reports and exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Navy Yard, Philadelphia, Pennsylvania. It is to be understood that the manufacturer shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product or its ingredients which are considered sufficient to warrant additional tests.

H-4. Specifications - When requesting specifications, refer to both title and number.

H-4a. Navy Aeronautical Specifications are aeronautical material and process specifications, issued under the cognizance of the Bureau of Aeronautics which have not been adopted either initially or in their current revised form as Navy Department Leaflet Specifications. These include approved specifications prepared by the Naval Aircraft Factory, and specifications prepared by this Bureau which were formerly designated "Tentative Navy Department Specifications." Copies of these specifications, process specifications and FM-1 forms may be obtained upon application to the Naval Aircraft Factory, Navy Yard, Philadelphia, Pennsylvania, or to the Bureau of Aeronautics, Navy Department, Washington, D. C.

H-4b. Copies of Navy Department leaflet specifications and any other specifications forming a part thereof, may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., except that Naval Activities should make application to the Commandant, Navy Yard, New York.

APPENDIX D

TENTATIVE
NAVY AERONAUTICAL SPECIFICATION
PAINT CAMOUFLAGE, SINGLE MISSION, BLACK

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids shall form a part of this specification and bidders and contractors should provide themselves with the necessary copies.

A-1a. Navy Department Specifications:

General Specifications for Inspection of Materials

A-1b. Navy Aeronautical Specifications:

ST-15	Inspection of Organic Protective Coatings for Aircraft.
D-15c	Dope, Nitrocellulose, Clear
D-16d	Dope, Nitrocellulose, Pigmented
E-5d	Enamel, Glyceryl Phthalate, Aircraft
M-485	Lacquer, Non-Specular
M-498	Dope, Non-Specular, Pigmented
P-27b	Primer, Zinc Chromate, Naval Aircraft
RM-44	Butanol

A-1c. Navy Department Specification:

51-G-1d Glycerin

A-1d. Federal Specification:

C-G-451 Glue, Animal, Granular, White, Grade J2.

B. GRADE, TYPE, AND COLORS.

B-1. This specification covers one grade and type of a pigmented, black, non-specular removable finish for the camouflage of aircraft during a single mission flight.

C. MATERIAL AND WORKMANSHIP.

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the approved and applicable raw material specifications.

C-2. The component ingredients shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-3. The pigment shall be finely ground and free from floating or caking in the container.

C-4. The product shall be homogeneous and free from coarse particles when examined under a flexible spatula.

C-5. The product conforming to this specification shall be designed for temporary use over Dope, Nitrocellulose, Clear and Pigmented, Specifications D-15 and D-16; Dope, Non-Specular, Pigmented, Specification M-498, Enamel Glyceryl Phthalate, Aircraft Specification E-5; Lacquer, Non-Specular, Specification M-485; and removal shall be effected without impairing or affecting these permanent finishes.

D. GENERAL REQUIREMENTS.

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS.

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product -

Non-volatile, minimum	19%
Volatile, maximum	81%

E-1b. Non-Volatile - The ratio of pigment (including extender) to binder shall not exceed 200%.

E-1c. Volatile - The volatile shall be 96% water.

E-2. Ingredients - All ingredients in the manufacture of this product shall comply with the re[illegible]ements of Section C and also of the following:

E-2a. Binder [illegible]ng Agents - Animal glue, granular, white, Federal Specif[illegible] Grade J2. This binder shall be modified as required to [illegible] properties of the product. The type of modifyin[illegible]ed.

[illegible] paint shall have incorporated therein a mo[illegible]

E-[illegible]gment shall consist of carbon black, Navy Aeronautical [illegible]131-1b.

E-2d. [illegible] Shall be added as required to meet requirements of color and gl[illegible]

E-3. Phy[illegible]ical Properties.

E-3a. Appearance - Shall be uniform, homogeneous and free from bubbles. There shall be no rough particles or separation of the pigments.

E-3b. Coarse Particles - Shall not exceed 0.1% by weight, retained on a number 325 screen.

E-3c. Weight per Gallon - At 25°C (77°F) shall not be less than 9.0 pounds.

E-3d. Water Soluble Material - The pigments shall be insoluble in water. The filtrate from a water mixture shall contain only such soluble adhesives as may be present.

E-4. Application Properties.

E-4a. Working Properties - When applied by spray, it shall be a freely working product. When applied by brush or sponge it shall show flowing and leveling properties equal to the standard product.

E-5a. Drying Properties - The film shall dry in not more than forty minutes when applied over lacquered or doped surfaces.

E-5b. Surface Appearance - The film, upon drying, shall be free from blisters, bubbles, silking and other irregularities of surface.

E-6. Film Properties.

E-6a. Color - Shall match the standard Navy non-specular Black.

E-6b. Gloss - The specular gloss shall not exceed 2 per mil when measured in accordance with the method described in Navy Aeronautical Specification M-485.

E-6c. Adhesion - The dried film shall not brush off when applied to a clean smooth surface of doped fabric, lacquered metal surface, or clean unpainted metal surface. A sprayed film that has dried for six hours at room temperature shall withstand for one hour a blast of cold water (18°C) emerging from a 3/8" nozzle under 35 pounds/sq. inch pressure and striking the panel at an angle of 45°. The panel shall be placed six inches below the nozzle and the streaming water shall be directed vertically down. At the end of this test the panel shall be uniformly covered with no washed out holes appearing in the film.

E-6d. Removal - Complete removal of the film shall be effected by rubbing the coated surface with a soft brush or sponge and warm water. Any residual stain adhering to non-specular lacquer M-485 white or light gray shall be removed by gentle scrubbing with a mild soap solution. Organic or strongly alkaline solvents are to be avoided.

E-6e. Surface Tension - The paint shall have incorporated therein a constituent capable of reducing the surface tension so that it will form a smooth continuous film when applied over surfaces not thoroughly cleansed from oil and grease.

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Specification ST-15.

F-2. Analyses and Tests.

F-2a. Shall be conducted on a comparative basis to a properly manufactured standard product and reported by the manufacturer as prescribed by Specification ST-15, the Applicable Raw Material Specifications, and Form No. FM-1. Manufacturers are advised to follow these instructions.

F-2b. Tests and Analyses to determine conformance with paragraphs in Section E shall be made on the packaged material.

F-2c. Metal panels which have been coated with light gray non-specular lacquer, Navy Aeronautical Specification M-485 over Zinc Chromate primer, P-27b, shall be used for these tests. Aluminum alloy panels are preferable.

F-3. Reports and Exhibits.

F-3a. The manufacturer shall report quantitatively where applicable and in the units or form specified, the results of all tests for the requirements of paragraphs in Section E.

F-3b. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the requirements in Section E headed "Application Properties," "Drying Properties," and "Film Properties."

F-4. Manufacturer's Formula - The manufacturer shall submit in appropriate manner a complete extraction of his batch production data in form, arrangement, and yield to be strictly comparable to the standard formula, including name, code, and source of each ingredient and the ingredient specification on which procurement of each ingredient is to be made and inspected. These data shall be approved by the Naval Aircraft Factory or the Bureau of Aeronautics. An exact copy of the approved formula shall be available for the Government Inspector at time of plant inspection. Approval of the formula does not constitute approval of the manufactured product. The formula may be disapproved if it is considered unsuited to the performance requirements, or if it contains an objectionable ingredient. Manufacturers are encouraged to submit alternative formulas which will show definite improvement in performance as compared to the standard.

F-5. Standard Formula on the basis of a 100-gallon yield is as follows:

51.5 lbs.	Glue, animal, granular, white, Federal Specification C-G 451, Grade J2.
34.3 lbs.	Carbon black, RM-131-1b.
68.6 lbs.	Diatomaceous silica (dicalite white filler, celite, 165-S, etc.)
85.5 gals.	Water.
2-1/8 gals.	Glycerin, Navy Specification 51G-1d.
1-1/4 lbs.	Camphor
2-1/8 gals.	Butanol, RM-44.

F-6. Inspection and Test of Standard Formula - Product Material which has been previously approved and is offered as being in strict compliance with the standard formula is required to be tested and reported only in respect to the physical properties listed below, provided the Government Inspector is satisfied by process inspection that the specified ingredients of proper quality have been used throughout and that they have been properly combined in the required proportions.

1. Solids Content
2. Weights per Gallon
3. Drying Time

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging, Packing, and Marking - Shall be in accordance with Specification ST-15.

G-2. Marking - Individual cans or containers shall be labeled to carry the following information:

(Manufacturer's Name)
SINGLE MISSION CAMOUFLAGE BLACK PAINT
Navy Aeronautical Specification _____
Manufacturer's Formula Number _____
Manufacturer's Batch Number _____
Net Quantity _____
Contract Number _____
Date of Manufacture _____
Thinning Directions - For brushing or spraying reduce with water as required.

H. NOTES.

H-1. This product is to be used as a single mission camouflage coating for aircraft. It is to be applied over the lacquer, with which Naval Aircraft are finished. The product shall be capable of being easily removed from the lacquer finish 18 to 36 hours after its application without producing any noticeable effect on the lacquer film.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C (77°F). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. Approval Procedure -

H-3a. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. Approval samples, together with ingredient samples, related test reports, and

exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Philadelphia, Pennsylvania. It is to be understood that the manufacturers shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturers for additional tests only after it has been clearly shown that changes have been made in the product or its ingredients which are considered sufficient to warrant conducting additional tests.

H-3b. Alternative Approval - In those cases where the manufacturer's reports and exhibits indicate clearly and unmistakably that all of the reported results are bonafide, the Supply Officer, Naval Aircraft Factory, may, at his discretion, approve the product in advance of completion of exposure or other government tests for consideration in connection with routine Naval Aircraft Factory proposals. Where it appears to be in the Government's interest because of the extended nature of the tests, such product may also be recommended to the Bureau of Supplies and Accounts as an approved product in advance of the completion of Government tests. Manufacturers are warned that full compliance with all specifications must be properly reported and that abbreviated reports or questionable data are not acceptable.

H-4. Specifications - May be obtained upon application to the Manager, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pennsylvania. When requesting specifications refer to both title and number.

APPENDIX E

TENTATIVE
NAVY AERONAUTICAL SPECIFICATION
LACQUER CAMOUFLAGE, SINGLE MISSION, BLACK (REMOVABLE)

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids shall form a part of this specification and bidders and contractors should provide themselves with the necessary copies.

A-1a. Navy Department Specifications:

General Specifications for Inspection of Materials

A-1b. Navy Aeronautical Specifications:

ST-15	Inspection of Organic Protective Coatings for Aircraft.
D-15c	Dope, Nitrocellulose, Clear
D-16d	Dope, Nitrocellulose, Pigmented
E-5d	Enamel, Glyceryl Phthalate, Aircraft
M-485	Lacquer, Non-Specular
M-498	Dope, Non-Specular, Pigmented
P-27b	Primer, Zinc Chromate, Naval Aircraft

B. GRADE, TYPE, AND COLORS.

B-1. This specification covers one grade and type of a pigmented, black, non-specular removable lacquer for the camouflage of aircraft during a single mission flight.

C. MATERIAL AND WORKMANSHIP.

C-1. The ingredient materials used in the manufacture of this product shall be carefully procured from responsible sources. They shall comply with the approved and applicable raw material specifications.

C-2. The component ingredients shall be intimately assembled and processed as required to produce a product which is stable and not subject to abnormal change with age in a sealed container.

C-3. The pigment shall be finely ground and free from floating or caking in the container.

C-4. The product shall be homogeneous and free from coarse particles when examined under a flexible spatula.

C-5. The product conforming to this specification shall be designed for temporary use over Dope, Nitrocellulose, Clear and Pigmented, Specifica-

tions D-15 and D-16; Dope, Non-Specular, Pigmented, Specification M-498, Enamel Glyceryl Phthalate, Aircraft Specification E-5; Lacquer, Non-Specular, Specification M-485; and removal shall be effected without impairing or affecting these permanent finishes.

D. GENERAL REQUIREMENTS.

D-1. The manufacturer shall comply with the specified requirements of testing and reporting this product and all ingredient materials entering therein.

E. DETAIL REQUIREMENTS.

E-1. Composition - Shall conform to the following percentages by weight:

E-1a. Product -

Non-volatile, minimum	40%
Volatile, maximum	80%

E-1b. Non-Volatile - The ratio of pigment (including extender) to binder shall not exceed 60%.

E-1c. Volatile - The volatile shall be as follows:

Ethyl alcohol, minimum	90%
Water, maximum	10%

E-2. Ingredients - All ingredients in the manufacture of this product shall comply with the requirements of Section C and also of the following:

E-2a. Binder and Modifying Agents - The binder shall consist of a resin soluble in ethyl alcohol, into which may be incorporated necessary plasticizers to give required properties.

E-2b. Pigment - The pigment shall consist of carbon black, Navy Aeronautical Specification RM-131-1b.

E-2c. Extender - Shall be added as required to meet requirements of color and gloss.

E-3. Physical Properties.

E-3a. Appearance - Shall be uniform, homogeneous and free from bubbles. There shall be no rough particles or separation of the pigments.

E-3b. Coarse Particles - Shall not exceed 0.1% by weight, retained on a number 325 screen.

E-3c. Weight per Gallon - At 25°C (77°F) shall not be less than 7.5 pounds.

E-3d. Water Soluble Material - The pigments shall be insoluble in water.

E-3e. Viscosity - The packaged material when reduced with equal parts of ethyl alcohol shall have a viscosity of not less than 0.5 poise absolute nor more than 1.75 poises absolute at 25°C.

E-4. Application Properties.

E-4a. Working Properties - When applied by spray, it shall be a freely working product. When applied by brush or sponge it shall show flowing and leveling properties equal to the standard product.

E-5a. Drying Properties - The film shall dry dust free in not more than ten minutes when applied over lacquered or doped surfaces.

E-5b. Surface Appearance - The film, upon drying, shall be free from blisters, bubbles, silking and other irregularities of surface.

E-6. Film Properties.

E-6a. Color - Shall match the standard Navy non-specular Black.

E-6b. Gloss - The specular gloss shall not exceed 2 per mil when measured in accordance with the method described in Navy Aeronautical Specification M-485.

E-6c. Baking Properties - A flow-out film, air dried 16 hours and baked at 80 to 85°C (175 to 185°F) for two hours, shall be hard, tough, smooth and free from all defects such as checking, wrinkling, and dulling.

E-6d. Cold Cracking - The film on the baked panel above shall withstand a bend test of 180° around a 3/16" rod at 0°C (32°F).

E-6e. Removal - Shall be accomplished by the use of a 50% mixture of ethyl alcohol and water.

E-6f. Hiding - When reduced 100% with ethyl alcohol complete coverage by one spray coat shall be obtained over D-16 orange dope or L-12 orange yellow lacquer.

E-6g. Metal Anchorage - The product shall show satisfactory adhesion to unprimed, anodized aluminum and after air-drying 24 hours shall withstand a bend of 180° over a 3/16" mandrel.

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Sampling by the manufacturer and by the Government Inspector shall be in accordance with Specification ST-15.

F-2. Analyses and Tests.

F-2a. Shall be conducted on a comparative basis to a properly manufactured standard product and reported by the manufacturer as prescribed by Specification ST-15, the Applicable Raw Material Specifications, and Form No. FM-1. Manufacturers are advised to follow these instructions.

F-2b. Tests and Analyses to determine conformance with paragraphs in Section E shall be made on the packaged material.

F-2c. Metal panels which have been coated with light gray non-specular lacquer, Navy Aeronautical Specification M-485 over Zinc Chromate primer, P-27b, shall be used for these tests. Aluminum alloy panels are preferable.

F-3. Reports and Exhibits.

F-3a. The manufacturer shall report quantitatively where applicable and in the units or form specified, the results of all tests for the requirements of paragraphs in Section E.

F-3b. The manufacturer shall submit exhibits of his test work showing the character and results of tests conducted to check conformance with the requirements in Section E headed "Application Properties," "Drying Properties," and "Film Properties."

F-4. Manufacturer's Formula - The manufacturer shall submit in appropriate manner a complete extraction of his batch production data in form, arrangement, and yield to be strictly comparable to a standard formula, including name, code, and source of each ingredient and the ingredient specification on which procurement of each ingredient is to be made and inspected. These data shall be approved by the Naval Aircraft Factory or the Bureau of Aeronautics. An exact copy of the approved formula shall be available for the Government Inspector at time of plant inspection. Approval of the formula does not constitute approval of the manufactured product. The formula may be disapproved if it is considered unsuited to the performance requirements, or if it contains an objectionable ingredient. Manufacturers are encouraged to submit alternative formulas which will show definite improvement in performance.

F-5. Inspection and Test Formula - Product Material which has been previously approved and is offered as being in strict compliance with the acceptable formula is required to be tested and reported only in respect to the physical properties listed below, provided the Government Inspector is satisfied by process inspection that the specified ingredients of proper quality have been used throughout and that they have been properly combined in the required proportions.

1. Solids Content
2. Weights per Gallon
3. Drying Time

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging, Packing, and Marking - Shall be in accordance with Specification ST-15.

G-2. Marking - Individual cans or containers shall be labeled to carry the following information:

(Manufacturer's Name)
LACQUER, CAMOUFLAGE, SINGLE MISSION BLACK (REMOVABLE)
Navy Aeronautical Specification _____
Manufacturer's Formula Number _____
Manufacturer's Batch Number _____
Net Quantity _____
Contract Number _____
Date of Manufacture _____
Thinning Directions - For brushing or spraying reduce with alcohol as required.

H. NOTES.

H-1. This product is to be used as a single mission camouflage coating for aircraft. It is to be applied over the lacquer with which Naval aircraft are finished. The product shall be capable of being easily removed from the lacquer finish 18 to 36 hours after its application without producing any noticeable effect on the lacquer film.

H-2. The material shall be purchased by volume, the unit being a U. S. Gallon at 25°C (77°F). The volume shall be determined by dividing the net weight in pounds by the weight per gallon.

H-3. Approval Procedure.

H-3a. Approval of Product - The right is reserved to reject bids on products which have not been subjected to the required tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to forward samples of the product which they propose to offer to the Navy in the future in order that check tests may be made. Approval samples, together with ingredient samples, related test reports, and exhibits shall be submitted directly to the Supply Officer, Naval Aircraft Factory, Philadelphia, Pennsylvania. It is to be understood that the manufacturers shall pay all transportation charges to and from this point. In the case of failure of the samples submitted to prove satisfactory, consideration will be given to the request of the manufacturers for additional tests only after it has been clearly shown that changes have been made in the product, or its ingredients, which are considered sufficient to warrant conducting additional tests.

H-3b. Alternative Approval - In those cases where the manufacturer's reports and exhibits indicate clearly and unmistakably that all of the reported results are bonafide, the Supply Officer, Naval Aircraft Factory, may, at his discretion, approve the product in advance of completion of exposure or other government tests for consideration in connection with routine Naval Aircraft Factory proposals. Where it appears to be in the Government's interest because of the extended nature of the tests, such product may also be recommended to the Bureau of Supplies and Accounts as an approved product

in advance of the completion of Government tests. Manufacturers are warned that full compliance with all specifications must be properly reported and that abbreviated reports or questionable data are not acceptable.

H-4. Specifications - May be obtained upon application to the Manager, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pennsylvania. When requesting specifications refer to both title and number.

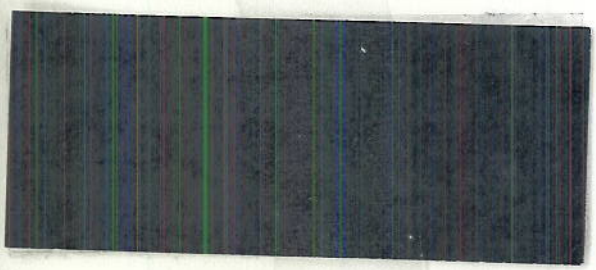
APPENDIX F

COLOR STANDARDS

LIGHT GRAY

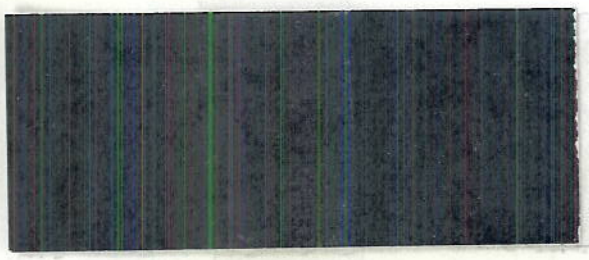
BLUE GRAY

INSIGNIA RED



INSIGNIA BLUE

INSIGNIA WHITE



BLACK