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FUNDAMENTAL RESEARCH

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CHEMICAL DIVISION

PARLIN LABORATORY

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SUBJECT: STRIPPABLE PROTECTIVE SPRAY COATINGS
NAVY RESEARCH CONTRACT NOrd-5216

PERIOD: JULY 1, 1945 TO DECEMBER 31, 1945

NOTEBOOKS: 1091, 2894 and 2131

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N 29343

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SUBJECT: STRIPPABLE PROTECTIVE SPRAY COATINGS
NAVY RESEARCH CONTRACT NOrd-5216

I - INTRODUCTION

This report covers the experimental work done under the subject research contract for the period July 1, 1945 to December 31, 1945. It supplements Parlin Laboratory Reports No. 900 and 906 which covered the experimental work done on this problem from January 1, 1944 through June 30, 1945.

In the first phase of this work as covered in Report No. 900, an investigation was made of the most likely candidates among the then available film formers (with the exception of the "Vinylites") from which a strippable sprayable protective coating could be formulated. Investigation of the "Vinylites" was not undertaken at that time in order to avoid duplication of the work being done at the Naval Ordnance Laboratory at Silver Spring, Maryland. In this phase of the work the following film formers were investigated: ethyl cellulose, nitrocellulose, cellulose aceto-butyrate, neoprene, Buna S, Buna N, butyl rubber, polyvinylbutyral and the 50/50 interpolymer of n-butyl isobutyl methacrylate. Of these, sprayable strippable protective coatings were developed based on ethyl cellulose, nitrocellulose and neoprene, all of which showed promise of meeting the general requirements for coatings of this type.

The second phase of this work as described in Parlin Laboratory Report No. 906 covered the experimental work undertaken to (1) field test the ethyl cellulose, nitrocellulose and neoprene types, (2) evaluate the "Vinylite" resins for use in strippable coatings, (3) develop adhesives to adhere vinyl and neoprene strippable coatings to steel and (4) improve the durability of the vinyl type coatings and particularly the NCLSS 193 stripping lacquer. This phase of the work indicated that (1) for most purposes the vinyl resin had better all-round combination of properties for stripping lacquer formulations than any of the other film formers examined, (2) the most promising adhesive for adhering vinyl stripping lacquers to steel was based on a phenol-formaldehyde modified butadiene/acrylonitrile synthetic rubber, (such adhesives are known under the tradenames Geytex or "Plichmond"), and (3) pigmentation particularly with carbon black, was the best means of improving the durability of the NCLSS-193 formulation and of the other stripping lacquer developed under the subject contract.

The final phase of the work as recorded in this report covers (1) surveillance tests of exposure series on the various formulations developed under the subject contract and of the NOLSS-153 lacquer and (2) a study of the gelation characteristics of the NOLSS-193 formulation.

II - RESULTS AND CONCLUSIONS

The general conclusions drawn from examination of the various exposure series now underway are as follows:

(1) Pigmentation is necessary, and is the most effective means of improving the durability of all the stripping lacquers developed in the work done under the subject contract. These include the NOLSS-193 type formulation developed by Lt. Commander Wm. H. Holst and his group at the Silver Spring Naval Ordnance Laboratory as well as the formulations developed by the Parlin Laboratory, and the durability results thus obtained check the du Pont Company's general experience in the field of protective finishes.

(2) Of the pigments evaluated which includes carbon black, aluminum powder, titanium dioxide/carbon black, lead chromate, cadmium sulphide, red lead, and zinc oxide, carbon black is the best all-around pigment for use in obtaining outdoor durability.

(3) Of the four general types of stripping lacquers studied, those based on the copolymers of vinyl chloride/vinyl acetate, when properly pigmented, have the highest order of durability. Those based on nitrocellulose show only a slightly greater degree of change in film properties, but because they do not originally have as good a combination of properties as the vinyl type, are not considered to be as satisfactory for most purposes. The neoprene type also exhibits good durability but is poorer in this respect than either the vinyl or nitrocellulose type, while those formulations based on ethyl cellulose are definitely the poorest.

(4) In the vinyl type as exemplified by the NOLSS-193 formulation, the durability of a system consisting of a clear film followed by a carbon black pigmented topcoat with a film thickness as low as 5 mils provides durability equivalent to a completely carbon black pigmented film at the end of one year exposure in Florida.

(5) Organic compounds used as heat and light stabilizers such as Stabilizer A (the monoglyceride of a vegetable source fatty acid) and Salol (phenyl salicylate) return only a very slight improvement in the durability of a clear vinyl film as do such anti-oxidants as phenyl alpha and phenyl beta naphthylamine when used in the ethyl cellulose and neoprene

types. In each case, however, the improvement in durability is insignificant as compared with the effect of pigmentation.

(6) The use of pigmentation to improve the durability of the vinyl type formulations not only retards the deterioration of the film, but is desirable in addition because of the nature of the deterioration which occurs when vinyl chloride/vinyl acetate copolymer films are exposed to the actinic rays of the sun. This type of exposure apparently breaks down the polymer in such a way as to release acidic products which causes corrosion to occur on metal substrates over which they are applied. Further, should the deterioration take place in the area where the film is adhered by means of an adhesive to any part of the equipment being protected, loss of adhesion is experienced.

(7) In the vinyl formulations and particularly the NOLSS-193 several plasticizers return good durability. They are di (2-ethyl-hexyl) phthalate, tricresyl phosphate and Paraplex G-25. Of these di (2-ethyl hexyl) phthalate is probably preferred as it combines good performance with the best low temperature flexibility.

The following conclusions can be drawn from a study of the gelation characteristics of the NOLSS-193 formulations:

(1) In order to obtain freedom from gelation under normal conditions of storage with the NOLSS-193 formulation, the complete elimination of the VYNL or VYNW grade of "Vinylite" resin and its replacement with the VYNS grade is necessary. A reduction in the amount of VYNL or VYNW in the formula reduces the tendency of the solution to gel on storage, but its complete elimination is needed for good solution stability.

(2) Another advantage in using 100% VYNS resin is that the solids at spraying viscosity can be increased from 25.0% to 27.5% and still retain good solution stability.

(3) The only disadvantage in eliminating the VYNL or VYNW resin as indicated above is a slight sacrifice in tensile strength, distensibility and low temperature flexibility. However, the decrease in these physical properties of the film is no greater than the variance in film properties caused by the different spraying techniques of different operators.

VII - EXPERIMENTAL

The conclusions reached in the previous section of this report concerning the outdoor durability of stripping lacquers are based on the results obtained from examining the following exposure series. They are listed in numerical order

A. Exposure Series J-2997

This series was put out to determine the relative durability of stripping lacquers based on neoprene, nitrocellulose and ethyl cellulose, all pigmented with carbon black. The lacquers were applied over clean bare steel panels to a film thickness of 7-10 mils.

At the end of one year's exposure in Florida, facing south at 45°, the following observations were made:

(1) Neoprene, nitrocellulose and ethyl cellulose formulations are still strippable and providing good protection to the substrate except that edge rusting is starting on the ethyl cellulose formulation.

(2) Each composition shows considerable chalking and very poor tear resistance. The nitrocellulose film is stiff and beardy but shows the least change from initial film properties of the three. The neoprene is soft and rubbery and has deteriorated more than the nitrocellulose type. The ethyl cellulose is stiff and brittle and shows the greatest deterioration of the three types.

B. Exposure Series J-3034

This series was put out to determine means of improving the durability of the MCLSS-193 stripping lacquer and method of packaging. Carbon black pigmented and aluminized vinyl (including the MCLSS-193 formulation) neoprene and ethyl cellulose types stripping lacquers were applied over the MCLSS-193 bridge on 15 x 15 inch wooden frames and also over airplane cloth on frames. Carbon black pigmented and aluminized "Dope" and a carbon black pigmented vinyl topcoat were also applied over the clear MCLSS-193 lacquer. The films were sprayed to a thickness of 40 ± 5 mils and exposed in Florida facing South at 45°.

At the end of one year's exposure the following observations were made:

(1) The pigmented vinyl type stripping lacquers have better initial properties and show less deterioration than either the neoprene or ethyl cellulose types.

(2) Pigmenting the clear vinyl stripping lacquer (MCLSS-193) with either carbon black or aluminizing, or topcoating with a carbon black vinyl topcoat definitely improves the durability. The use of a 5 mil thick carbon black pigmented vinyl topcoat appears to be just as effective as completely pigmenting the film. The clear MCLSS-193 lacquer at this stage has failed completely by becoming very brittle and showing large holes eroded completely through the film.

(3) While carbon black pigmented or aluminized "Duco" topcoats over the clear KOLSS-193 lacquer are not practical because of poor intercoat adhesion, the clear films underneath show only a slight degree of deterioration, emphasizing the effectiveness of a pigmented film in blocking out the actinic rays of the sun and hence protecting the subcoat.

Comparative data on the progressive weathering of the above films is contained in Chart Number I at the end of this report.

C. Exposure Series J-3036

This series was put out to determine the effect on the durability of a "Vinylite" coating of (1) pigmenting with carbon black, titanium dioxide/lampblack and aluminum, (2) of varying the pigment to binder ratio for each pigment, (3) use of stabilizers such as Stabilizer A, Salol, red lead, blue lead, antimony oxide and lead titanate, (4) use of tricresyl phosphate, di (2-ethyl hexyl) phthalate, dibutyl sebacate, Paraplex G-25 and methoxyglycol acetyl ricinoleate as plasticizers, and (5) use of higher molecular weight and higher vinyl chloride content vinyl resins. The lacquers were applied to a film thickness of 15-20 mils over clean bare steel panels.

After nine month's exposure in Florida, facing south at 45°, the following general observations were made:

(1) The clear vinyl stripping lacquers have relatively poor durability, failing in less than three months by becoming darker, showing surface checking and corroding the substrate. The addition of organic stabilizers such as Salol and Stabilizer A has no appreciable effect in preventing the deterioration.

(2) Pigmentation with carbon black, titanium dioxide/lampblack or with aluminum definitely improves the durability. At this stage in the exposure no single pigment is outstandingly better than the other except that in general the blacks and aluminums show less chalking than the grays. However the aluminum modifications show rusting of the substrate in all cases except where blue lead or Salol is used in conjunction with the aluminum.

(3) Of the plasticizers tested tricresyl phosphate, di (2-ethyl hexyl) phthalate and Paraplex G-25 return the best physical properties at this stage in the exposure. The other plasticizers tested, methoxyglycol acetyl ricinoleate and dibutyl sebacate, are the poorest with the films in which they are contained showing the greatest loss of distensibility.

The following detailed observations were also made:

(1) Stabilizers

(a) In the pigmented films, there appears to be no appreciable difference in the effect of such stabilizers as red lead, blue lead, Stabilizer Aer Salol (except in the case of aluminum as noted above). In the clears the effect of organic stabilizers is insignificant.

(b) The percentage of stabilizers at this stage is not critical. Blue lead up to 20% on the resin can be used in the pigmented formulations with little or no effect on the film properties.

(2) Pigmentation

(a) The ratio of carbon black to binder does not appear to be too critical. Ratios in the range of 7.5/100 to 12.5/100 return satisfactory film properties on exposure. Lampblack is equally as good as carbon black.

(b) The ratio of 1/9 blend of lampblack/titanium dioxide can be used up to 60/100 without a deleterious effect on the film properties. Neither antimony oxide nor lead titanate offers any advantage when used in place of part of the titanium dioxide.

(c) Aluminum powder can only be used in quantities less than 20% of the binder without deleteriously affecting the film properties. Increasing amounts, however, have the advantage of decreasing the moisture vapor transmission rate. However, because of the rusting of the substrate, aluminum powder could only be used as a final topcoat over the clear.

(3) Higher Vinyl Chloride/Molecular Weight Resin Combinations. The use of higher vinyl chloride resin combinations such as are obtained by replacing part of the VMMH type with VYNS offer no improvement in durability, but return better initial film properties.

D. Exposure Series J 3057

This exposure series was put out to determine the relative durability of vinyl type stripping lacquers pigmented with carbon black, lead chromate and cadmium sulphide. The lacquers were applied to clean bare steel to a film thickness of 12-15 mils.

After eight months in Florida, facing south at 45°, the following observations were made:

(1) All compositions stripped readily and none of the steel substrates showed any rusting.

(2) All compositions except those formulated with cadmium sulphide are still in fairly good shape, all showing a

slight decrease in toughness. The blacks show slight chalking, the yellows have darkened considerably and show slight chalking, while the reds show bad small surface checking and color fading.

At this point in the exposure the carbon black modifications show the least change, the lead chromates next and the cadmium sulphides are poorest. Clear films at the same thickness are known to show failure in less than two month's exposure in Florida over steel.

E. Exposure Series J-3071

This series was put out to determine the relative effect of steel and aluminum substrates on the durability of clear and pigmented vinyl stripping lacquers, with and without Stabilizer A and blue lead. The lacquers were applied over clean bare steel and Alclad panels to a film thickness of 12-15 mils.

At the end of eight month's exposure in Florida, facing south at 45°, the following observations were made:

(1) There appears to be no difference in the durability caused by either steel or Alclad.

(2) The only films showing any appreciable degree of deterioration are the clears which have darkened, show bad checking, and have decreased considerably in tensile strength and distensibility. In addition both the aluminum and steel panels under the clears show bad corrosion (slight corrosion at end of one month's exposure).

(3) The grays are showing slightly more chalking than the blacks, while the yellows (lead chromate) are beginning to show surface checking.

(4) All the pigmented formulations have lost to a small extent some of their film toughness, but are still providing good protection to both steel and Alclad without any trace of corrosion.

F. Exposure Series J-3073

This series was put out to determine the relative durability of various strippable lacquers over the NOLSS-193 webbing lacquer. The strippable lacquers being evaluated are (1) Clear NOLSS-193, (2) NOLSS 193 pigmented with carbon black, titanium dioxide/lamphlack and aluminum, (3) clear NOLSS-193 followed by 5 mils of carbon black pigmented modification of NOLSS-193, (4) duplicates of the first three classes based on lower molecular weight vinyl resins and plasticized with trioresyl phosphate in place of di (2 ethyl hexyl) phthalate, and (5) neoprene types pigmented with carbon black and with aluminum

The series was prepared by enveloping one cubic foot test houses with NOLSS-193 bridging lacquer and applying the above listed topcoats to a 40 mil film thickness. Each house contains one pound of silica gel, a polished 40 mm. steel projectile, and a silica gel indicator. Vinyl sheets (.050 inches) were used as the windows.

At the end of eight months exposure in Parlin, New Jersey, the following observations were made:

(1) None of the steel projectiles show any corrosion.

(2) The clears have darkened and are showing considerable surface checking.

(3) The pigmented compositions show little visual change.

8. Exposure Series Z-3092

This series was put out to determine (1) the optimum thickness of carbon black pigmented NOLSS-193 needed to protect a clear NOLSS-193 film on outdoor exposure, (2) the effect of molecular weight and vinyl chloride content on the durability of a stripping lacquer of the NOLSS-193 type, (3) the effect of using different types of carbon black in pigmented NOLSS-193 and (4) the effect of dispersing the carbon black in a steel ball mill versus a Y & P mixer. The lacquers were applied at both a 40 mil and a 20 mil thickness over clean bare steel and were adhered to the edges of the panels with "Pliobond" adhesive.

At the end of six month's exposure in Florida, facing south at 45°, the following observations were made:

(1) A two mil thick carbon black pigmented modification of the clear when applied over the clear definitely improves the durability of the system and at this stage in the exposure is as effective as totally pigmenting the film.

(2) The clears have all darkened considerably, show bad surface checking, decreased toughness, and rusting of the substrate regardless of the vinyl chloride content or molecular weight of the resin used. However, it is evident that a film of the clear thicker than 20 mils is necessary for the clear to have a durable life longer than the equivalent of six months in Florida, because at this point the 20 mil thick film of NOLSS-193 can be considered to have completely failed, whereas the 40 mil thick film of NOLSS-193 still retains considerable toughness. Rusting of the substrate under the clears was evident in less than three months in Florida.

(3) There is apparently no appreciable difference at this stage in the exposure between the different grades of carbon black or in the methods of grinding being evaluated.

Please refer to the chart at the end of this report showing the effect of exposure on the film properties of the formulations included in this series. Note particularly the tensile strength and elongation of the 20 mil thick films of NOLSS-193 and NOLSS-193 with a 2 mil thick topcoat of carbon black pigmented NOLSS-193 at the end of six months' exposure.

H. Exposure Series J-3108

This series was put out to evaluate several stabilizers for vinyl stripping lacquers both in clear and pigmented (carbon black and aluminum) formulations and to determine the effect on durability of formulating without mineral oil. The lacquers were applied over clean bare steel to film thickness of 12-15 mils.

At the end of four months' exposure in Florida, facing south at 45°, the following observations were made:

(1) None of the stabilizers being evaluated (Stabilizer A, Salol, red lead, blue lead, litharge and lead chromate) have any appreciable effect on durability either in the clear or pigmented formulations. The clears failed in less than two months by darkening, surface checking, loss of toughness and promotion of corrosion on the steel substrate.

(2) Pigmenting with carbon black or aluminum returns definitely better durability than clear formulations with or without an organic stabilizer. However, carbon black is better than aluminum in that all aluminum formulations show a tendency to cause rusting of the substrate except when used in conjunction with blue lead or Salol. In addition the aluminized films are deteriorating slightly more than the carbon black formulations.

(3) Eliminating the mineral oil from the clears has a deleterious effect in that it impairs the strippability of the film on exposure.

I. Exposure Series J-3132

This exposure series was put out to determine the effect on the durability of the NOLSS 193 formulation of (1) pigmenting with several grades of carbon black and (2) different types of black pigments with and without Stabilizer A and Salol. The lacquers were applied to clean bare steel at a film thickness of 30-40 mils and were adhered to the edges of the panels with "Pliobond" adhesive.

After two months' exposure in Florida, facing south at 45°, the following observations were made:

(1) Pigmentation is necessary to prevent deterioration of NOLSS-193, which shows rusting on the substrate and a slight loss of tensile strength.

(2) There appears to be no appreciable difference at this point in the exposure between the various grades of carbon black or in the type of black pigment used.

(3) The effect of stabilizers in the pigmented compositions is negligible compared to the effect of pigmenting.

J. Exposure Series J-3134

Because previous corrosion tests had indicated that certain iron compounds had a beneficial effect on the corrosion resistance of vinyl compositions, this exposure series was put out to determine the effect on durability of (1) iron butyl phthalate and (2) iron naphthenate versus Stabilizer A and Salol as stabilizers for clear vinyl stripping lacquers. The lacquers were applied to clean bare steel to a film thickness of 30-35 mils.

At the end of four months' exposure in Florida, facing south at 45°, the following observations were made:

(1) All compositions are causing rusting of the substrate. This began at the end of one month.

(2) Iron butyl phthalate and iron naphthenate have a definitely deleterious effect on the durability of the film, failing completely by bad checking with the cracks extending in places completely through the film to the substrate.

It is noteworthy, however, that experiments which were run to detect any effect of manufacturing or shipping vinyl stripping lacquers in iron equipment or containers have indicated that small quantities of metallic iron contamination have no deleterious effect on the durability or corrosion resistance of these lacquers. This conclusion is based on the results of exposing pigmented formulations made by grinding the pigment in steel mills with steel balls (see series J-3092) and from accelerated (U-V exposure) tests on clears containing varying amounts of finely divided metallic iron. No deleterious effect on solution stability could be detected from storage in iron containers.

(3) Stabilizer A and Salol have no appreciable effect on the durability of the clear film.

The conclusions reached in the previous section of this report concerning the gelation characteristics of the NOLSS-193 formulation were based on the following work:

Because of the gelation difficulties encountered with formulation NOLSS-193 as originally formulated in which the ratio of VYNW (OR VYNL)/VYHS was 20/80, a limited study was undertaken to determine means of reducing the tendency of this formulation to gel on extended storage. The following tabulated data indicate the direction and how far it is necessary to go to obtain a product

with the minimum tendency to gel with the minimum sacrifice in the physical properties of the film, retaining the same non-volatile content.

Starting with the following original formula, the following modifications yielded the following data:

			%
*VINL (OR VINW)	-	20.8	3.1
VINS	-	79.2	11.9
di (2-ethyl hexyl)phthalate		40.0	6.0
Mastban 603		24.7	3.7
Stabilizer A		2.0	0.3
Methyl Ethyl Ketone		532.1	75.0
		565.8	100.0%

*VINL and VINW impart practically the same gelation characteristics with VINL tending to cause slightly more gelation at the same ratio. VINL was used in place of VINW at times due to being more readily available.

Percent VINW	(1) 0	(2) 10	(3) 15	(4) 20
Visc. at 25°C. #15 du Pont Cup	12 sec.	13 sec.	15 sec.	18 sec.
Analy. Total Solids	25.0%	24.3%	24.7%	24.6%
Gelation after 16 hours at 40°F.	None	V.Sl.gel.	Sl gel	Def.gelled
Gelation after 2 weeks at 40°F.	None	Sl.gel.	Def gel	Def.gel
Tensile strength (sprayed)	1286 psi.	1424 psi.	1410 psi.	1260 psi.
Tensile strength (cast)	1870 "	1986 "	2120 "	2155 "
Elongation (sprayed)	338%	357%	344%	322%
Elongation (cast)	400%	432%	443%	462%
Cold Crack at -40°F. (sprayed)	Cracked	Cracked	Cracked	Cracked
Cold Crack at -40°F. (cast)	OK	OK	OK	OK

These data indicate that while a definite improvement can be made in the gelation characteristics of formulation NOLSS-193 by completely eliminating VYNL or VYNW and using 100% VYNS, only a slight sacrifice in the physical properties of the resulting film is obtained. From the above data, the loss in tensile strength can only be detected by testing cast films and is less than the difference obtained by normal variance in the spraying technique. While it is known that VYNL or VYNW resin has better low temperature flexibility the improvement gained by using these resins in conjunction with VYNS at least up to 20% of the resin, cannot be detected as the sprayed films all fail when bent around a 1/8 inch mandrel at -40°F. while the cast films all show no cracking.

The total solids content of the NOLSS-193 formulation has also been found to be quite critical with regard to the gelation characteristics of the final product. In the modified formula for NOLSS-193 containing 10% VYNW made up to 23, 24, 25 and 26% non-volatile content the following difference in gelation characteristics were noted:

Theo. Total Solids	Analytical Total Solids	Gelation after 16 hrs. @ 40°F.
23%	22.8%	Very sl. gel.
24%	23.8%	Very sl. gel.
25%	24.7%	Sl. gel.
26%	25.8%	Def. gelled

It would, therefore, appear that a product containing as little as 10% VYNW on the resin is still a borderline product for gelation when formulated at 25% total solids, and because a product formulated with 100% VYNS at 27.5% show no gelation in the same test, it would seem that the complete elimination of the VYNW is necessary for formulating a gelation proof product at 25% total solids when stored under normal conditions.

It should be pointed out, however, that the gel formed by the NOLSS-193 formulation containing 10% VYNW is reversible and the solution can be returned to a semi-fluid state by allowing it to come to room temperature after which rapid agitation will return it to a sprayable viscosity.

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CHART NO. I (J-3034)

SYSTEM	ORIGINAL* T.S.	ELONG.	MVTR	3 MONTHS** T.S.	ELONG.	MVTR.	6 MONTHS** T.S.	ELONG.	MVTR.	12 MONTHS** T.S.	ELONG.	MVTR	REMARKS
NOLSS-193 System	1420	300.0	35	1050	358.0	62	985	415.0	62	-	-	-	Failed completely
NOLSS-193 bridge plus J-200-X-6463, Black E/C type	495	40.0	136	875	27.5	174	1200	31.0	207	1290	8.0	191	Very brittle
NOLSS-193 bridge plus aluminized E/C type	486	29.0	113	800	21.5	170	1105	13.0	137	1175	-	127	Elongation Too low to be measured
NOLSS-193 bridge plus J-200-X-6453 Neoprene type	450	400.0	55	550	135.0	43	680	85.0	154	773	40.0	38	
NOLSS-193 bridge plus aluminized Neoprene type	340	110.0	29	391	41.0	53	437	40.0	292	542	26.0	121	
NOLSS-193 bridge plus J-200-X-6624 black vinyl type	1480	340.0	60	1830	237.0	74	1570	215.0	45	-	-	-	Too brittle to cut into test strips
NOLSS-193 bridge plus aluminized modification of J-200-X-6624	970	260.0	16	1000	158.0	39	820	175.0	86	-	-	-	Too brittle to cut into test strips
NOLSS-193 system plus one double coat N/C black lacquer	1420	300.0	-	1500	365.0	80	1630	440.0	51	1775	375.0	57	
NOLSS-193 system plus one double coat aluminized N/C lacquer	1420	300.0	---	1620	420.0	60	1510	440.0	49	1520	270.0	52	
NOLSS-193 system plus approx. 5 mils. J-200-X-6624	1300	365.0	45	1550	430.0	57	1400	435.0	66	1480	357.0	54	
J-200-X-6463 over airplane cloth	-	-	206	-	-	145	-	-	181	-	-	227	Very brittle
J-200-X-6453 over airplane cloth	-	-	43	-	-	106	-	-	94	-	-	62	
J-200-X-6624 over airplane cloth	-	-	57	-	-	72	-	-	111	-	-	85	Very brittle
NOLSS-193 system pigmented with carbon black	1070	300.0	55	1580	375.0	95	1510	405.0	45	1352	293.0	69	
NOLSS-193 system aluminized	800	260.0	32	870	255.0	42	860	232.0	41	946	192.0	40	

*Original tests run on Suter Tester
**Run on Scott Tester

T/S. = pounds/square inch
Elong.= percent
MVTR = grams/100 square meters/hour at 39.5°C. under a vapor pressure differential corresponding to 100% relative humidity on one side of the film and less than 3 percent on the other side.

CGM:MCN
1/16/46

CHART NO. II - (J-3092)

SYSTEM	ORIGINAL T.S.	ORIGINAL ELONG.	ORIGINAL MVTR.	3 MONTHS T.S.	3 MONTHS ELONG.	3 MONTHS MVTR	6 MONTHS T.S.	6 MONTHS ELONG	6 MONTHS MVTR	REMARKS
NOLSS-193 - 40 mils	1750	470	49	1152	309	46	1262	296	71	Badly darkened and checked, conside able rusting of substrate
NOLSS-193 - 38 mils + 2 mils NOLSS-193 Pigmented Black	1670	435	37	1715	354	52	1787	405	41	
NOLSS-193 - 35 mils + 5 mils NOLSS-193 Pigmented Black	1750	455	39	1798	344	36	1880	405	36	
NOLSS-193 - 30 mils + 10 mils NOLSS-193 Pigmented Black	1710	432	45	1667	352	40	1635	357	37	
NOLSS-193 - 25 mils + 15 mils NOLSS-193 Pigmented Black	1670	455	68	1758	362	48	1919	408	43	
NOLSS-193 Pigmented Black - 40 mils	1450	410	49	1532	296	45	1703	320	45	
NOLSS-193 - 20 mils	1715	455	68	693	72	86	667	69	117	Badly darkened and bad checking substrate badly rusted
NOLSS-193 - 18 mils + 2 mils - NOLSS-193 Pigmented Black	1720	440	66	1750	349	65	1610	354	67	
NOLSS-193 - 15 mils + 5 mils NOLSS-193 Pigmented Black	1790	450	66	1710	291	72	1585	338	72	
NOLSS-193 - 10 mils + 10 mils NOLSS-193 Pigmented Black	1590	430	65	1608	293	83	1439	312	90	
NOLSS-193 Pigmented Black - 20 mils	1890	410	63	1888	314	72	1710	333	70	

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