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ANTI-CORROSIVE COATINGS FOR MAGNESIUM

II - TIDE LEVEL RESISTANCE

by

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ABSTRACT

This study was undertaken with a view toward providing an anti-corrosive organic finishing system affording a high degree of protection for magnesium and its alloys as used in Naval aircraft. The investigation includes the evaluation of a few existing organic coatings as compared with a number of experimental compositions prepared in the laboratory. An attempt has been made to study likely materials grouped according to their resin composition. It was found necessary to group the composition in this manner due to the large number of formulations involved. This report describes the behavior of all materials when exposed to the ocean at tide level at Miami, Florida, and to weathering, also at Miami. A previous report covering the behavior of the same materials when exposed to Salt Spray was published by this Laboratory on 15 May 1946. From the results of this report as well as those of the Salt Spray Report, recommendations have been made bearing on the future course of this investigation.

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INTRODUCTION

A. Authorization

1. These studies were authorized by Bureau of Aeronautics letter Aer-E-254-AMM/4-1 dated 15 March 1944.

B. Statement of Problem

2. The use of magnesium and its alloys in aircraft construction for Naval use has thus far been restricted to non-structural parts such as instrument panels and for the preparation of some of the engine castings. Possessing about one-third the weight of the alloys of aluminum, magnesium could be of considerable value if its use could be extended to include structural members and skin. The principle drawback preventing this adaptation is magnesium's unusual susceptibility to corrosion, especially in the presence of salt water and salt laden atmospheres. Thus, the development of a suitable protective coating for magnesium would make possible further advancement in the design of Naval aircraft insofar as the use of magnesium is concerned.

3. It is the purpose of this investigation to examine various corrosion inhibitive pigments, several types of vehicles, and other factors affecting the ability of an organic coating to impede the corrosion of magnesium alloys. The results of this work should indicate the future course to be followed in the development of a suitable organic protective coating for magnesium such that this metal may be used more extensively in aircraft construction.

4. The present report describes the preparation of the exposed specimens along with the results obtained from the Tide Level and the Miami weathering exposure. The conclusions and recommendations set forth herein are based on the findings of this report along with a consideration of the findings of the Salt Spray Report on this same subject. (Reference 9)

C. Known Facts Bearing on the Problem

5. The protection of magnesium alloys has been investigated extensively during the past several years. Three general lines of attack have been followed in attempting to render magnesium generally useful in aircraft design. They are: (a) improved alloys; (b) improved surface treatments; and, (c) superior organic protective coatings.

6. The producers of magnesium have done considerable work to improve its corrosion resistance by proper alloying and refinement. It has been fairly well established that the presence of iron, nickel, and copper even in minute amounts, will cause an otherwise good alloy to exhibit poor resistance to corrosive influences. The manufacturers of magnesium are constantly striving to produce alloys extremely low in these objectionable metals.

7. Until the last few years the principal surface treatments for magnesium have consisted of hot chemical dips which produce a surface coating considerably more resistant to corrosion than the untreated metal. The principal objection to such treatments is the fact that the coating does not form a tightly adhering layer. In fact it is possible to remove it by lightly rubbing the surface. To overcome this deficiency anodic treatments have been developed which exhibit superior

corrosion resistance and which form a **tightly** adhering layer which can be removed only by cutting into the metal with a sharp edge. Considerable research is under prosecution currently to improve surface treatments and it is predicted that much can be done to advance the corrosion resistance of magnesium alloys in this manner.

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8. The third method used for protecting corrodable magnesium surfaces is through the application of organic films. The research staffs of numerous paint manufacturers have devoted considerable time and effort toward the development of a system offering maximum protection to magnesium and its alloys. The consensus of representatives of a number of organizations working in this field is that the composition and the purity of the alloy is of considerably more importance than the quality of any applied high grade organic coating system. Published reports on this subject (references 1-8) demonstrate that a good zinc chromate primer such as that described by Army-Navy Specification AN-TT-P-656B followed by adequate topcoats of high grade alkyd enamel or pyroxilyn lacquer offers fair protection. Thus, one phase of our problem is resolved to the selection of the optimum system from those available. To this end selected proprietary systems, with which the laboratory has had previous experience, were included in this investigation.

METHODS

A. Materials

9. The materials used in this research were of standard commercial grades and were provided by reputable manufacturers.

10. The magnesium alloys for this experiment were obtained from three sources, namely: Dow Chemical Company; American Magnesium Company; and Revere Copper and Brass Company. Alloys FS-1H of the Dow and Revere Companies, and AMC-52S of the American Magnesium Company were selected since they meet the requirements of Navy Specification 47M2, alloy 18, and are among the most readily available alloys adaptable to aircraft construction. The composition of these alloys as received from each manufacturer is shown in Table I. The magnesium sheets from the Dow and Revere Companies were received in untreated condition except for a film of grease normally applied for preservation prior to fabrication. The magnesium sheets from the American Magnesium Company had been chrome-pickled. By means of a die the sheets were cut into convenient size for panels. (See Plate I for illustration) The finished panels consisted of two sections as illustrated, riveted together, thus forming a panel of 7 X 12 inches and containing a one-inch lap. This construction was selected in order to simulate skin construction in aircraft. Before riveting, a coat of primer was applied to each section of the panel with an extra coat going into the lap. Aluminum rivets were used. The corners and edges of all panels were radiused to reduce the possibility of inducing corrosion around improperly protected sharp edges which are difficult to coat. By selecting a single type of alloy as produced by several manufacturers, it was hoped to develop information on the relative resistance to corrosion of this alloy when produced under slightly different conditions, thus having slight variations in composition.

TABLE I

Composition of Alloys

	<u>Dow Chemical Co.</u>	<u>Amer. Mag. Co.</u>	<u>Revere Copper & Brass Co.</u>
Rec'd condition	Oiled	Chrome pickled*	Oiled
Designation	FS-1H	AMC-52S	FS-1H
Aluminum	2.78%	2.72%	2.72%
Zinc	1.11	0.97	1.25
Manganese	0.47	0.23	1.16
Silicon	0.01	0.01	0.01
Copper	0.008	0.008	0.014
Iron	0.002	0.002	0.001
Chromium	None	0.03	None
Nickel	None	None	None
Magnesium	balance	balance	balance

* boiled in KOH solution and then given regular sealed chrome pickel treatment.

11. The pigments selected for inclusion in this study are listed in Table II, along with their source and manufacturer's code number where known. Also included are some C.P. grade chemicals which have been reported as contribution to corrosion inhibition.

TABLE II

Pigments

<u>Code</u>	<u>Name</u>	<u>Manufacturer</u>
Y467D	Zinc Yellow	E. I. duPont de Nemours & Co. Inc.
X-2082	Zinc Yellow	Imperial Color and Pigment Co.
X-2127	Zinc Yellow	Imperial Color and Pigment Co.
	Strontium Chromate	Kentucky Color and Pigment Co.
	Zinc Chromium Selenate	Kentucky Color and Pigment Co.
721	Zinc Tetroxy Chromate	New Jersey Zinc Company
	Ferrous Ammonium Phosphate	E. I. duPont de Nemours & Co. Inc.
1085	Lead Chromate	Reichhold Chemicals, Inc.
	Lead Sulfate	J. T. Baker Co. C.P.
	Potassium Chromate	J. T. Baker Co. C.P.
	Barium Chromate	J. T. Baker Co. C.P.
	Calcium Chromate	J. T. Baker Co. C.P.
	Magnesium Chromate	J. T. Baker Co. C.P.
	Magnesium Sulfate	J. T. Baker Co. C.P.

12. As a matrix in which to study the pigments of Table II the vehicle specified in Specification An-TT-P-656B (Zinc Chromate Primer) was selected.

13. Although the major effort to improve protection against corrosion was concentrated in the development or selection of superior primers, several standard, and

two experimental topcoats were used over the experimental primers. These standard topcoats are listed in Table III along with the two experimental formulations developed in the laboratory for this experiment.

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TABLE III

Standard Topcoat Compositions

duPont Light Gray Lacquer, Spec. AN-L-21 (Flat)
 duPont Sea Blue Lacquer, Spec. AN-TT-L-51 (Gloss)
 duPont Light Gray Alkyd Enamel, Spec. AN-E-7 (Flat)
 duPont Sea Blue Alkyd Enamel, Spec. AN-E-3 (Gloss)
 United Chromium, Inc. Ucilon Gray

Experimental Topcoats

<u>EV-1</u>		<u>EK-1</u>	
Titanium Dioxide (Rutile)	157 gms.	Carbon Black	10 gms.
Iron Blue	91	Titanium Dioxide (Rutile)	30
Iron Oxide	40	Iron Blue	207
Carbon Black	47	Acryloid B-72	1034
Xylol	370	Acryloid B-75	1377
Vinylite I	867	Xylol	291
Methyl iso-butyl Ketone	335		
	<u>1907</u>		<u>2949</u>

B. Experimental Procedure

14. At the outset it was recognized that this problem does not lend itself to a rapid solution due to the fact that accelerated laboratory tests for corrosion resistance are not too adequate or reliable, particularly where organic coatings are employed as a protective medium. The major portion of the experimental data must be obtained from prolonged outdoor exposure to conditions similar to those likely to be encountered in actual service. Outstanding among these outdoor tests is the tide range exposure during which the panel is mounted on a rack at the edge of the ocean in such a manner as to be entirely submerged at high tide, and completely exposed to the air at low tide. This experiment conducted at Miami, Florida, for a minimum period of six months constitutes the most severe test to which the systems are subjected. The major portion of the data of this report was obtained from this test, and it should predict actual service performances quite accurately.

15. To supplement the results obtained from tide range evaluation, panels were prepared for exposure to the industrial atmospheres of Philadelphia and Norfolk, and for land rack exposure at Miami, Florida. An additional set of panels were exposed to the normal atmosphere on the laboratory roof in Washington, D. C. However, the Washington test was discontinued after six months as no appreciable change in any system was apparent. Another set of panels covering the phenolic primers was prepared for exposure in a National Carbon Accelerated Weathering unit. This test was discontinued after several weeks inasmuch as no changes were apparent in any of the systems under study. Still another set of panels was prepared for exposure to the accelerated salt spray test. The results of this test were the

subject of a previous report, Anti-Corrosive Coatings for Magnesium, I - Salt Spray Resistance, dated 15 May 1946. (Reference 9)

16. In September, 1945, a hurricane hit the South Florida Coast during which a majority of the tide range panels were lost after having been exposed for only a few months without showing any significant results. In order to replace the lost panels, and inasmuch as the duplicate set of panels exposed to the weather at Washington, D. C. had shown practically no evidence of deterioration, this set was sent to Florida where they were placed on tide range exposure. It is from this set of panels that the data on tide level exposure were obtained.

D. Formulations

17. To facilitate the planning, preparation, and evaluation of formulations selected for this study, the formulas were classified into groups based on the type vehicle used in their preparation. The first series composed of phenolic primers and designated as the Phenolic Series contained formulations using phenolic resins exclusively. A similar group known as the Alkyd Series was prepared on the bases of alkyd resins. Primer formulations based on vinyl, acrylate, and furane resins were grouped together in the series which was designated as the Miscellaneous Series. The phase of this study concerned with the evaluation of inhibitive pigments employed the vehicle of AN-TT-P-656B consisted of primers designated as the Standard Series. Each series was exposed together and will be considered individually before comparison with each other.

18. Complete formulation data on all experimental primers are contained in Tables IV through IX. The composition or source of each vehicle is listed in Tables IV and V. The vinylite formulations and the formula for Lacquer I referenced in Table IX are shown in Table V. Reference should be made to Tables IV through IX for all information related to the details of composition. However, abbreviated data adequately identifying each experimental formula are contained in the tables of exposure data to enable the reader to follow the course of the behavior of each class of compounds during exposure.

DATA OBTAINED AND DISCUSSION

19. The panels of this experiment were divided into four major groups according to their resin content. Therefore, in the presentation of data and the subsequent discussion, each group will first be considered individually, and then finally, a comparison between groups will be made. Where possible a comparison or an evaluation of each of the following will be made:

- (1) Topcoats
- (2) Pigments
- (3) Resin content of the various vehicles
- (4) Variation of the Pigment-Volume relationship
- (5) Alloys by Dow, American Magnesium and the Revere Companies

20. A system of numbers was used to designate the extent of deterioration of the organic films and the subsequent corrosion of the magnesium alloy. These numbers range from ten (10) down to zero (0), and are defined as follows:

- 10 - No corrosion
- 9 - Evidence of corrosion on edge of panel
- 8 - Evidence of corrosion or small blisters forming away from edge of panel (first failure of the organic film)

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- 7 - Definite evidence of corrosion through film
- 6 - Corrosion spots spreading with exposure of the metal or corrosion product
- 5 - Failure of film - 1 to 5% of panel
- 4 - Failure of film - 5 to 10% of panel
- 3 - Failure of film - 25% of panel
- 2 - Failure of film - 50% of panel
- 1 - Complete failure of film with corrosion of 75% of panel
- 0 - Film and most of panel destroyed

21. While the above numbers are defined for the evaluation of corrosion, the same system was used for grading the general appearance of the organic films. In the latter case the degree of chalking, fading, checking, alligating, peeling, and color retention were the chief considerations. Therefore, the system of numbers evaluates in this case the relative appearance of the film as compared to its appearance when new.

A. Phenolic Series

22. This series is so designated because each of the experimental primers is based on a phenolic resin as the principal and common binder ingredient. Complete data on the formulation of these phenolic primers is found in Table VI. Tables X, XI and XII briefly outline the composition of each primer and also present the data obtained from both Tide Level exposure and Weather exposure at Miami, Florida. Table XIII gives the data for the comparison of the alloys of the three different manufacturers. Plates 2 and 3 are photographs of the panels after their return to the laboratory.

23. Topcoats Evaluation - From an inspection of the panels after their return to the laboratory, and a study of the data it was evident that the enamel topcoat was superior to the lacquer topcoat insofar as general appearance was concerned. This was strikingly true in the comparison of the color retention properties of the enamel versus the lacquer. The enamel had retained its initial blue color, through with some loss of gloss, but the lacquer had turned brown. It was, however, possible to remove this brown surface on the lacquer by vigorous rubbing and washing. There was no noticeable difference between the enamel and the lacquer insofar as protection against corrosion was concerned. (These results confirm the findings on this same subject made in the Salt Spray Report. (See reference 9))

24. Variation of the Pigment-Volume Relationship - Panels 16 to 21 inclusive, and 38 to 43 inclusive were coated with films having P-V concentrations ranging from 35% to 60% inclusive. Results of this test do not indicate any appreciable difference in the degree of protection offered by any particular pigment-volume concentration as compared to another. Of those panels having the lacquer topcoat no difference could be seen. In the case of the enamel topcoat, panel 43 was slightly superior to the others, but it is doubtful that this is sufficient evidence to say that a pigment-volume concentration of 60% offers the most protection to magnesium. Whatever differences which might have appeared as a result of the variable pigment-volume relationship were obscured by the high quality of the resinous binder and the topcoats. Further investigation of this phase of the problem will be necessary before an optimum pigment-volume concentration can be designated. Here again, the previous findings of the Salt Spray Report, (reference 9) are confirmed.

25. Resin Modification - It will be noted from Tables X, XI and XII that phenolic

resins of several modifications have been used in this experiment. This was done in an effort to evaluate the degree of polymerization and oil length as properties affecting the quality of the primer insofar as its protection of magnesium is concerned. Inspection of the panels at the conclusion of their exposure, and study of the data failed to reveal any differences between the several modifications of phenolic resin primers. Here again, other factors such as the high quality of the topcoats, may have overshadowed slight differences in the quality of the resins. This result confirms the previous similar result found as a result of the Salt Spray Test (reference 9).

26. Pigment Comparison - In view of the fact that it will be shown later in this report that zinc tetroxy chromate is an inferior pigment in the presence of alkyd type binders, it is very noteworthy that this same pigment shows up quite well in the presence of phenolic type binders. Zinc tetroxy chromate exhibits no marked superiority to the other pigments used in the Phenolic Series, but it is at least equal to any of them. Zinc chromate, strontium chromate, and zinc chromium selenate all show up favorably as pigments, there being little if any difference between them. On the other hand, the combination of zinc dust and zinc oxide comprised a very poor choice. If anything, corrosion was accelerated by this combination. These results are also confirmed by those of the Salt Spray Report, (reference 9).

27. Magnesium Alloy Comparison - In this phase of the experiment magnesium alloys from three manufacturers were used, (Dow, American Magnesium, and Revere). At the conclusion of the experiment it was very evident that the Revere Alloy was much more susceptible to corrosion than were those from the Dow and American Magnesium Companies. The latter two alloys performed well, with the one from the American Magnesium Company showing a slight superiority over the other. These facts are well illustrated by the data of Table XIII, and the photograph, Plate 4. Study of the chemical analyses of the three alloys, Table I, shows the Revere metal to contain much greater quantities of copper, manganese, and zinc than do the other two alloys. The significant conclusion from this phase of the experiment is that not even a good organic coating will protect an improperly constituted alloy. This result is also confirmed by the Salt Spray Report, (reference 9).

B. Alkyd Series

28. This series is based on primers having an Alkyd Resin as their principal binder ingredient. Complete data as to their composition may be found in Table VII along with two proprietary materials which were included in this study at the request of the Bureau of Aeronautics. The exposure data for this series will be found in Tables XIV, XV and XVI, while Plates 5 and 6 show the panels at the completion of the experiment.

29. Topcoat Evaluation - In this series, as in the Phenolic Series, all primers were applied in duplicate, one being covered with a lacquer topcoat while the other was covered with an enamel topcoat. Again the enamel topcoat shows up superior to the lacquer. The principle difference between the two is in color retention, the enamel remaining blue, though with loss of gloss, while the lacquer has been covered with a brown film.

30. Resin Comparison - It will be noted that in this series, primers employing five different resins were used, and that four different pigments were used in conjunction with each resin. A study of the data of Tables XIV, XV and XVI and

inspection of the panels at the completion of their exposure clearly show Beckosol No. 1 to be inferior to the other resins examined. Under the lacquer topcoat, the vehicle of the standard primer (control) was superior to the experimental vehicles. However, in conjunction with the enamel topcoat it appears that Glyptal, Z.V. 3293 is the best vehicle, being slightly superior to the standard primer. Rezyl 728-5, Beckosol No. 1313, and Beckosol No. 1320 are about equal in their performance.

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31. Effect of Long Grinding and Addition of Small Amounts of Maleic Acid - In an effort to determine what effect, if any, extra grinding and the addition of small amounts of maleic acid (surface active material) would have on the quality of primers, four experimental primers were prepared using Zinc Chromate as a pigment, and using resins, Rezyl 728-5, and Beckosols No. 1, No. 1313, and No. 1320. (Glyptal Z.V. 3293 was not used). These primers were ground one week instead of the usual 48 hours, and small amounts of maleic acid were added to them. Examination of the panels after exposure indicates, in the case of the lacquer topcoat, no advantage for this technique, but some improvement in the quality of the primers is apparent when used in conjunction with the enamel topcoat. In general, it appears that long grinding and the use of maleic acid are of some benefit. (This conclusion also is confirmed by the Salt Spray Report).

32. Pigment Comparison - Inspection of the panels and the exposure data (Tables XIV, XV and XVI) clearly indicate that zinc tetroxy chromate is inferior to zinc chromate, strontium chromate, and zinc chromium selenate when used in an alkyd matrix. Since this same pigment stood out as an excellent one in the phenolic series, one might conclude that zinc tetroxy chromate is inferior only when used in conjunction with an alkyd resin. The remaining three pigments performed in equal fashion, no one standing out as superior to the others.

33. Alloy Comparison - As in the Phenolic Series, the Revere Alloy was far inferior to the Dow and the American Magnesium Alloys. The latter two again performed well with the American Magnesium Alloy showing a slight edge over the Dow Alloy. (Refer to Table XVII for the data on this phase of the experiment. Also, see Plate 7)

C. Standard Series

34. This series is so designated because the standard vehicle of primer AN-TT-P-656B is used throughout while the pigment is varied. The primary object of the study of this group of formulations was to establish the relative characteristics of a number of inhibitive pigments when incorporated into the standard vehicle of zinc chromate primer, AN-TT-P-656B. In each case the pigment of the standard primer was replaced on a volume basis with one of the experimental pigments. Exposure panels were prepared in sets of four, each of which was finished with a different topcoat. In addition to the gloss lacquer (AN-TT-L-51) and the gloss enamel (AN-E-3), used heretofore, systems were included which employed flat lacquer (AN-L-21) and flat alkyd enamel (AN-E-7). While permitting the usual observations these systems also offer a comparison of a glossy versus flat finishing coat.

35. Full information concerning the composition of each formulation of this group will be found in Table VIII. Tables XVIII to XXIII inclusive contain data on the condition of the panels as they were exposed, and Plates 8, 9 and 10 show the panels at the completion of the experiment.

36. Topcoat Evaluation - Once again the enamel topcoat proved to be superior to the lacquer topcoat. In the comparison of the flat lacquer with the gloss lacquer there appeared to be little difference in the overall qualities of each. The flat gray lacquer showed better color retention, but a gray chalky film had formed on this

lacquer, and in addition many of the panels had a heavy deposit of some form of fouling upon them. Vigorous washing and rubbing would remove this deposit. The glossy blue lacquer was covered with a dull brown film as was the case in previous tests. In the case of the flat and gloss enamels, the superiority of the gloss enamel was quite evident. The flat, gray enamel appeared about the same as the flat lacquer with the exception of the chalky film. Several of the flat finished panels (both lacquer and enamel) were cleaned in spots, and it was noted that the fouling on these panels had caused some pitting of the metal.

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37. Pigment Evaluation - After inspection of the panels and study of the data of this series, the pigments were rated on their inhibitive qualities. In this rating, general appearance has been considered as well as corrosion. These ratings are as follows:

Very Good:-

- Zinc Tetroxy Chromate
- Zinc Chromate (Imp. #2082)
- Calcium Chromate
- Zinc Chromate-90%; Magnesium Chromate-10%
- Zinc Chromium Selenate
- Zinc Chromate (Control DuPont AN-TT-P-656B)
- Zinc Chromate (Imp. #2127)

Good:-

- Strontium Chromate
- Zinc Chromate-90%; Magnesium Oxide-10%

Fair:-

- Zinc Chromate (Imp. X2082)
- Zinc Chromate (Imp. X2127)
- Zinc Chromate-90%; Magnesium Sulfate-10%

Poor:-

- Barium Chromate
- Potassium Chromate

Very Bad:-

- Lead Chromate
- Lead Sulfate

38. With the single exception of zinc tetroxy chromate the evaluation of the above pigments substantiates the findings of the Salt Spray Report. The very high position of zinc tetroxy chromate is somewhat surprising in view of its indicated poor value as a pigment in the Alkyd Series Tests of this report. Explanation of this pigments good showing in this phase of the experiment may lie in the fact that the vehicle used is a combination of phenolic and alkyd resins, and it will be recalled that zinc tetroxy chromate appeared very good in the presence of phenolic resins as shown by the Phenolic Series results in this report.

D. Miscellaneous Series

39. This set of experiments comprising three small series of similar type materials was included to observe the role of vehicles not commonly employed for this type of application when exposed simultaneously with more orthodox systems. In the case

of each vehicle evaluated a primer was formulated using several anti-corrosive pigments. The exact formulation of each group is indicated in Table IX, while a qualitative formula along with the exposure data are presented in Tables XXIV to XXIX inclusive. Plates 11 and 12 show the panels at the completion of the experiment.

40. Vinyl Group - Of this group the combination of Vinyl Resins VMCH-VYHH proved far superior to either the XYHL or AYAF. The VICH-VYHH also proved to be better than the control coatings. Zinc tetroxy chromate stood out as an inferior pigment in combination with vinyl resins.

41. Acryloid Group - This entire group of panels withstood the tests in excellent manner, their performance being at least equal to if not superior to the standard control primer. Acryloids B-72 and B-75 do not show any superiority over Acryloid A-10 modified with nitrocellulose as was the case in the Salt Spray Test. The performance of all the pigments in conjunction with the acryloid resins appear to be about equal.

42. Furane Group - The performance of this group was inferior to the standard control primer, and also many of the experimental primers.

E. General Comparison of All Series

43. Collective consideration of all the panels and their primers subjected to these exposure tests indicates that the Phenolic Group is slightly superior in quality to all except the Acryloids. In view of the relatively high cost of the acrylic resins it appears that the phenolic type primers offer the most promise for the development of an ideal primer for magnesium. The standard series was slightly inferior to the phenolics, but slightly better than the alkyds. Vinyl VMCH-VYHH appeared to be on a par with the phenolics, but the remaining vinyls and the furanes were inferior primers.

CONCLUSIONS

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44. Throughout the discussion of data, certain conclusions were reached insofar as a particular series was concerned. The following remarks are believed justified when considering collectively all the phases of this experiment as well as the results of the preceding report on this same subject - Salt Spray Resistance (reference 9).

(a) Slight variations in the composition of the magnesium alloy may lead to alloys which are very susceptible to corrosion. The presence of copper, manganese, and zinc apparently contributes to this increased susceptibility to corrosion. It is therefore essential that a suitable alloy be selected and its composition strictly controlled, for even the highest quality organic coating will not protect a poorly constituted alloy. Of the three alloys tested, the one from the American Magnesium Company is slightly superior to the Dow alloy, and far superior to the Revere alloy.

(b) Between the limits of normal practice the pigment-volume relationship is not critical in the formulation of anti-corrosive primers for magnesium.

(c) Differences arising from varying oil lengths and degree of polymerization of phenolic resin varnishes used in magnesium primers do not assume significant proportions.

(d) Zinc Dust has no place in the formulation of anti-corrosive primers for magnesium. Other pigments which appear to be, at best, only poor inhibitors of corrosion are, lead sulfate, lead chromate, potassium chromate and barium chromate.

(e) Pigments exhibiting good anti-corrosive properties are Zinc Chromate, Strontium Chromate, Zinc Chromium Selenate, Calcium Chromate, and when used in conjunction with phenolic resins, Zinc Tetroxy Chromate. It also appears that some improvement may be gained by the addition of small amounts of magnesium salts, particularly magnesium chromate, to primers containing the pigments listed above.

(f) Long grinding and the addition of anti-settling or dispersing agents such as maleic acid bring about a slight improvement in the quality of the primer. However, since the amount of improvement is small, further study of this technique should be made in order to determine whether it is definitely worthwhile.

(g) At least some of the acrylic and vinyl resins may be used in conjunction with a good pigment in order to formulate a good anti-corrosive primer for magnesium. However, these resins do not show any outstanding superiority to the alkyd and phenolic combinations of matrices, and therefore are not likely to supercede them.

(h) The phenolic resin primers are slightly superior to the alkyd resin primers.

(i) Alkyd enamel topcoats proved to be superior to lacquer type topcoats. The difference was especially noticeable in the case where an alkyd primer was used under the two respective topcoats. This would indicate that the degree of compatibility between topcoat and primer may be of considerable importance in determining the overall protective qualities of a topcoat-primer system.

RECOMMENDATIONS

25. It is recommended that the future course of investigation toward the development of a high quality organic protective coating system for magnesium be along the following lines:

- (a) The development of a vehicle of the phenolic type for a primer of superior quality.
- (b) The determination of which pigment of the following five has the best corrosion inhibitive properties:
 - (1) Zinc Chromate
 - (2) Strontium Chromate
 - (3) Zinc Chromium Selenate
 - (4) Calcium Chromate
 - (5) Zinc Tetroxy Chromate (when used with phenolic type vehicles)
- (c) Investigation of the role of the magnesium salts, particularly magnesium chromate, in the formulation of anti-corrosive primers.
- (d) Further evaluation of the use of maleic acid and similar dispersing agents in the formulation of anti-corrosive primers.
- (e) Studying the effect of compatability between topcoats and primers on the overall anti-corrosive properties of a coating system for magnesium.
- (f) Selection of a magnesium alloy of minimum susceptibility to corrosion, and upon which an organic coating system will show its best qualities.

TABLE IV
COMPOSITION OF VEHICLES
PHENOLICS

<u>Code</u>	<u>Manufacturer</u>	<u>Type Resin</u>	<u>Type Oil</u>	<u>Oil Length</u>	<u>Solvent</u>
VF-803	Bakelite Corp.	tert-butyl phenolic	Dehydrated Castor	15 gals.	Min. Spts.
VF-842	" "	p-phenyl phenolic	" "	25 gals.	Min. Spts. & Xylol
VF-862	" "	tert-butyl phenolic	" "	25 gals.	Min. Spts.
VF-893	" "	p-phenyl phenolic	" "	15 gals.	Xylol
XK-16302	" "	Dispersion			Pet. Naphtha

ALKYDS

Rezyl 728-5	Am. Cyanamid	Congo mod. glycer.Phth.		Medium	Xylol
Beckosol No. 1	Reichhold	Oil & phenol mod. alkyd		Medium	
Beckosol No. 1313	"	glyceryl phtalate		Medium short	Hyd. Naphtha
Beckosol No. 1320	"	phenol mod. alkyd		short	Xylol
ZV 3293	Gen. Electric	phenolic, rosin & drying oil mod. alkyd	Linseed oil	short	Xylol & VM&P

VINYLS

<u>Code</u>	<u>Manufacturer</u>	<u>Type Resin</u>	<u>Mol. Wt.</u>	<u>Solvent</u>
VMCH	Bakelite Corp.	Copolymer Vinyl Acetate & Vinyl Chloride	10,000	mixed Ketones & Xylol
VYHH	" "	Copolymer Vinyl Acetate & Vinyl Chloride	10,000	mixed Ketones & Xylol
AYAF	" "	Polyvinyl Acetate		mixed alcohols & Ketones
XYHL	" "	Polyvinyl Butyral		mixed alcohols

ACRYLATES

<u>Code</u>	<u>Manufacturer</u>	<u>Type Resin</u>	<u>Solvent</u>
C-10	Resinous Prods.	methyl acrylate	Ethyl Acetate
B-72	" "	73% ethyl methacrylate, 27% methyl acrylate	Toluol
B-75	" "	73% ethyl methacrylate, 27% methyl acrylate	Cellosolve Acetate & Solvesso No. 1

TABLE V
SPECIAL VEHICLES

Vynylite I

VYHH	11.11 oz.
Mesityl Oxide	7.54
Methyl iso-butyl Ketone	14.70
Xylol	2.25
Santicizer M-17	1.58
	<u>37.08</u>

Vynylite II

VMCH	19.03 oz.
Mesityl Oxide	12.91
Methyl iso-butyl Ketone	25.18
Xylol	<u>38.10</u>
	95.22

Vynylite III

AYAF	40 oz.
Ethyl Alcohol	40
Methyl iso-butyl Ketone	52
n-butyl Alcohol	8
	<u>140</u>

Vynylite IV

KYHL	15 oz.
Methanol	40
Ethanol	40
Cellosolve	5
	<u>100</u>

Lacquer I

1/4 sec. N.C.	50 oz.
5-6 sec. N.C.	27
n-butyl Acetate	<u>123</u>
	200

TABLE VI

Composition of Primers-Phenolic Series

Panel No.	Zn Yellow or Other Pigment	Asbestine	VF803 or other Phenolic Resin	XK-16302	Cobalt Naph. (6%)	Lead Naph. (24%)	Xylol	10% Aluminum Stearate
PP-1	Control							
2	550 gms	98 gms	654 gms	181 gms	2.4 gms	4.8 gms	188 gms	78 gms
3	588	105	660 (1)	196	3.2	6.5	192	84
4	590	105	634 (2)	197	2.9	6.3	244	84
5	576	103	664 (3)	192	2.5	4.9	624	82
6	660	118	590	437	2.1	4.5	328	94
7	692	124	561 (2)	442	2.7	5.7	390	100
8	601 (a)	98	654	181	2.4	4.8	208	78
9	580 (b)	96	640	180	2.3	4.8	206	77
10	644 (a)	105	634 (2)	197	2.9	6.3	264	84
11	625 (b)	103	624 (2)	194	2.9	6.2	205	83
12	315 (c)	95	632	178	2.3	4.7	214	76
13	345 (a)(c)	95	632	178	2.3	4.7	234	76
14	550 (d)	98	654	181	2.4	4.8	188	78
15	286 (e)		319	96	1.3	3.0	28	0.5 (4)
16	629	112	614	178	2.3	4.7	213	90
17	698	125	557	157	2.0	4.2	224	100
18	753	135	483	137	1.6	3.8	256	108
19	814	145	442	118	1.5	3.2	234	116
20	872	156	380	105	1.3	2.8	283	125
21	900	161	324	90	1.3	2.6	302	129
22	465 (f)	111	633	175	2.3	4.6	254	84
23	Control							

- (a) Strontium Chromate
 (b) Zinc Tetroxy Chromate
 (c) Plus 158 gms Impedex
 (d) Zinc Chrome Selenate
 (e) Zn dust + 72 gms ZNO
 (f) Zn Yellow + 109 gms ZNO

- (1) VF882
 (2) VF862
 (3) VF893
 (4) Mn Naphthinate

UNCLASSIFIED

TABLE VII

Composition of Primers - Alkyd Series

Panel No.	Inhibitive Pigment (gms)	Asbes-tine (gms)	Alkyd Resin (gms)	BK 3962 (gms)	10% AL Stearate (gms)	6% Co Naphth. (gms)	24% Pb Naphth. (gms)	Xylol (gms)
PA-1	448 (1)	80	702 (5)	161	64	1.8	3.5	320
2	489 (2)	80	702 (5)	161	64	1.8	3.5	471
3	492 (3)	82	715 (5)	163	65	1.8	3.6	412
4	451 (4)	80	702 (5)	161	64	1.8	3.5	321
5	464 (1)	83	704 (6)	166	66	2.3	4.8	183
6	507 (2)	83	704 (6)	166	66	2.3	4.8	183
7	464 (3)	83	704 (6)	166	66	2.3	4.8	183
8	467 (4)	83	704 (6)	166	66	2.3	4.8	183
9	461 (1)	82	822 (7)	165	66	2.1	4.4	126
10	504 (2)	82	822 (7)	165	66	2.1	4.4	126
11	497 (3)	82	822 (7)	165	66	2.1	4.4	132
12	461 (4)	82	822 (7)	165	66	2.1	4.4	126
13	488 (1)	87	788 (8)	175	70	2.1	4.4	367
14	533 (2)	87	788 (8)	175	70	2.1	4.4	387
15	526 (3)	87	788 (8)	175	70	2.1	4.4	387
16	488 (4)	87	788 (8)	175	70	2.1	4.4	367
17	516 (1)	95	656 (9)	190	76	1.3	2.7	247
18	564 (2)	95	656 (9)	190	76	1.3	2.7	247
19	542 (3)	92	641 (9)	185	74	1.3	2.6	264
20	516 (4)	95	656 (9)	190	76	1.3	2.7	247
21	*448 (1)	80	702 (5)	161	64	1.8	3.5	320
22	*464 (1)	83	704 (6)	166	66	2.3	4.8	183
23	*461 (1)	82	822 (7)	165	66	2.1	4.4	126
24	*488 (1)	87	778 (8)	175	70	2.1	4.4	367

25-27 Control

* Contains 1.6 gms Maleic Acid

(1) Zn Yellow

(2) St. Chromate

(3) ZTO

(4) Zinc Chromium Selenate

(5) Rezyl 728-5

(6) Beckosol #1

(7) Beckosol #1313

(8) Beckosol #1320

(9) Glyptal-ZN 3293

TABLE VIII

Composition of Primers - Standard Series

Panel No.	Inhibitive Pigment (gms)	Asbes-tine (gms)	Rezyl 113 (gms)	BK 3962 (gms)	10% Al Stearate (gms)	6% Co Naphth. (gms)	24% Pb Naphth. (gms)	Xylol (gms)
PS-1	521 (1a)	94	673	186	74	2.6	5.4	167
2	564 (2)	94	673	186	74	2.6	5.4	330
3	900 (3)	94	673	186	74	2.6	5.4	280
4	942 (4)	91	659	182	73	2.6	5.4	182
5	427 (5)	94	673	186	74	2.6	5.4	360
6	697 (6)	93	672	186	74	2.6	5.4	167
7	521 (1b)	94	673	186	74	2.6	5.4	360
8	409 (1a) 49 (7)	81	586	162	65	2.3	4.7	503
9	697 (8)	93	672	186	74	2.6	5.4	317
10	520 (9)	94	673	186	74	2.6	5.4	280
11	474 (10)	79	568	157	62	2.2	4.6	300
12	Control							
13	391 (1a) 66 (11)	94	673	186	74	2.6	5.4	610
14	454 (1a) 50 (12)	90	651	180	72	2.5	5.2	188
15	521 (1c)	94	673	186	74	2.6	5.4	360
16*	770 (1c)		990	275	118	5.5	8.2	450
17	770 (1b)		990	275	77	5.5	8.2	481

- * Contains 1.54 gms. Maleic Anhydride
- | | |
|------------------------|----------------------------|
| (1a) Zn Chromate | (6) Barium Chromate |
| (1b) Zn Chromate | (7) Magnesium Oxide |
| (1c) Zn Chromate | (8) Calcium Chromate |
| (2) Strontium Chromate | (9) Zinc Chromium Selenate |
| (3) Lead Chromate | (10) ZTO |
| (4) Lead Sulphate | (11) Magnesium Chromate |
| (5) Potassium Chromate | (12) Magnesium Sulphate |

TABLE IX

Composition of Primers - Miscellaneous Series

Panel No.	Pigmentation		Binder		Thinner	Asbes
	Amount	Pigment	Amount	Item	Amount	Item
PV-1	438 gms	Zn Yellow	2070 gms	Vinylite I&II	313 gms	Xylol 78gms
2	474	Sr Yellow	"	"	363	" 78
3	472	ZTO	"	"	1144	" 78
4	437	ZnCr Selenate	"	"	438	" 78
5	237	Zn Yellow	802	" III	127	" 42
6	258	Sr Yellow	"	"	127	" 42
7	255	ZTO	"	"	160	" 42
8	236	ZnCr Selenate	"	"	127	" 42
9	142	Zn Yellow	864	" IV	50	" 25
10	154	Sr Yellow	"	"	50	" 25
11	151	ZTO	"	"	50	" 25
12	141	ZnCr Selenate	"	"	50	" 25
13	Control (AN-TT-P-656b)					
14	Control Ucilon Primer 405-P					
PK-1	327	Zn Yellow	1326	² Acryloid I	384	⁴ Thinner 58
2	354	Sr Yellow	"	"	384	" 58
3	376	ZTO	"	"	384	" 58
4	326	ZnCr Selenate	"	"	384	" 58
5	644	Zn Yellow	1801	³ Acryloid II	215	Xylol 115
6	597	Sr Yellow	"	"	465	" 115
7	694	ZTO	"	"	215	" 115
8	643	ZnCr Selenate	"	"	215	" 115
PF-1	536	Zn Yellow	800	Duralon 4	48	m-iso-butyl Ketone 96

1 - 580 gms Vinylite I
1490 gms Vinylite II

2 - 60 gms Lacquer I
1266 gms Acryloid C-10

3 - 1035 gms Acryloid B-72
766 gms Acryloid B-75

4 - 35 gms Ethyl Lactate
327 gms n-Butyl Acetate
25 gms Ethyl Acetate
47 gms Dibutyl Phthalate

TABLE X

TIDE LEVEL EXPOSURE OF PHENOLIC SERIES - CORROSION

Primer	Gloss Lacquer Topcoat							Gloss Enamel Topcoat								
	Panel No.	Months Exposure						Final	Panel No.	Months Exposure						Final
Jones Dabney #3122 Zn.Cr. Primer	P-1	10	10	9	9	9	9	9	P-23	10	10	10	10	9	9	9
Zn. Yellow in 15 gal.tert.butyl phenolic vehicle	2	10	10	10	9	9	9	9	24	10	10	10	10	9	9	9
Zn. Yellow in 25 gal. p-phenolic vehicle	3	10	10	10	10	9	9	9	25	10	10	10	10	10	9	9
Zn. Yellow in 25 gal.tert.butyl phenolic vehicle	4	10	10	10	10	9	9	9	26	10	10	10	10	10	10	10
Zn. Yellow in 15 gal. p-phenolic vehicle	5	10	10	10	10	9	9	9	27	10	10	10	10	9	9	8
As PP-2 with twice the disp. resin	6	10	10	9	9	9	9	8	28	10	10	10	10	9	9	8
As PP-4 with twice the disp. resin	7	10	9	9	9	9	9	9	29	10	10	10	10	10	10	10
Sr.Cr. in 15 gal.tert.butyl phenolic vehicle	8	10	10	10	10	9	9	9	30	10	10	10	9	9	9	9
ZTO Cr. in 15 gal.tert.butyl phenolic vehicle	9	10	10	10	10	9	9	9	31	10	10	10	10	10	9	9
Sr.Cr. in 25 gal.tert.butyl phenolic vehicle	10	10	10	10	10	9	9	9	32	10	10	10	10	10	9	9
ZTO Cr. in 25 gal.tert.butyl phenolic vehicle	11	10	10	10	10	10	10	10	33	10	10	10	10	9	9	9
Zn. Yellow Ferr.Amm.Phos. in 15 gal.tert.butyl phenolic vehicle	12	10	10	10	10	9	9	9	34	10	10	10	10	10	9	9
Sr.Cr.Ferr.Amm.Phos. in 15 gal.tert.butyl phenolic vehicle	13	10	10	10	10	9	9	9	35	10	10	10	9	9	8	8
Zn.Cr. Selenate in 15 gal.tert.butyl phenolic vehicle	14	10	10	10	10	9	9	9	36	10	10	10	10	9	9	9
Zn. dust and ZnO in 15 gal.tert.butyl phenolic vehicle	15	5	2	0	0	0	0	0	37	5	2	0	0	0	0	0
As PP-2 at 35% p.v.c.	16	10	10	10	10	10	9	9	38	10	10	9	9	9	8	8
As PP-2 at 40% p.v.c.	17	10	10	10	10	10	9	9	39	10	10	9	9	9	8	8
As PP-2 at 45% p.v.c.	18	10	10	10	10	10	9	9	40	10	9	9	9	9	8	8
As PP-2 at 50% p.v.c.	19	10	10	10	10	10	9	9	41	10	10	9	9	9	9	8
As PP-2 at 55% p.v.c.	20	10	10	9	9	9	9	9	42	10	10	10	9	9	8	7
As PP-2 at 60% p.v.c.	21	10	10	9	9	9	8	8	43	10	10	10	10	10	9	9
Similar to PP-2	22	10	10	10	10	10	9	9	44	10	10	10	9	9	9	9
DuPont Spec. AN-TT-P-656B	46	10	10	10	9	9	9	9	45	10	10	10	9	9	9	9

* Panel rated upon return to Laboratory.

TABLE XI

TIDE LEVEL EXPOSURE OF PHENOLIC SERIES - GENERAL APPEARANCE

	Gloss Lacquer Topcoat						Gloss Enamel Topcoat									
	Panel No.	Months Exposure					Final	Panel No.	Months Exposure					Final		
		1	2	3	4	5	6		1	2	3	4	5	6		
<u>Primer</u>																
Jones Dabney #3122 Zn.Cr. Primer	P-1	9	7	7	6	6	5	6	P-23	9	8	7	7	7	7	7
Zn. Yellow in 15 gal.tert.butyl phenolic vehicle	2	9	7	7	6	6	6	6	24	9	8	7	7	7	7	7
Zn. Yellow in 25 gal. p-phenolic vehicle	3	9	7	7	6	6	6	6	25	9	8	7	7	7	7	7
Zn. Yellow in 25 gal.tert. butyl phenolic vehicle	4	9	7	7	6	6	6	6	26	9	8	7	7	7	7	7
Zn. Yellow in 15 gal. p-phenolic vehicle	5	9	7	7	6	6	6	6	27	9	8	7	7	7	7	7
As PP-2 with twice the disp. resin	6	9	7	7	6	6	6	6	28	9	8	7	7	7	7	7
As PP-4 with twice the disp. resin	7	9	7	7	6	6	6	6	29	9	8	7	7	7	7	7
Sr.Cr. in 15 gal.tert.butyl phenolic vehicle	8	9	7	7	6	6	6	6	30	9	8	7	7	7	7	7
ZTO Cr. in 15 gal.tert.butyl phenolic vehicle	9	9	7	7	6	6	6	6	31	9	8	7	7	7	7	7
Sr.Cr. in 25 gal.tert.butyl phenolic vehicle	10	9	7	7	6	6	6	6	32	9	8	7	7	7	7	7
ZTO Cr. in 25 gal.tert.butyl phenolic vehicle	11	9	7	7	6	6	6	6	33	9	8	7	7	7	7	7
Zn. Yellow Ferr.Amm.Phos. in 15 gal.tert.butyl phenolic vehicle	12	9	7	7	6	6	6	6	34	9	8	7	7	7	7	7
Sr.Cr.Ferr.Amm.Phos. in 15 gal.tert.butyl phenolic vehicle	13	9	7	7	6	6	6	6	35	9	8	7	7	7	7	7
Zn.Cr.Selenate in 15 gal.tert.butyl phenolic vehicle	14	9	7	7	6	6	6	6	36	9	8	7	7	7	7	7
Zn. dust and ZnO in 15 gal.tert.butyl phenolic vehicle	15	6	6	0	0	0	0	0	37	6	6	0	0	0	0	0
As PP-2 at 35% p.v.c.	16	9	7	7	6	6	6	6	38	9	8	7	6	6	6	6
As PP-2 at 40% p.v.c.	17	9	7	7	6	6	6	6	39	9	8	7	6	6	6	6
As PP-2 at 45% p.v.c.	18	9	7	7	6	6	6	6	40	9	8	7	6	6	6	6
As PP-2 at 50% p.v.c.	19	9	7	7	6	6	6	6	41	9	8	7	7	7	7	6
As PP-2 at 55% p.v.c.	20	9	7	7	6	6	6	6	42	9	8	7	7	7	7	5
As PP-2 at 60% p.v.c.	21	9	7	7	6	6	6	6	43	9	8	7	7	7	7	7
Similar to PP-2	22	9	7	7	6	6	6	6	44	9	8	7	7	7	7	7
DuPont Spec. AN-TT-P-656B	46	8	7	6	4	3	2	6	45	9	8	7	7	7	7	7

TABLE XII

MIAMI WEATHER EXPOSURE OF PHENOLIC SERIES - GENERAL APPEARANCE

	Gloss Lacquer Topcoat							Gloss Enamel Topcoat								
	Panel No.	Months Exposure						Final	Panel No.	Months Exposure						Final
		2	4	6	8	10	12			2	4	6	8	10	12	
<u>Primer</u>																
Jones Dabney #3122 Zn.Cr. Primer	P-1	10	8	7	6	6	5	5	P-23	10	8	7	7	7	6	6
Zn. Yellow in 15 gal.tert.butyl phenolic vehicle	2	10	8	7	6	6	5	5	24	10	8	7	7	7	6	6
Zn. Yellow in 25 gal. p-phenolic vehicle	3	10	8	7	6	6	5	5	25	10	8	7	7	7	6	6
Zn. Yellow in 25 gal.tert.butyl phenolic vehicle	4	10	8	7	6	6	5	5	26	10	8	7	7	7	6	6
Zn. Yellow in 15 gal. p-phenolic vehicle	5	9	8	7	6	6	5	5	27	10	8	7	7	7	6	6
As PP-2 with twice the disp. resin	6	10	8	7	6	6	5	5	28	10	8	7	7	7	6	6
As PP-4 with twice the disp. resin	7	10	8	7	6	6	5	5	29	10	8	7	7	7	6	6
Sr.Cr. in 15 gal.tert.butyl phenolic vehicle	8	10	8	7	6	6	5	5	30	10	8	7	7	7	6	6
ZTO Cr. in 15 gal.tert.butyl phenolic vehicle	9	10	8	7	6	6	5	5	31	10	8	7	7	7	5	5
Sr.Cr. in 25 gal.tert.butyl phenolic vehicle	10	10	8	7	6	6	5	5	32	10	8	7	7	7	6	6
ZTO Cr. in 25 gal.tert.butyl phenolic vehicle	11	10	8	7	6	6	5	5	33	10	8	7	7	7	6	6
Zn. Yellow Ferr.Amm.Phos. in 15 gal.tert.butyl phenolic vehicle	12	10	8	7	6	6	5	5	34	10	8	7	7	7	6	6
Sr.Cr.Ferr.Amm.Phos. in 15 gal.tert.butyl phenolic vehicle	13	10	8	7	6	6	5	5	35	10	8	7	7	7	6	6
Zn.Cr. Selenate in 15 gal.tert.butyl phenolic vehicle	14	10	8	7	6	6	5	5	36	10	8	7	7	7	6	6
Zn. dust and ZnO in 15 gal.tert.butyl phenolic vehicle	15	10	8	7	6	6	5	5	37	10	8	7	7	7	6	6
As PP-2 at 35% p.v.c.	16	10	8	7	6	6	5	5	38	10	8	7	7	6	5	5
As PP-2 at 40% p.v.c.	17	10	8	7	6	6	5	5	39	10	8	7	7	6	5	5
As PP-2 at 45% p.v.c.	18	10	8	7	6	6	5	5	40	10	8	7	7	6	5	5
As PP-2 at 50% p.v.c.	19	10	8	7	6	6	5	5	41	10	8	7	7	6	5	5
As PP-2 at 55% p.v.c.	20	10	8	7	6	6	5	5	42	10	8	7	7	6	5	5
As PP-2 at 60% p.v.c.	21	10	8	7	6	6	5	5	43	10	8	7	7	6	5	5
Similar to PP-2	22	10	8	7	6	6	5	5	44	10	8	7	7	6	5	5
DuPont Spec. AN-TT-P-656B	46	10	8	7	6	6	5	5	45	10	8	7	7	7	4	5

TABLE XIV
TIDE LEVEL EXPOSURE OF ALKYD SERIES - CORROSION

Resins	Pigments	Gloss Lacquer Topcoat						Gloss Enamel Topcoat									
		Panel No.	Months Exposure						Panel No.	Months Exposure							
			1	2	3	4	5	6		1	2	3	4	5	6		
Rezyl 728-5	Zinc Chromate	A-1	10	9	9	9	8	8	8	A-25	10	10	9	9	8	8	8
	Zinc Chromate*	21	10	10	9	9	8	8	8	45	10	10	10	10	9	9	9
	Sr. Chromate	2	10	10	10	9	8	7	7	26	10	10	10	9	9	8	7
	ZTO Chromate	3	10	10	9	9	8	7	6	27	10	10	10	9	8	7	6
	Zn.Cr.Selenate	4	10	10	10	10	8	8	8	28	10	9	9	9	8	8	8
Beckosol #1	Zinc Chromate	5	9	8	8	8	8	7	7	29	10	9	8	8	2	0	0
	Zinc Chromate*	22	10	9	9	9	8	8	8	46	10	10	9	9	9	9	9
	Sr. Chromate	6	10	10	9	9	9	8	7	30	10	10	10	9	8	8	6
	ZTO Chromate	7	10	10	10	9	7	7	5	31	9	8	8	7	6	-	4
	Zn.Cr.Selenate	8	10	10	9	9	9	8	7	32	10	9	9	8	7	-	5
Beckosol #1313	Zinc Chromate	9	10	9	9	9	9	8	8	33	10	10	10	9	9	8	7
	Zinc Chromate*	23	10	10	9	9	8	8	8	47	10	10	10	10	9	9	9
	Sr. Chromate	10	10	10	9	9	8	8	8	34	10	9	9	9	8	7	7
	ZTO Chromate	11	10	10	10	10	9	8	8	35	10	10	10	10	9	9	8
	Zn.Cr.Seleante	12	10	9	9	9	8	8	7	36	10	10	9	9	9	8	8
Beckosol #1320	Zinc Chromate	13	10	10	9	9	8	8	8	37	10	9	9	9	8	8	8
	Zinc Chromate*	24	10	9	9	9	8	8	8	48	10	10	10	10	9	9	9
	Sr. Chromate	14	10	10	10	9	8	7	7	38	9	9	9	9	9	9	9
	ZTO Chromate	15	10	10	10	9	8	8	6	39	10	10	10	9	8	8	8
	Zn.Cr.Selenate	16	10	9	9	9	8	8	7	40	9	9	9	9	8	8	8
Z.V.3293	Zinc Chromate	17	10	10	9	9	8	8	8	41	10	10	9	9	9	9	9
	Sr. Chromate	18	10	10	9	9	8	8	8	42	10	10	10	9	9	9	9
	ZTO Chromate	19	10	10	9	9	8	8	6	43	10	10	9	9	9	8	8
	Zn.Cr. Selenate	20	10	10	9	9	9	9	9	44	10	10	10	9	9	9	8
Controls:																	
AN-TT-656B (duPont)		49	10	9	9	9	9	8	8	50	10	10	10	10	9	9	9
Nat'l. Paint Prod. #115 Primer		52	10	10	10	9	8	7	7	51	9	9	9	9	7	7	6
Ault & Wiborg #26983 Mg. Primer		54	10	10	10	9	8	8	8	53	10	10	10	9	9	9	8

*Plus Maleic Acid and Additional Grinding

TABLE XV

TIDE LEVEL EXPOSURE OF ALKYD SERIES - GENERAL APPEARANCE

Resins	Pigments	Gloss Lacquer Topcoat							Gloss Enamel Topcoat								
		Panel No.	1	2	3	4	5	6	Final	Panel No.	1	2	3	4	5	6	Final
Rezyl 728-5	Zinc Chromate	A-1	9	7	6	6	5	4	4	A-25	9	8	7	6	6	6	6
	Zinc Chromate*	21	9	7	6	6	5	4	4	45	9	8	7	7	7	7	7
	Sr. Chromate	2	9	7	6	6	5	4	4	26	9	8	7	7	7	7	6
	ZTO Chromate	3	9	7	6	6	5	4	3	27	8	7	7	7	7	5	5
	Zn.Cr.Selenate	4	9	7	6	6	5	4	4	28	9	8	7	7	7	7	6
Beckosol #1	Zinc Chromate	5	8	7	6	5	4	4	3	29	9	8	7	2	0	0	0
	Zinc Chromate*	22	8	7	6	6	5	4	3	46	9	8	7	7	7	7	7
	Sr. Chromate	6	8	7	6	5	5	4	3	30	9	8	7	7	7	5	5
	ZTO Chromate	7	8	7	6	5	4	4	2	31	8	8	7	6	4	3	3
	Zn.Cr.Selenate	8	9	7	6	6	5	4	3	32	9	8	7	7	7	0	3
Beckosol #1313	Zinc Chromate	9	9	7	6	6	5	4	4	33	9	8	8	8	7	7	6
	Zinc Chromate*	23	9	7	6	6	5	4	4	47	8	8	7	7	7	6	6
	Sr. Chromate	10	9	7	6	6	5	4	4	34	9	8	8	8	7	6	6
	ZTO Chromate	11	9	7	6	6	5	4	4	35	9	8	8	8	7	7	6
	Zn.Cr.Selenate	12	9	7	6	6	5	4	4	36	9	8	7	6	6	6	6
Beckosol #1320	Zinc Chromate	13	9	7	6	6	5	4	4	37	9	8	7	7	7	7	6
	Zinc Chromate*	24	9	7	6	6	5	4	3	48	9	8	7	7	7	7	6
	Sr. Chromate	14	9	7	6	6	5	4	4	38	8	7	7	7	7	6	6
	ZTO Chromate	15	9	7	6	6	5	4	3	39	9	8	7	7	7	7	5
	Zn.Cr.Selenate	16	8	7	6	6	5	4	4	40	8	8	7	7	7	7	6
Z.V. 3293	Zinc Chromate	17	9	7	6	6	5	4	4	41	9	8	7	7	7	7	7
	Sr. Chromate	18	9	7	6	6	5	4	4	42	9	8	7	7	7	7	7
	ZTO Chromate	19	9	7	6	6	5	4	3	43	9	8	7	7	7	7	6
	Zn.Cr.Selenate	20	9	7	6	6	5	4	4	44	9	8	7	7	7	7	7
Controls:																	
AN-TT-656B (DuPont)		49	8	7	5	4	2	1	4	50	9	8	7	7	7	7	7
Nat'l. Paint Prod. #115 Primer		52	8	7	6	4	3	2	4	51	8	8	6	6	6	5	5
Ault. & Wiborg #26983 Mg. Primer		54	8	7	6	5	3	2	4	53	9	8	7	7	7	7	7

* Plus Maleic Acid and Additional Grinding

TABLE XVI

MIAMI WEATHER EXPOSURE OF ALKYD SERIES - GENERAL APPEARANCE

Resins	Pigments	Gloss Lacquer Topcoat							Gloss Enamel Topcoat								
		Panel No.	Months Exposure						Final	Panel No.	Months Exposure						Final
			2	4	6	8	10	12		2	4	6	8	10	12		
Rezyl 728-5	Zinc Chromate	A-1	9	9	7	7	7	5	5	A-25	9	9	8	8	7	5	5
	Zinc Chromate*	21	9	9	7	7	7	5	5	45	9	9	8	7	7	5	5
	Sr. Chromate	2	9	9	7	7	6	5	5	26	9	9	8	8	7	5	5
	ZTO Chromate	3	9	9	7	7	7	5	5	27	9	9	8	8	7	5	5
	Zn.Cr.Selenate	4	9	9	7	7	7	5	5	28	9	9	8	8	7	5	5
Beckosol #1	Zinc Chromate	5	9	9	7	7	7	5	5	29	9	9	8	8	7	5	5
	Zinc Chromate*	22	9	9	7	7	7	5	5	46	9	9	8	7	7	5	5
	Sr. Chromate	6	9	9	7	7	7	5	5	30	9	9	8	8	7	5	5
	ZTO Chromate	7	9	9	7	7	7	5	5	31	9	9	8	8	8	5	5
	Zn.Cr.Selenate	8	9	9	7	7	7	5	5	32	9	9	8	8	7	5	5
Beckosol #1313	Zinc Chromate	9	9	9	7	7	7	5	5	33	9	9	8	8	8	6	6
	Zinc Chromate*	23	9	9	7	7	7	5	5	47	9	9	8	7	7	5	5
	Sr. Chromate	10	9	9	7	7	7	5	5	34	9	9	8	8	8	6	6
	ZTO Chromate	11	9	9	7	7	7	5	5	35	9	9	8	8	8	6	6
	Zn.Cr.Selenate	12	9	9	7	7	7	5	5	36	9	9	8	7	7	5	5
Beckosol #1320	Zinc Chromate	13	9	9	7	7	7	5	5	37	9	9	8	7	7	5	5
	Zinc Chromate*	24	9	9	7	7	7	5	5	48	9	9	8	7	7	5	5
	Sr. Chromate	14	9	9	7	7	7	5	5	38	9	9	8	7	7	4	4
	ZTO Chromate	15	9	9	7	7	7	5	5	39	9	9	8	7	7	5	5
	Zn.Cr.Selenate	16	9	9	7	7	7	5	5	40	9	9	8	7	7	5	5
Z.V. 3293	Zinc Chromate	17	9	9	7	7	7	5	5	41	9	9	8	7	7	5	5
	Sr. Chromate	18	9	9	7	7	7	5	5	42	9	9	8	7	7	5	5
	ZTO Chromate	19	9	9	7	7	7	5	5	43	9	9	8	7	7	5	5
	Zn.Cr.Selenate	20	9	9	7	7	7	5	5	44	9	9	8	7	7	5	5
Controls:																	
An-TT-656B (DuPont)		49	9	9	7	6	6	4	4	50	9	9	8	7	7	5	5
Nat'l. Paint Prod. #115 Primer		52	9	9	7	6	6	3	3	51	9	9	8	7	7	4	4
Ault. & Wiborg #26983 Mg.Primer		54	9	9	7	6	6	4	4	53	9	9	8	7	7	5	5

* Plus Maleic Acid and Additional Grinding

TABLE XVII

ALLOY COMPARISON - ALKYD SERIES

Alloy (Manufacturer)	Primer		Panel No.	Tide Level Exposure														
	Vehicle	Pigment		Corrosion						General Appearance								
				Months Exposure						Months Exposure								
				1	2	3	4	5	6	Final	1	2	3	4	5	6	Final	
Dow	Rezyl 728-5	Zn.Chr.	25-1	10	10	9	9	8	8	8	9	8	7	6	6	6	6	6
Amer. Mag.	"	"	25-2	10	10	9	9	8	8	8	8	7	7	6	6	6	5	5
Revere	"	"	25-3	10	9	8	8	6	**	5	8	7	7	6	5	**	4	4
Dow	Beckosol #1	Zn.Chr.	29-1	10	9	8	8	2	0	0	9	8	7	6	2	0	0	0
Amer. Mag.	"	"	29-2	9	9	9	8	7	5	3	8	8	7	7	7	4	3	3
Revere	"	"	29-3	9	6	4	4	0	0	0	8	7	4	4	0	0	0	0
Dow	Beckosol #1313	Zn.Chr.	33-1	10	10	10	9	9	8	8	9	8	8	8	7	7	7	7
Amer. Mag.	"	"	33-2	10	9	9	9	9	9	9	9	8	8	7	7	7	7	7
Revere	"	"	33-3	10	9	9	8	7	5	5	9	8	8	7	7	4	4	4
Dow	Beckosol #1320	Zn.Chr.	37-1	10	9	9	9	8	8	8	9	8	7	7	7	7	7	7
Amer. Mag.	"	"	37-2	10	9	9	9	9	9	9	9	8	7	6	6	6	7	7
Revere	"	"	37-3	9	8	8	8	7	6	5	8	8	7	7	7	5	4	4
Dow	Glyptal #3293	Zn.Chr.	41-1	10	10	9	9	9	9	8	9	8	7	7	7	7	7	7
Amer. Mag.	"	"	41-2	10	10	10	10	9	9	9	9	8	7	7	7	7	7	7
Revere	"	"	41-3	10	9	9	9	8	7	7	9	8	7	7	7	6	6	6
Dow	Rezyl 728-5+*	Zn.Chr.*	45-1	10	10	10	10	9	9	9	9	8	7	7	7	7	7	7
Amer. Mag.	"	"	* 45-2	10	10	10	10	9	9	9	9	8	7	7	7	7	7	7
Revere	"	"	* 45-3	9	8	7	7	6	**	4	8	8	7	6	5	**	4	4

* Plus Maleic Acid and Additional Grinding

** Removed from exposure racks because of signs of excessive corrosion.
Topcoat = (AN-E-3)

TABLE XVIII

TIDE LEVEL EXPOSURE OF STANDARD SERIES - CORROSION

Standard Series Pigment in AN-TT-656B Vehicle	Gray Lacquer (AN-L-21(Flat))								Blue Lacquer (AN-TT-L51(Gloss))							
	Panel No.	1	2	3	4	5	6	Final	Panel No.	1	2	3	4	5	6	Final
Zinc Chromate	S-1	10	10	10	9	9	8	8	S-15	10	9	9	9	8	8	8
Strontium Chromate	2	10	9	9	9	8	8	8	16	10	10	9	9	8	8	7
Lead Chromate	3	10	10	9	8	7	0	0	17	10	9	8	8	8	2	0
Lead Sulfate	4	9	4	4	0	0	0	0	18	7	4	0	0	0	0	0
Potassium Chromate	5	10	-	Lost	-	-	-	-	19	10	9	9	8	8	7	6
Barium Chromate	6	10	10	10	9	9	9	8	20	10	10	10	9	9	9	8
Zn. Chromate (IMP. X2082)	7	10	10	9	9	9	8	8	21	10	9	9	9	8	8	8
Zn. Chr. - 90%, Magnesium Oxide - 10%	8	10	9	9	9	9	8	8	22	10	9	9	9	9	9	9
Calcium Chromate	9	10	10	10	9	9	9	9	23	10	9	9	9	9	9	9
Zn. Chr. Selenate	10	10	9	9	9	8	8	8	24	10	9	9	9	9	8	8
Zn. Tetroxy Chromate	11	10	10	10	10	9	9	9	25	10	10	10	9	9	9	7
Zn. Chr. (DuPont AN-TT-P-656B)	12	10	10	10	9	8	8	8	26	10	9	9	9	9	8	8
Zn. Chr. - 90%, Mg. Chr. - 10%	13	10	9	9	9	9	8	8	27	10	10	10	9	9	9	8
Zn. Chr. - 90%, Mg. Sulfate - 10%	14	10	10	10	9	9	8	8	28	10	9	9	9	8	8	8
Zn. Chr. (IMP. X2127)									58	10	9	9	9	9	9	8
Zn. Chr. (IMP. 2127)									59	10	10	10	9	9	9	8
Zn. Chr. (IMP. 2082)									60	10	10	10	9	9	9	9

TABLE XIX

TIDE LEVEL EXPOSURE OF STANDARD SERIES - CORROSION

Standard Series Pigment in AN-TT-656B Vehicle	Gray Enamel (AN-E-7(Flat))							Blue Enamel (AN-E-3(Gloss))								
	Panel	Months Exposure						Fi-	Panel	Months Exposure						Fi-
	No.	1	2	3	4	5	6	nal	No.	1	2	3	4	5	6	nal
Zinc Chromate	S-29	10	9	9	9	8	8	8	S-43	10	9	9	9	9	9	8
Strontium Chromate	30	10	10	9	9	8	8	8	44	10	9	9	9	8	8	7
Lead Chromate	31	10	9	9	8	6	0	0	45	10	9	8	7	4	0	0
Lead Sulfate	32	7	4	0	0	0	0	0	46	7	4	0	0	0	0	0
Potassium Chromate	33	10	7	9	9	8	8	7	47	10	9	8	8	7	6	6
Barium Chromate	34	10	10	9	9	8	8	8	48	10	10	9	9	9	9	9
Zn. Chromate (IMP. X2082)	35	10	10	9	9	8	8	8	49	10	9	9	9	9	8	8
Zn. Chr. - 90%, Magnesium Oxide - 10%	36	10	9	9	9	8	8	8	50	10	10	10	9	9	9	8
Calcium Chromate	37	10	9	9	9	4	7	8	51	10	10	10	9	9	9	9
Zn. Chr. Selenate	38	10	10	9	9	8	9	8	52	10	10	9	9	9	8	8
Zn. Tetroxy Chromate	39	10	10	10	10	9	9	9	53	10	10	10	9	9	8	8
Zn. Chr. (DuPont AN-TT-P-656B)	40	10	10	9	9	9	9	9	54	10	10	9	9	8	8	8
Zn. Chr. - 90%, Mg. Chr. - 10%	41	10	10	10	9	9	9	9	55	10	10	10	10	10	9	8
Zn. Chr. - 90%, Mg. Sulfate - 10%	42	10	10	10	9	9	9	9	56	10	9	9	9	9	9	8
Zn. Chr. (IMP. X2127)									57	10	9	9	9	9	9	8
Zn. Chr. (IMP 2127)									61	10	10	9	9	9	9	8
Zn. Chr. (IMP. 2082)									62	10	10	10	10	10	9	9

TABLE XX

TIDE LEVEL EXPOSURE OF STANDARD SERIES - GENERAL APPEARANCE

Standard Series Pigment in AN-TT-656B Vehicle	Gray Lacquer (AN-L-21(Flat))							Blue Lacquer (AN-TT-1-51(Gloss))								
	Panel	Months Exposure						Fi-	Panel	Months Exposure						Fi-
	No.	1	2	3	4	5	6	nal	No.	1	2	3	4	5	6	nal
Zinc Chromate	S-1	7	7	6	6	6	5	6	S-15	7	7	6	4	4	3	4
Strontium Chromate	2	7	7	6	6	6	5	5	16	7	7	7	5	4	3	4
Lead Chromate	3	7	7	6	6	5	0	0	17	7	7	7	4	4	0	0
Lead Sulfate	4	7	7	6	0	0	0	0	18	7	7	0	0	0	0	0
Potassium Chromate	5	7	-	-	-	-	-	lost	19	8	8	8	7	7	6	4
Barium Chromate	6	7	7	6	6	6	6	4	20	7	7	6	4	3	3	3
Zn. Chromate (IMP. X2082)	7	7	7	6	6	6	5	5	21	7	7	6	4	3	3	3
Zn. Chr. - 90%, Magnesium Oxide - 10%	8	7	7	6	6	6	5	5	22	7	7	6	4	4	3	3
Calcium Chromate	9	7	7	6	6	6	6	6	23	7	7	6	4	4	4	4
Zn. Chr. Selenate	10	7	7	6	6	6	6	6	24	7	7	6	4	4	3	4
Zn. Tetroxy Chromate	11	7	7	6	6	6	6	7	25	7	7	6	4	4	4	2
Zn. Chr. (DuPont AN-TT-P-656B)	12	7	7	6	6	6	6	6	26	7	7	6	4	4	3	4
Zn. Chr. - 90%, Mg. Chr. - 10%	13	7	7	6	6	6	6	5	27	7	7	6	4	4	4	4
Zn. Chr. - 90%, Mg. Sulfate - 10%	14	7	7	6	6	6	6	5	28	7	7	5	4	3	3	3
Zn. Chr. (IMP. X2127)									58	7	7	6	5	4	4	4
Zn. Chr. (IMP. 2127)									59	7	7	6	5	4	4	4
Zn. Chr. (IMP. 2082)									60	7	7	6	5	4	4	4

TABLE XXI

TIDE LEVEL EXPOSURE OF STANDARD SERIES - GENERAL APPEARANCE

Standard Series Pigment in AN-TT-656B Vehicle	Gray Enamel (AN-E-7(Flat))							Blue Enamel (AN-E-3(Gloss))								
	Panel No.	1	2	3	4	5	6	Final	Panel No.	1	2	3	4	5	6	Final
Zinc Chromate	S-29	7	7	6	6	6	5	3	S-43	8	7	7	7	7	7	5
Strontium Chromate	30	8	7	7	6	6	6	3	44	8	7	7	7	7	7	5
Lead Chromate	31	8	7	6	6	5	0	0	45	8	7	7	7	5	0	0
Lead Sulfate	32	8	7	0	0	0	0	0	46	8	7	0	0	0	0	0
Potassium Chromate	33	9	8	7	7	7	7	4	47	7	6	6	5	4	4	4
Barium Chromate	34	9	7	6	5	5	5	4	48	8	8	7	7	7	7	6
Zn. Chromate (IMP. X2082)	35	9	8	8	8	8	8	3	49	8	8	7	7	7	7	6
Zn. Chr. - 90%, Magnesium Oxide - 10%	36	9	8	8	8	8	8	3	50	8	8	7	7	7	7	7
Calcium Chromate	37	9	8	8	8	8	7	3	51	8	8	7	7	7	7	7
Zn. Chr. Selenate	38	9	8	8	8	8	8	3	52	8	8	7	7	7	7	7
Zn. Tetroxy Chromate	39	9	7	6	6	6	6	5	53	8	8	7	7	7	7	7
Zn. Chr. (DuPont AN-TT-P-656B)	40	9	7	6	6	6	6	5	54	8	8	7	7	7	4	5
Zn. Chr. - 90%, Mg. Chr. - 10%	41	9	7	6	6	6	6	4	55	8	8	7	7	7	7	7
Zn. Chr. - 90%, Mg. Sulfate - 10%	42.	9	7	6	6	6	6	3	56	7	7	7	7	7	6	6
Zn. Chr. (IMP. X2127)									57	8	8	7	7	7	7	6
Zn. Chr. (IMP. 2127)									61	8	8	7	7	7	7	6
Zn. Chr. (IMP. 2082)									62	8	8	7	7	7	7	7

TABLE XXII

MIAMI WEATHER EXPOSURE OF STANDARD SERIES - GENERAL APPEARANCE

Standard Series Pigment in AN-TT-656B Vehicle	Gray Lacquer (AN-L-21(Flat))							Blue Lacquer (AN-TT-L51(Gloss))								
	Panel	Months Exposure						Fi- nal	Panel	Months Exposure						Fi- nal
	No.	2	4	6	8	10	12		No.	2	4	6	8	10	12	
Zinc Chromate	S-1	7	7	6	6	4	2	2	S-15	8	7	6	5	4	3	3
Strontium Chromate	2	7	7	6	6	4	2	2	16	8	7	6	5	4	3	3
Lead Chromate	3	7	7	6	6	4	2	2	17	8	7	6	5	4	3	3
Lead Sulfate	4	7	7	6	6	4	2	2	18	8	7	6	5	4	3	3
Potassium Chromate	5	7	7	7	7	6	1	1	19	6	6	5	4	3	1	1
Barium Chromate	6	7	7	6	6	4	2	2	20	9	7	6	5	4	3	2
Zn. Chromate (IMP. X2082)	7	7	7	6	6	4	2	2	21	9	7	6	5	4	3	3
Zn. Chr. - 90%, Magnesium Oxide - 10%	8	7	7	7	6	2	2	2	22	8	6	5	4	4	2	2
Calcium Chromate	9	7	7	6	6	4	2	2	23	9	7	6	5	4	3	2
Zn. Chr. Selenate	10	7	7	6	6	4	2	2	24	9	7	6	5	4	3	3
Zn. Tetroxy Chromate	11	7	7	6	6	4	2	2	25	9	7	6	5	4	3	3
Zn. Chr. (DuPont AN-TT-P-656B)	12	7	7	6	6	4	2	2	26	9	7	6	5	4	2	2
Zn. Chr. - 90%, Mg.Chr. - 10%	13	7	7	6	6	4	2	2	27	9	7	6	5	4	2	2
Zn. Chr. - 90%, Mg.Sulfate - 10%	14	7	7	6	6	4	2	2	28	8	7	6	5	4	4	4
Zn. Chr. (IMP. X2127)									58	9	7	6	5	4	2	2
Zn. Chr. (IMP. 2127)									59	9	7	6	5	4	2	2
Zn. Chr. (IMP. 2082)									60	9	7	6	5	4	2	2

TABLE XXIII

MIAMI WEATHER EXPOSURE OF STANDARD SERIES - GENERAL APPEARANCE

Standard Series Pigment in AN-TT-656B Vehicle	Gray Enamel (AN-E-7(Flat))								Blue Enamel (AN-E-3(Gloss))							
	Panel No.	Months Exposure						Fi- nal	Panel No.	Months Exposure						Fi- nal
		2	4	6	8	10	12			2	4	6	8	10	12	
Zinc Chromate	S-29	9	8	7	7	5	2	2	S-43	9	8	7	6	4	4	4
Strontium Chromate	30	9	8	7	7	5	2	2	44	9	8	7	6	4	4	4
Lead Chromate	31	9	8	7	7	4	2	2	45	9	8	7	6	4	4	4
Lead Sulfate	32	9	8	7	7	4	2	2	46	9	8	7	6	4	4	4
Potassium Chromate	33	7	9	9	9	8	8	1	47	6	6	5	5	5	3	2
Barium Chromate	34	9	8	8	7	5	2	1	48	9	7	6	5	4	3	2
Zn. Chromate (IMP. X2082)	35	9	8	8	7	5	2	2	49	9	7	6	5	4	3	3
Zn. Chr. - 90%, Magnesium Oxide - 10%	36	9	9	9	9	8	7	3	50	9	7	6	5	4	3	3
Calcium Chromate	37	8	8	8	8	8	7	3	51	9	7	6	5	4	3	3
Zn. Chr. Selenate	38	10	8	8	7	5	2	2	52	9	7	6	5	4	3	3
Zn. Tetroxy Chromate	39	9	8	8	7	5	2	2	53	9	7	6	5	4	3	3
Zn. Chr. (DuPont AN-TT-P-656B)	40	10	8	8	7	5	2	2	54	9	7	6	5	4	3	3
Zn. Chr. - 90%, Mg. Chr. - 10%	41	10	9	8	7	5	2	2	55	9	7	6	5	4	3	2
Zn. Chr. - 90%, Mg. Sulfate - 10%	42	10	9	8	7	5	2	2	56	9	7	6	5	4	2	2
Zn. Chr. (IMP. X2127)									57	9	7	6	5	4	3	3
Zn. Chr. (IMP. 2127)									61	9	7	6	5	4	3	3
Zn. Chr. (IMP. 2082)									62	9	7	6	5	4	3	3

TABLE XXIV

TIDE LEVEL EXPOSURE OF MISCELLANEOUS SERIES - CORROSION

Vehicle	Pigment	Panel No.	Vinyl Topcoat (EV-1)						Lab Rating
			Months Exposure						
			1	2	3	4	5	6	
VMCH-VYHH	Zinc Chromate	V-1	10	10	10	10	9	9	9
"	Sr. Chromate	2	10	10	10	10	10	9	9
"	ZTO Chromate	3	10	9	9	9	9	9	7
"	Zn. Cr. Selenate	4	10	9	9	9	9	9	9
"	Sr. Chr.-90%; Amm. Ferro. Phos.-10%	15	10	9	9	9	8	7	5
AYAF	Zinc Chromate	5	10	10	9	9	9	6	4
"	Sr. Chromate	6	10	10	9	9	9	7	5
"	ZTO Chromate	7	10	10	9	9	8	8	4
"	Zn. Chr. Selenate	8	10	10	9	9	9	9	9
XYHL	Zn. Chromate	9	10	10	9	9	9	9	8
"	Sr. Chromate	10	10	10	10	10	8	7	6
"	ZTO Chromate	11	10	10	10	10	9	9	7
"	Zn. Cr. Selenate	12	10	10	10	8	8	7	6

Vinyl Controls

Ucilon Primer 405P--Ucilon Topcoat (EV-2)	V-13	10	10	9	8	7	7	5
AN-TT-P-656B--Gloss Lacquer Topcoat (AN-TT-L51)	V-14	10	10	9	8	8	8	6

TABLE XXV

TIDE LEVEL EXPOSURE OF MISCELLANEOUS SERIES - CORROSION

Vehicle	Pigment	Panel No.	Acryloid Topcoat (EK-1)						Lab. Rating
			Months Exposure						
			1	2	3	4	5	6	
Acryloid A-10-Nitrocel	Zn. Chromate	K-1	10	10	10	10	9	9	9
"	Sr. Chromate	2	10	10	9	9	9	9	9
"	ZTO Chromate	3	10	10	9	9	9	8	8
"	Zn.Cr. Selenate	4	10	10	9	9	9	9	9
Acryloid B-72 & B-75	Zn. Chromate	5	10	10	9	9	8	8	7
"	Sr. Chromate	6	10	10	9	9	9	9	8
"	ZTO Chromate	7	10	10	10	9	9	9	8
"	Zn.Cr. Selenate	8	10	10	10	9	9	9	8

Furane Series - Zn. Chromate

Topcoat	Panel No.	Months Exposure						Lab. Rating
		1	2	3	4	5	6	
Lt. Gray Alkyd Enamel (AN-E-7)	F-1	10	10	10	10	9	9	8
Sea Blue Alkyd Enamel (AN-E-3)	2	10	10	8	8	8	7	6
Lt. Gray Lacquer (AN-L-21)	3	10	10	9	9	8	7	8
Sea Blue Lacquer (AN-TT-6-51)	4	10	9	9	9	8	8	6

TABLE XXVI

TIDE LEVEL EXPOSURE OF MISCELLANEOUS SERIES - GENERAL APPEARANCE

Vehicle	Pigment	Panel No.	Vinyl Topcoat (EV-1)						Lab. Rating
			Months Exposure						
			1	2	3	4	5	6	
VIMH-VYHH	Zinc Chromate	V-1	8	8	8	8	8	8	8
"	Sr. Chromate	2	8	8	8	8	8	8	8
"	ZTO Chromate	3	8	8	8	8	8	8	6
"	Zn.Cr. Selenate	4	8	8	8	8	8	8	8
"	Sr.Chr.-90%;Amm. Ferro.Phos.-10%	15	8	8	8	7	7	6	4
AYAF	Zinc Chromate	5	8	8	8	7	7	4	4
"	Sr. Chromate	6	8	8	8	7	7	6	5
"	ZTO Chromate	7	8	8	8	7	7	7	5
"	Zn.Cr. Selenate	8	8	8	8	7	7	2	6
XYHL	Zinc. Chromate	9	8	8	8	7	7	4	6
"	Sr. Chromate	10	8	8	8	7	6	5	2
"	ZTO Chromate	11	8	8	8	7	7	7	5
"	Zn.Cr. Selenate	12	8	8	8	7	7	6	4

Vinyl Controls

Ucilon Primer 405P--Ucilon Topcoat (EV-2)	V-13	6	5	4	3	3	3	4
AN-TT-P-656B--Gloss Lacquer Topcoat (AN-TT-L51)	V-14	8	8	6	4	4	3	5

TABLE X.VII

TIDE LEVEL EXPOSURE OF MISCELLANEOUS SERIES - GENERAL APPEARANCE

Vehicle	Pigment	Panel No.	Acryloid Topcoat (EK-1)						Lab. Rating
			Months Exposure						
			1	2	3	4	5	6	
Acryloid A-10 Nitrocel	Zn Chromate	K-1	9	8	8	8	8	8	8
"	Sr. Chromate	2	9	8	8	8	8	8	7
"	ZTO Chromate	3	9	8	8	8	8	7	7
"	Zn.Cr. Selenate	4	9	8	8	8	8	8	8
Acryloid B-72 & B-75	Zn. Chromate	5	7	7	6	5	5	5	5
"	Sr. Chromate	6	7	7	6	5	5	5	5
"	ZTO Chromate	7	7	7	6	5	5	5	5
"	Zn.Cr. Selenate	8	7	7	6	5	5	5	5

Furane Series - Zn. Chromate

	Panel No.	Months Exposure						Lab. Rating
		1	2	3	4	5	6	
Lt. Gray Alkyd Enamel (AN-E-7)	F-1	9	8	7	7	7	7	3
Sea Blue Alkyd Enamel (AN-E-3)	2	8	8	7	7	7	6	3
Lt. Gray Lacquer (AN-L-21)	3	7	7	6	6	6	5	4
Sea Blue Lacquer (AN-TT-6-51)	4	7	7	6	4	4	2	2

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TABLE XXVIII

MIAMI WEATHER EXPOSURE OF MISCELLANEOUS SERIES - GENERAL APPEARANCE

Vehicle	Pigment	Panel No.	Vinyl Topcoat (EV-1) Months Exposure						Lab. Rating
			2	4	6	8	10	12	
VMCH-VYHH	Zn. Chromate	V-1	9	8	7	6	5	3	3
"	Sr. Chromate	2	9	8	7	6	5	3	3
"	ZTO Chromate	3	9	8	7	6	5	2	3
"	Zn.Cr. Selenate	4	9	8	7	6	5	3	3
"	Sr.Chr.-90%; Amm. Ferro.Phos-10%	15	9	8	7	6	5	4	4
AYAF	Zn. Chromate	5	9	8	7	5	4	2	3
"	Sr. Chromate	6	8	8	6	5	3	2	3
"	ZTO Chromate	7	9	8	7	6	4	3	3
"	Zn.Cr. Selenate	8	9	8	7	6	5	3	3
XYHL	Zn. Chromate	9	9	8	7	6	5	3	3
"	Sr. Chromate	10	8	8	6	5	3	2	2
"	ZTO Chromate	11	9	8	7	6	5	3	3
"	Zn.Cr.Selenate	12	8	8	6	5	3	2	2

Vinyl Controls

Ucilon Primer 405P-Ucilon Topcoat (EV-2)	V-13	7	3	3	3	3	2	3
AN-TT-P-656B-Gloss Lacquer Topcoat (AN-TT-L51)	V-14	9	8	7	6	5	4	3

TABLE XXIX

MIAMI WEATHER EXPOSURE OF MISCELLANEOUS SERIES - GENERAL APPEARANCE

Vehicle	Pigment	Panel No.	Acryloid Topcoat (EK-1)					12	Lab. Rating
			2	4	6	8	10		
Acryloid A-10-Nitrocel	Zn. Chromate	K-1	10	9	9	8	7	5	6
"	Sr. Chromate	2	10	9	9	8	7	5	6
"	ZTO Chromate	3	10	9	9	8	7	5	6
"	Zn.Cr.Selenate	4	10	9	9	8	7	5	6
Acryloid B-72 & B-75	Zn. Chromate	5	10	9	8	7	5	5	5
"	Sr. Chromate	6	10	9	8	7	5	5	5
"	ZTO Chromate	7	10	9	8	7	5	5	5
"	Zn.Cr.Selenate	8	10	9	8	7	5	5	5

Furane Series - Zn. Chromate

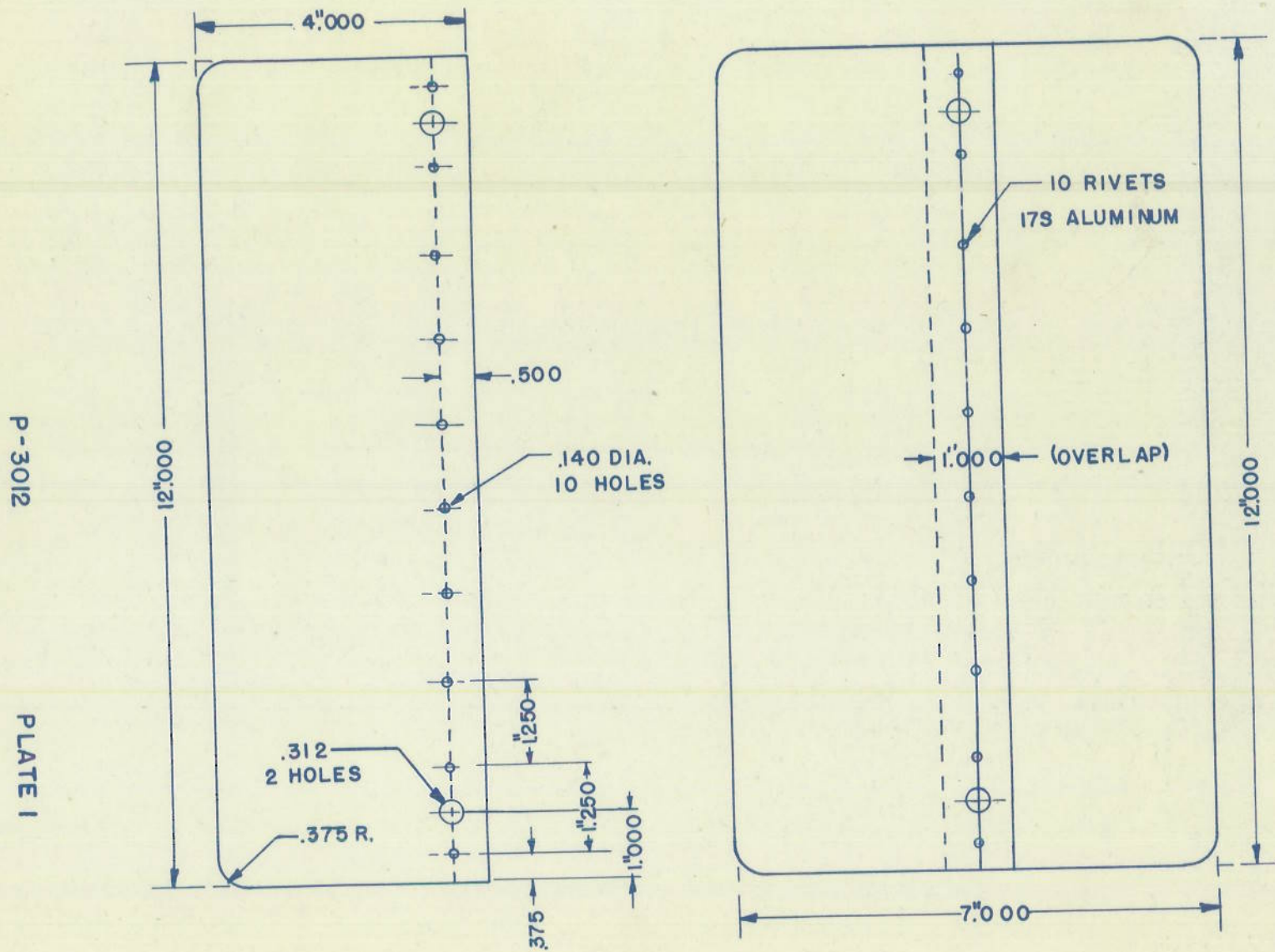
Topcoat	Panel No.	2	Months Exposure				12	Lab. Rating
			4	6	8	10		
Lt. Gray Alkyd Enamel (AN-E-7)	F-1	10	9	9	9	8	8	6
Sea Blue Alkyd Enamel (AN-E-3)	2	10	9	7	7	6	6	6
Lt. Gray Lacquer (AN-L-21)	3	10	8	6	6	6	5	4
Sea Blue Lacquer (AN-TT-6-51)	4	9	8	7	6	6	5	4

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REFERENCES

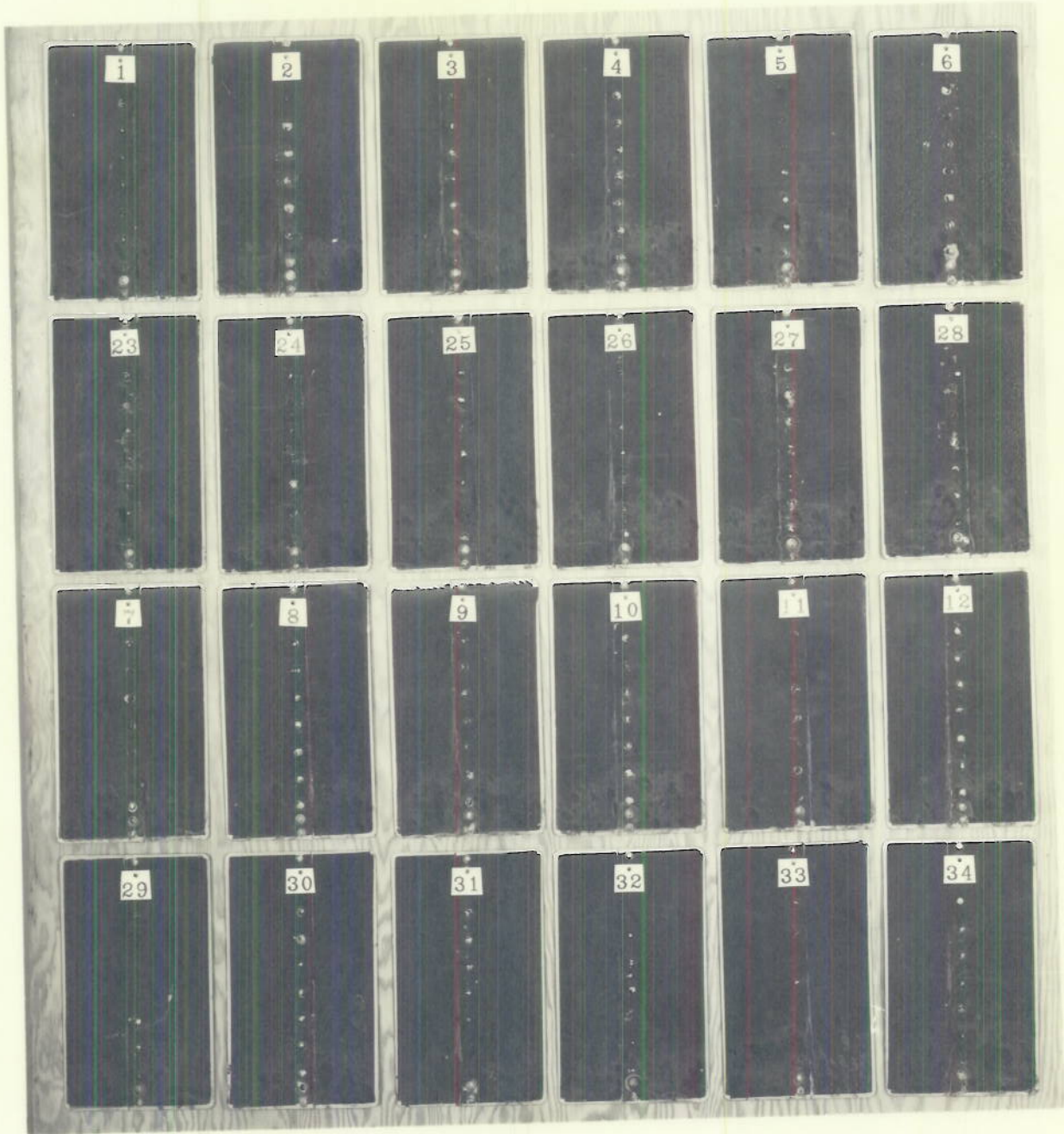
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5. The Dow Chemical Co., Magnesium Division, Tech. Memo. No. 6, Coastal Exposure of Magnesium Alloys, (Sept. 1944).
6. Golden Gate Production Club, Primers for Non-Ferrous Metals I, (1939).
7. Golden Gate Production Club, Primers for Magnesium and Aluminum Alloys II, (1939).
8. Golden Gate Production Club, Primers for Magnesium and Aluminum Alloys III, (1944).
9. NRL Report P-2835 entitled, "Anti-Corrosive Coatings for Magnesium I - Salt Spray Resistance dated 15 May 1946.

NOTE: ALL EDGES TO BE RADIUSSED



MAGNESIUM EXPOSURE PANEL
SCALE: $\frac{1}{2}$

UNCLASSIFIED



L-51

E-3

L-51

E-3

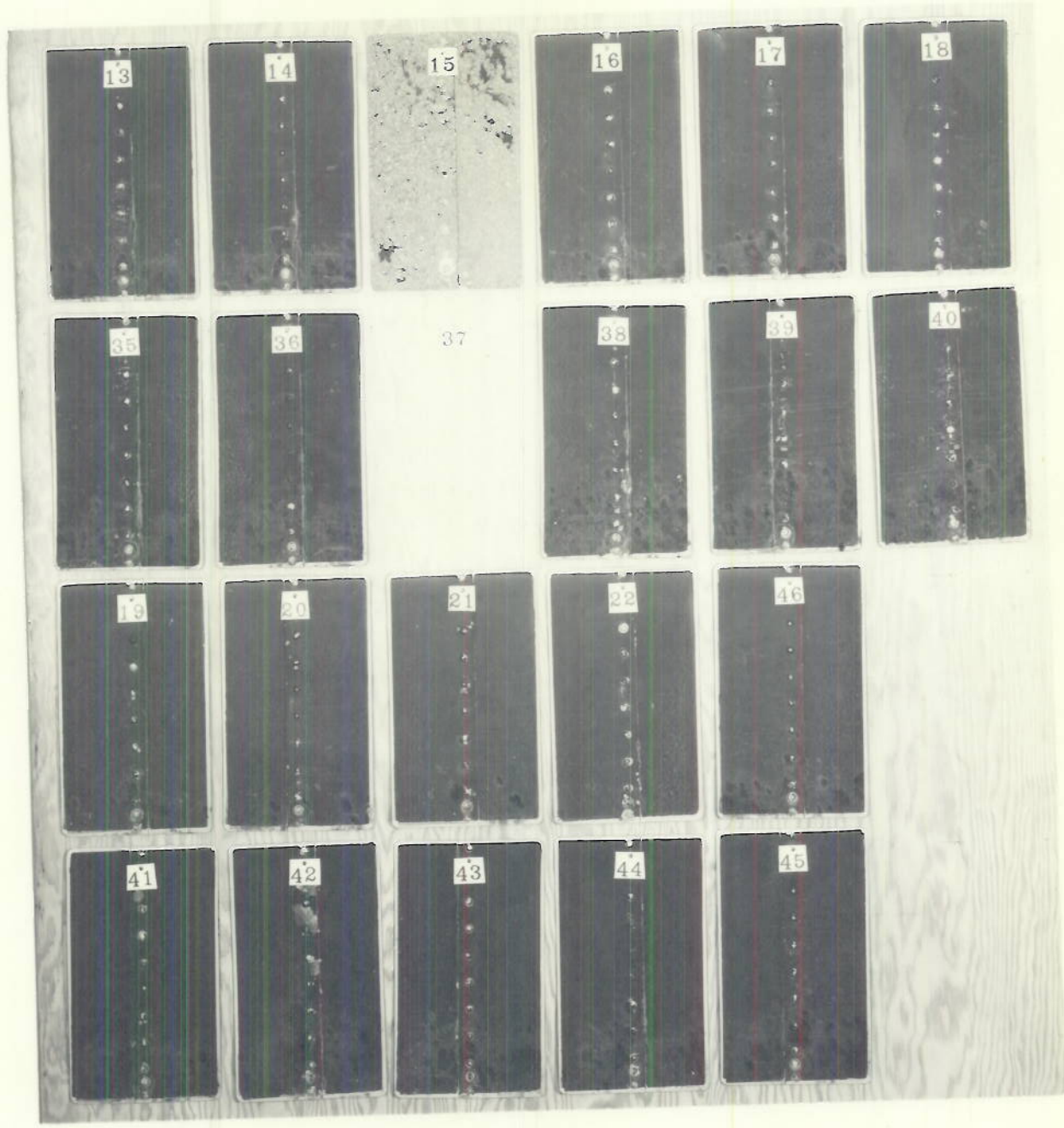
PHENOLIC SERIES

L-51

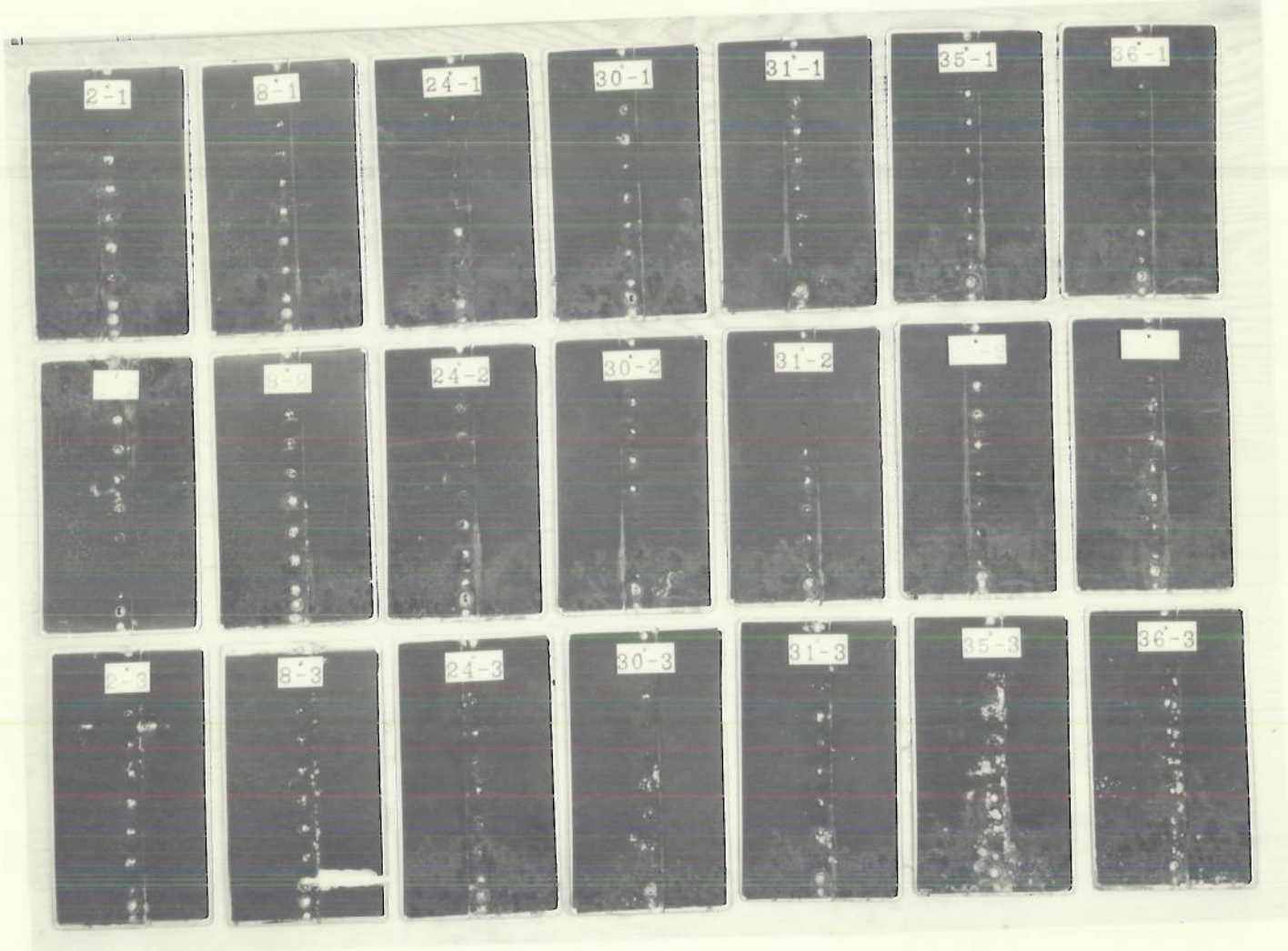
E-3

L-51

E-3



PHENOLIC SERIES



DOW

AM. MAG.

REVERE

ALLOY COMPARISON - PHENOLIC SERIES

PLATE 4

UNCLASSIFIED

REZ. 728-5

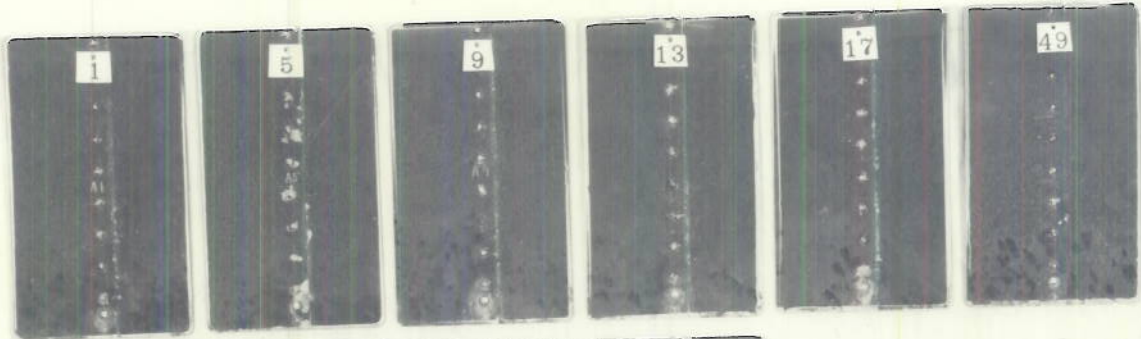
BECK. I

BECK. 1313

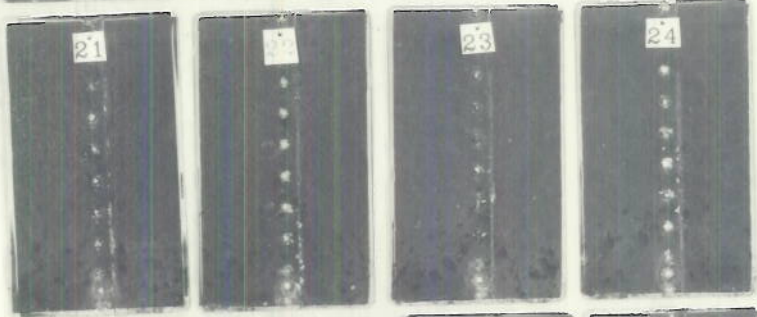
BECK. 1320

Z.V. 3293

CONTROLS



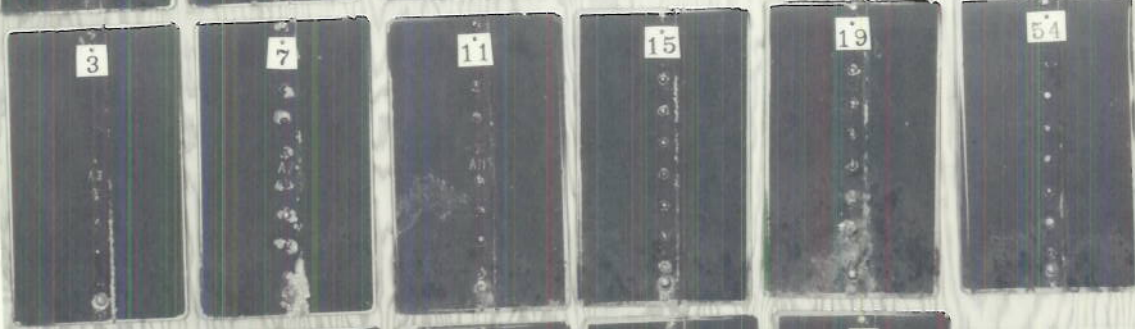
ZINC CHROMATE



ZINC CHROMATE PLUS MALEIC ACID



SR. CHROMATE



ZN.T.O. CHROMATE



ZN.CHR. SELENATE

REZ.728-5

BECK. I

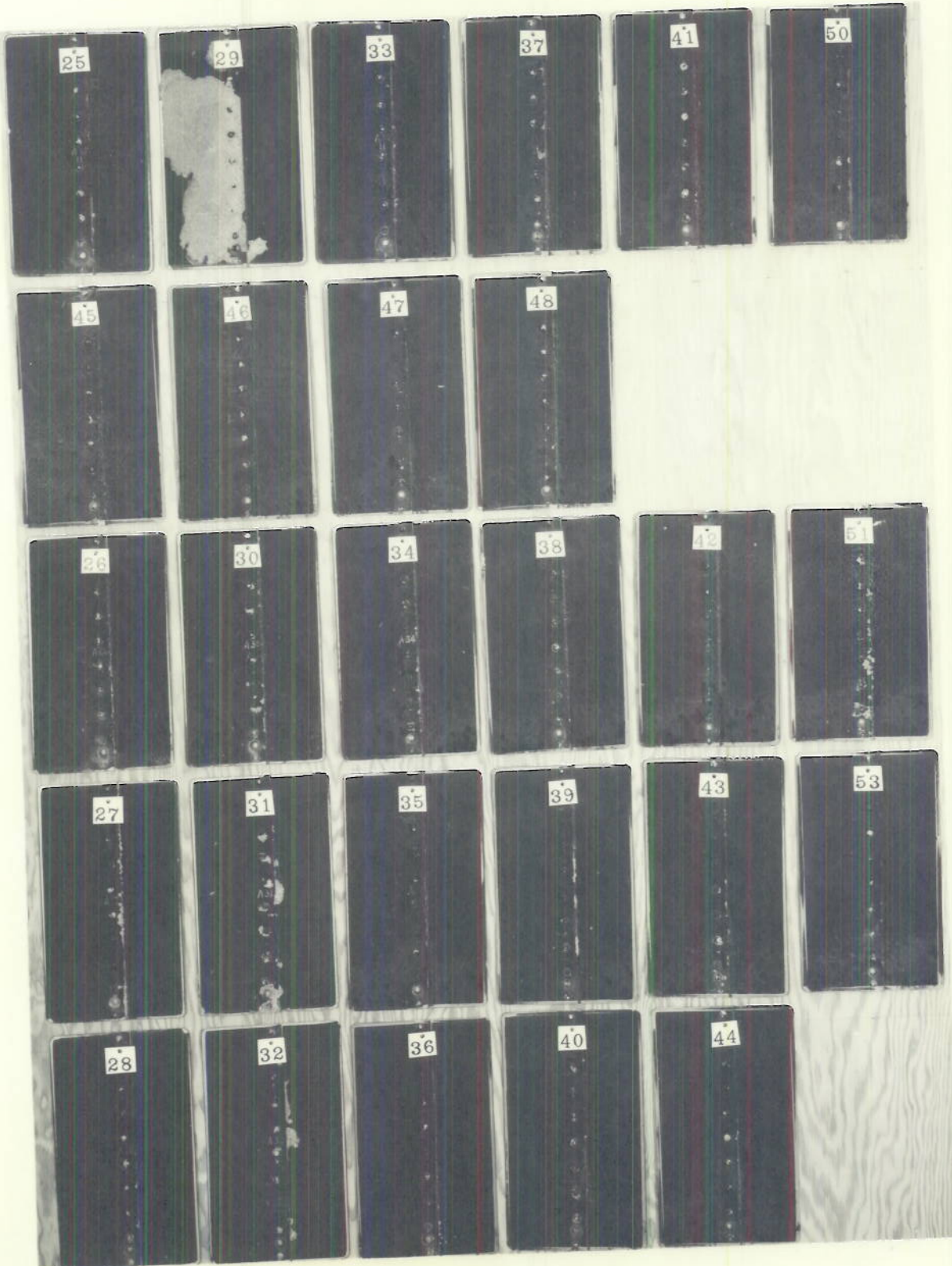
BECK. 1313

BECK. 1320

Z.V. 3293

CONTROLS

UNCLASSIFIED



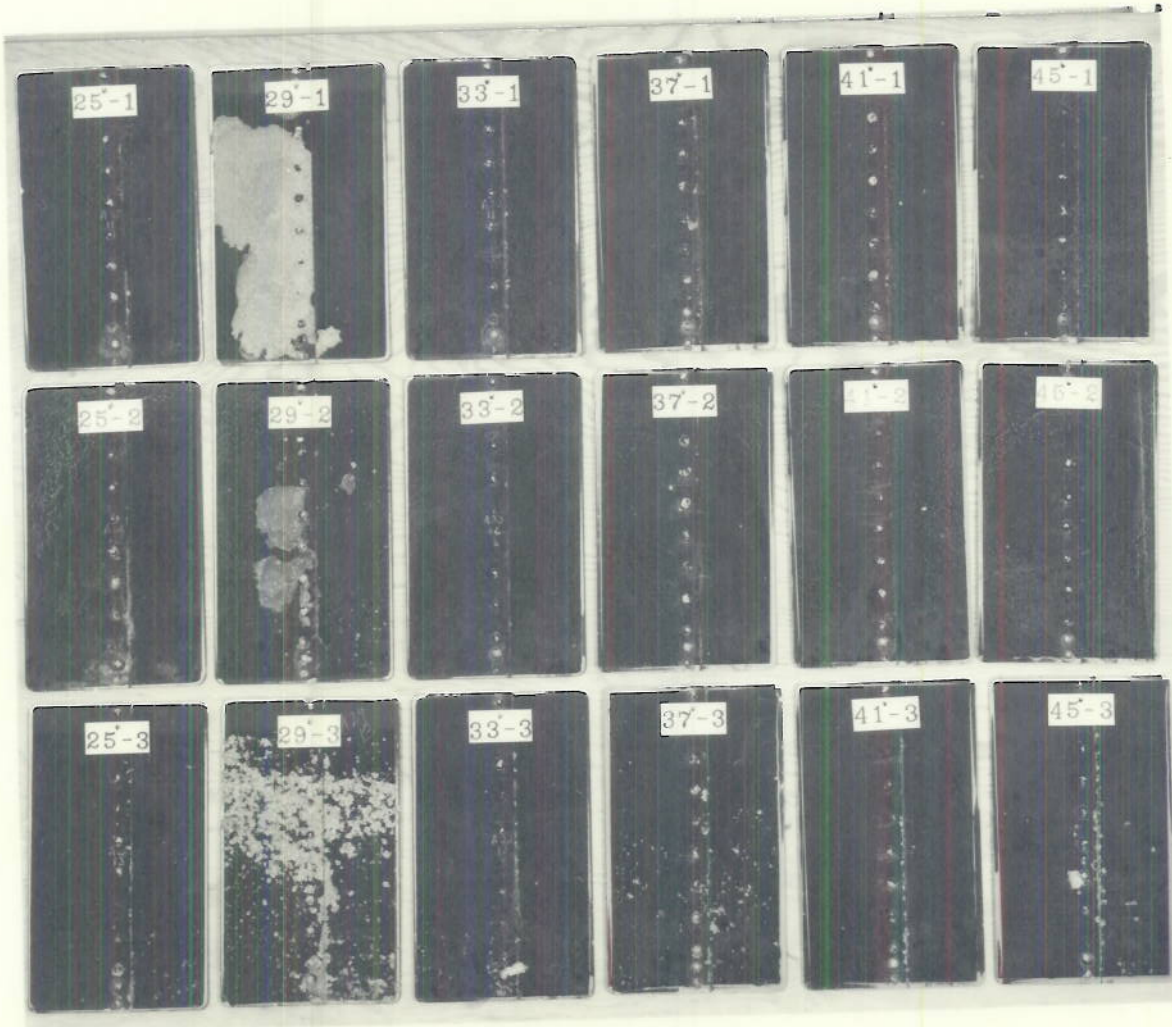
ZN.
CHROMATE

ZN.CHR.
PLUS
MALEIC
ACID

SR.
CHROMATE

ZN.T'O.
CHROMATE

ZN.CHR.
SELENATE



DOW

AM. MAG.

REVERE

ALLOY COMPARISON - ALKYD SERIES

ZN. CHR.

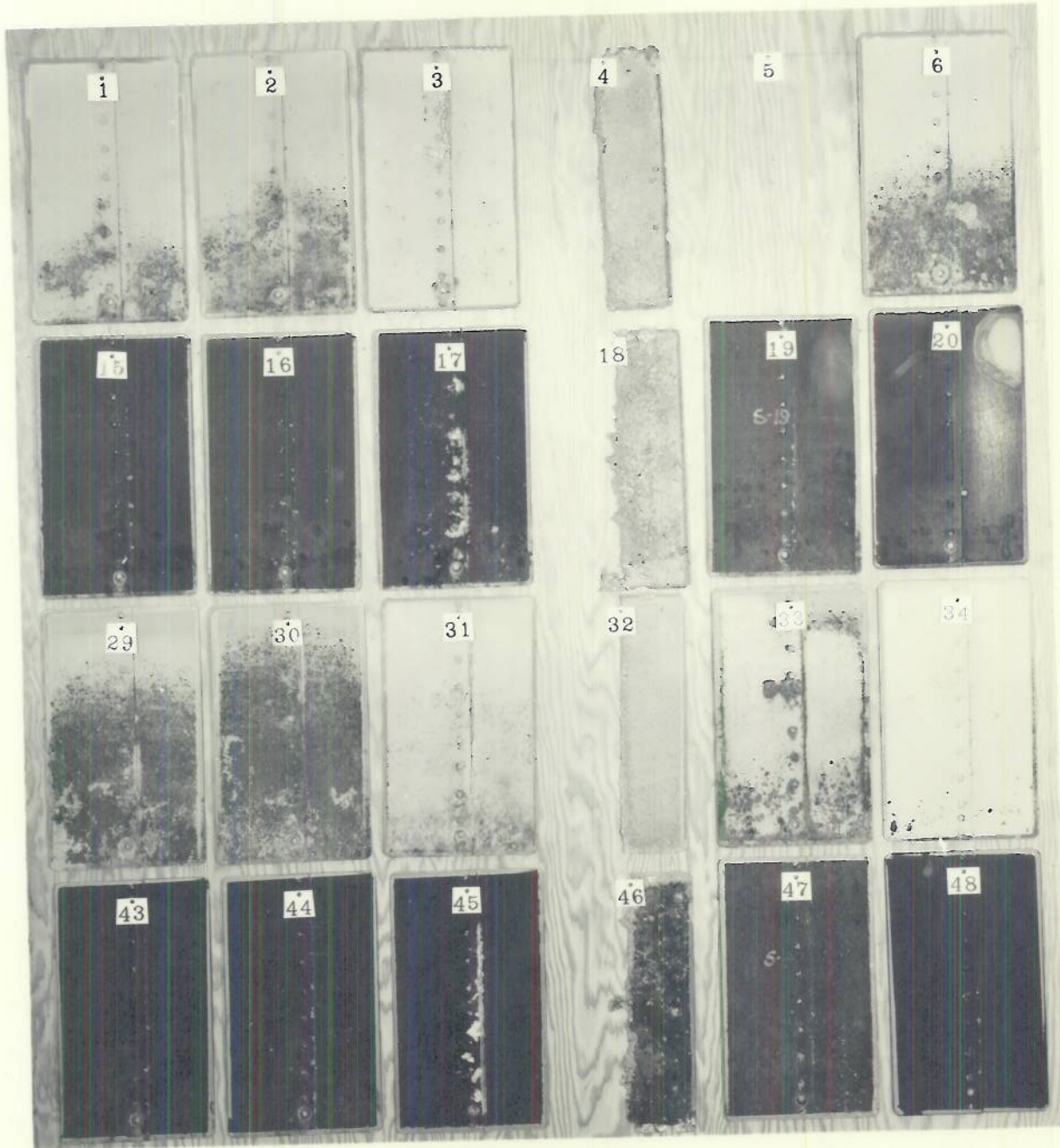
SR. CHR.

PB. CHR.

PB. SULFATE

K. CHR.

BA. CHR.



L-21

L-51

E-7

E-3

STANDARD SERIES

ZN.CHR.(IMP.X2082)

ZN.CHR.-90%
MG.OXIDE-10%

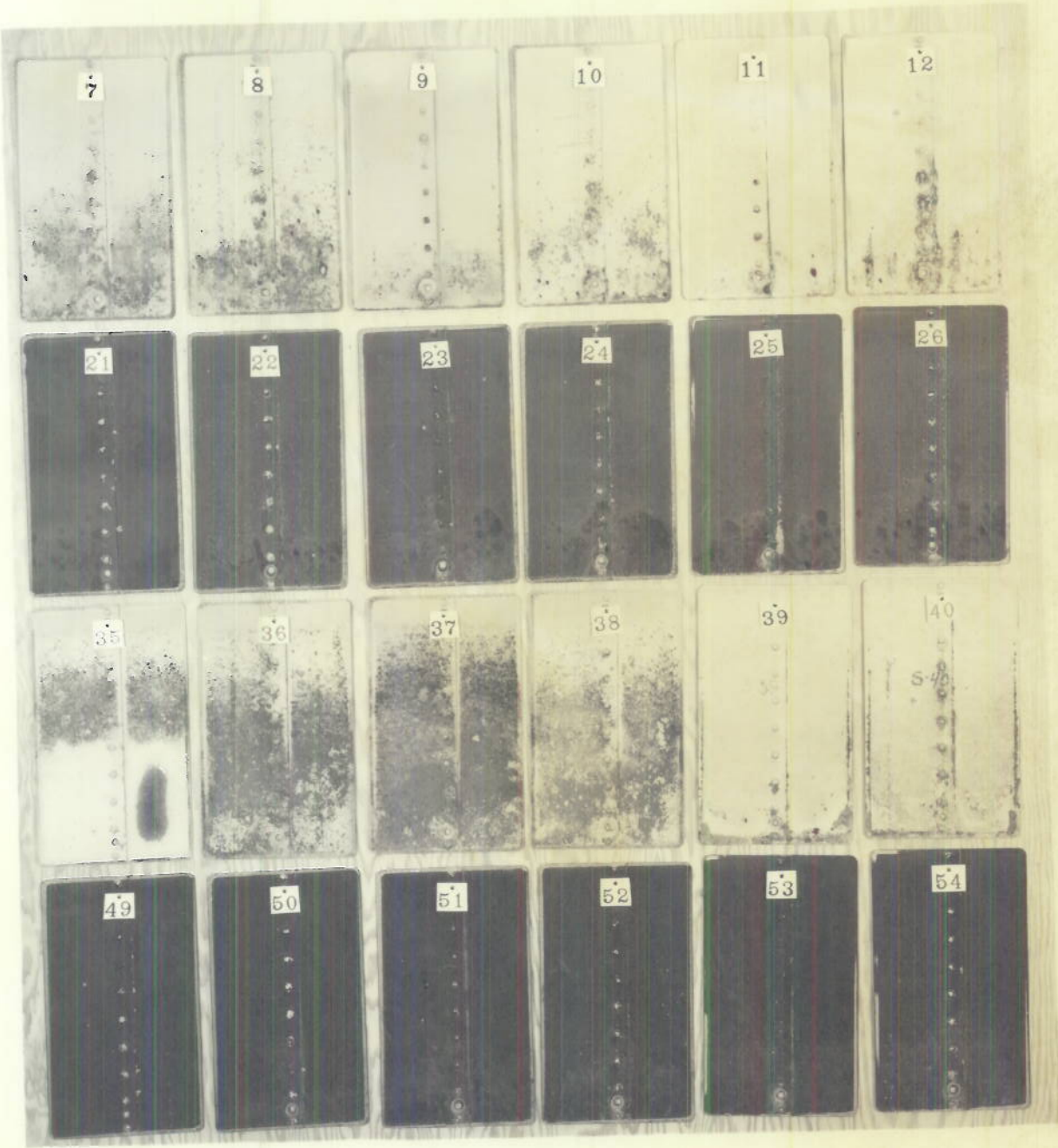
CA.CHR.

ZN.CHR.SELENAE

ZN.TET.CHR.

ZN.CHR.
(AN-TT-P-6569)

UNCLASSIFIED



L-21

L-51

E-7

E-3

STANDARD SERIES

PLATE 9

ZN.CHR.-90%
MG.CHR.-10%

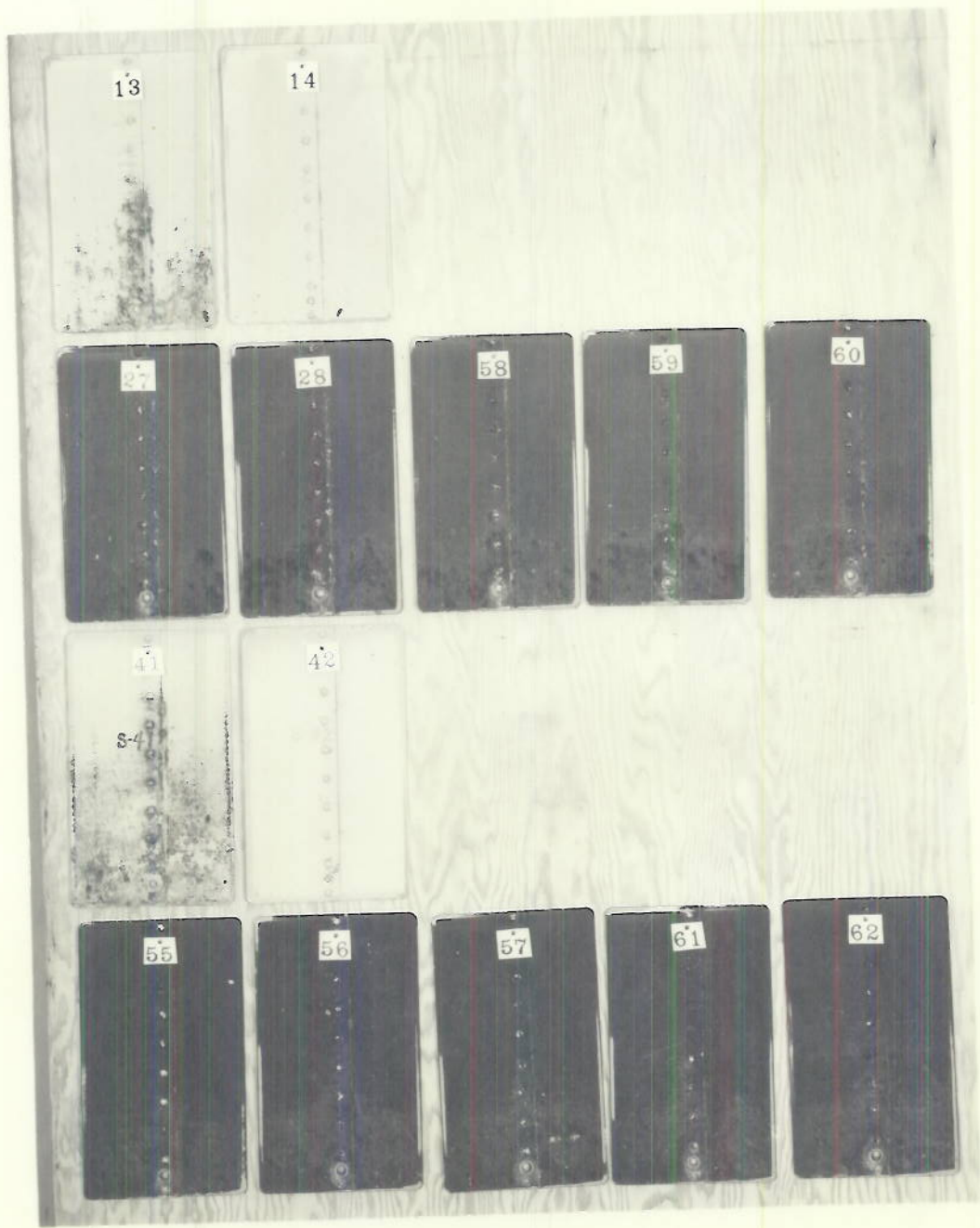
ZN.CHR.-90%
MG.SULF.-10%

ZN.CHR.(IMP.X2127)

ZN.CHR.(IMP.2127)

ZN.CHR.(IMP.2082)

UNCLASSIFIED



L-21

L-51

E-7

E-3

STANDARD SERIES

PLATE 10

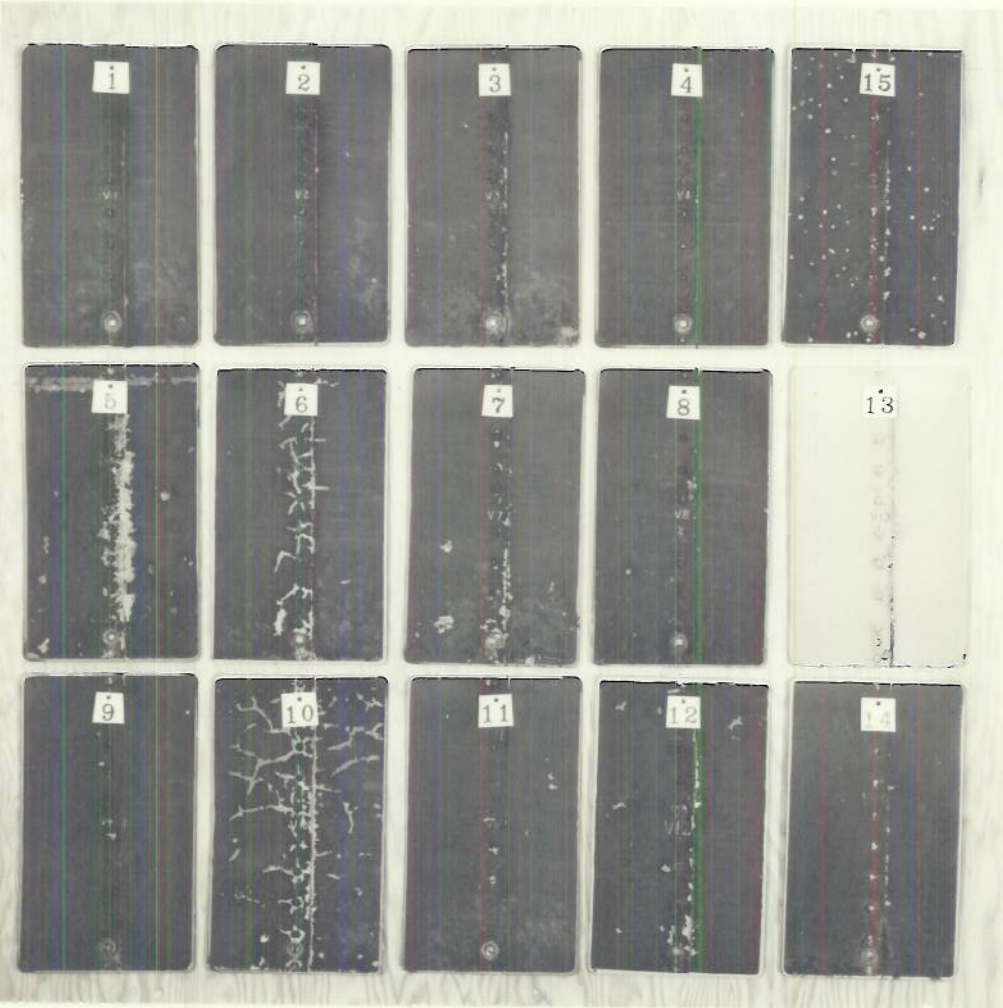
ZN.CHR.

SR.CHR.

ZN.TETROXY CHR.

ZN.CHR.SELENATE

SR.CHR.-90%
AMM.FERRO.PHOS.-10%



VMCH-VYHH

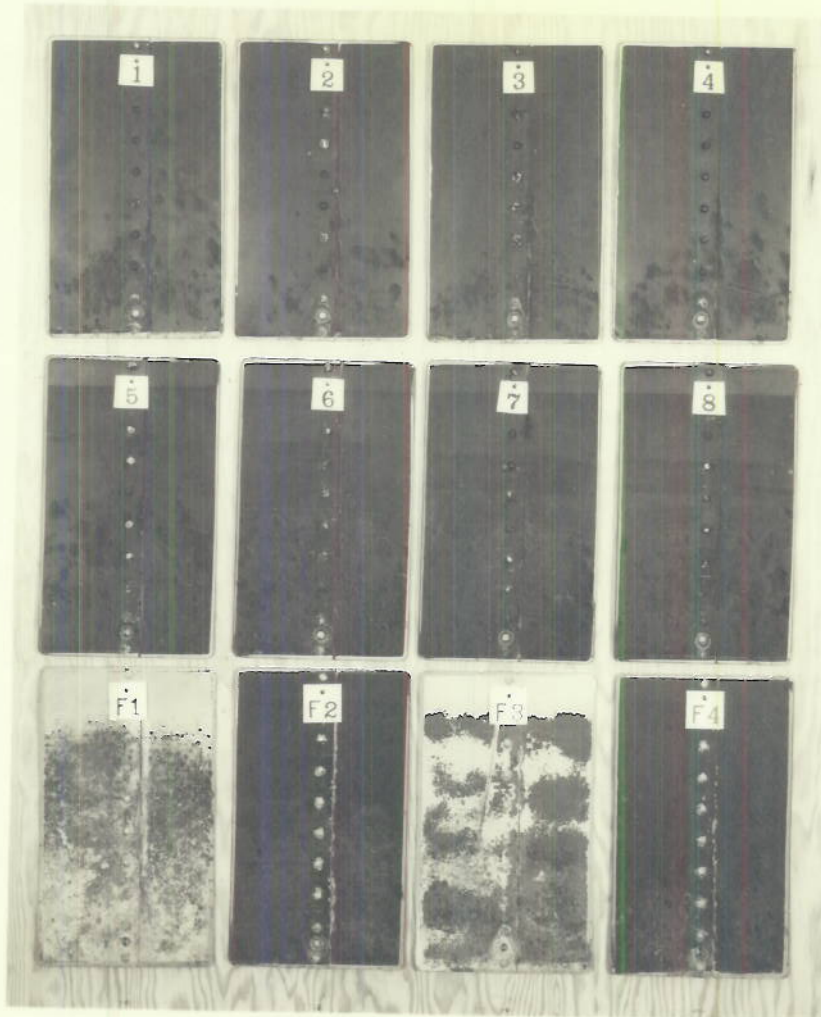
AYAF

XYHL

(VINYL GROUP)

(13 & 14 = CONTROLS)

MISCELLANEOUS SERIES



A-10 PLUS
NITROCEL

B-72 PLUS
B-75

FURANES
(ZN.CHR.)

(ACRYLOID & FURANE GROUP)

MISCELLANEOUS SERIES