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Marshall Laboratory
November 11, 1953

MEMORANDUM REPORT NO. M-653

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LABORATORY EVALUATION OF GLIDDEN'S "NUBELON S" ENAMEL

The Glidden Company has recently devoted a sizeable proportion of their trade journal advertising to promotion of "Nubelon S" Enamel. A letter from Mr. F. Backer, of Export Sales, reported that "Nubelon S" is being actively merchandised abroad, with one particular end-use being as an enamel for electric ranges. Mr. Backer supplied a copy of a brochure published by Glidden, entitled "Nubelon S - a Silicone Modified Enamel", listing its outstanding properties as

Hardness
Corrosion Resistance
Flexibility
Adhesion
Abrasion Resistance
Stain Resistance
Grease Resistance
Discoloration Resistance
Chemical Resistance
Hot Soap Resistance
Heat Resistance

and giving the price as "approximately $9.50 a gallon".

The sole domestic contact we have had with "Nubelon S is at Martin Steel Products Company, a Cleveland

Region account that manufactures prefabricated steel silo sections. A sample obtained by Cleveland Sales was gray in color (#4979 Gray "Nubelon S", by inference from the Glidden brochure), and as yet it has not been possible to obtain a white sample. With all types of appliances being listed among the suggested typcial applications, it was decided that the gray sample should be evaluated against some of our best appliance systems, both active and experimental, in order to characterize "Nubelon S", at least in a preliminary way. The systems included are:

Primer		Topcoat	
828-002	Refrigerator Primer	704-24494	Refrigerator Enamel
828-014	"Polymer X" Primer	722-24946	Washing Machine Enamel
------		828-014	"Polymer X" Primer
P-100-U-64408	Experimental Primer	P-100-U-55845	"Polymer MD" Topcoat

GENERAL CONCLUSIONS:

828-014, or more specifically its flowcoating modification 828-004, would be a logical counter-offering for "Nubelon S". Advantages of 828-014 would be lower bake, lower cost, superior detergent resistance, and better flexibility, with the only significant deficiency appearing in acid resistance tests. It is possible that if the 828-014 were given a bake approaching the 45' x 450°F recommended for "Nubelon S", its acid resistance and flexibility would approach that of the Glidden material.

The "Polymer MD" system is equal or superior to the "Nubelon S" system in all tests conducted except flexibility.

DETAILED RESULTS:

Gloss:

"Nubelon S" has excellent gloss, roughly equal to 828-014 and superior to our conventional refrigerator or washing machine systems. The "MD" system, however, was significantly higher in gloss than the "Nubelon S".

Application Properties:

"Nubelon S" most closely approached 828-014 in type and degree of application difficulty. With the special spray thinner recommended by Glidden, it is difficult to obtain films over 1.0 mil without popping, sagging, or wrinkling.

Baking Schedules:

The recommended schedule for "Nubelon S" is 45 minutes at 450°F. Schedules used for other systems evaluated are as follows:

Primer	Enamel	Primer Bake	Enamel Bake
828-002	704-24494	30' x 350°F.	20' x 300°F
828-014	722-24946	15' x 400°F.	30' x 300°F.
---	828-014	---	15' x 400°F.
P-100-U-64408	P-100-U-55845	30' x 350°F.	30' x 300°F.

Hardness:

"Nubelon S" is equal to 828-014, and thus considerably harder than any of our conventional enamels or "MD".

Flexibility:

Under standard impact and mandrel tests, 828-014 and "Nubelon S" are equal, and superior to the other systems tested. Under more severe forming stress, such as bending the metal back upon itself, the 828-014 is definitely more flexible.

Adhesion:

The 828-002/704-24494 and the "MD" primer-enamel systems are superior in knife scratch adhesion, with the "Nubelon S" and 828-014 being slightly inferior and substantially equal.

Corrosion Resistance:

After 500 hours salt spray exposure, there are no significant differences in extent of rust creepage from the score line.

Stain Resistance:

"Nubelon S", "MD" and 828-014 are equal and best; the 828-002/704-24494 system is significantly inferior.

Grease Resistance:

After two months immersions in a 50/50 oleic acid/cottonseed oil mixture at 77°F, the "Nubelon S" and 828-014 have softened slightly but have retained film integrity and show no spalling. The "MD" system shows no evidence of

softening, swelling, or spalling. The 828-002/704-24494 system has softened to a greater degree than any of the other systems, although the degradation noted results from enamel weaknesses as the primer remains unaffected.

Acid Resistance:

When immersed in 10% solutions of citric and lactic acid at an elevated temperature (100°F), the "MD" system was appreciably better than the "Nubelon S". "Nubelon S", in turn, had a distinct advantage over the other systems, including 828-014. However, at low film thicknesses such as might be obtained in flowcoating, the 828-014, in one series of tests, gave better protection against more dilute acid solutions than "Nubelon S".

Detergent Resistance:

When immersed in a solution of 1% TIDE at 160°F., the "MD" system was slightly superior to 828-014. The "Nubelon S" fell down badly in this test, being definitely inferior to the 828-014/722-24946 system, and losing film integrity completely at 10 days. Comparative ratings for "MD" and 828-014 at this stage were 8.5 and 7.0.

Discoloration Resistance:

Since an expected weakness of a high "Epon" content system (which analytical determinations have shown "Nubelon S" to be) is poor color retention, a critical examination of this quality was conducted. An instrumental comparison of color change after 7 days exposure to ultraviolet light shows equal yellowing for "Nubelon S" and 828-014. Under direct exposure to sunlight (approximately 100 hours) the "Nubelon S" shows a significantly greater degree of yellowing than 828-014. When exposed behind ordinary window glass, at the end of two months the "Nubelon S" has yellowed noticeably and the 828-014 shows considerable bleaching. The latter test is being continued.

It appears from this data that the "Nubelon S" is no better and perhaps slightly poorer than 828-014 in color retention. However, it should be remembered that the sample we have is gray, and there is a possibility that, in the white "Nubelon S" enamels, Glidden has found a way to overcome the discoloration - thus accounting for their confidence in recommending this quality for such appliances as refrigerators. We will be unable to investigate this possibility until such time as a white sample becomes available.

ANALYTICAL INFORMATION:

The "Nubelon S" Enamel has the following analysis

Total Solids	64%
Vehicle Solids	50%
P/B Ratio	80/100
Vehicle Composition	
Epon	40%
Silicone	12%
Alkyd	48%
Alkyd Composition	
Glyc. Phth.	70%
Oil (Soya?)	24%
Excess Glyc.	6%

It is probable that the silicone is present as a reacted portion of the vehicle (a silicone-alkyd.).

GENERAL:

Detailed information in testing procedures and results is recorded in Notebook #5630, beginning on page 94.

We request Wilmington Sales to inform the regional offices of the Laboratory's interest in obtaining a sample of "Nubelon S" White Enamel.

Exposure Series connected with the evaluation of "Nubelon S" are Nos. 13336 and 13370.

MARSHALL LABORATORY

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11/11/53