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INSIDE WALL PAINT FOR CHEMICAL LABORATORIES
(HEAT- AND FUME-RESISTING ENAMEL PAINT)

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I. INTRODUCTION

The Bureau is often asked to give information concerning the kind of paint to use on the walls and ceilings of chemical laboratories. Governmental agencies, colleges, commercial laboratories, and others are interested in this subject. It is well known that white lead paints, although excellent for other purposes, should not be used in painting chemical laboratories. However, as the result of tests and experience in painting the chemical laboratories of this Bureau, additional information has been obtained on the subject. It is the purpose of this letter circular to tell something of the properties of fume-resisting paints, to suggest a procedure for painting, to suggest a specification for the paint, and to show some typical results of tests of paints purchased under the specification.

The usual flat washable wall paints (of the type of Federal Specification TT-P-51a) and the usual mill gloss whites (of the type of Federal Specification TT-E-506) are excellent for ordinary interior use; but conditions existing in chemical laboratories, commercial kitchens and bakeries, tobacco factories, gas works, refrigerator rooms, dairies, sewage-disposal plants, etc., cause paints of this kind to become discolored. Exposure to ammonia or to continued high temperature causes the drying oils, commonly used in white paints, to turn yellow; and hydrogen sulphide or ammonium sulphide blackens any paint containing iron or lead, either in the pigment or in the drier.

II. PROPERTIES OF THE PAINT

To produce paint that will not be discolored by heat or the fumes of the ordinary chemical laboratory, a special composition is required. The pigment must be free from lead and iron, and may consist of light-proof lithopone, titanated lithopone, the various titanium pigments, zinc oxide, or a mixture of these. The vehicle must also be free from lead or other metallic compounds used as driers, and preferably from linseed, soya, tung, or other drying oils. A vehicle frequently used consists of the best grade of damar resin dissolved in turpentine or mineral spirits and plasticized with a softener such as pine oil. In addition to damar resin, some of the newer synthetic resins of the alkyd and phenolic types and the newer type of rubber resins and chlorinated rubber resins dissolved in solvents are finding use on walls, floors, and general interior surfaces of chemical laboratories.

White paints meeting this description are available from a number of paint manufacturers in flat, eggshell or semigloss, and full-gloss enamel finishes. When tints are desired, care must be used in selecting the proper tinting pigment to avoid discoloration. Glass panels painted with a white enamel of this type and with tints made by grinding into it small amounts of dry chrome-oxide green (Cr_2O_3) (which met Federal Specification TT-C-231) and dry lampblack (which met Federal Specification TT-L-71), to make light green and light gray enamels respectively, all retained their original colors on exposure, under a bell jar, to an atmosphere saturated with water and ammonium sulphide vapors. On the other hand, a pale buff tint obtained by adding dry yellow ochre (meeting Federal Specification TT-O-111) to the white enamel was converted into a fairly dark battleship gray by a 24-hour exposure to the same atmosphere, because of the formation of black iron sulphide.

In order to obtain the desired resistance to discoloration, it may be necessary to subordinate certain other properties. The usual architectural white enamel paint is apt to be more flexible than the fume-resisting enamel, and the "four-hour" type of white enamel (Federal Specification TT-E-506, Type A) is apt to be more water-resistant.

If there is no problem of chemical fumes or continuous heat, or if no trouble has been experienced under the conditions of use with the discoloration of ordinary enamels, there is no occasion to use the special heat- and fume-resisting type of enamel paint.

It is not to be inferred from what has been said that other types of coatings may not be used as "laboratory paints". The modern casein cold-water paint (Federal Specification TT-P-23), the modern synthetic resin (alkyd type) cold-water paint, and aluminum paint (2 pounds of aluminum powder or paste mixed with one gallon of a suitable spar varnish) are useful in some cases.

III. PAINTING PROCEDURE

1. Unpainted Walls

When used on unpainted plaster or concrete, the clean surface should be primed first, then painted with a body coat before applying the heat- or fume-resisting enamel, which is strictly a finishing paint. Whenever possible, it is recommended that the same manufacturer's products be used throughout the process to avoid any danger of incompatibility of coatings.

The priming coat should be a pigmented plaster primer and sealer of the type meeting Federal Specification TT-P-56, and in this instance should contain no lead pigments. In order to insure freedom from small plaster cracks, streaks, suction spots, etc., the primed surface should be carefully inspected, and if necessary, touched up before applying the intermediate or body coat. In order to avoid "alligatoring", which is a cracked condition of the top coat caused by soft or insufficiently dried undercoats, <u>each coat must be allowed to dry hard</u>. The intermediate coat may consist of a flat paint of the type meeting Federal Specification TT-P-51a, which, as in the case of the priming coat, should contain no lead pigments, mixed with the primer-sealer paint in the proportion of one gallon of the flat paint to one or two quarts of the primer-sealer, and thinned, if necessary, with a small amount of turpentine. The addition of the sealer paint to the flat paint produces a less porous film, and tends to prevent spotting of the final coat. This is particularly true if the final coat is to be egg-shell or semigloss.

Where only a two-coat job is desired, there is commercially available a combination primer and intermediate mixture which may be used. The fume-resisting enamel is applied as the second or final coat. Generally, this enamel should not be applied over itself (two coats), nor should any of it be added to the under-coats. The reason for this is that the damar-resin type of enamel, when brushed out in a film, sets up quickly, but stays soft for a considerable time; likewise the customary procedure, according to good painting practice, is to build up suitable ground coats, and apply the enamel as a finishing material. Linseed oil, drier, varnish, oil colors, etc., should not be added to this fume-resisting enamel. Nothing should be added, except a small amount of turpentine for thinning, if necessary. This type of enamel is apt to pull somewhat under the brush, as it sets to touch rather quickly. It should be flowed on like an enamel and not brushed out like a house paint. Care should also be taken that sagging does not occur. In specific cases, the manufacturer's directions for application should be followed.

If wood trim has to be coated, several coats of a good interior varnish (Federal Specification TT-V-71) are recommended, rather than paint or enamel. If the wood must be enameled to blend with the walls, the same painting procedure as that used on the walls should be followed. Aluminum paint may be used as a primer on wood.

2. Old Painted Walls

On old painted walls containing flat wall paint, the surface should be cleaned *thoroughly* - washing with soap and water if necessary to remove all dust, dirt, grease, soot, chemical salts, and particularly any powdery material on the surface of the painted plaster. It may be surprising to some to suggest that a size or sealing coat be applied over the old flat wall paint before applying the finishing, fume-resisting enamel. However, old coats of flat wall paint are apt to be quite porous - so much so that a finish coat of paint, particularly a semi-gloss type, applied directly over the old flat coat is almost certain to dry unevenly (spotted). If the old paint appears to be quite porous, the *first* coat on repainting may be a combination sealer and undercoater, for example a paint containing one or two quarts of plaster sealer (Federal Specification TT-P-56) added to each gallon of flat wall paint (Federal Specification TT-P-51a). Each paint should be specified to be free from lead in the pigment. This coat of paint should be allowed to dry *hard*, and then a finishing coat of the fume-resisting enamel is applied.

IV. SPECIFICATION FOR HEAT- AND FUME-RESISTING ENAMEL PAINT

The following specification is suggested for purchasing the heat- and fume-resisting enamel for walls and ceilings of chemical laboratories. It has been used by two Governmental agencies in purchasing this special type of paint, and several well-known brands of fume-resisting white enamels have been found to conform to it. It should be noted that the ordinary ready-mixed, interior flat wall paint (Federal Specification TT-P-51a) and interior gloss enamel (Federal Specification TT-E-506), although they may not contain lead pigments, usually contain a little lead or other metallic compounds introduced as a drier, and will fail to meet the specification for this reason. These two types of paint are likely also to contain a considerable amount of drying oil (linseed, soya bean, tung oil, etc.), which might cause the materials to fail in the test for resistance to heat or ammonia fumes.

Suggested Specification for Fume- and Heat-Resisting White Enamel

The fume- and heat-resisting enamel may be ordered in flat, eggshell (semi-gloss) and full gloss. The purchaser should state the gloss desired. Ordinarily, the full gloss is recommended for best resistance to steam and moisture, although the eggshell finish has less glare and is slightly superior for fumes of ammonia and for heat above 130°F. The full gloss is the easiest to wash.

The enamel shall be free from any lead pigments, and the vehicle shall be free from any drying metals and vehicle components liable to discoloration by fumes or heat. The pigment may be any suitable mixture of titanium pigments, zinc sulphide pigments, or lead-free zinc oxide. No restriction is placed on the combination to use. The vehicle shall be of the resin-varnish type. No restriction is placed on the ratio of pigment to vehicle, so long as the enamel is of a good brushing consistency, and meets the hiding power requirement.

The enamel shall be of an easy flowing consistency, shall be self-leveling (brush marks shall disappear), shall be a brilliant white, resistant to fumes, and shall set rapidly to a very smooth, white finish that will stay white.

The fume- and heat-resisting enamel shall meet the following requirements:

(1) It shall have a daylight reflectance of at least 82 percent in the full gloss, and at least 84 percent in the flat and eggshell finishes, relative to magnesium oxide as the standard.

(2) The wet hiding power over a black and white checkerboard (described in Federal Specifications TT-P-51a and TT-E-506 with amendments) shall be not less than 180 square feet per gallon for the gloss and not less than 200 square feet for the flat and eggshell enamels.

(3) On a smooth, properly prepared surface, one gallon shall cover at least 400 square feet.

(4) The enamel shall set to touch (not come off on the finger) within two hours at a temperature between 70-90°F, and shall dry firmly overnight to a smooth, brilliant white, adherent film.

(5) One brushed coat on a tin panel (#31 gage) allowed to dry for 24 hours at room temperature, and then bent over a one-half inch mandrel, shall show no cracking. The film shall show pronounced adhesion to the tin.

(6) One brushed coat, applied on white milk glass, allowed to dry for 24 hours, then placed in a dark cabinet (for example Gardner color change cabinet) containing ammonia fumes (equal parts by volume of strong ammonium hydroxide and water), and kept there for 24 hours (at room temperature), shall meet the test for yellowing. One brushed coat, applied on white milk glass, allowed to dry for 24 hours, then placed in an oven at 200°F for 24 hours, shall meet the test for yellowing. In either the ammonia test or the heat test, the ratio of the measured reflectance of the exposed panels, using the red filter (see note), divided by the measured reflectance using the blue filter, shall be not more than 1.14, all values relative to magnesium oxide.

Note: In making the above reflectance measurements and those to follow, the red filter used is Standard Lighthouse Red, Corning Glass Works #246. The blue glass filter is Corning Signal Blue (70%) #556. The daylight filter is Corning Daylite Glass #590. The Hunter Reflectometer (H. A. Gardner Circular #461) is a suitable instrument.

(7) One brushed coat, applied on white milk glass, allowed to dry for 24 hours, then exposed for 24 hours (room temperature) in a desiccator saturated with fumes of ammonium sulphide and a humidity close to saturation, shall show a minimum of darkening. The result shall be the same if hydrogen sulphide is substituted for ammonium sulphide. In either case, (whether ammonium sulphide or hydrogen sulphide is used), the reflectance of the exposed panels, using the red filter, shall be not less than 78 percent relative to magnesium oxide.

Note: A large desiccator having two, all glass, gas-tight, stopcocks for both inlet and outlet is recommended for this test. The desiccator cover must make a gas-tight joint with the desiccator proper. About 200 ml of distilled water, saturated with hydrogen sulphide gas, is placed in the bottom of the desiccator. The glass panels are then put in the desiccator, and the cover placed on it. Hydrogen sulphide gas, led through a bubbling tower containing distilled water saturated with the gas, is passed into the desiccator until all the air is driven out. Both stopcocks are then closed and the panels kept there for 24 hours. Then the reflectance is measured immediately. For the ammonium sulphide test, hydrogen sulphide gas is passed into

100 ml of concentrated ammonium hydroxide until saturated. Then 67 ml more of concentrated ammonium hydroxide and 134 ml of water are added. This mixture is placed in the bottom of the desiccator, the panels put in place, and the desiccator covered. The panels are allowed to remain for 24 hours and the reflectance measured immediately.

(8) One brushed coat, applied on milk glass, allowed to dry for 24 hours, then immersed in water (room temperature) saturated with hydrogen sulphide for 24 hours shall show no appreciable darkening or other discoloration. After drying the daylight reflectance shall not be below 78 percent.

(9) In all of the laboratory tests, the sample under test shall be the equal of or better than a high grade, acceptable fume- and heat-resisting, laboratory enamel meeting this specification.

V. RESULTS OF TESTS UNDER THE PROPOSED SPECIFICATION

Three commercial paints purchased by the Government were tested under this specification and met all requirements. The vehicles appeared to be of the same damar-resin type and, when separated from the pigments, they all dried to practically water-white, glossy, very adherent, but rather brittle films. The approximate compositions of the paints and the results of tests for hiding power, whiteness, and retention of color follow:

Paint No.	1	2	3
Gloss	semi-gloss	full gloss	full gloss
Pounds per gallon	11.2	10.1	12.0
Volatile thinner, %	23	27	20
Nonvolatile vehicle, %	33	41	32
Pigment, %	44	32	48
Pigment, composition:			
Titanium oxide, %	present	100	
Lithopone, %	none	--	63
Zinc oxide, %	none	--	--
Titanium-barium pigment, % . . .	none	--	26
Barium sulphate, %	present	--	--
Silicates, %	present	--	--
Wet hiding power, sq.ft./gal. . . .	300	320	180
Daylight reflectance, %	84	84	84
Ammonia fume test - ratio	1.04	1.02	1.03
Heat test - ratio	1.05	1.04	1.05
Ammonium sulphide fume test, % reflectance	80	79	80
Hydrogen sulphide fume test, % reflectance	78	81	80
Hydrogen sulphide immersion test, % reflectance	79	80	79